

Interoperability In Digital Government: A Bibliometrics Analysis

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Abstract

The purpose of this research is to explain the development of research on Interoperability in Digital Government from 2013 to 2023 based on the Scopus database. This research uses the scoping review method with a bibliometrics approach. This research finds that research on interoperability in digital government has developed significantly in the last ten years. Judging from the publication, which has increased yearly in terms of number. Likewise, in terms of contributing authors with many citations as evidence of other researchers' primary references. Moreover, the United States dominates research contributions by having many documents and citations. Then, research on Interoperability in Digital Government has two major concepts as theoretical references, namely electronic government and interoperability. These two big concepts became the basis for analyzing Interoperability in Digital Government research. Furthermore, the trend of research on this topic in the last two years has focused on digital transformation (DT). The significance of this research lies in successfully comprehensively mapping the development, basic concepts, and future of studies on interoperability in digital government.

Keywords: digital government, interoperability, bibliometrics analysis, Scopus

1. Introduction

Digital government has been used as a strategy for administrative reform in many countries around the world, and expectations of potential benefits are sometimes unrealistic (Gil-Garcia and Flores-Zúñiga 2020). Developed and developing countries may obtain similar benefits from digital government initiatives, such as efficiency, effectiveness, transparency, and accountability, among others (Wang, Medaglia and Zheng 2018). However, results are often modest, and it is not always easy to generate visible impacts, particularly in the short term (Zhu and Kindarto 2016; Ziemba et al. 2016). In addition, there is no clear consensus about the definition of digital government, and different conceptualizations include and highlight various aspects (Alateyah, Crowder and Wills 2013; Luna-Reyes and Gil-Garcia 2014). The

significant number of definitions and defining elements of digital government has created a great diversity of potential measures of success and failure (Dawes and Pardo 2002).

In general, models explaining the success of digital government initiatives can be categorized into two main areas: first, the implementation of these initiatives by government agencies, and second, their adoption by citizens, businesses, and other significant users. Each of these two perspectives has its concepts, measurements, and theoretical models, and there have been very few attempts to integrate these two views into a comprehensive model of digital government success (Henning 2018).

Improved interoperability among public organizations and between public and private organizations is of critical importance to make digital government more successful (Rezaei et al. 2014). The mobilization of electronic information across organizations has the potential to modernize and enhance information exchanges. The current information exchange is, however, often inefficient and error-prone (Harrison et al. 2011). Exchanges of information and services are fragmented and complex, plagued by technical and organizational problems (Corrêa et al. 2014). For digital Government to be successful, it must develop agile, citizen-centric, accountable, transparent, effective, and efficient government operations and services (Maheshwari and Janssen 2014). The integration of government information resources and processes, and thus the interoperability of independent information systems, is essential to achieve these goals. Yet, most integration and interoperability efforts face serious challenges and limitations (Gottschalk 2009).

Based on this explanation, it can be simply understood that the topic of research on Interoperability in Digital Government is an issue that is currently being discussed, starting from the concept to its implementation, which has its problems. Therefore, this research offers the novelty of focusing on identifying the development of publications on interoperability in digital government. This is vital as part of a more in-depth knowledge repertoire related to the topic. More than that, this research will explain and analyze comprehensively the structure the publication trend from the keywords that are key in discussing this topic. This is an effort to map and unpack the fundamental theories used to build arguments and concepts about Interoperability in Digital Government in the last decade. This research actually fills the gap in research from Napitupulu and Yakub (2021) which only focuses on discussing the general literature on e-government. So, this research aims to be more specific about Interoperability in digital government. Therefore, the purpose of this research is to explain the development of research on Interoperability in Digital Government from 2013 to 2023 based on the Scopus database.

2. Theoretical Framework: Interoperability in Digital Government

Interoperability refers to a property of diverse systems and organizations that enables them to work together (Malinauskiene 2014; Reif and Meeus 2022). Interoperability is the ability of government organizations to share information and integrate information and business processes using common standards and work practices (Henning 2018; Margariti et al. 2022). When data and services are provided to and accepted between systems and organizations, they are said to interoperate. In a narrow sense, the term interoperability is often used to

describe technical systems. In a broader sense, social, political, and organizational factors influencing systems and system performance must also be considered (Gottschalk 2009). Interoperability issues are categorized into four different granularity levels. The first granularity level of interoperability issues consists of data interoperability, process interoperability, rule interoperability, object interoperability, software system interoperability, and cultural interoperability. The second granularity level of interoperability issues focuses on Knowledge interoperability, which consists of elements coming out of data interoperability, process interoperability, rules interoperability, and cultural interoperability. Service interoperability incorporates facts from process interoperability, data interoperability, rules interoperability, and software systems interoperability. Social network interoperability consists of cultural and data interoperability elements, and electronic identity interoperability is strongly related to objects, software systems, and rules interoperability. The third granularity level of interoperability issues includes cloud interoperability, which takes elements from service, knowledge, and identity interoperability and tries to infuse them with cloud characteristics. Lastly, the fourth granularity level of interoperability issues involves ecosystem interoperability, which deals with virtual and digital enterprises and is related to cloud and social network interoperability (Koussouris et al. 2011; Rezaei et al. 2014).

Meanwhile, the digital government uses information and communication technologies (ICTs) in government agencies. Inter-organizational information integration has become a key enabler for e-government. Integrating and sharing information across traditional government boundaries involves complex interactions between various participants, all using complicated technical and organizational processes. From a technical perspective, systems designers and developers must regularly overcome problems related to multiple platforms, diverse database designs and data structures, highly variable data quality, and incompatible network infrastructure. From an organizational perspective, these technical processes often involve new work processes, mobilization of limited resources, and evolving inter-organizational relationships. These necessary changes are influenced by specific social interaction types, including group decision-making, learning, understanding, trust-building, and conflict resolution (Pardo and Tayi 2007).

A recent line of digital Government research has emphasized the importance of inter-organizational information sharing in the public domain. For example, (Schooley and Horan 2007) explored information sharing relative to service performance. They utilized a conceptual framework for time-critical information services as an analytical lens. Inter-organizational systems concepts provide a targeted means to look at the cross-organizational features of a socio-technical system. Examples include criminal justice and services to citizens. These examples demonstrate a need to improve capabilities to share data, information, and experiences across departmental, organizational, geographic, and institutional boundaries. Such inter-organizational improvements in information sharing will enhance the performance of public sector services (Schooley and Horan 2007).

Each of the nine constraining influences on digital government integration and interoperability is described by Jochen Scholl and Klischewski (2007), first, Constitutional/legal constraints: Integration and interoperation may be outright unconstitutional because the democratic constitution requires powers to be divided into separate levels and branches of government. The US Constitution, for example, separates government into federal, state, and local government

levels and legislative, judicial, and executive branches. Total integration and interoperability between and among branches and levels might upset constitutional checks and balances. On the other hand, the constitution also affords and sanctions integration and interoperability within certain boundaries. Second, Jurisdictional constraints: Since, under the constitution, governmental and non-governmental constituencies operate independently from each other and own their information and business processes, integration, interoperability, and information sharing cannot be imposed on them. Instead, as an independent entity, each constituency's participation in any interaction is voluntary. However, using jurisdictional authority, the government entity can integrate and cooperate with other entities (Jochen Scholl and Klischewski 2007).

Three, Collaborative constraints: Organizations are distinct in their disposition and readiness for collaboration and cooperation. Experience, socio-political organization, and leadership style influence the willingness and adeptness of potential interoperation. However, in cases of compatible leadership styles, adequate socio-political organization, and positive past experiences, integration and interoperation might flourish. Fourth, Organizational constraints: Organizational processes and resources may differ between organizations to such an extent that integration and interoperation might prove challenging to achieve without standardizing processes, systems, and policies. Yet, when organizations align their organizational context, they enable increased degrees of integration and interoperability. Five, Informational constraints: While transactional information might be more readily shared, strategic and organizational information might not be; also, information quality issues arise when integrating information sources across various control and quality standards domains. Still, information stewardship fosters the use of shared information, which promotes stewardship for sharing information (Jochen Scholl and Klischewski 2007).

Six, Managerial constraints: Interoperation becomes inherently more complex when parties with incongruent interests and needs become involved. As a result, the demands of the respective management task might exceed the management capacity of interoperating partners. However, interoperation and integration can materialize along the lines of shared interests. Seventh, Cost constraints: Integration and interoperation between diverse constituencies might be limited to the lowest common denominator in terms of availability of funds; also, unexpected budget constraints might pose severe challenges to long-term interoperation projects over time. On the other hand, information-sharing initiatives have reportedly helped contain costs. Within the cost boundaries of the respective partners, specific projects are sustainable. Eight, Technological constraints: The heterogeneity of e-government platforms and network capabilities might limit the interoperability of systems to relatively low standards.

On the other hand, an increasing number of e-government information systems might adhere to higher standards over time, making increased interoperability possible. Nine, Performance constraints: As performance tests suggest, the higher the number of interoperating partners, the lower the overall system performance regarding response time. Yet, focusing on prioritized needs might enable fewer but more effective interoperations (Jochen Scholl and Klischewski 2007).

Based on the reviewed literature on systems interoperability and stages-of-growth models, (Gottschalk 2009). Figure 1 illustrates the maturity levels for interoperability in digital

government. Semantic interoperability is the extent to which information systems using different terminology can communicate, and organizational interoperability is the extent to which organizations using other work practices can communicate.

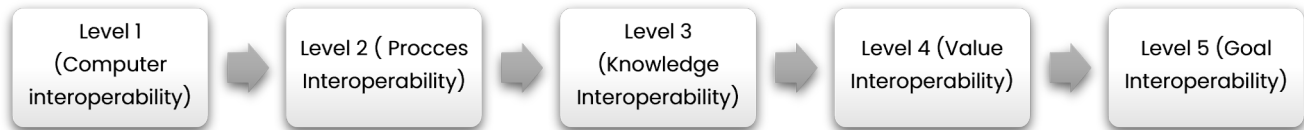


Figure 1: Maturity levels for interoperability in digital government.

Level 1 (Computer interoperability): Computers require hardware and software systems to communicate. Today, several products and technical solutions deal with the challenges relating to physical connectivity and communication between systems involved in a given exchange. These solutions generally function by sharing messages or employing tightly coupled workflow designs. However, what is lacking from most available technology solutions (and would improve the odds of integration success) is the ability to exchange messages directly and meaningful, context-driven data between autonomous systems. The challenges of enabling each system to appropriately understand the shared information relating to the logical aspects of using and sharing data and business processes based on their intended meaning. This is part of a broader problem known as the semantic interoperability problem. Semantic interoperability must be examined and resolved at both the computer and process levels (Corrêa et al. 2014; Sta 2018).

Level 2 (Process interoperability): In a given work process, each employee does his or her tasks in a way adapted by both the organization and the person. Aligning work processes in interoperating organizations enhances e-government interoperability. Alignment is possible in sub-processes, complete processes, and sets of processes (Kalogirou, Stasis and Charalabidis 2022; Sharma and Panigrahi 2015). **Level 3 (Knowledge interoperability):** In knowledge sharing, a flow strategy is focused on collecting and storing knowledge in interoperating organizations. While electronic work processes handle information, knowledge work is dealt with by employees in collaborating organizations. At this level, effectiveness and learning in inter-organizational relationships from interoperability are essential. Organizations must establish and maintain collaborative relationships in which knowledge sharing is critical to resolving numerous issues related to data definitions and structures, diverse database designs, highly variable data quality, and incompatible network infrastructure (Chen, Wang and Chen 2014; Gil-Garcia and Sayogo 2016; Wukich et al. 2017)

Level 4 (Value interoperability): In value creation, interoperating organizations may have different value configurations. A distinction is often made between value chains, shops, and networks (Tripathi, Gupta and Bhattacharya 2013). The best-known value configuration is the value chain. In the value chain, value is created by efficiently producing goods and services based on various resources. Primary activities in the value chain include inbound logistics, production, outbound logistics, marketing and sales, and service. The value shop creates value for clients through creative problem-solving based on knowledge resources. Primary activities include problem identification, solutions, decisions, implementation, and evaluation. In the value network, value is created through efficient connections of subscribers.

Primary activities include services, contacts, and infrastructure. Interoperability at this level of value creation is concerned with interactions between primary activities in different value configurations present in electronic government. While a public hospital is a problem-solving organization for patients, having a value shop as the dominant value configuration, a public transportation authority is a production organization, having a value chain as the dominant value configuration. At this level, the added value from interoperability is significant (Gottschalk 2009).

3. Research Methods

3.1. Research Techniques and Data Acquisition

This research uses the scoping review method. A scoping review is a transparent and methodical approach to locating and thoroughly analyzing all pertinent literature about the research issue. Mapping the corpus of literature on a subject is the goal of scoping research. Scoping reviews aim to provide a summary of a potentially substantial and varied collection of literature on a wide range of subjects (Colquhoun et al. 2014). The data source for this research comes from the Scopus database. The reason is that today's Scopus database has become the largest and most reputable indexation that world's academics have recognized. Document data taken from the Scopus database is limited from 2013 to 2023. This is because, in that period, the topic of research on interoperability in digital government is of great concern to world researchers. Moreover, today's practical aspects of governance have adopted digital technology as an important facility. The data retrieval strategy in the Scopus database is in Table 1.

Table 1: The data retrieval strategy in the Scopus database

Search Document	"Interoperability in digital government"
Search within	Article Title
Scopus document search strategy	ref (interoperability and in and digital and government) and pubyear > 2012 and (limit-to (pubstage , "final")) and (limit to (doctype , "ar")) and (limit-to (subjarea , "soci")) and (limit-to (language , "english")) and (limit to (srctype , "j"))).
Period Time	2013-2023
Subject Area	Social Science
Source Type	Journal
Language	English
Search date	January 16, 2024

Table 1 shows some filter steps to find valid document data in the Scopus database. Based on the parameters in the table, 51 documents were obtained. This data has gone through several filter stages to ensure its accuracy.

3.2. Research Approach

This research uses a bibliometrics approach. Bibliometrics analyzes empirical data from published literature to examine publication patterns within a discipline. Thus, bibliometrics can be used by researchers to evaluate the body of literature related to their topic and identify important themes (Vogel and Güttel 2013). Bibliometric studies have a lengthy research history and have been used to evaluate the performance of publications on various topics. They employ publication records to evaluate the condition and advancement of a particular topic (Subekti, Mutiarin and Nurmandi 2023).

3.3. Research Analysis and Visualization Techniques

This research uses VOSviewer software to analyze and visualize data. This research uses VOSviewer software to process bibliometric data for display, such as document publications each year, author contributions, countries, articles, and journals based on the number of citations. Likewise, in analyzing and displaying Networks, Overlays, and Density, based on keywords from the Interoperability in Digital Government research topic. VOSviewer has been used in several study disciplines to conduct bibliometric mapping studies. The VOSviewer analysis, based on the visualization of similarities, the VOS technique, condenses a significant amount of data into a single graphic. As a result, a cluster is formed by linked phrases in the text-mining routine's map (Van Eck and Waltman 2010, 2013, 2014). Using citation connections, bibliographic coupling, and co-occurrence analysis, researchers can identify themes or clusters of nations, organizations, and keywords used in the titles and abstracts of published works. To illustrate the proximity of particular keywords, authors, journals, organizations, or nations in different research streams, academics can evaluate many aspects of an underlying study topic using a single color (Subekti, Nurmandi and Salahudin 2022).

4. Result

4.1. Trend of Publication in Worldwide

Data results from the Scopus database produced 51 documents on Interoperability in Digital Government from 2013 to 2023. The data can be displayed and analyzed to produce significant findings on the focus of the study of digital government. In addition, the data will also help explain the global publication trends on interoperability in digital government, indexed by Scopus, which is a world-renowned index. This aims to understand how the topic has developed in the world research constellation. Based on the data obtained, the initial part of this research will map the trend starting from publications per year, publication sources, country contributions, authors, and affiliations. Figure 2 shows the number of document publications per year from 2013 to 2023 on the topic of political Interoperability in Digital Government indexed by Scopus.

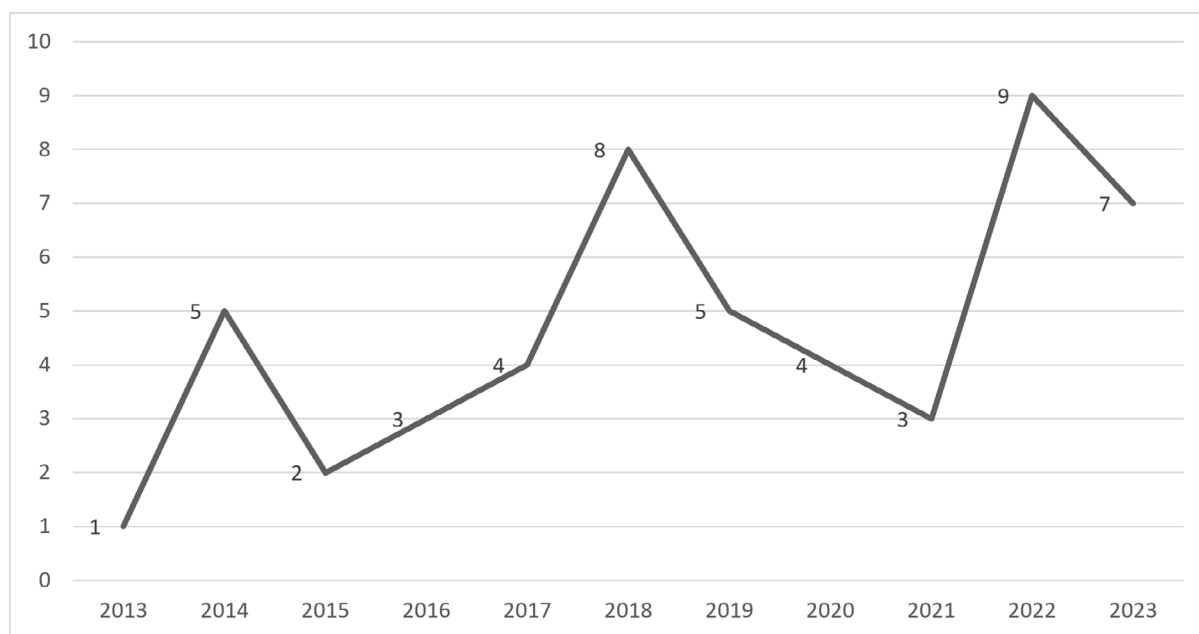


Figure 2: Document by years.

The data in Figure 2, research publications on interoperability in digital government in the last ten years, have been developed from many publications each year. In 2013, there was only one publication document, which increased by five in 2014. However, it fell again in 2015 to only two papers, growing again in 2016 by three and in 2017 by 4. In 2018, the publication experienced a reasonably high spike, totaling eight documents. In 2019, there were five documents; in 2020, there were four documents; and in 2021, there were three. In 2022, it had the most publications, with nine papers in the last ten years; finally, in 2023, it dropped slightly to 7 papers. These data show that research on interoperability in digital government attracts academics to explore it further, as evidenced by the consistency of research publications in the Scopus database, which include discussions from diverse perspectives and case studies.

The year 2022 saw the most publications on this topic. Identifying some significant publications, first, research from (Debeljak and Dečman 2022) ways of working and collaborating, paired with dynamic socio-economic change, have highlighted the main challenge facing Europe's urban municipalities. Being the part of the public sector closest to citizens and their needs, the challenge addresses digital transformation's goals to support and promote broader growth in the digital domain optimally and to realise digital transformation benefits such as user-friendly and citizen-centred services, increased quality of life and better business environments. Urban municipalities must identify local strengths, priorities and needs, including performance and digital maturity assessment, and define strategic goals and implementation roadmaps to implement digital transformation optimally. Furthermore, they must increase city administration, decision-maker and citizens awareness of the opportunities and benefits digitally enabled solutions offer. A comprehensive digital maturity self-Assessment is the first step towards successful digital transformation. An example of a framework for such an assessment is the framework of the European Commission's Intelligent Cities Challenge (ICC explains the digital transformation (DT) of cities in Slovenia. The research findings explain that one would expect larger municipalities to be digitally more mature than smaller ones because they have more resources at their disposal. However, our

results prove that this is not the complete picture. There is, however, a relationship between municipality population size and digital maturity, including indicators of open data sharing and security, but not entirely in the manner expected. Furthermore, our analysis has shown that municipality population size does not influence overall digital maturity but individual digital maturity indicators, highlighting the need to develop more detailed and accurate individual digital maturity indicators. Although the influence of municipality population size on overall digital maturity could not be demonstrated, its partial influence on individual sets is essential to achieve efficient DT.

Second, research from Kalogirou, Stasis and Charalabidis (2022) explains how to assess and improve the National Interoperability Framework in Greece. Interoperability needs and solutions are constantly changing due to the new policies, legal acts, initiatives, and emerging technologies. The European Interoperability Framework (EIF) provides recommendations and implementation guidelines in a moving technological environment. Consequently, EIF cannot be as static as it used to be in previous years. EIF should be a flexible and adaptive framework that covers the constant new requirements of Digital Interoperable Public Services (DIPS). Then, the third research from Margariti et al. (2022) although there are still many challenges and limitations regarding organizational factors. A detailed and comparative review on the evaluation of existing assessment models and tools is provided revealing the need for a holistic assessment. As result of the research, a new model is introduced for organizational interoperability assessment enhancing existing holistic models and corresponding tools with additional attributes. The development process of the new model (MOIA discusses a holistic model for assessing organizational interoperability in public administration. The findings explain that a new model for organizational interoperability assessment is introduced, enhancing existing holistic models and corresponding tools with additional attributes. The development process of the new model (MOIA) is presented, and the justification of alignment with the corresponding recommendations of the new EIF is described. An incremental methodological approach of evaluation waves is followed to assess the additional attributes required to consider barriers and concerns regarding organizational interoperability. The Greek Electronic Public Procurement System (ESIDIS) was used as the case study to validate the use of the model and calculate the model's attribute weights. Table 2 shows author contribution data.

Table 2: Author contributions

No	Author	Document	Citations
1	Zheng i	2	72
2	Alarabiat a	2	10
3	Hujran o	2	10

The data in Table 2 show the authors who contributed the most based on the number of citations they have from their Scopus-indexed research documents. Zheng I is the largest, with two papers and 72 citations. Then, Alarabiat also has two documents with ten citations. Likewise, Hujaran o only has two publications and ten citations. This shows that the academic expert on Interoperability in Digital Government is Zheng I from China. Many researchers have referred to his writings as the primary reference. Then, Table 3 shows contribution data from affiliates around the world.

Table 3: Affiliations contributions

No	Affiliations	Citations
1	Center for Technology in Government, University at Albany	99
2	Universitas Muhammadiyah Malang	99
3	Delft University of Technology	61
4	Department of Digitalization, Copenhagen Business School	53

The data in Table 3 describes the affiliations that contribute the most to research on Interoperability in Digital Government based on their number of citations. The Center for Technology in Government, University at Albany, has the highest contribution with 99 citations. Likewise, the University of Muhammadiyah Malang has 99 citations, making it the highest contributor to research on this topic. These two highest affiliations come from two continents; the University at Albany is from New York, United States. Meanwhile, Muhammadiyah University of Malang is from Indonesia. Furthermore, Delft University of Technology has 61 citations. Then, the Department of Digitalization, Copenhagen Business School, has 53 citations. More than that, Table 4 shows contribution data from countries.

Table 4. County contributions

No	Country	Document	Citation
1	United States	9	152
2	Netherland	4	115
3	China	5	85
4	Australia	5	67

The data in Table 4 display the countries with the highest contribution to research publications on Interoperability in Digital Government based on the number of citations and documents they have. Table 3 shows that the United States has the highest contribution, with the number of documents totaling nine and the number of citations, which is 152. This aligns with the affiliation contribution in Table 2, which shows that universities in the United States have the highest citations. Then, the Netherlands became the second-highest contributing country, with 115 citations, although it only has four documents. Furthermore, China has five documents and 85 citations, and Australia has five and 67 citations. The number of citations and documents is not directly proportional. Table 5 shows the contribution of sources that publish research on Interoperability in Digital Government.

Table 5: Source contributions

No	Source	Document	Citation
1	Government Information Quarterly	12	362
2	Transforming Government: People, Process and Policy	3	35
3	Information Government	2	26
4	Electronic Government	2	17
5	International Journal of Information Management	2	62
6	Sustainability (Switzerland)	2	21

Table 5 shows the journals that published the most research on interoperability in digital government from 2013 to 2023. Government Information Quarterly is the most popular, with 12 documents and 362 citations. Then, Transforming Government: People, Process and Policy only published three documents and had 35 citations. Furthermore, the Information Government has two papers and 26 citations; the Electronic Government has two documents and 17 citations. Meanwhile, the International Journal of Information Management has two records and 62 citations, and Sustainability (Switzerland) publishes two papers and 21 citations. Scopus indexes these six journals with a high quartile of Q1. This means that all of these journals are highly reputable publication sources and are recognized by the academic world. Thus, the process of incoming articles will be rigorous in its peer review. This is what makes the resulting publication articles of excellent quality. Furthermore, this list of six articles can also be a reference for researchers who discuss these topics to submit their manuscripts because the scope is appropriate.

4.2. Identification Of Key Issues In Interoperability In Digital Government

This research seeks to display networks, overlays, and densities of interoperability in digital government. Network visualization is a way to display a network of keywords about interconnected political party coalitions. Then, overlays attempt to show research trends from year to year. Meanwhile, Density aims to explain topics that still have an excellent opportunity to be researched related to the theme of political party coalitions. This study uses the number of keyword occurrences at least twice in all included research publications analyzed using VOSviewer. Figure 3 shows the network based on keywords from research on Interoperability in Digital Government from 2013 to 2023 indexed by Scopus.

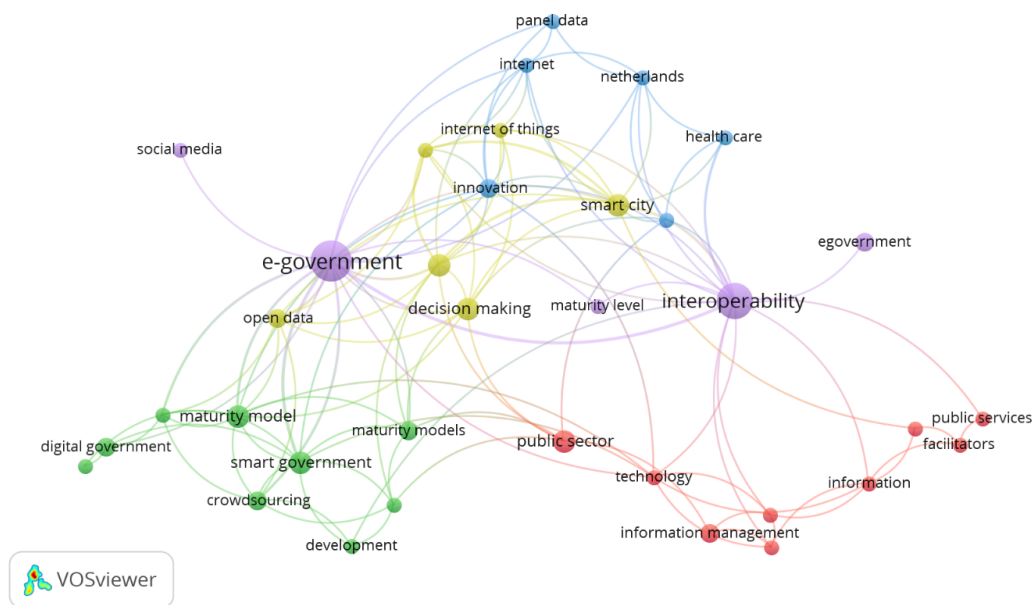


Figure 3: Network by keyword.

Analysis using VOSviewer resulted in five clusters marked with different colors. This aims to make it easier to identify the network from these keywords. Cluster 1 is red: Information management, Information, Facilitators, Public service, technology, and public sector. Cluster 1 shows discussions about the use of technology for the benefit of public services. Then, cluster 2 is marked in green: digital government, maturity model, competent government, development, and crowdsourcing. Cluster 1 discusses the broad concepts used in the context of research on interoperability in digital government.

Furthermore, cluster 3 is marked in yellow: open data, decision-making, smart city, and internet of things. Cluster 3 is a collection of discussions about government decision-making based on digital data sets. Furthermore, cluster 4, interoperability, e-government, and social media, is marked in purple. Finally, cluster 5 is blue: innovation, internet, and data panels. Cluster 5 discusses government innovation in using the Internet as a public service facility. Table 6 shows the keywords important in the discussion about Interoperability in Digital Government.

Table 6: Important keywords

No	Keywords	Occurrences	Total link strength
1	E-Government	14	28
2	Interoperability	11	22
3	Smart city	4	16
4	Digital transformative	4	15
5	Smart government	4	12
6	Maturity model	4	11
7	Decision making	4	10
8	Public sector	3	6
9	Innovation	3	11
10	Open data	3	9

Table 6 shows which keywords are essential in discussing Interoperability in Digital Government. E-government is the keyword with the highest occurrences and the most vital relationship with research on Interoperability in Digital Government. This explains that e-government is the central concept used as the basis for discussing the topic. Digital government, e-Government, and e-governance are terms that have become synonymous with the use of ICTs in government agencies. Inter-organizational information integration has become a key enabler for e-Government. Integrating and sharing information across traditional government boundaries involves complex interactions between various participants, all using complicated technical and organizational processes. From a technical perspective, systems designers and developers must regularly overcome problems related to multiple platforms, diverse database designs and data structures, highly variable data quality, and incompatible network infrastructure. From an organizational perspective, these technical processes often involve new work processes, mobilization of limited resources, and evolving inter-organizational relationships. These necessary changes are influenced by specific social interaction types, including group decision-making, learning, understanding, trust building, and conflict resolution (Dolan 2014; Koo 2019).

Governments worldwide recognize e-Government as a strategic option to enhance their (internal and external) operations. To foster citizen-centric services, they need to integrate themselves and stakeholders vertically and horizontally. This can be achieved by bringing efficiency and experience to e-business and e-government. That requires new e-business models to reduce costs and improve services in government (Sta 2018).

Then, digital transformation is also the most important keyword in the Interoperability in Digital Government research topic. DT is associated with changes in the infrastructure, products, services, business processes, business models, and strategies of an organization, as well as its inter-organizational relationships in extended business networks (Margariti et al. 2022) although there are still many challenges and limitations regarding organizational factors. A detailed and comparative review on the evaluation of existing assessment models and tools is provided revealing the need for a holistic assessment. As result of the research, a new model is introduced for organizational interoperability assessment enhancing existing holistic models

and corresponding tools with additional attributes. The development process of the new model (MOIA. However, an isolated view of those changes that does not consider the complex institutional setting of the public sector will underestimate the challenges throughout the governmental transformation (Chanias, Myers and Hess 2019). Transformation in the public sector involves changes in the quality of specific social structures (Meijer and Bekkers 2015). Rather than a simple improvement in performance, it entails a fundamental change in the structures, processes, and/or culture of public sector organizations, which may involve the organizational structures of agencies, the administrative relationships between citizens using public services and the organizations providing them, or changes in the bureaucratic culture and external relationships between agencies (Pollitt and Bouckaert 2017). Figure 4 shows the trend of research on Interoperability in Digital Government indexed by Scopus from 2013 to 2023.

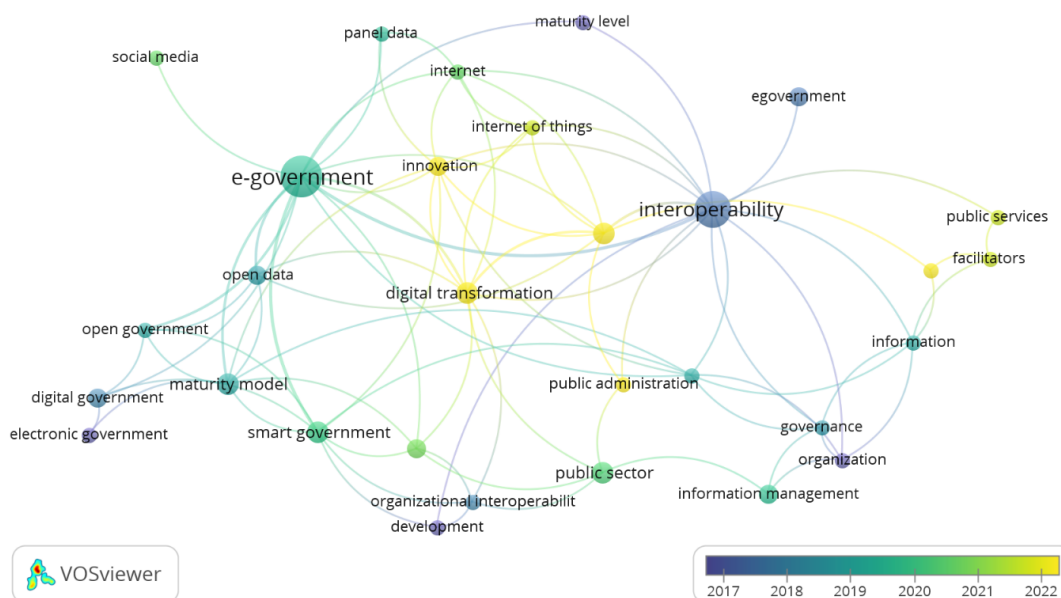


Figure 4: Overlay by keywords.

In 2017, research on Interoperability in Digital Government took more perspectives on development, organization, and maturity. Then, in 2018–2019, research on Interoperability in Digital Government took the point of view of information management, the public sector, competent government, information, and so on. The latest 2022 research on Interoperability in Digital Government shifted to discussing DT, innovation, and public services. Then, Figure 5 displays the keyword-based density of research topics on Interoperability in Digital Government published from 2013 to 2023 and indexed by Scopus.

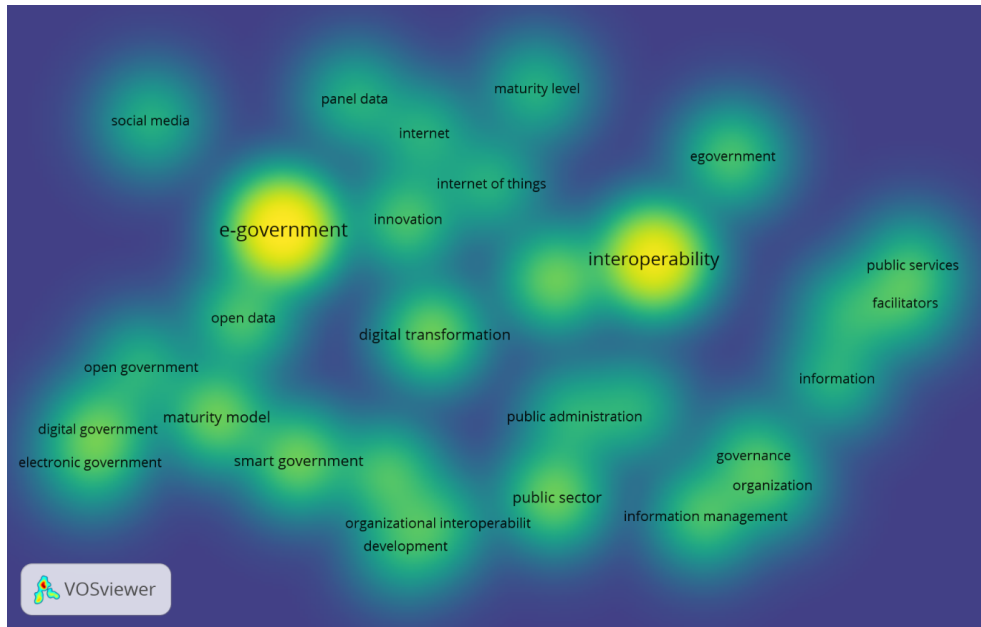


Figure 5: Density by keywords.

The density from VOSviewer can show which keywords have been discussed and which have not. The density of keywords can be identified by the words highlighted in yellow; the more keywords surrounded by yellow, the more keywords have been discussed. Conversely, if the yellow color is not very intense on the keyword, it has yet to be addressed too much in the research. Therefore, these keywords can be used as a novelty in future research.

Figure 5 shows that the keywords DT, innovation, public sector, digital government, competent government, governance, public service, open government, and so on are slightly surrounded by yellow. These keywords still need to be discussed more regarding their perspectives on interoperability in digital government. This means that these keywords can be addressed in future studies as an offer of novelty.

5. Discussion

DT creates digital government, a term sometimes considered as synonymous with e-government (American studies) or as the next evolutionary stage of "e-government" (McLoughlin and Wilson 2013). Conceptually, e-Government and digital government are often considered similar but fundamentally differ in their approach, purpose, and scope. "E-government," in its generic definition, involves using information technology in the public sector to ensure access and delivery of government information and user-oriented services (Silcock 2001). It also involves transforming the government (Spirakis, Spiraki and Nikolopoulos 2010). Central to the concept of e-government is forming a symbiotic relationship between the government and its citizens and effectively using ICTs to facilitate that relationship while increasing transparency so that citizens can trust government activities (Anderson et al. 2015).

New developments in the literature have brought a special focus to the concept of digital government. It goes beyond the surface aspects of digital innovation and recognizes that technology plays a central role in driving transformational change that permeates the structure and operations of public organizations. Digital government emphasizes that digital innovation is related to digital bits and profoundly impacts the relationship between public institutions and the communities they serve. The shift from e-government to digital government, as discussed by Vlahovic and Vracic (2015), requires a broader scope of initiatives to bring about substantial changes in online service delivery through government portals. The goal is to develop a transformed technology-based system that provides a superior user experience, aligns with strategic objectives, and fundamentally improves government functions, as Barcevičius et al. (2019) emphasized.

Furthermore, in the context of implementing digital government, there is a need for continuity and collaboration within each system to run effectively and efficiently. Therefore, the emergence of interoperability in the context of digital government is significant because interoperability is the primary foundation of effective, efficient, and integrated digital public services. Without interoperability, digital systems in government will continue to work in silos, hindering collaboration, innovation, and services that are responsive to the needs of the community.

According to Gottschalk (2009), interoperability is the "ability of diverse systems and organizations to work together." According to Estermann, Riedl and Neuroni (2009), interoperability is a crucial factor in determining the digital government's maturity. The capacity of systems to communicate is known as interoperability capability. Both governments and citizens are beginning to place more value on interoperability. According to Layne and Lee (2001), it makes it possible for citizens to obtain government services as "one-stop shopping," which saves a substantial amount of time and effort. The ability of two or more units to exchange services with one another, accept services from other units, and employ those services to enable them to work together efficiently is known as organizational interoperability (Legner and Lebreton 2007). One of the interoperability challenges facing networked companies is semantic interoperability. Interactions with humans and other systems are necessary for inter-organizational information systems to function. This aspect of interoperability can only be satisfied with the application of communication standards. Partners can perform a conventional business function in a more advanced digital manner using a standards-based technology platform. According to Pardo and Tayi (2007), a common information systems platform is a collection of standards that enable network users to interact and conduct business transactions online.

In comparison to the current fragmented system of delivery, it allows the government to deliver digital services more quickly (due to improved back-end processes), with fewer errors (due to a consolidated view of data), and at a lower cost (due to the elimination of duplication of data entry and processing). Though interoperability benefits citizens and the government, there are several obstacles and restrictions on its spread because it is a complicated phenomenon with limitations in several areas, including technology, organizational capacity, syntactics, and semantics (Scholl et al. 2012). This is in line with the findings of this study, which explain that with the many dynamics and attention of the government and the country's color related to this concept, academics are interested in discussing its use in more depth. The findings of

this study explain that in the last ten years, research and publications on the reputable Scopus database have increased significantly, discussing interoperability in digital government.

This study also found that DT has become the epicenter of discussion in recent times in the study of interoperability in digital government. This also confirms that this topic will still be relevant and should be studied more deeply by comparing various empirical events. To increase their efficiency and quality of services, governments must embrace DT. Despite the high expectations around DT methods, there is no actual data on how governments implement DT in the hierarchical bureaucracy setting and how flexibility is established to allow advancement. With adjustments to various organizational components, DT in government propagates in waves, affecting the entire administrative system from the provincial to the national levels and encompassing both drastic and gradual changes. Flexibility can be policy- or technology-enabled, rising with DT advancements. Bureaucratic levels and organizational components also have a role in forming flexibility. This study promotes a multidisciplinary approach to comprehending DT fully and provides information to assist other governments in developing DT agendas (Gil-Garcia and Flores-Zúñiga 2020).

Moreover, future research on future interoperability in digital government will still be of particular interest to scientists worldwide. Especially in Europe, the EIF and the Interoperable Europe Act (IEA) have been developed. Both are very important in the DT of the European government, especially in building a collaborative, efficient, and cross-border digital government. The European Union developed the EIF to ensure interoperability between government systems in member states. The EIF aims to facilitate the delivery of cross-border and cross-sector digital public services in an efficient and integrated manner (Kalogirou and Charalabidis 2019). Meanwhile, the IEA is a proposed EU regulation that supports the implementation of the EIF in a stronger and more binding manner. The legal framework aims to establish a more formalized and structured interoperability governance across Europe (Reif and Meeus 2020; Vrecar, Schade and Martinez 2024).

6. Conclusion

The conclusion is that research on interoperability in digital government has developed significantly in the last ten years. Judging from the publication, the number has increased yearly in terms of number. Likewise, in terms of contributing authors with many citations as evidence of other researchers' primary references. Moreover, the United States dominates research contributions by having many documents and citations. Then, research on Interoperability in Digital Government has two major concepts as theoretical references, namely electronic government and interoperability. These two significant concepts became the basis for analyzing Interoperability in Digital Government research. Furthermore, the trend of research on this topic in the last two years has focused on DT. This aligns with the finding that research on interoperability in digital government from the point of view of DT still has an excellent opportunity to be conducted because there has not been much discussion.

Furthermore, although this study comprehensively explained the development of research on interoperability in digital government, there are limitations regarding document data retrieval sources, which are only from one Scopus database. Therefore, recommendations for

future research can use other databases such as Web of Science or PubMed as document data sources. This is so that the data obtained is more numerous and diverse.

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