

# Research Trends in E-Government Interoperability: Mapping Themes and Concepts Based on The Scopus Database

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*Abstract: Advances in information and communication technology, in the provision of public services, have affected all aspects of electronic governance. This widespread use has resulted in vast amounts of data, which governments and other entities can collect and analyse to measure, assess and improve service interoperability. Interoperability is the ability of software to collaborate. Currently, studies on the interoperability of e-government applications are the focus of research by previous researchers to develop information and communication technology to realize the smooth exchange of information in all elements of government. This study aims to determine the development of research on interoperability in e-government by conducting an in-depth analysis of research trends and dominant themes in e-government interoperability. This research is a systematic review using VosViewer and Nvivo Qualitative Software Analysis, and both are used to uncover trending issues and research themes on e-government interoperability. This research data was obtained through the Scopus database using a search strategy to find relevant documents. The results show that research trends related to e-government interoperability issues have declined recently. In addition, this study also presents the highest citations, funding sponsors, and research connectivity between countries. Furthermore, this study also produces six dominant themes related to e-government interoperability, namely*

*Interoperability, E-government, Systems, Technology, Data, and Services. Some of the findings produced in this study are expected to provide a comprehensive picture of research trends in e-government interoperability for researchers in the future.*

*Keywords: Interoperability, e-government, e-government interoperability, research trend, Scopus*

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## 1. Introduction

Advances in information and communication technology (ICT) of public service delivery have influenced all aspects of electronic governance (Dwivedi & Bharti, 2014). Electronic government (e-government) aims to leverage ICT to deliver government services openly, efficiently, and effectively at a reasonable cost (Mahmoud et al., 2019). Users around the world rely on ICT (e.g., mobile phones, social media, online services) to address their economic, social, and cultural needs (El Aichi & El Kettani, 2011). This widespread use has produced massive amounts of data (i.e., Big Data), which governments and other entities can collect and analyse to measure, assess, and improve service interoperability (Mahmoud et al., 2019). Drath & Barth, (2011) define interoperability as "Interoperability describes the ability of software tools to collaborate". The presence of interoperability is then characterized by aspects of consistency, openness and interconnectedness (Barth et al., 2012; Drath & Barth, 2011). Kotsev et al. (2016) assess the interoperability and openness of this technology as an essential component that cannot be separated from the current "internet of things". The presence of openness standards in the realm of interoperability arises because of the desire of many parties involved in the ICT market to implement ICT innovation, based on broad and standard open standards (Aliprandi, 2011). Thus, the presence of ICT offers excellent opportunities, as well as challenges.

Interoperability is increasingly important, as e-government continues to add and improve services (Sharma & Panigrahi, 2015) and become a one-stop service portal (Tripathi et al., 2011). As such, interoperability requires flexibility and adaptability (El Aichi & El Kettani, 2011) to ensure connectivity with other software-independent systems (Parrish et al., 2017). For example, data management platforms can use uniformity of metadata (Myrseth et al., 2011) and custom application programming interfaces (APIs) to streamline performance, so that external parties can easily expose the resulting metadata records (Amorim et al., 2017). The close relationship between the concepts of interoperability and sustainability comprises several aspects, including economic, ecological, ethical, and social factors (Aranda et al., 2020).

Currently, studies on the interoperability of e-government applications have become the focus of research, by previous researchers, to develop ICT, to realize the smooth exchange of information across all elements of government (El Benany & El Beqqali, 2017). Caramancion & Pauline Abesamis (2020) in their research, revealed that well-integrated organizational governance could improve state performance; the value of integration in question is influenced by human factors that run e-government. Meanwhile, in his research, Dhanasekaran et al.(2019) revealed that interoperability could be

one approach that can improve performance in integrating big data. In line with that, Mahmoud et al. (2019) suggest using an interoperability and integration approach in managing big data, to positively impact the development of e-government applications in realizing better governance. E-government interoperability is seen as a set of multidimensional, complementary, and dynamic capabilities that can support government success in studying optimal government interoperability (Pardo et al. 2012).

Rico-Pinto & Sánchez-Torres, (2018) have conducted an in-depth analysis of this topic by identifying previous studies to identify the factors that influence the implementation of interoperability between government agencies. Based on the various focus studies related to interoperability that researchers have produced, we find that no previous research has mapped themes and concepts, based on the trend of publications, that have been carried out on this topic. It is on this basis that this research was conducted. In the future, it is hoped that this research can help provide an overview to future researchers about the extent to which the development of trend studies on this topic has been carried out. In addition, by mapping the themes on the trends of this study, future researchers will also have a clear picture of themes that have not been highlighted by previous researchers and motivate them to develop them further through more in-depth research. In this study, we identify thematic trends in interoperability research on e-government in various international journals. We use the Scopus search engine to categorize publications, related to e-government interoperability, across various journal sources. To process and visualize the data mined from Scopus, we use the VOSviewer software. Furthermore, the Nvivo 12 Plus software is used to identify study topics and develop trends in the analysed collection of scientific articles.

## 2. Related work

E-government interoperability is vital to support public services' dynamic and integrated transformation (El Aichi & El Kettani, 2011). Interoperability in e-Government aims to link multiple systems, information, and work models among different government agencies in a state or around the world (Ordiyasa et al., 2016). integration in e-government services prompted Alshehab et al. (2019) to reengineer an effective government sharing model, using semantic web technology. In addition to semantic web technology, the use of Software Agents can also be added, so that the provision of services can be integrated securely in the client's perspective (Marques et al., 2011). Saputra (2013) also offers service integration using a web map service model, which is intended to improve the performance of e-government applications, based on Geographic Information System (GIS).

In addition to the study of government, interoperability has also given a lot of influence on other fields. Interoperability in the legal realm, for example, Gascó & Jiménez (2011), in their research, reveals that in the judiciary, the role of interoperability is present, as a means for legal and judicial authorities to increase cooperation, based on the use of ICT. Furthermore, interoperability in the business realm has risen in recent times. The business paradigm that was initially stand-alone has now evolved towards constructing a complex ecosystem and provides extensive opportunities for collaboration to reduce organizational barriers occurring so far (Agostinho et al., 2016). By analysing the Building Information Modelling (BIM) software, Aranda et al (2020) consider that increasing the interoperability of BIM software can result in significant cost reductions in every project undertaken

and minimize the technical constraints encountered. BIM and GIS interoperability can then be improved by aligning and linking the core information concepts of a running system (Jetlund et al., 2020).

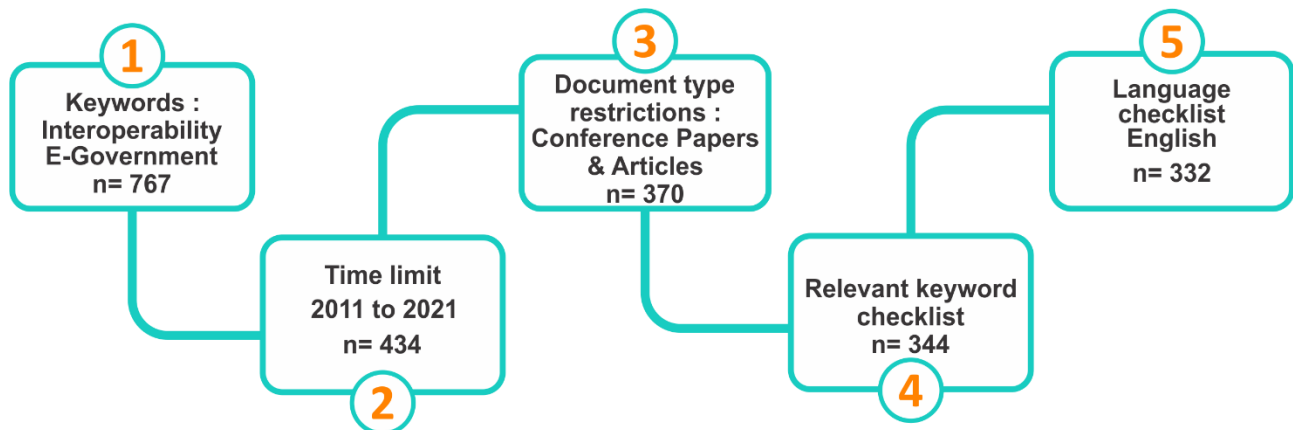
In the biomedical field, interoperability provides connected applications, in increasing the ability to generate biological knowledge (Hoehndorf et al., 2011). Meanwhile, in the clinical area, the principle of interoperability is realized by presenting a feature that can improve the performance of Clinical decision-support systems (CDSSs) (Marcos et al., 2013). Interoperability is also an essential component in improving the quality of Personal Health Records (PHR) to connect with Electronic Health Records (EHRs) to increase the accuracy of clinical decisions. On the other hand, patients can see the progress of ongoing care (Saripalle et al., 2019).

The presence of interoperability in the disaster area has also had a good impact, thus, encouraging the region's readiness to respond to disaster events. D R Maidment (2017) revealed that by presenting the concept of interoperability in each application system placed on rivers in the United States, it produces information from high-resolution flood forecasts with real-time observations, accompanied by flood inundation mapping and can provide insight into information, related to what is being faced with increasing effectiveness, in handling flood emergency response. In terms of learning, interoperability is also a vital component to improve the learning process's significance within the scope of e-learning (Chaker et al., 2014). Finally, in the realm of smart cities, interoperability is a problem that needs to be addressed continuously (Alonaizi & Manuel, 2021)

### 3. Methodology

This study aims to examine a collection of scientific articles, discussing e-government interoperability, that have been published in reputable international journals with the Scopus index. Scopus is one of the most extensive and comprehensive sources of citations and has a database of abstracts from peer-reviewed literature, such as scientific articles, books, and conference proceedings (Liao et al., 2019; Zahra et al., 2021). In addition, the review article in this study is also intended to conceptualize the study of e-government interoperability, through several research questions, namely: (1) How are the research trends in the theme of e-government interoperability? (2) What are the dominant research issues and themes in the study of e-government interoperability?. These two questions will be explained through data findings and discussion of the data processing results that will be carried out using the VOSviewer and Nvivo 12 Plus software.

Figure 1: Data Mining Step. Source: Created by the author



Furthermore, article mining using the Scopus database is carried out through several stages. In the first stage, we categorize the search using two keywords, "Interoperability" and "E-Government," identified by category title, abstract, or keywords, resulting in 767 documents. In the second stage, we limited the time by modifying the database search to 10 years from 2011 to 2021; this time limit was chosen to get the latest reference, regarding the issue of E-Government Interoperability. At this stage, the investigation resulted in 434 documents. Then in the third stage in this study, we determine the focus of the type of document to be analysed, namely the Conference Paper (264 documents) and Scientific Article (106 documents) type, which then produces 370 documents. After examining the abstracts and titles of the 370 documents produced, we found that there were several documents that were not relevant to the issue, to increase the relevance of the topic being studied, in the fourth stage, we classify the keywords used in each scientific paper by checking the keywords related to e-government and producing a total of 344 document results; in this stage, the interoperability keyword is intentionally not selected to avoid overly general consequences. In the fifth stage, so that the data processing process does not experience language bias, we categorize the documents produced by only mining documents that use English; the result is that there are a total of 332 documents that will then be analysed.

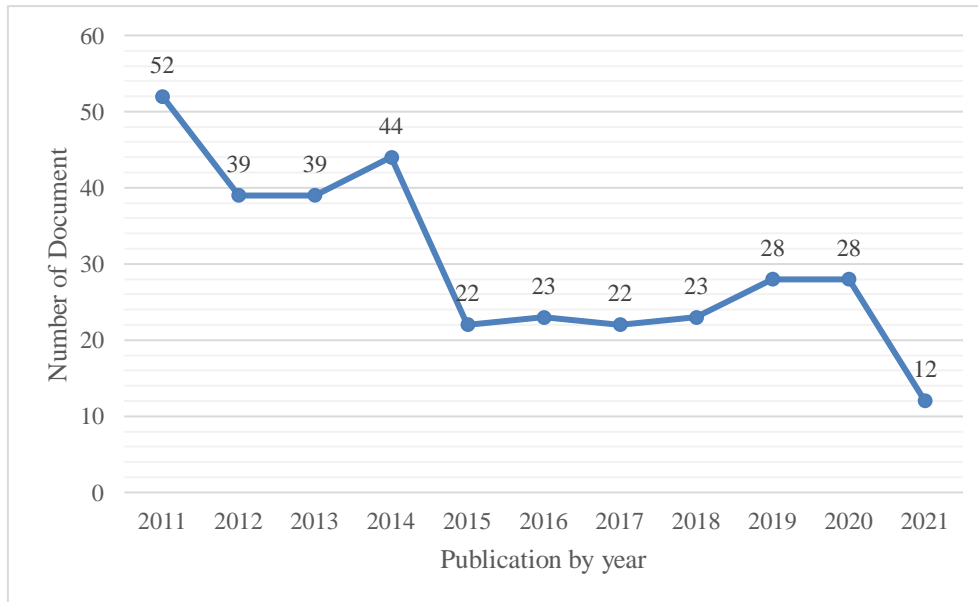
## 4. Findings and discussion

### 4.1. Trend Publication

For a decade, from 2011-2021, the number of studies related to e-government interoperability, in general, experienced less significant fluctuations and more towards a downward trend. Based on the article search results using the Scopus database, we found 332 document articles relevant to the keywords and article search strategies used. In 2011 there were 52 publications produced related to e-government interoperability, but the following two years experienced a decrease in 39 publications. In 2014 research interest increased to 44 publications; however, this increase was only valid in 2014. The following year, the number of publications decreased drastically to 22 and 23 and then

seemed to be slowing over the next three years. In 2019 and 2020, the number of publications increased to 28 publications. Then, from 2021 to December, where this data was mined, it showed a downward trend, again, until only 12 publications were produced.

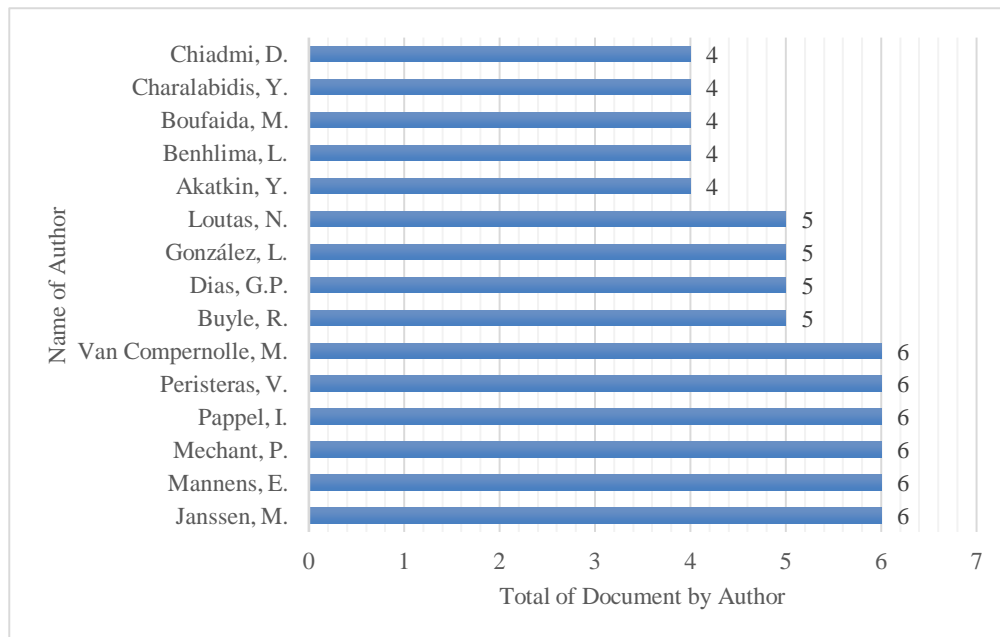
Figure 2: Publication Trend on Interoperability E-Government by Years. Source: Scopus database.



#### 4.2. Authorship and Highest Citation

The figure below shows the authors with the highest number of documents on the issue of e-government interoperability. Seven authors have published six documents for each author, namely (1) Janssen, M., (2) Mannens, (3) E., Mechant, P., (4) Pappel, I., (5) Peristeras, (6) V., Buyle, R., and (7) González, L. Meanwhile the other nine authors have contributed five and four documents to each author (see figure 3 below). The number of documents for each author was generated not only as the primary author for each paper, but also several authors were found to collaborate, so that the number of individual documents was calculated together and resulted in the number shown in figure 3.

Figure 3: Publication by Authors. Source: Scopus database.



The table below shows ten of the articles with the highest number of citations on the theme of e-government interoperability. Pardo T.A., Nam T., Burke G.B., (2012) became the authors with the most number of citations on this issue. This high number of citations also provides new knowledge about several papers which are the most important references when discussing the issue of e-government interoperability.

Table 1: Article with Hight Citation. Source: Scopus database.

Document Title	Authors and Year	Cited by
E-Government Interoperability: Interaction of Policy, Management, and Technology Dimensions	(Pardo T.A., Nam T., Burke G.B., 2012)	107
Forward to the Past: Lessons for the future of e-government from the story so far	(Bannister F., & Connolly R, 2012)	50
Enhancing visibility in international supply chains: The data pipeline concept	(Klievink B., Van Stijn E., Hesketh D., Aldewereld H., Overbeek S., Heijmann F., Tan Y.-H, 2012)	46
Interoperability in big, open, and linked data-organizational maturity, capabilities, and data portfolios	(Janssen M., Estevez E., Janowski T, 2014)	40
Interoperable privacy-aware E-participation within smart cities	(Patsakis C., Laird P., Clear M., Bouroche M., Solanas A, 2015)	26

A universal system for fair non-repudiable certified e-mail without a trusted third party	(Paulin & Welzer, 2013)	22
Information systems interoperability in public administration: Identifying the major acting forces through a Delphi study Open Access	(D Soares & Amaral, 2011)	22
A service-oriented integration platform to support a joined-up e-government approach: The Uruguayan experience	(González L., Ruggia R., Abin J., Llambías G., Sosa R., Rienzi B., Bello D., Álvarez F., 2012)	20
Digital records keeping to information governance in Estonian local governments	(Pappel I., Pappel I., Saarmann M., 2012)	18
Understanding Municipal Service Integration: An Exploratory Study of 311 Contact Centers	(Nam & Pardo, 2014)	17

### 4.3. Distribution and Network Citation by Country

Of the 332 scientific articles published in Scopus indexed journals, authors from 69 countries have contributed to the theme of e-government interoperability. Countries with the highest number of publications are Greece (25), Italy (24), Belgium (19), Morocco (19), Germany (15), Portugal (15), Spain (15), Estonia (14), United States (14), Indonesia (13), Austria (12), India (12), Netherlands (12), Brazil (10), South Africa (9). Among these countries, European countries are the countries that have a high interest in the theme of e-government interoperability. In contrast, the countries of the Asian continent are represented by two countries, namely Indonesia and India (seen in the table below).

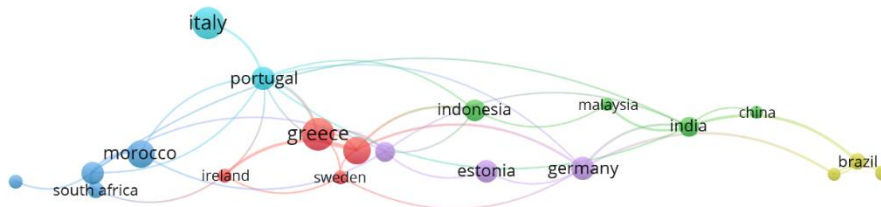
Table 2: Country Distribution by Document, Citation, and Link Strength Source: Scopus database.

Country	Documents	Citation	Total link strength
Greece	25	68	8
Italy	24	60	2
Belgium	19	87	11
Morocco	19	54	5
Germany	15	106	9
Portugal	15	96	12
Spain	15	76	0
United States	14	144	9
Estonia	14	63	2
Indonesia	13	26	5
Netherlands	12	119	7
India	12	75	11



The connectivity of citation relationships, from the study results, also occurs in each country; this is indicated by the total link strength in each country. Portugal has the highest total link strength emergence, which amounts to 12 links. In addition, the relevance of scientific issues discussed in the theme of e-government interoperability also appears in each country. Twenty countries are connected, resulting in 6 clusters, where each cluster is displayed in a different colour. For example, Cluster 1 is red (Greece, Belgium, Sweden, Ireland), Cluster 2 is green (Indonesia, India, Malaysia, China), Cluster 3 is blue (Morocco, United States, South Africa, Switzerland), and Cluster 4 is yellow. (Brazil, Norway, Egypt), Cluster 5 is purple (Germany, Estonia, Netherlands), and Cluster 6 is light blue (Italy, Portugal). Besides that, the figure shows that each country has a different size scale. The larger the circle scale, the more documents produced.

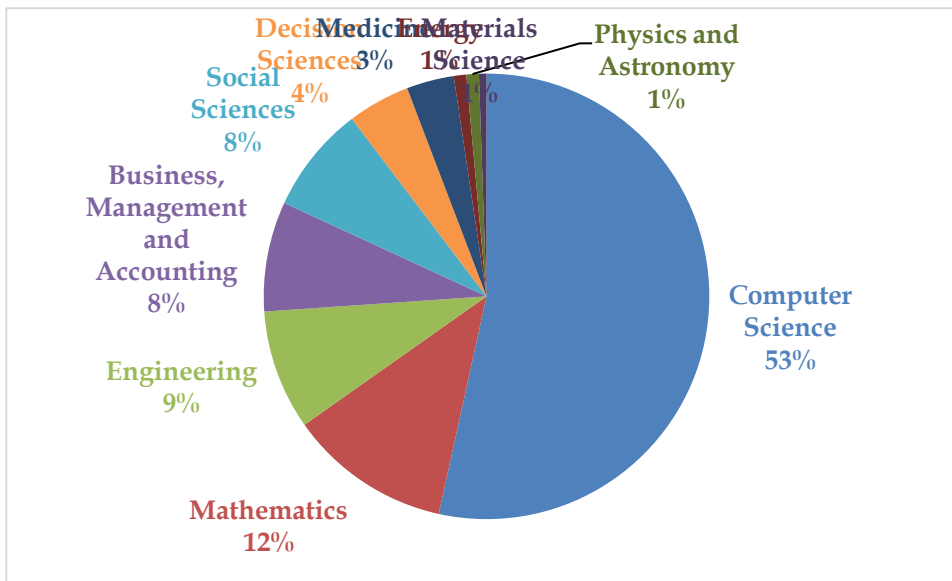
Figure 4: Network Visualisation Citation by Country. Source: Scopus database.



#### 4.4. Publication Venues by Subject Area

The number of publications on e-government interoperability in the period 2011-2021 is half dominated by the Computer Science subject area with a percentage (53%), Mathematics (12%), Engineering (9%), Business, Management and Accounting (8%), Social Sciences (8%), Decision Sciences (4%), Medicine (3%) as well as several other subject areas that have a low proportion. In total, there are 22 subject areas in this issue.

Figure 5: Document by Subject Area. Source: Scopus database.



Meanwhile, we have previously seen the number of documents in each subject area, we showed the highest citation of compositions, based on specific subject areas, in the table below. The subject area of Computer Science became the subject area with the highest number of citations, followed by the subject area of Social Science in the second position. In addition, several authors were found to occupy several subject areas with the same publication. This happened because the author's research theme or research title met the criteria as a multi-subject area. For example, in this case, the work of Pardo T.A., Nam T., Burke G.B., (2012) with the title E-Government Interoperability: Interaction of Policy, Management, and Technology Dimensions, and Bannister & Connolly, (2013) with the title Forward to the Past: Lessons for the future of e-government from the story so far, these two articles are interpreted as two subject areas, namely entering the themes of Computer Science and Social Science, as well as several other of research.

Table 3: Highest Citation by Subject Area. Source: Scopus database.

Document Title	Authors and Year	Source	Subject Area	Cited by
E-Government Interoperability: Interaction of Policy, Management, and Technology Dimensions	(Pardo et al., 2012)	Social Science Computer Review 30	Computer Science	107
Forward to the Past: Lessons for the future of e-government from the story so far	(Bannister & Connolly, 2012)	Information Policy		50
A service-oriented integration platform to support a joined-up e-government approach: The Uruguayan experience	(González et al., 2012)	Lecture Notes in Computer Science Lecture Notes in Bioinformatics	Mathematics	20
Applying intelligent agents and semantic web services in eGovernment environments	(García-Sánchez et al., 2011)	Expert Systems		13

Towards semantically interoperable metadata repositories: The Asset Description Metadata Schema	(Shukair et al., 2013)	Computers in Industry	Engineering	16
Implementation of service-based e-government and establishment of state IT components interoperability at local authorities	(Ingrid Pappel & Pappel, 2011)	2011 3rd International Conference on Advanced Computer Control, ICACC		16
Information systems interoperability in public administration: Identifying the major acting forces through a Delphi study	(Delfina Soares & Amaral, 2011)	Journal of Theoretical and Applied Electronic Commerce Research	Business, Management, and Accounting	22
Integration of government services using semantic technologies	(Hreňo et al., 2011)	Journal of Theoretical and Applied Electronic Commerce Research		16
E-Government Interoperability: Interaction of Policy, Management, and Technology Dimensions	(Pardo et al., 2012)	Social Science Computer Review	Social Sciences	107
Forward to the Past: Lessons for the future of e-government from the story so far	(Bannister & Connolly, 2012)	Information Policy		50
A critical survey of selected government interoperability frameworks	(Ray et al., 2011)	Transforming Government: People, Process and Policy	Decision Sciences	17
Developing a roadmap for planning and implementation of interoperability capability in e-government	(Sharma & Panigrahi, 2015)	Transforming Government: People, Process and Policy		16
Unraveling transparency and accountability in blockchain	(Rizal Batubara et al., 2019)	PervasiveHealth: Pervasive Computing Technologies for Healthcare pp. 204-213	Medicine	10
Prerequisites for the Adoption of the X-Road Interoperability and Data Exchange Framework: A Comparative Study	(Saputro et al., 2020)	International Conference on eDemocracy and eGovernment		4

#### 4.5. Research Funding

Table 4: Research Funding Interoperability E-Government. Source: Scopus database.

Funding Sponsor	Total Document	Percentage
European Commission	14	22%
Horizon 2020 Framework Programme	7	11%
Seventh Framework Programme	4	6%
Horizon 2020	3	5%
Bundesministerium für Bildung und Forschung	2	3%
European Regional Development Fund	2	3%
Ministarstvo Prosvete, Nauke i Tehnološkog Razvoja	2	3%
Universitas Indonesia	2	3%

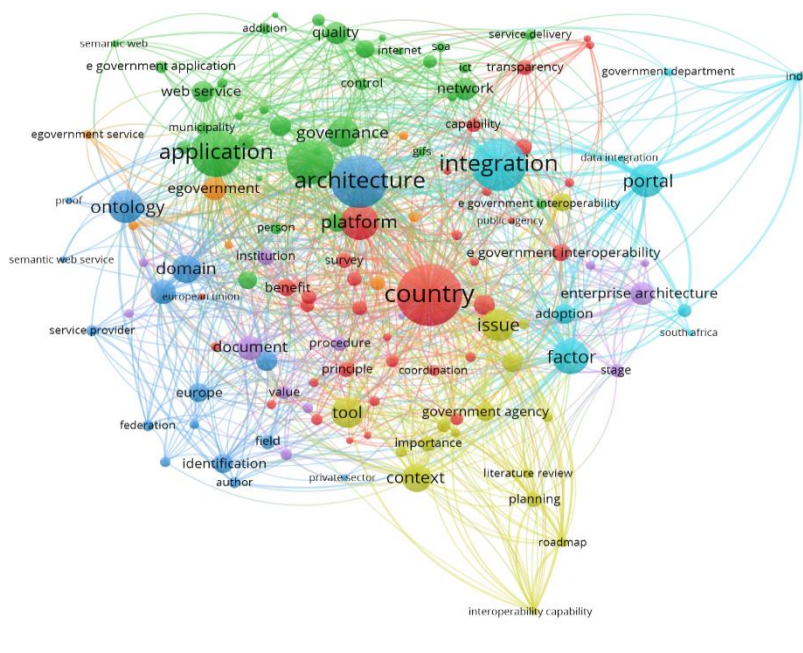
Of the number of institutions that provide research funding, 36 donor agencies offer funds for authors to discuss the issue of e-government interoperability. Some of the institutions with the highest intensity of funding contributions are European Commission (14 documents), Horizon 2020 Framework Program (7 documents), Seventh Framework Program (4 documents), Horizon 2020 (3 documents), Bundesministerium für Bildung und Forschung (2 documents), European Regional Development Fund (2 documents), Ministarstvo Prosvete, Nauke i Tehnološkog Razvoja (2 documents), and University of Indonesia (2 documents). Meanwhile, several other institutions only contributed 1 document to this issue. Donors from the European region have become the highest funding agencies in e-government interoperability research so far. According to the United Nations Department of Economic and Social Affairs (DESA) E-Government index 2020 report, Europe is the region that has the most countries with the highest quality of e-government development. The high ranking index that Europe has is one of the reasons why many e-government studies are carried out in the region, which comes with various study points of view, ranging from planning and projection (Murgante et al., 2011), implementation (Kirstein et al., 2019; Lips et al., 2020; Ansgar Mondorf & Wimmer, 2016), as well as an evaluation of the running of an e-government program in Europe (Pino et al., 2013; Rantos, 2011), and in this case study e-government interoperability is one of the themes discussed (Bovalis et al., 2014).

In addition, the form of funding can also be grouped based on the sponsor's status or the funding provider's background. Of the eight funding providers above, Supranational Funding is the financier who contributed the most with five funding programs. The primary funding agency for supranational funding is the European Commission through the five funding programs they have run with a total of 30 documents produced. Furthermore, on the government side, there are two funders who each contributed two documents, namely the Bundesministerium für Bildung und Forschung (Federal Ministry of Education and Research) from Germany, and Ministarstvo Prosvete, Nauke i Tehnološkog Razvoja (Ministry of Education, Science and Technology Development) The state of Serbia. Finally, for the University, the University of Indonesia from the State of Indonesia is the only one of the eight highest funders that produced the most documents of 2 documents.

### 4.6. Network Linkage in E-Government Interoperability

In this section, 332 scientific articles, which are then processed using the VOSviewer software, visualize related terms. In total, 131 term items appear in the analysis map, based on text data from 332 articles. Text items can be defined as themes of research related to e-government interoperability. It is the same as the citation by country analysis in the previous section. The image below shows the clustering; each cluster has been grouped and can be seen in the table.

*Figure 6: Networks Visualisation interoperability E-Government. Source: Processed by the author using Vosviewer.*



*Table 5: Items by Cluster on Network Visualisation interoperability E-Government. Source: Processed by the author using Vosviewer.*

Cluster	Items	Color	Percent- age	Total
Cluster 1	Country, platform, benefit, e-government interoperability, performance, capability, transparency, survey, society, e-service.	Red	28%	35
Cluster 2	Application, government service, governance, network, quality, web service, semantic interoperability, efficiency, interoperability framework, number.	Green	27%	34
Cluster 3	Architecture, ontology, domain, user, Europe, requirement, identification, service provider, field, semantic web service.	Blue	14%	18
Cluster 4	Issue, tool, context, stakeholder, e-government system, interoperability capability, importance, insight, roadmap.	Yellow	11%	14

Cluster 5	Enterprise architecture, document, stage, procedure, value, scope, institution, measure, heterogeneity, vocabulary.	Purple	10%	13
Cluster 6	Integration, portal, factor, adoption, dimension, data integration, government department, south Africa, India.	Light blue	5%	6
Cluster 7	E-government, guideline, e-government service, co-operation, transformation, Serbia, mean.	Orange	5%	7
Total			100%	131

Each cluster has a different colour and a different thickness of the term scale; this can then describe how far the concept or term is studied in e-government interoperability studies. The thicker the scale of the resulting term, the term, or concept, has become the main focus in studies related to e-government interoperability, so that future researchers can quickly identify related themes but are still minimally researched so that they can be investigated further.

Cluster 1, the terms that appear in the cluster identify that the focus of the research carried out is related to the usefulness of the presence of e-government interoperability on government performance in a country. A relevant article, as a reference in this research, for example, González et al. (2012), explains that service-oriented integration platforms can improve the development of interconnection of e-government platforms and maximize service performance. Furthermore, this study was conducted by taking the example of the experience in Uruguay, where an e-government platform with a focus on platform interoperability, through two platform components, namely Middleware infrastructure and Security Systems, is strategic in developing an e-government approach .

Cluster 2, the discussion on e-government interoperability, focuses on quality applications, networks, and frameworks. Bruzza et al. (2020) explain that using spatial data in e-government services has had a good impact on the services produced. In addition, his research also conducted an in-depth review of the application of the latest spatial data used in e-government services in two countries, namely Ecuador and Peru.

Furthermore, Cluster 3, focuses on the study of the architecture and ontology of the services used to support the realization of e-government interoperability. Sedek et al. (2012), in their research, offer the concept of the architecture used for e-government services, its implementation, the concept, and architecture is based on the use of technology through Web portals, portlets, service component architecture, Web services, and Business Process Execution Language. (BPEL). Another study related to this cluster is from Ordiyasa et al. (2017), which offers an adaptive ontology method in improving the Quality of Service (QoS) in the resulting e-government services.

Cluster 4, focuses on tools and context in the issue of developing e-government interoperability. In this study, a related article is one of A Mondorf & Wimmer (2017), examining the contextual components of the enterprise architecture framework, which is intended for use in e-government services in Europe. The architectural elements contained in the Enterprise Architecture (EA) can provide a foundation in creating an interoperability architecture of e-government services, both in the program stage and in ongoing projects.

Where as, cluster 5, shows how offering an enterprise architecture approach can answer the need for e-government interoperability. A study that discusses this can be seen in the article Agarwal et al. (2017), which explains the purpose of corporate architecture in supporting e-government interoperability. Furthermore, Nakakawa et al. (2018) try to provide detailed guidelines or procedures for implementing enterprise architecture, within the scope of e-government, by taking into account the owned e-government maturity model. The courses offered in this study, have been implemented in Ugandan public entities. In addition, other related studies were also carried out in India (Paul & Paul, 2012), in Egypt and Syria (Mohamed et al., 2013), in Iran (Aliee et al., 2017), and in Ethiopia (Gebayew & Arman, 2019).

Cluster 6, focuses on the integration stage between portals, which relates to the data integration stage from the various e-government portals available. An example of a related article, in this case, Tripathi et al. (2011), explains the crucial factors underlying the successful adoption of an e-government interoperability technology, namely, the three dimensions of data integration, including integration, communication integration, and data integration. The overall integration of this data will then provide maximum results on the quality of the e-government services offered. Finally, cluster 7, talks about the issue of cooperation, between public sector organizations, in delivering interoperable e-government services. An example of an article related to this issue is Casalino et al. (2014), which identifies the main aspects of interoperability through an approach to identifying and analysing barriers in organizations to increase the presence of e-government interoperability. As well as offering an effective model, to improve the cooperation of public sector organizations.

#### **4.7. Dominant Issues in E-Government Interoperability Studies**

In addition to displaying the VOSviewer software above, we also processed articles related to e-government interoperability, using the Nvivo 12 Plus software in this section. Nvivo 12 Plus is a software that can assist researchers in managing and organizing data, facilitating data analysis, identifying themes, exploring insights, and developing conclusions (Sotiriadou et al., 2014). Total processing was carried out on 332 articles, by placing the title and abstract parts of the article. The title and abstract were chosen because several obstacles were found in accessing the entire document. Namely, it took a long time, plus not all journals identified had free access. Titles and abstracts obtained from the Scopus database are exported into Comma-separated Values (CSV) files, then processed into Portable Document Format (PDF) and analyzed in Nvivo 12 Plus.

The results of Word Frequency Queries on the collection of titles and abstracts that are processed, show the themes that appear most often in the article. These words then give meaning to an issue that tends to be the main topic discussed in a collection of 332 articles.



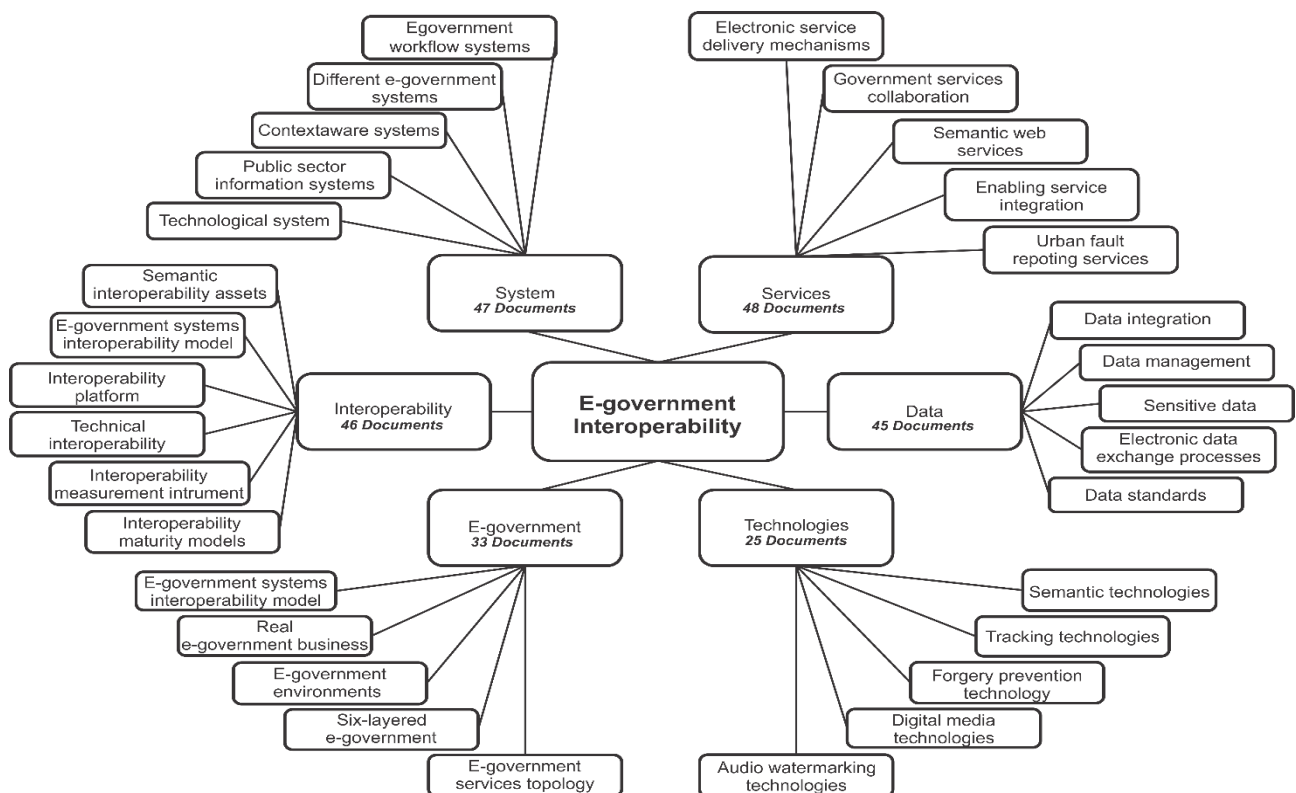


Figure 8: Dominant Study Themes in of E-Government Interoperability. Source: Processed by the author using Noivo 12 Plus.



#### 4.9. Mapping of the theme of E-Government Interoperability Studies

Figure 9: Mapping of the Theme of E-Government Interoperability Studies. Source: Processed by the author.



The figure above shows the mapping of research topic themes on e-government interoperability. Interoperability in e-government is divided into six focus themes: interoperability, e-government, systems, technology, data, and services. When discussing this issue, researchers widely studied the pieces that are service with 48 documents, then continued with the system 47 document theme, interoperability theme with 46 documents, data theme with 45 documents, e-government theme with 33 documents, and technologies theme with 25 documents. Each of these themes then has several sub-themes, the dominant sub-themes that appear when discussing one of the themes. This sub-theme then describes the study opportunities that scholars can use in the future when they want to build a study related to one of the themes in e-government interoperability.

In its implementation, e-government interoperability faces many complex problems, one of which is related to technical interoperability aspects in the performance of interoperability development, are faced with human resource constraints in understanding how interoperability is implemented, so that it can be achieved through technical mastery of the technology being implemented (Caramancion & Pauline Abesamis, 2020). This aspect of technical interoperability is part of the six dominant focus themes that are widely discussed by researchers, namely the theme of interoperability. Furthermore, still on the theme of interoperability, Margariti et al. (2020) try to present a model for assessing the maturity of organizational interoperability in public service practices, by conducting a comprehensive review of the available interoperability literature, so that they can then create the assessment metrics needed to assess interoperability performance in public service.

On the data theme, we highlight the data integration sub-theme, which later became one of the challenges that emerged, along with the increasingly massive e-government development (Oumkaltoum et al., 2019). Different service applications, at each government level, present data uniformity problems to realize service synchronization (Kawtrakul et al., 2011). Oumkaltoum et al., (2019) suggested using a hybrid approach, to improve e-government interoperability accompanied by data integration. Then the hybrid approach in question was carried out using a, data warehouse-based approach and an event-driven architecture (EDA). Previously, other studies have also used generic data models to improve interoperability, focusing on four features to consider in its implementation: standard modelling language, entity-relationship modelling, vocabulary for data exchange and methodology, which aims to improve data integration (Ryhänen et al., 2014).

Mapping by Janssen et al. (2013) revealed that interoperability is defined as, the relationship between the system and the service form, which is carried out using data grouping techniques in one central control system (Fitriani, 2018), the e-government interoperability aims to integrate all systems, technology, data, and services (Kacem & Abid, 2016). In his study, e-government interoperability is designed to connect with various institutions in providing services, sharing information, public data, and control systems. From the mapping that we have compiled, in line with the thoughts of Sun et al. (2015) on front-office integration, front-office integration is intended to manage information from internal and external, to create effective and efficient services or from multiple governments and non-governments (Pardo et al., 2012). System interoperability, in implementing e-government, is a real challenge in facilitating the exchange of good information between institutions (Barakat & El Beqqali, 2020).

Building an e-government system aims to integrate systems, technology, services, and data from every level (Paroški et al., 2013), by prioritizing interoperability, information data are interconnected through a system designed by the government (Bovalis et al., 2014); the data represent standard data (Colpaert et al., 2014). Looking at the mapping image above, each element in e-government has several variables in the data aspect; data management, data integration, standard data, sensitive data, and electronic data. All steps start with measurable planning and policies in designing e-government interoperability (Lam, 2005). Dias (2011) suggests that, to assess the maturity of e-government implemented by the government or organization, it can be seen from two main dimensions, namely; integration and multichannel through systems, such as those found in this study, can realize maturity, in addition to services provided as an integrated service category through web services, application services or service models, electronic services (Marques et al., 2011)

In the end, in realizing e-government interoperability, it is necessary to pay attention to several aspects described as dominant themes in this study, starting from the e-government theme itself, interoperability, data, systems, services, and technology. These dominant themes are then considered as themes that researchers often discuss to describe the problems in e-government and the obstacles faced, so that this system does not run optimally and creates a setback on the side of interoperability. Gupta & Jana(2003) consider that improving performance makes mature organizational/government governance integrated through the interoperability of the services provided.

## 5. Conclusion and further work

The findings of this study indicate some interesting facts, regarding the interest of researchers, in conducting research related to e-government interoperability in the last decade. In document intensity, we find that the trend of research related to this issue has decreased over the previous five years. Furthermore, our findings have also shown some other vital things that can be useful for researchers in the future, firstly, related to authors with the highest number of publications related to this issue, where each contributed to 6 documents during the data collection period. In addition, the highest number of citations was also found (Pardo TA, Nam T., Burke GB, 2012) along with the country with the highest distribution of documents (Greece), the country with the highest citation (United States), and the country with the highest influence network power (Portugal).

The findings of this study have also shown, that the subject area of study has revealed a lot related to the issue of e-government interoperability over the past decade, which ultimately places the subject area of Computer Science as the highest subject area with a total percentage of 53%. In terms of research funding, we found eight institutions that contributed to this issue's donation of research funds. The sponsorship status of the highest research fund donor is Supranatioan Funding (5 institutions), then followed by the Government (2 institutions) and the University (1 institution). Continuing with other findings, this study has also shown several network linkages of terms that appear in 332 processed scientific articles, which are then divided into 6 clusters, with each cluster containing several terms that describe the focus of the study being conducted. The last finding, that is no less important, is that this research has shown the direction of dominant issues (interoperability, government, services, information, data, public, e-government, work framework) accompanied by

a mapping of dominant themes, that have been produced consisting of six themes including interoperability, e-government, systems, technology, data, and services.

Some of the findings produced in this study are expected to provide a comprehensive picture of research trends in e-government interoperability for researchers in the future. In addition, this study can provide practical implications for stakeholders, to pay attention to several dominant issues and themes that emerge as aspects, that must receive full attention when they want to realize the presence of e-government with high interoperability. Furthermore, we recognize that this research cannot be separated from many shortcomings, one of which is using a single database, (Scopus) so that there may still be document references that are not presented for analysis in this study. For this reason, we sincerely hope that future researchers will be able to conduct further research, to improve knowledge and scientific contributions related to e-government interoperability, by considering using other databases.

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