Systematic Literature Review on Enterprise Architecture in the Public Sector

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Abstract: Enterprise architecture (EA) is an approach to improve the alignment between the organization's business and their information technologies. It attempts to capture the status of the organizations' business architecture, information resources, information systems, and technologies so that the gaps and weaknesses in their processes and infrastructures can be identified, and development directions planned. For this reason, EA has become a popular approach also in the public sector to increase their efficiency and ICT utilization. Yet researchers have largely ignored this context, and it seems that quite little is known about how EA is developed, implemented, or adapted in different countries and in the public sector. We thus conducted a systematic literature review to identify the major research topics and methods in studies focusing on public sector EA. We analyzed 71 identified articles from the past 15 years. Our analysis shows that the development viewpoint, case studies in developed countries, and local settings seem to form mainstream EA research in the public sector. Taken together, it seems that public sector EA is scattered, and there is no strong, single research stream. Instead the researchers conduct local case studies. This means the knowledge on EA development, implementation or adaptation, their challenges and best practices does not accumulate. There is consequently a need for more research in general, and targeted research in some specific segments.

Keywords: Enterprise Architecture, Public Sector, Systematic Literature Review, Government Enterprise Architecture.

1. Introduction

The enterprise architecture (EA) concept has increasingly gained the attention of public sector actors around the world. By 2007, Liimatainen et al. (2007) stated that 67% of countries were implementing EA or similar programs, and up to 93.3% of countries were planning to launch EA initiatives within a year or two. However, these initiatives turned out to be difficult to implement, despite EA providing numerous benefits. For instance, it may play an important role in achieving better connectivity and interoperability between information systems, rationalizing data structures, unifying business processes, and standardizing technologies (Saha, 2010; UN, 2008; OpenGroup, 2008). In fact, numerous EA benefits, such as improved decision-making, reduced IT costs, better business-IT alignment, re-use of resources, and regulatory compliance, among many others, have been identified (Tamm et al., 2011; Boucharas et al., 2010; Kappelman et al., 2008; Lange et al., 2012; Niemi & Pekkola, 2017).

Despite the evident benefits, EA initiatives seem to face challenges in practice (e.g. Alwadain et al., 2015; Bui et al., 2015; Kimpimäki, 2014). Thus, it is easy to press for more research and practical guidance. However, as the public sector and the private sector are fundamentally different in terms of environmental factors, transactions, structures and processes, and goals (Caudle et al., 1991), private sector studies, often focusing on EA development methods and frameworks (Rouhani et al., 2015; Simon et al., 2013), do not provide adequate instructions for the public sector.

So, despite there being several studies on EA utilization in public sector activities (Hjort-Madsen, 2007; Lemmetti & Pekkola, 2012), little is actually known about the broad spectrum of EA. For example, Rouhani et al. (2015), Scholl et al. (2011), and Simon et al. (2013) all point out the need for understanding more about EA in general, and in the public sector in particular. In the public sector context, Scholl et al. (2011:353) stated that

> *"…we dismiss the drive for establishing Enterprise Architectures in the public sector as inappropriate and problematic, at a minimum. Institutional architectures represent governance structures, and interoperability in the public sector requires governance structures different from the private sector."*

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This motivates our study, in which we conduct a systematic literature review on "how EA has been studied in information system research in the public sector, what are the main research topics there, and what are the main themes related to EA in the public sector." We utilize the pragmatic guidelines of Kitchenham and Charters (2007) to review and analyze what categories, issues, geographies, countries, methods, and approaches are common in public sector EA research.

The paper is organized as follows. First, we present the background literature, and then describe the sample and methods in Section 3. We use the subsequent section to provide the results of a content analysis of 71 research articles. In Section 5 we discuss the results, and we provide conclusions in Section 6.

2. Background

2.1 EA and EA in the public sector

Enterprise architecture is an approach for managing the complexity of an organization's structures, business environments, and different information systems, and for facilitating the integration of strategy, personnel, business, data, and IT (Goethals et al., 2006; Hjort-Madsen, 2006; Kluge et al., 2006). It provides a collage of several architectural models, such as business architecture, information architecture, information systems architecture, and technology architecture (Jonkers et al., 2006; Lankhorst et al., 2005). Those models describe the current situation of the organization, conceptualize its future vision, and provide a transition plan for how to reach the future vision (Armour et al., 1999; Lankhorst et al., 2005). In other words, EA provides a holistic view of the organization and its different components and structures, and thus can be seen as *"a kind of city plan that details policies and standards for the design of infrastructure technologies, databases, and applications"* (Ross, 2009:172).

Despite this high-level conceptualization, there is no globally accepted definition of EA (Niemi & Pekkola, 2017; Tamm et al., 2011). As it is often understood either as a taxonomy, a methodology, or a masterplan, and perhaps even all three simultaneously, EA endeavors are challenging (Niemi & Pekkola, 2017; Rohloff, 2005). However, the term 'enterprise' indicates that EA could be used to consider a company, an institution, or a department within a company or an institution (Guijarro, 2007), while the term 'architecture' aims at creating some kind of structure of a complex and isolated environment using systematic approaches (Armour & Kaisler, 2001). In the public sector context, EA is also referred to as Government Enterprise Architecture (GEA), National Enterprise Architecture (NEA), or e-government Enterprise Architecture (Liimatainen et al., 2007).

The EA concept has indeed been used in the public sector (Guijarro, 2007; Hjort-Madsen, 2007; Lemmetti & Pekkola, 2014; Peristeras & Tarabanis, 2000). One of the most popular applications is its use as a methodology to improve the interoperability and efficiency of inter- and intra-organizational IT systems (Hiekkanen et al., 2013; Hjort-Madsen, 2006; Janssen et al., 2013; Lemmetti & Pekkola, 2014). Other uses include strategic planning and data stores consolidation, among others (Hjort-Madsen, 2007; Boucharas et al., 2010; Nilsson, 2008; Ross & Weil, 2005). These initiatives are usually voluntary, although some law-mandated examples exist, as in the U.S. ("The E-Government Act," 2002) and Finland ("Act on Information Management Governance in Public Administration," 2011).

Governments normally consist of many agencies with different structures and service/business-areas. This often leads to duplicated information systems and fragmented business services and process, decreasing the possibility of cross-agency interoperability (Saha, 2010). Therefore, governments pursue EA initiatives, in addition to the aforementioned general EA benefits, to allow for end-to-end business processes across all state agencies, to increase online services (Saha, 2010), to provide new tools to manage business and IT alignment within agencies for better integration of technologies, to rationalize data structures and applications, and to provide business modularity (OpenGroup, 2008; Ask & Hedström, 2011; Guijarro, 2007).

2.2 Related literature reviews

Several literature reviews on EA have been conducted. Those include Langenberg and Wegmann (2004), Schelp and Winter (2009), Schönherr (2008), and Simon et al. (2013), which all investigate EA research in general, Lucke et al. (2010), which studies critical success factors, and Makola and Hotti (2013), which focuses on critical success factors in healthcare sector. Mykhashchuk and Schweda (2011) and Winter (2010) used a literature review to study enterprise architecture management, Andersen and Carugati (2014) to investigate enterprise architecture evaluation, and Boucharas et al. (2010) to study EA contributions.

None of these reviews, however, focused on EA and the public sector. Nevertheless, some EA public sector literature reviews have been conducted (Tambouris et al., 2014; Zheng & Zheng, 2013), but their focus is very narrow: services provision systems requirements (Tambouris et al., 2014) or public sector EA within a single country (Zheng & Zheng, 2013).

Consequently, there is evidently a need for a literature review that maps research into public sector EA in order to understand what is known, or not known, in the field.

3. Research method

Our study follows Kitchenham and Charters' (2007) practical guidelines, which comprise of three main stages: planning, execution, and result analysis. We will first focus on the planning and execution stages to describe how we carried out our review.

3.1 Databases and keywords selection

In order to gain understanding of the state of public sector EA research, we decided to focus on scientific databases. We identified and selected the following sources as they cover the field of public sector EA and provide access to relevant publications. These databases also have the highest impact and include the most important articles from journals and proceedings. They are:

- The E-Government Reference Library, version 10.5 (http://faculty.washington.edu/jscholl/egrl/index.php)
- AIS Electronic Library (http://aisel.aisnet.org/)
- ACM Digital Library (http://portal.acm.org)
- IEEE Xplore (http://www.ieee.org/web/publications/xplore/)
- Science Direct – Elsevier (http://www.elsevier.com)
- Springer Link (http://www.springerlink.com)
- Taylor and Francis (www.tandfonline.com)
- Google Scholar (www.scholar.google.com)

We started by identifying relevant search terms, which we defined after an initial literature search of known EA articles and their reference lists. In particular, we looked at the titles and keywords, and analyzed the abstracts and skimmed the contents. The final search terms were all potential combinations of 'enterprise architecture,' 'public sector,' 'public ICT,' 'electronic government,' 'public administration,' 'public organization,' 'government enterprise architecture,' 'national enterprise architecture,' 'government architecture,' 'e-government enterprise architecture,' and 'government EA.'

3.1.1 Criteria and selected articles

Every article that matched the search criteria was recorded (this resulted in 1858 candidate articles), and the first author then reviewed and re-reviewed each article. As suggested by Kitchenham and Charters (2007), we used the following inclusion and exclusion criteria:

- Inclusion: English peer-reviewed studies, including conference proceedings, journal articles, and book chapters; studies that focus on EA in the public sector.
- Exclusion: Studies not in English; studies not related to the research questions; duplicated studies; short articles.

After excluding the articles using the exclusion criteria (the number of candidate articles was reduced to 184), the rest were analyzed in detail. The analysis of their titles and abstracts (number of candidate articles was reduced to 116) and an evaluation based on the full text reduced the number of candidate articles to 71. We repeated this analysis in a random order to ensure no mistakes were made. Finally, the reference lists of the candidate articles were checked to guarantee we included all representative articles. Table 1 shows the number of articles per source and in the selection process.

Table 1: Selected articles based on keywords

Source	*Keyword search*	*Candidate*	*Selected*
E-gov Lib	54	51	27
AISeL	13	10	5
ACM	167	7	5
TandFonline	32	0	0
Elsevier	46	3	3
IEEE	187	21	12
Springer	559	9	8
Scholar	800	15	11
Total	1858	116	71

Our sample thus consisted of 71 articles: 50 (70.42%) published in conference proceedings, 18 (25.35%) in journals and 3 (4%) in books.

3.1.2 Qualitative analysis

After identifying the articles, we analyzed them in detail. For each article, we recorded their bibliographical information (author affiliation, year of publication, type of publication), research methods used, number of citations, and content-specific issues, such as the coverage and objective of the study. We also classified the articles according to their topic, i.e. whether the article focused on developing EA initiatives in that country (development), implementing EA, i.e. utilizing the models and frameworks (implementation), or adopting EA, i.e. how EA practices are rooted in the organizations (see Figure 1 for details). Finally, we recorded their research methods and scope (whole government, specific organization or agency, or some subsection).

Classified topics	*Definition and description*
EA development	Studies on EA development, frameworks, modeling, or similar architecture development-related issues.
EA implementation	Studies on how existing EA frameworks/methods/approaches can be implemented or are implemented in the public sector.
EA adoption	Studies on how organizations actually use or adapt EA, or on understanding the use of EA, or how EA works in the public sector.
Overlapping	Overlap between the aforementioned topics.

Figure 1: EA categories in the public sector

We also identified the main research issues for each article, which are listed in Table 2.

Table 2: Research themes that emerged from the articles

Themes	*Descriptions*
Interoperability and integration	Those focusing on interoperability, integration, or both.
EA maturity	Those focusing on EA maturity, EA evaluation, and assessment.
EA alignment and strategy	Those focusing on alignment, strategy, or both.
Framework	Those focusing on frameworks, including interoperability frameworks, business architecture frameworks, evaluation frameworks, reference EA, and issues related to frameworks.
Modeling	Those focusing on models or modeling, such as the benchmarking model, domain model, data model, and issues related to models.
Role of EA	Those focusing on the role of EA in the public sector.

Themes	*Descriptions*
Developing EA	Those focusing on how agencies are developing EA
Implementing EA	Those describing how agencies are implementing EA.
Using EA	Those focusing on how agencies use and/or understand EA
General	Those focusing on EA in general, such as EA skills, concepts, use, and impact.

3.1.3 Extraction form

After identifying different categories and criteria, we collected the following information from each article. Figure 2 illustrates a data extraction form for each article. The extraction forms and all the codes are summarized as Appendix A.

Item	*Description*
Topics	Articles belong either to development, implementation, or adoption EA, or to multiple categories, which are defined in Figure 1.
Themes	Description of the articles' main research themes, which are defined in Table 2.
Bibliographical information	Authors, year of publication, title, and source of publication.
Publication type	Book, journal article, conference article, workshop article.
Quantitative relevance	Included communities, geography, coverage, research methods, distribution, number of citations, and country of research.

Figure 2: Data extraction form

3.1.4 Quality assessment

In addition, in order to assess the quality of each article, we defined four quality assessment questions (QA) to check the biases and validation of the proposals (Kitchenham & Charters, 2007). Each article was scored according to the quality assessment questions (Table 3). Positive answers were valued as one (Y), negative as zero (N), and partly as 0.5 (P). All included articles earned a score of three or higher (see Appendix A for scores). We therefore consider that the quality of the sample was adequate.

Table 3: Quality assessment questions

No.	*Questions*	*Y*	*P*	*N*
Q-1	How clearly did the context of the selected article relate to the public sector?	It stated clearly that it was a study of EA in the public sector.	It was only mentioned or described on occasion.	It neither mentioned nor described a study of EA in the public sector.
Q-2	How well are the main topics of the selected articles mentioned?	It explicitly mentioned issues.	It described or mentioned issues, but not clearly.	It did not mention or describe issues.
Q-3	How well are the categories of selected articles described?	It explicitly described them.	It mentioned or described them, but not clearly.	It did not mention or describe them.
Q-4	How clear are the communities, geographical distribution, coverage, and methods mentioned?	It clearly stated all of the aspects.	It mentioned one/some of them.	It did not state them clearly.

4. Results

In this section, we present both the qualitative and quantitative results.

4.1 Qualitative findings

4.1.1 Topics and main research themes

In order to answer the question "What are the main research topics related to EA in the public sector?" we classified each article's research topic. The majority focused on EA development (36 articles; 56.25%), while 14.06% (9 articles) focused on EA implementation, 29.69 % (19 articles) on EA adoption, and 10.94% (7 articles) on two or three of these topics (Figure 3).

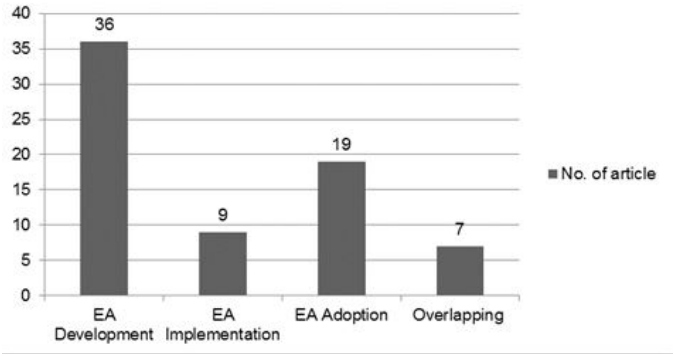

Figure 3: Research topics on EA in the public sector

We also identified the research themes. Figure 4 show that studies on frameworks accounted for 33.80% (24 articles), followed by using EA with 21.12% (15 articles). The two groups with the lowest number of articles were developing EA and EA alignment and strategy, which both accounted for approximately 2.81% (2 articles), while other themes accounted for 4.22% to 9.85% (3 to 7 articles).

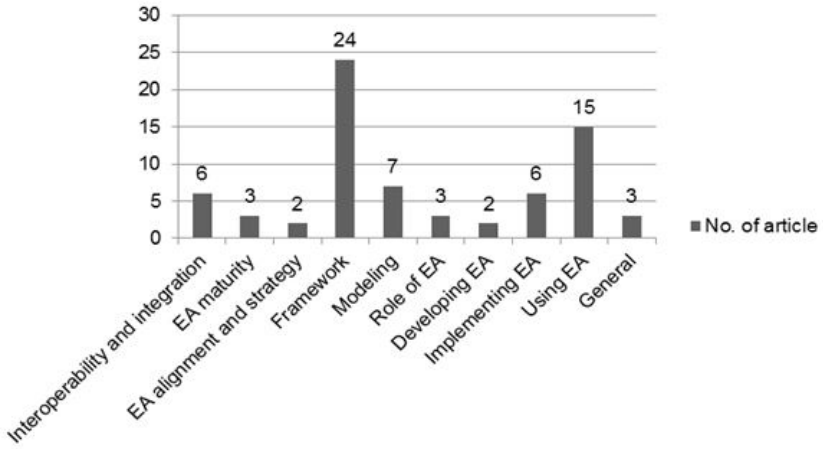

Figure 4: Research themes on EA in public sector

Our findings showed that the public sector seems to be using their own frameworks instead of using current, established frameworks, such as Zachman (Sowa & Zachman, 1992; Zachman, 1987), TOGAF (TOGAF, 2011), or FEAF (U.S. CIO, 2013). This happens, for example, in Korea (Lee & Kwon, 2013; Lee et al., 2013), Singapore (Saha, 2009), and Thailand (Suchaiya & Keretho, 2014). Moreover, many governments were very flexible towards GEA concept. The agencies, within the governmental bodies, select their own frameworks based on the factors such as economic, socio-economic, infrastructure status, and business status (Janssen & Hjort-Madsen, 2007; Janssen & Cresswell, 2005; Lemmetti, & Pekkola, 2012). The detail about the selected articles and their content is listed in Appendix A.

4.1.2 Cross-analysis between themes and topics

We used cross-analysis between themes and topics to get insights about public sector EA research. As presented in Table 4, the majority of articles focused on EA development, EA implementation, and EA adoption. They belonged to the themes of frameworks (19 out of 36 articles), implementing EA (6 out of 9 articles), and using EA (10 out of 16 articles) respectively.

It is worth mentioning that EA alignment is an important feature of EA (Gregor & Martin, 2007; Lemmetti & Pekkola, 2014) that has not been extensively studied. Indeed, only two articles (Gregor & Martin, 2007; Gregor & Martin, 2002) focusing on EA development addressed the issue, and no other article considered it.
Appendix B provides more detail about the articles and the relationships between different themes and research topics.

Table 4: Themes addressed in the articles, and the number of articles on each topic

Themes	*EA development*	*EA implementation*	*EA adoption*	*Overlapping*
Interoperability and integration	2	2	2	
EA maturity	1		2	
EA alignment and strategy	2			
Framework	19	1	1	3
Modeling	7			
Role of EA	2		1	
Developing EA				2
Implementing EA		6		
Using EA			13	2
General	3			

4.2 Quantitative analysis

In this section, we provide the results of our quantitative analysis from two different perspectives: distribution over time and geography. This included consideration of authors and co-authors, research methods used, country specificity, and scope and coverage, i.e. whether the focus was at an international, central government, lines of business, local, provincial or regional, or municipality level. Finally, a brief citation analysis allowed us to identify the most influential articles.

4.2.1 Geographical distribution

The analysis of first authors and their home countries revealed that almost two thirds of studies on public sector EA originate from Europe, with a quarter from Asia and marginal contributions from the Americas, Oceania, and Africa. This shows that EA research is largely driven by European researchers. An explanation for the strong Europe-Asia dominance could relate to the attention paid to EA by several governments in those regions (Table 5).

Table 5: Number of publications by geography and by countries

Number of publications by geography			*Number of publication by developed/developing countries*		
Area	*No. of Pub (First author)*	*Percentage*	*Area*	*No. of Pub (First authors)*	*Percentage*
Europe	43	60.56%	Developed	56	78.87%
Asia	16	22.54%	Developing	15	21.13%
Americas	6	8.45%			
Oceania	4	5.63%			
Africa	2	2.82%			

In a similar vein, almost four out of five articles come from the developed world, with only around 20% from developing countries. Furthermore, the articles from the developing world mainly focus on the frameworks in the development category (10 out of 15 articles).

Table 6 illustrates how the articles are scattered across different topics; while 42 articles (59.15%) focused on a country, 12 (16.90%) compared two or more countries. The results indicate that studies that compare more than two countries' EA adoption and implementation are either complex to conduct, because of the need for in-depth understanding of EA practice and the need to cooperate with government agencies, or have not been of interest to researchers. For example, no article in the implementation category uses comparative research.

Table 6: Country-specificity of articles according to the topics

Group	*Single country*	*Comparative between more than two countries*	*Not mentioned*
Development	13	7	16
Implementation	9	0	0
Adoption	16	2	1
Overlapping	4	3	0
Total	42	12	17
%	59.15%	16.90%	23.94%

4.2.2 Distribution over time

Figure 5 illustrates how the number of public sector EA studies has increased rapidly since 2007.

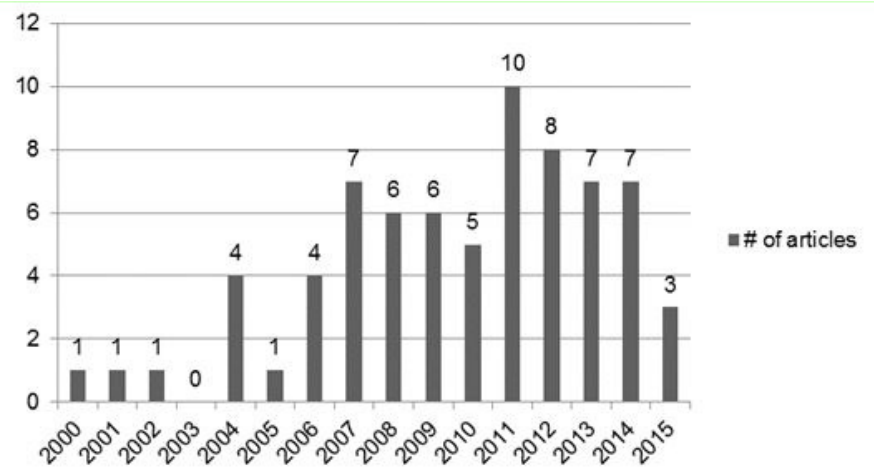

Figure 5: Number of articles each year

From 2007 to 2015, 59 articles (about 83%; approximately 7 articles per year) were published, while prior to this there were only 12 articles (about 17%; roughly 2 articles per year). This indicates that public sector EA is getting more attention. Analyzing the authors' geographical distribution reveals that scholars from Asia and the developing world in particular have become active. The Asian group (19.72%) of EA researchers is the second largest group after Europe (60.56%). Moreover, 56 articles had authors from the developed world (78.87%), and 15 (21.13%) had authors from the developing world (10/15 from Asia, 5/15 from Africa).

4.2.3 Communities

Whether the articles are written by practitioners or academics indicates something about their practical relevance. We thus analyzed all authors and their backgrounds. Four categories of author groups were identified: academics, academics and government agencies, academics and enterprises, and government agencies (Table 7). Most articles were written by academics (59 articles, 83.10%), or by academics and government agencies (8 articles, 11.27 %). The other single articles were by government agencies (3 articles, 4.23%) or academics and enterprises (1 article, 1.41%).

Table 7: Number of publications by author background

Categories	*No. of articles*	*Percentage*
Academics	59	83.10%
Academics and government agencies	8	11.27%
Government agencies	3	4.23%
Academics and enterprises	1	1.41%

Although academics' articles were written for academic purposes, it should be noted that they might still have a strong practical relevance (see Section 4.2.4). Interestingly, from 11 articles by governmental authors, 5 originate from the same group of authors in Greece (Peristeras & Konstantinos, 2004; Peristeras & Tarabanis, 2000; Peristeras & Tarabanis, 2004; Tarabanis, 2001; Peristeras, 2004). Given that there was also another Greek study (Anthopoulos et al., 2010), Greek dominance in public sector EA practitioner research is evident. Other countries include Finland (two articles by the same group), South Korea (two articles by the same group), and Bangladesh (Azad et al., 2008).

The only article resulting from enterprise-academic cooperation studied the maturity of EA programs and interoperability collaboration in 13 countries (Gøtze et al., 2009).

4.2.4 Scope and coverage

Figure 6 shows that 59% (42 articles) of the articles focus on single country-specific issues. Of those, 12 are Finnish studies. Far behind is the U.S. with six articles, Australia and the Netherlands with four articles each, India and Italy with three articles, and Korea, Sweden, and Demark with two articles. Of the 12 (17%) comparative studies, the majority compare different European countries (9 out of 12). Interestingly, 17 articles (24%) do not clearly state where the study was conducted as their focus was, for example, on theory or documentation, such as frameworks or modeling.

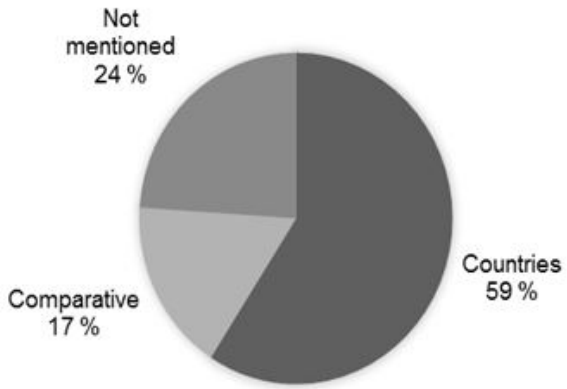

Figure 6: Geography of research

We then divided the articles into five groups: international, focusing on two or more countries; central, focusing on the central government in a country; local, focusing on a certain province, region, or municipality; line of business (LoB), focusing on the lines of business; and a general group for generic EA studies, such as those on developing frameworks.

Most articles (47.89%) do not indicate any particular coverage but remain generic (see Table 8), followed by two groups, international and LoB, with 17.65% and 14.08% respectively, 10.29 % on a certain central government, and 7.35% on a local level (e.g. provincial, regional, municipal).

Table 8: Article coverage by group

Topic	*General*	*International*	*Central government*	*Local*	*LOB*
Development	23	7	2	0	4
Implementation	3	0	2	0	4
Adoption	8	2	3	4	2
Overlapping	0	3	1	3	0
Total	34	12	8	7	10
%	47.89%	17.65%	10.29%	7.35%	14.08%

There are several reasons for this kind of distribution. Research tries to generalize the results, making the generic development studies common. Similarly, local practices are reported mainly in the form of case studies, making generalizability and potential theory building more difficult. This issue is emphasized in EA research, which still seems to be relatively practitioner-oriented.

In terms of the LoB analysis level, development and implementation both have four articles, while adoption accounts for three articles. Moreover, if these ten articles and their point of foci are analyzed in detail, their business areas are revealed. Eight areas emerging from the data are show in Table 9. This indicates that no particular business area dominates EA research, although healthcare has gained slightly more interest. However, it is evident that many LoBs have not applied EA, or have reported it in the form of academic publications. In addition, EA research seems to lack studies on many important lines of governmental activities, such as taxation, customs, or education.

Table 9: Detail of LoB area

#	*Area*	*Number of articles*
1	Healthcare	3
2	Statistics	2
3	Immigration and naturalization services	1
4	Digital preservation	1
5	Road administration and state treasury	1
6	Lands management	1
7	Social services	1
	Total	10

4.2.5 Research methods

We adopted Zheng and Zheng's (2013) framework to categorize the research methods used in the articles. However, based on the characteristics of the articles, we decided to add the new category of design science research (DSR), which refers to the construction of an artifact and its evaluation (Hevner et al., 2004; Sein et al., 2011).

Table 10: Research methods

Factor	*Research methods*	*Number of articles*
Theoretical (11)	1.1 Theoretical framework building	9
	1.2 Critical literature review	2
Empirical (42)	2.1 Interview	6
	2.2 Survey	7
	2.3 Observation	1
	2.4 Secondary data	6

Factor	*Research methods*	*Number of articles*
	2.5 Comparative studies	4
	2.6 Case studies	14
	2.7 DSR	4
Descriptive (19)	3.1 Theoretical and practice integration	7
	3.2 Practice illustrations and introduction	5
	3.3 Viewpoints	7
Prescriptive (3)	Prescriptive	3
	Total	72

Table 10 illustrates that there are 11 articles using a theoretical approach; empirical methods account for 42 articles, including 14 articles using case studies, 6 using interviews, and 7 using surveys; 19 articles are descriptive and 3 use prescriptive studies. Although the case study method appears dominant, a variety of different approaches is evident. This can be seen as either positive, since the topic is being approached from several viewpoints, or as negative, as the studies seldom replicate others.

Three articles use multiple research methods; Janssen (2012) and Scholl et al. (2011) combine interviews and surveys, and Strano and Rehmani (2007) use interviews, observations, and secondary data.

4.2.6 Number of citations

In order to identify the core literature, the most-cited articles were identified by using Google Scholar. The 71 selected articles were cited 1027 times in total, giving an average number of citations of 14.46. The ten most-cited publications are listed in Table 11. However, it should be noted that the number of citations tends to increase over time, so the list may change within a few years.

Table 11: Most cited public sector EA articles by February 2016

Articles	*No. of citations*	*Outlet*
V. Peristeras & Tarabanis, 2000	115	European Journal of Information Systems
Gregor et al., 2007	88	Information Technology & People
M. Janssen & K. Hjort-Madsen, 2007	72	Hawaii International Conference on System Sciences
Hjort-Madsen, 2006	63	Hawaii International Conference on System Sciences
M. Janssen & Kuk, 2006	58	Hawaii International Conference on System Sciences
V. Peristeras & Konstantinos, 2004	50	International Conference on Electronic Commerce
Strano & Rehmani, 2007	43	Information Systems and e-Business Management
V. Peristeras, 2004	42	Knowledge Management in Electronic Government
Hjort-Madsen, 2007	36	Transforming Government: People, Process, and Policy
Pardo, Nam, & Burke, 2012	35	Social Science Computer Review

5. Discussion

The majority of public sector EA research focuses on EA development (56.25%). In comparison, EA implementation accounts for 14.06% of articles, which indicates that researchers are not yet involved comprehensively in EA practices and activities. Consequently, EA seems to represent more of a practical approach than a theoretical view as, for example, attempts at broader theory development are scarce. This can be explained by pragmatic issues, as the researchers need to first be involved in the practical field, where many agencies have not gained experience from implementing or adapting EA. Theory development is thus very difficult in this immature field, and governmental agencies are still drafting their EA models and developing appropriate practices and processes.

Most public sector EA studies focus on frameworks and modeling (31/71, roughly 43.66%) and on the issues relevant to using EA (15/71, approximately 21.12%). Although this trend of focusing on frameworks seems

promising in terms of cumulative knowledge, each government, unfortunately, develops, tailors, and uses a framework based on their own economic, socio-economic, and infrastructure status- They seem not to be using popular, established frameworks such as TOGAF, FEAF, and ZACHMAN (Urbaczewski & Mrdalj, 2006). This finding parallels with the literature that the EA practitioners tend to use the frameworks and methodologies either as idea contributors, or just adapting them according to their own needs (Kotusev & Storey, 2015; Lange & Mendling, 2011; Smith et al., 2012), As a results, this makes it very difficult to find any common aspect among the EA frameworks in the public sector, Consequently one evident avenue for future research is considering this perspective, such as how, why, and which condition governments can or cannot use existing frameworks, and how to reduce their complexity (c.f. Saha, 2007).

In contrast, there seems to be a lack of studies focusing on EA maturity, alignment and strategies, and evaluation. In addition, missing are studies on policy or policy-making, governance, and security (e.g. how policies impact to GEA implementation, which content should be considered for EA implementation, EA adoption); on the identification of ICT literacy, on the actors and users' skills, and on their characteristics, particularly in the developing countries (and studies comparing those to developed countries).

Literature in the selected articles does not seem to clearly distinguish the difference between public sector EA and private sector EA, or whether there is any difference. Further research on public sector EA and its specific needs need to be considered. For example, Ojo et al. (2012) argued that more than 40% of the GEA programs were terminated due to poor execution. Yet those failures are not reported in the EA literature. The studies of such failure would be highly valuable for everyone launching EA initiatives, whether in the private or public sector. However, as the public sector is constantly examined, evaluated, and monitored by the media and citizens, their EA investments and failures are equally examined. Poor EA implementation and execution easily lead to increased public spending, little reward, and the denouncement of failing EA. As the EA benefits are evident (Tamm et al., 2011; Boucharas et al., 2010; Kappelman et al., 2008; Lange et al., 2012; Niemi & Pekkola, 2017), the need to understand and steer EA implementation and adaption is thus evident.

The interest in public sector EA seems to be gaining more attention. Analyzing the past 15 years, we find that most articles were published from 2007 to 2015 (59 articles, 82.35%). This trend reflects governments' attention to EA, and parallels the claim of Liimatainen et al. (2007) that up to 93.3% of countries were planning to launch EA initiatives soon. Researchers seem to have followed the practitioners here.

Public sector EA has gained increasing interest from scholars from Asia and the developing world (all of their research was published after 2008). The Asian group (22.54%) of EA researchers is also the second largest group after the Europeans (60.56%). This indicates that public sector EA studies are primarily driven by Europe, which is in line with Simon et al. (2013). However, those involved in EA in Asia and developing countries will press for more research as, for example, cultural issues, values, and government structures differ significantly from those in Europe.

Within the public sector, governmental agencies are critical for national EA projects as they participate in all of their phases. Consequently, understanding their role, what has happened, and why certain activities are taken become more important. However, only eight of the articles (11.27%) emerged from cooperation between academics and government agencies. This implies that the researchers remain somehow distant from the practitioners. This is also evident from the research methods usage (Table 10), as the researcher acting or participating within the practitioner community, such as by using ethnographic methods or observations, seems rare in the public sector EA studies. In contrast, most studies rely on interviews, surveys, and other informant-dependent methods. It should also be noted that GEA is often developed through the joint actions of researchers and practitioners, and later maintained by civil servants. This again emphasizes the need to incorporate practitioners and civil servants in the research endeavors, as they can better understand the root causes and causal relationships between actions, decisions, and consequences.

5.1 Recommendations for future work

There are some evident opportunities for further research on the public sector EA. First, our analysis (Figure 3) shows that current public sector EA research is topically scattered. Development aspects are emphasized, while implementation and adoption have gained less interest. This fragmentation becomes even more evident when the research themes are analyzed (Figure 4); frameworks and using EA are studied, while all other themes emerging from the literature have gained only sporadic interest. Given that EA research largely fails to

focus on problems regularly mentioned in the EA literature, such as governance structures, EA management, and security (Kaisler et al., 2005; Jan & Christine, 2014), future research is needed.

Second, although GEA has attracted interest from researchers, in practice the success of GEA is somehow limited. Consequently, questions relating to whether GEA is effective and needed can be asked. Furthermore, what is the impact of GEA in socio-economic terms? Is there any alternative GEA that would allow a country to better achieve its vision and strategy? What is the relationship between EA with other management approaches, such as COBIT, ITIL, or others? How is EA institutionalized in the public sector? What are the root causes of EA problems in the public sector (c.f. Dang & Pekkola, 2016a, 2016b)? These are potential questions for academics and practitioners to consider.

Third, GEA is typically first developed by researchers and practitioners, and later maintained by civil servants who usually lack skills in and knowledge of EA. Thus, government agencies may find themselves unable to monitor GEA and its progress, and to continue or maintain EA work. This means we need to study the roles taken up during GEA development, implementation, and adoption. Moreover, we have identified seven LoBs that the researchers have studied, including healthcare, statistics, immigration and naturalization services, digital preservation, road administration and state treasury, lands management, and social services. However, we cannot find clear evidence from the selected articles about whether the articles were targeted for some particular application of the EA approach. This would indeed be another topic for further research.

Finally, most GEA is deployed in the developed world, in countries that usually have a stable government and governance structures, sufficient resources, and high IT awareness and literacy. These factors can be considered prerequisites for GEA programs. Yet the situation is different in most developing countries. Therefore, we need more research on EA deployment in different settings and contexts, such as in developing countries that have to deal with frequent changes in their government structures, non-stable legal frameworks, a lack of necessary resources, and a low awareness of IT benefits.

5.2 Limitations

There are some limitations to this study. First, only articles in English were analyzed, so articles and the topics in other languages, such as German or French, were ignored, which may have biased the results. On the other hand, English is the de facto standard language in science, so the impact of articles in other languages on global public sector EA research would be minimal. Second, only eight online databases were included, which means we might have missed some articles published in journals or conferences not indexed in the selected databases (although scholar.google.com also complements other sources). Finally, our data collection period ended at the end of 2015, and articles published at the end of the year may not have been indexed by that point, and were thus excluded.

6. Conclusion

This paper reports the results of a systematic literature review on public sector EA. The 71 articles identified demonstrate the immaturity and early-phaseness of public sector EA research. Most articles still focus on development issues and frameworks, which, nevertheless, are essential to carry out EA work in different organizations. Yet very little is actually known about how those frameworks and practices are actually used and followed, how well they fit with their purposes, what the challenges are, and how different organizations, stakeholders, actors, employees, and citizens react. This calls for more research on implementation and adaption issues in an ever-increasing variety of organizations.

We also categorize public sector EA research into three groups: EA development, EA implementation, and EA adaptation. From these groups, we gathered insights by using qualitative analysis. The results show that the majority of the studies focus on EA development, specifically on frameworks and modeling. In contrast, the results suggest that future research may concentrate more on EA implementation from the perspective of interoperability and integration, and alignment and strategy, to gain an understanding of pragmatic problems. This will help governments and agencies form connected governments and reduce the number of fragmented business services.

Our contribution to the research is thus the illustration of the state of public sector EA research, and our offering of potential future research directions. We believe the results also help practitioners in understanding

what we, the researchers, know about an increasingly pervasive phenomenon with a significant practical impact, namely public sector EA research.

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Appendicies

Appendix A. List of selected study article, quality assessment and data

#	Selected reference articles	Q-1	Q-2	Q-3	Q-4	SQ	TP	TM	CM	First author	GO	cited	Year	CR	MT
A1	Shaanika, I. and T. Iyamu, *Deployment of Enterprise Architecture in The Namibian Government: The Use of Activity Theory to Examine the Influencing Factors* S. The Electronic Journal of Information Systems in Developing Countries, 2015. 71(6): p. 1-21.	1	1	1	1	4	C3	S9	A	Namibia	IN	0	2015	C	E6
A2	Bui, Q.N., M.L. Markus, and S. Newell, *Alternative Designs in Widespread Innovation Adoption: Empirical Evidence from Enterprise Architecture Implementation in US State Governments*, in *International Conferences on Information Systems*. Fort Worth 2015.	1	1	1	1	4	C3	S9	A	U.S.	ED	0	2015	P	E4
A3	Bui, Q., Increasing *the Relevance of Enterprise Architecture through "Crisitunities" in U.S. State Governments*. MIS Quarterly Executive, 2015. 14(4).	1	1	1	1	4	C3	S9	A	U.S.	ED	0	2015	P	E4
A4	Tambouris, E., Kaliva, E., Liaros, M., & Tarabanis, K. (2014). A Reference Requirements Set for Public Service Provision Enterprise Architectures. *Software and Systems Modeling*, 13(3), 991-1013.	1	1	1	1	4	C1	S4	A	Greece	ED	0	2014	G	T2
A5	Suchaiya, S., & Keretho, S. (2014). Analyzing National e-Government Interoperability Frameworks: A Case of Thailand, *Digital Information Management (ICDIM), 2014 Ninth International Conference on Digital Information Management*.	1	1	0.5	1	3.5	C4	S4	A	Thailand	IN	0	2014	T	E5
A6	Shaanika, I., & Iyamu, T. (2014). *Developing Enterprise Architecture Skills: A Developing Country Perspective*. Paper presented at the Key Competencies in ICT and Informatics. Implications and Issues for Educational Professionals and Management IFIP Advances in Information and Communication Technology Volume 444, 2014, pp 52-61.	1	1	1	1	4	C1	S10	A	Namibia	IN	0	2014	G	E2
A7	Lemmetti, J., & Pekkola, S. (2014, 2014). *Enterprise Architecture in Public ICT Procurement in Finland*. Paper presented at the Electronic Government and Electronic Participation: Joint Proceedings of Ongoing Research and Projects of IFIP WG 8.5 EGOV and ePart, Dublin, Ireland.	1	1	1	1	4	C3	S9	A	Finland	ED	0	2014	G	E4
A8	Kaushik, A., & AparnaRaman. (2014). The new data-driven Enterprise Architecture for e-Healthcare: Lessons from the Indian Public Sector. *Government Information Quarterly*, Volume 32, Issue 1, January 2015, Pages 63-74.	1	1	1	1	4	C2	S8	A	India	IN	0	2014	L	E6
A9	Gill, A., Smith, S., Beydoun, G., & Sugumaran, V. (2014). *Agile Enterprise Architecture: A Case of a Cloud Technology-enabled Government Enterprise Transformation*. Paper presented at the PACIS 2014 Proceedings. Paper 121.	1	1	1	1	4	C1	S4	A	Australia	ED	1	2014	G	D1
A10	Edward, I. Y. M., Agusdian, A., Shalannanda, W., & Lestariningati, S. I. (2014). *Proposal of TOGAF ADM Enterprise Continuum for Organization-specific Solution on e-Government*. Paper presented at 2014 International Conference on Electrical Engineering and Computer Sciences.	1	1	1	1	4	C1	S4	A	Indonesia	IN	0	2014	G	E1
A11	Zheng, T., & Zheng, L. (2013). Examining e-government Enterprise Architecture Research in China: A Systematic Approach and Research	1	1	1	1	4	C1	S10	A	China	IN	5	2013	G	T2

#	Selected reference articles	Q-1	Q-2	Q-3	Q-4	SQ	TP	TM	CM	First author	GO	cited	Year	CR	MT
	Agenda. *Government Information Quarterly*, 30(1), S59-S67.														
A12	Mohamed, M. A., Galal-Edeen, G. H., & Has-san, H. A. (2013). *Towards Adoption of Government Enterprise Architecture: The Cases of Egypt and Syria*. Paper presented at the 13th European Conference on eGovernment (ECEG 2013), Como, Italy.	1	1	1	1	4	C3	S9	A	Egypt	IN	1	2013	T	E6
A13	Lee, Y.-J., Kwon, Y.-I., Shin, S., & Kim, E.-J. (2013). *Advancing Government-wide Enterprise Architecture - A Meta-model Approach*. Paper presented at the 15th International Conference on Advanced Communication Technology (ICACT).	1	1	1	1	4	C2	S8	G	Korea	ED		2013	G	D2
A14	Lee, J. D., & Kwon, Y. I. (2013). *A Study on Strategy Planning and Outcome of EA in Korea*. Paper presented at the 15th International Conference on Advanced Communication Technology (ICACT).	1	1	1	1	4	C2	S8	G	Korea	ED	1	2013	G	P
A15	Janssen, M., Flak, L. S., & Sæbø, Ø. (2013). Government Architecture: Concepts, Use and Impact. In M. A. Wimmer, M. Janssen & H. J. Scholl (Eds.), *Electronic Government: Proceedings of the 12th IFIP WG 8.5 International Conference, EGOV 2013* (pp. 135-147). Koblenz, Germany.	1	1	1	1	4	C1	S10	A	The Netherlands	ED	1	2013	T	T1
A16	Hiekkanen, K. K., J.J.; Collin, J.; Patricio, E.; Helenius, M.; Mykkanen, J. (2013). *Architects' Perceptions on EA Use -- An Empirical Study*. Paper presented at the IEEE 15th Conference on Business Informatics (CBI).	1	1	1	1	4	C3	S9	A	Finland	ED	2	2013	G	E2
A17	Al-Nasrawi, S. I., M. (2013). *An Enterprise Architecture Mapping Approach for Realizing e-government*. Paper presented at the Third International Conference on Communications and Information Technology (ICCIT 2013), Beirut.	1	1	1	1	4	C1	S5	A	Lebanon	IN	1	2013	G	P
A18	Scherer, S., & Wimmer, M. A. (2012). E-participation and Enterprise Architecture Frameworks: An Analysis. *Information Polity: The International Journal of Government & Democracy in the Information Age*, 17(2), 147-161.	1	1	1	1	4	C1	S4	A	Germany	ED	6	2012	G	D3
A19	Paul, A., & Paul, V. (2012). The e-Government Interoperability through Enterprise Architecture in Indian perspective, *World Congress on Information and Communication Technologies (WICT)*.	1	1	1	1	4	C1	S4	A	India	IN	4	2012	G	D1
A20	Pardo, T. A., Nam, T., & Burke, G. B. (2012). E-Government Interoperability: Interaction of Policy, Management, and Technology Dimensions. *Social Science Computer Review*, 30(1), 7-23.	1	1	1	1	4	C1	S4	A	U.S.	ED	35	2012	G	T1
A21	Ojo, A., Janowski, T., & Estevez, E. (2012). *Improving Government Enterprise Architecture Practice – Maturity Factor Analysis*. Paper presented at the Hawaii International Conference on System Sciences	1	1	1	1	4	C3	S2	A	China	IN	5	2012	G	E2
A22	Mohamed, M. A. G.-E., G.H.; Hassan, H.A.; Hasanien, E.E. (2012). *An Evaluation of Enterprise Architecture Frameworks for e-government*. Paper presented at the Computer Engineering & Systems (ICCES), 2012 Seventh International Conference on Computer Engineering & Systems (ICCES 2012).	1	1	1	1	4	C1	S4	A	Egypt	IN	0	2012	G	D3
A23	Lemmetti, J., & Pekkola, S. (2012). Understanding Enterprise Architecture: Perceptions by the Finnish Public Sector. In H. J. Scholl, M. Janssen, M. Wimmer, C. Moe & L. Flak (Eds.), *Electronic Government: Proceedings of the 11th IFIP WG 8.5 International Conference, EGOV 2012* (pp. 162-173). Kristiansand, Norway.	1	1	1	1	4	C3	S9	A	Finland	ED	2	2012	G	E4

#	Selected reference articles	Q-1	Q-2	Q-3	Q-4	SQ	TP	TM	CM	First author	GO	cited	Year	CR	MT
A24	Janssen, M. (2012). Sociopolitical Aspects of Interoperability and Enterprise Architecture in E-Government. *Social Science Computer Review,* 30(1), 24-36.	1	1	1	1	4	C1	S1	A	The Netherlands	ED	17	2012	G	E1, E2
A25	Baldoni, R. (2012). Federated Identity Management Systems in e-government: The Case of Italy. *Electronic Government, an International Journal,* 9(1), 64 - 84.	1	1	1	1	4	C2	S4	A	Italy	ED	20	2012	C	E6
A26	Valtonen, K., Mäntynen, S., Leppänen, M., & Pulkkinen, M. (2011). *Enterprise Architecture Descriptions for Enhancing Local Government Transformation and Coherency Management.* Paper presented at the 15th IEEE International Enterprise Distributed Object Computing Conference Workshops.	1	1	0.5	1	3.5	C4	S4	GA	Finland	ED	1	2011	P	AD
A27	Scholl, H. J., Kubicek, H., & Cimander, R. (2011). Interoperability, Enterprise Architectures, and IT Governance in Government. In M. Janssen, H. J. Scholl, M. A. Wimmer & Y.-h. Tan (Eds.), *Electronic Government: Proceedings of the 10th IFIP WG 8.5 International Conference, EGOV 2011* (pp. 345-354). Delft, The Netherlands.	1	1	1	1	4	C1	S4	A	U.S.	ED	5	2011	T	E1, E2
A28	Scherer, S., & Wimmer, M. A. (2011). Reference Framework for E-Participation Projects. In E. Tambouris, A. Macintosh & H. Bruijn (Eds.), *Electronic Participation: Proceedings of the 3rd IFIP WG 8.5 International Conference, ePart 2011* (pp. 145-156). Delft, The Netherlands.	1	1	1	1	4	C1	S4	A	Germany	ED	6	2011	G	D1
A29	Scherer, S., & Wimmer, M. A. (2011). Analysis of Enterprise Architecture Frameworks in the Context of e-participation, *Proceedings of the 12th Annual International Digital Government Research Conference: Digital Government Innovation in Challenging Times Pages 94-103* (pp. 94–103). College Park, MD, USA: ACM.	1	1	1	1	4	C1	S4	A	Germany	ED	5	2011	G	D1
A30	Saarelainen, M.-M. H., V. (2011). Does Enterprise Architecture Form the Ground for Group Decisions in eGovernment Programme? Qualitative Study of the Finnish National Project for IT in Social Services, *Enterprise Distributed Object Computing Conference Workshops (EDOCW), 2011 15th IEEE International.*	1	1	1	1	4	C3	S6	A	Finland	ED	2	2011	L	E4
A31	Larsson, H. (2011). Ambiguities in the Early Stages of Public Sector Enterprise Architecture Implementation: Outlining Complexities of Interoperability. In M. Janssen, H. J. Scholl, M. A. Wimmer & Y.-h. Tan (Eds.), *Electronic Government: Proceedings of the 10th IFIP WG 8.5 International Conference, EGOV 2011* (pp. 367-377). Delft, The Netherlands.	1	1	1	1	4	C2	S1	A	Sweden	ED	2	2011	L	E6
A32	Bouwman, H. v. H., Harrie; Janssen, Marijn; and Versteeg, Gerrit (2011). Business Architectures in the Public Sector: Experiences from Practice. *Communications of the Association for Information Systems,* Vol. 29, Article 23.	1	1	1	1	4	C1	S4	A	The Netherlands	ED	7	2011	L	E6
A33	Becker, C., Barateiro, J., Antunes, G., Borbinha, J., & Vieira, R. (2011). On the Relevance of Enterprise Architecture and IT Governance for Digital Preservation. In M. Janssen, H. J. Scholl, M. A. Wimmer & Y.-h. Tan (Eds.), *Electronic Government: Proceedings of the 10th IFIP WG 8.5 International Conference, EGOV 2011* (pp. 332-344). Delft, The Netherlands.	1	1	1	1	4	C1	S4	A	Portugal	ED	5	2011	L	T1
A34	Ask, A., & Hedström, K. (2011). Taking Initial Steps towards Enterprise Architecture in Local Government. In K. N. Andersen, E. Francesconi, Å. Grönlund & T. M. v. Engers (Eds.), *Proceedings of the 2nd International*	1	1	1	1	4	C3	S9	A	Sweden	ED	0	2011	P	E6

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#	Selected reference articles	Q-1	Q-2	Q-3	Q-4	SQ	TP	TM	CM	First author	GO	cited	Year	CR	MT
	Conference on Electronic Government and the Information Systems Perspective (EGOVIS 2011) (pp. 26-40). Toulouse, France.														
A35	Aagesen, G., van Veenstra, A., Janssen, M., & Krogstie, J. (2011). The Entanglement of Enterprise Architecture and IT-Governance: The Cases of Norway and the Netherlands, *Proceedings of the 44th Hawaii International Conference on System Sciences (HICSS-44)* (pp. 1-10). Kauai, Hawaii USA: IEEE Computer Society Conference Publishing Services.	1	1	0.5	1	3.5	C4	S9	A	Norway	ED	19	2011	T	E5
A36	Valtonen, K., Korhonen, I., Rekonen, R., & Leppänen, M. (2010). EA as a Tool in Change and Coherency Management – a Case of a Local Government. In R. H. Sprague, Jr. (Ed.), *Proceedings of the 43rd Hawaii International Conference on System Sciences (HICSS-43)* (pp. 1-10). Koloa, Kauai, HI: IEEE.	1	0.5	0.5	1	3	C4	S7	GA	Finland	ED	2	2010	P	AD
A37	Penttinen, K., & Isomäki, H. (2010). Stakeholders' Views on Government Enterprise Architecture: Strategic Goals and New Public Services, *Proceedings of the 1st International Conference on Electronic Government and the Information Systems Perspective (EGOVIS 2010)* (pp. 1-8). Bilbao, Spain.	1	1	1	1	4	C3	S9	A	Finland	ED	5	2010	G	E1
A38	Carota, S., Corradini, F., & Re, B. (2010). *The Role of Applicative Cooperation in the Marche Region Enterprise Architecture.* Paper presented at the eChallenges, 2010.	1	1	1	1	4	C3	S1	A	Italy	ED	0	2010	P	D2
A39	Anthopoulos, L. G., Gerogiannis, V. C., & Fitsilis, a. P. (2010). *Measuring E-government Adoption by Governments: The Greek Case.* Paper presented at the Comparative E-Government, Integrated Series in Information Systems	1	1	1	1	4	C3	S2	G	Greece	ED	4	2010	C	D2
A40	Anajafi, F., Nassiri, R., & Shabgahi, G. L. (2010). *Developing Effective Project Management for Enterprise Architecture Projects.* Paper presented at the 2nd International Conference on Software Technology and Engineering(ICSTE).	1	1	1	1	4	C1	S5	A	Iran	IN	0	2010	G	D3
A41	Valtonen, K., Seppänen, V., & Leppänen, M. (2009). Government Enterprise Architecture Grid Adaptation in Finland, *Proceedings of the 42nd Hawaii International Conference on System Sciences (HICSS-42)* (pp. 128 (121-110)). Waikoloa, Big Island, Hawaii.	1	0.5	0.5	1	3	C1	S4	A	Finland	ED	9	2009	C	AD
A42	Valtonen, K., & Leppa¨nen, M. (2009). Business Architecture Development at Public Administration – Insights from Government EA Method Engineering Project in Finland. In *Information Systems Development*.	1	1	1	1	4	C4	S7	A	Finland	ED	5	2009	G	E6
A43	Seppänen, V., Heikkilä, J., Liimatainen, K. (2009). Key Issues in EA-Implementation: Case Study of two Finnish Government Agencies, *Proceedings of the 11th IEEE Conference on Commerce and Enterprise Computing, 114-120.*	1	1	1	1	4	C2	S8	A	Finland	ED	18	2009	L	E6
A44	Saha, P. (2009). *Architecting the Connected Government: Practices and Innovations in Singapore.* Paper presented at the Proceeding ICEGOV '09 Proceedings of the 3rd International Conference on Theory and Practice of Electronic Governance.	1	1	1	1	4	C2	S8	A	Singapore	ED	4	2009	G	D2
A45	Hjort-Madsen, K., & Pries-Heje, J. (2009). Enterprise Architecture in Government: Fad or Future?, *Proceedings of the 42nd Hawaii International Conference on System Sciences (HICSS-42)* (pp. 131-110). Waikoloa, Big Island, Hawaii.	1	1	1	1	4	C3	S9	A	Denmark	ED	22	2009	G	E1

#	Selected reference articles	Q-1	Q-2	Q-3	Q-4	SQ	TP	TM	CM	First author	GO	cited	Year	CR	MT
A46	GØTze, J., Christiansen, P. E., Mortensen, R. K., & Paszkowski, S. (2009). Cross-National Interoperability and Enterprise Architecture. *Informatica*, 20(3), 369-396.	1	1	1	1	4	C3	S1	AE	Denmark	ED	9	2009	T	E2
A47	Liimatainen, K., Heikkilä, J., & Seppänen, V. (2008). *A Framework for Evaluating Compliance of Public Service Development Programs with Government Enterprise Architecture*. Paper presented at the Proceedings of the 2nd European Conference on Information Management and Management Studies.	1	1	1	1	4	C1	S4	A	Finland	ED	7	2008	G	D1
A48	Isomaki, H., & Liimatainen, K. (2008). Challenges of Government Enterprise Architecture Work – Stakeholders' Views. In M. A. Wimmer, H. J. Scholl & E. Ferro (Eds.), *Electronic Government: Proceedings of the 7th [IFIP WG 8.5] International Conference, EGOV 2008* (pp. 364-374). Turin, Italy.	1	1	1	1	4	C3	S9	A	Finland	ED	23	2008	G	E1
A49	Harris, P. T. (2008). *Enterprise Architecture and its Role in Solving Business Issues: Case Study of the NSW Department of Lands*. Paper presented at the IEEE 8th International Conference on Computer and Information Technology Workshops.	1	1	1	1	4	C1	S4	A	Portugal	ED	5	2008	L	E6
A50	Chakravarti, B. (2008). *An Enterprise Architecture Framework for Building Service Oriented e-governance Portal*. Paper presented at the 2008 IEEE Region 10 Conference.	1	1	1	1	4	C1	S4	A	India	IN	5	2008	C	D3
A51	Baldoni, R., Fuligni, S., Mecella, M., & Tortorelli, F. (2008). The Italian e-Government Enterprise Architecture: A Comprehensive Introduction with Focus on the SLA Issue. In *5th International Service Availability Symposium, ISAS 2008 Tokyo, Japan, May 19-21, 2008 Proceedings*.	1	1	1	1	4	C2	S8	A	Italy	ED	14	2008	C	D3
A52	Azad, M. A. K., Khan, M. A. A., & Alam, M. (2008). *Government Enterprise Architectures: Present Status of Bangladesh and Scope of Development*. Paper presented at the Proceeding ICEGOV '08 Proceedings of the 2nd international conference on Theory and practice of electronic governance Pages 459-460 ACM New York, NY, USA ©2008.	1	1	1	1	4	C1	S4	GA	Bangladesh	IN	3	2008	C	D3
A53	Weerakkody, V., Janssen, M., & Hjort-Madsen, K. (2007). Integration and Enterprise Architecture Challenges in e-government: A European Perspective. *International Journal of Cases on Electronic Commerce*.	1	1	1	1	4	C1	S1	A	UK	ED	27	2007	T	E6
A54	Strano, C., & Rehmani, Q. (2007). The Role of the Enterprise Architect. *Information Systems and e-Business Management, 2007, Volume 5, Number 4, Page 379*.	1	1	1	1	4	C1	S8	A	U.S.	ED	43	2007	G	E1, E3, E4
A55	Janssen, M., & Hjort-Madsen, K. (2007). *Analyzing Enterprise Architecture in National Governments: The Cases of Denmark and the Netherlands*. Paper presented at the Proceedings of the 40th Hawaii International Conference on System Sciences, 218a.	1	1	0.5	1	3.5	C4	S9	A	The Netherlands	ED	72	2007	T	E5
A56	Hjort-Madsen, K. (2007). Institutional Patterns of Enterprise Architecture Adoption in Government. *Transforming Government: People, Process and Policy*, 1(4), 333-349.	1	1	1	1	4	C3	S4	A	Denmark	ED	36	2007	G	T1
A57	Guijarro, L. (2007). Interoperability Frameworks and Enterprise Architectures in e-government Initiatives in Europe and the United States. *Government Information Quarterly*, Volume 24, Issue 1, January 2007, Pages 89-101.	1	1	1	1	4	C1	S4	A	Spain	ED	2	2007	T	E6

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#	Selected reference articles	Q-1	Q-2	Q-3	Q-4	SQ	TP	TM	CM	First author	GO	cited	Year	CR	MT
A58	Gregor, S., Hart, D., & Martin, N. (2007). Enterprise Architectures: Enablers of Business Strategy and IS/IT Alignment in Government. *Information Technology & People*, 20(2), 96-120.	1	1	1	1	4	C1	S3	A	Australia	ED	88	2007	L	P
A59	Christiansen, P. E., & Gøtze, J. (2007). Trends in Governmental Enterprise Architecture: Reviewing National EA Programs. *The Journal of Enterprise Architecture*.	1	1	1	1	4	C1	S2	A	Denmark	ED	21	2007	G	E2
A60	Lynch, N. (2006). *Enterprise Architecture – How Does it Work in the Australian Bureau of Statistics?* Paper presented at the ACIS 2006 Proceedings. Paper 49.	1	1	1	1	4	C3	S9	A	Australia	ED	0	2006	L	D3
A61	Janssen, M., & Kuk, G. (2006). *A Complex Adaptive System Perspective of Enterprise Architecture in Electronic Government.* Paper presented at the Proceedings of the 39th Hawaii International Conference on System Sciences.	1	1	1	1	4	C3	S9	A	The Netherlands	ED	58	2006	C	E5
A62	Hjort-Madsen, K. (2006). Enterprise Architecture Implementation and Management: A Case Study on Interoperability, *Proceedings of the 39th Hawaii International Conference on System Sciences (HICSS-39)* (71-10). Kauai: Computer Society Press.	1	1	1	1	4	C2	S1	A	Denmark	ED	63	2006	L	E6
A63	Farooq, M. K. S., S. ; Awais, M.M. . (2006). *Devolution of e-Governance among Multilevel Government Structure.* Paper presented at the Innovations in Information Technology, 2006.	1	1	1	1	4	C1	S4	A	Pakistan	IN	3	2006	G	D1
A64	Janssen, M. C., A. (2005). *The Development of a Reference Architecture for Local Government.* Paper presented at the System Sciences, 2005. HICSS '05. Proceedings of the 38th Annual Hawaii International Conference on *System Sciences*.	1	1	0.5	1	3.5	C4	S4	A	The Netherlands	ED	15	2005	P	AD
A65	V Peristeras, K. T. (2004). The Governance Enterprise Architecture (GEA) High-level Object Model. In *Knowledge Management in Electronic Government*: Springer.	1	1	1	1	4	C1	S5	GA	Greece	ED	42	2004	G	T1
A66	Peristeras, V., & Tarabanis, K. (2004). Advancing the Government Enterprise Architecture -GEA: The Service Execution Object Model. In R. Traunmüller (Ed.), *Electronic Government: Proceedings of the 3rd [IFIP WG 8.5] International Conference, EGOV 2004* (pp. 476-482). Zaragoza, Spain.	1	1	1	1	4	C1	S5	GA	Greece	ED	33	2004	G	T1
A67	Peristeras, V., & Konstantinos, T. (2004). *Governance Enterprise Architecture (GEA): Domain Models for e-governance.* Paper presented at the 6th International Conference on Electronic Commerce (ICEC 2004), Delft, The Netherlands.	1	1	1	1	4	C1	S5	GA	Greece	ED	50	2004	G	T1
A68	Bellman, B., & Rausch, F. (2004). Enterprise Architecture for e-Government. In R. Traunmüller (Ed.), *Electronic Government: Proceedings of the 3rd [IFIP WG 8.5] International Conference, EGOV 2004* (pp. 48-56). Zaragoza, Spain.	1	1	1	1	4	C1	S6	A	U.S.	ED	34	2004	G	D3
A69	Martin, N. & G., Shirley., (2002). *Enterprise Architectures and Information Systems Alignment: Policy, Research and Future Implications.* Paper presented at the ACIS 2002 Proceedings. Paper 30.	1	1	1	1	4	C1	S3	A	Australia	ED	7	2002	T	T1
A70	Tarabanis, K., Peristeras, V., Fragidis, G. (2001). Building an Enterprise Architecture for Public Administration: A High-level Data Model for Strategic Planning, *Proceedings of ECIS: Global Co-operation in the New Millenium, 987-998.*	1	1	1	1	4	C1	S5	GA	Greece	ED	30	2001	T	D1

#	Selected reference articles	Q-1	Q-2	Q-3	Q-4	SQ	TP	TM	CM	First author	GO	cited	Year	CR	MT
A71	Peristeras, V., & Tarabanis, K. (2000). Towards an Enterprise Architecture for Public Administration Using a Top-down Approach. *European Journal of Information Systems 9 (4), 252-260.*	1	1	1	1	4	C1	S5	GA	Greece	ED	115	2000	T	T1

Research topics (TP): EA Development (C1); EA Implementation (C2); EA Adoption (C3); Overlapping (C4).
Research themes (TM): Interoperability and integration (S1); EA maturity (S2); EA alignment and strategy (S3); Framework (S4); Modeling (S5); Role of EA (S6); Developing EA (S7); Implementing EA (S8); Using EA (S9); General (S10).
Communities (CM): Academics and government employees (GA); Academics (A); Academics and enterprises (AE); Government employees (G).
Coverage (CR): General (G); International (T); Central government (C); Provincial/local/state/municipal (P); Line of business (L)
Method (MT): Theoretical framework building (T1); Critical literature Review (T2); Interview (E1); Survey (E2); Observation (E3); Secondary data (E4); Comparative studies (E5); Case studies (E6); Theoretical and practice integration (D1); Practice illustrations and introduction (D2); Viewpoints (D3); Prescriptive (P); Action design (AD).
Geography (GO): Authors from developed world (ED); developing countries (IN)

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Appendix B. Metadata themes within topic in EA research in public sector

SIssue	*# Article*	*Sub-issue**	*Issue with category*							
			EA development		*EA implementation.*		*EA adoption*		*Overlapping*	
			#article	*Reference*	*#article*	*Reference*	*#article*	*Reference*	*#article*	*Reference*
Framework	24	FI	4	A54, A17, A16, A24						
		BA	2	A29, A38						
		FE	3	A25, A26, A15						
		EV	2	A44, A19						
		FG					1	A53	3	A61, A2, A23
		FS	8	A49, A30, A47, A60, A6, A46, A7, A1	1	A22				
Using EA	12						10	A1, A2, A3, A4, A9, A13, A20, A31, A45, A34, A42, A58, A57	2	A32, A52
Modeling	7		7	A68, A67, A64, A63, A62, A37, A14						
Interoperability and Integration	6		2	A21, A50	2	A28, A59	2	A35, A43		
Implementing EA	6				6	A48, A40, A41, A10, A11, A5				
EA Maturity	3		1	A56			2	A36, A18		
General	3		3	A3, A8, A12						
Role of EA	3		2	A51, A65			1	A27		
EA Alignment and Strategy	2		2	A55, A66						
Developing EA	2								2	A33, A39
Total	*71*		*36*		*9*		*19*		*7*	

*Frameworks for Interoperability (**FI**); Business Architecture (**BA**); Framework for e-participation (**FE**); Evaluation Framework (**EV**); Framework in general (**FG**); EA framework in some specific context, such as data architecture, application architecture, technology architecture, and Identify Management Framework (**FS**).