Review Article

An exploration of the many ways to approach the discipline of enterprise architecture

Patrick Saint-Louis and James Lapalme

Abstract

Despite growing interest in enterprise architecture (EA) around the world in recent years, a lack of common understanding is frequently described by EA researchers/practitioners. We conducted a systematic mapping study and it revealed that the extent to which the authors/researchers are focused on EA, the sectors in which they are working, the academic disciplines in which they have studied, the countries where their affiliated organizations are located, the subject areas of the journals/publishers of their publications and the way they have approached EA and its practitioners are some major elements that might influence the existing uniformity in EA. In addition, this study demonstrates how important it is to pay attention to the definition of 'enterprise architecture' itself. The contribution of this study is the organization of the EA literature according to three major questions concerning 'who' have been published in the literature, 'where' they have been located and 'what' their publications are about. This helps to better identify sources of variety which could be on the basis of the lack of common understanding in EA and provides practitioners and stakeholders a better understanding of this challenge. This also provides relevant directions for future studies.

Introduction

Contemporary organizations regularly encounter challenges meeting their Information Technology (IT) needs, be it a simple tool with which to save and organize data, an indispensable strategic and competitive weapon or unique routine administrative tasks, such as decision-making that needs fulfilling.[1] According to some researchers, enterprise architecture (EA) is the discipline and practice that emerged in order to help organizations meet these challenges[2] in order to survive in an increasingly dynamic environment full of interruptions and change.

EA has generated growing interest in recent years, as shown by the numerous scientific articles published by EA researchers and practitioners, EA conferences organized around the world and new frameworks built to improve EA practice. But researchers and practitioners have described a serious lack of 'uniformity' in EA, as presented in Table 1, in spite of this significant progress.

The lack of 'uniformity' in EA is also presented in the study by Lapalme[4] as the 'existence of many ways to approach EA'. This study intends to identify the elements in the literature that can play a role in this challenge that EA is facing. To achieve this objective, this article systematically selected and reviewed the EA literature by following a few research questions.

Ecole de technologie superieure, Montreal, Quebec, Canada

Corresponding author:
Patrick Saint-Louis, Ecole de technologie superieure, 1100, rue Notre-Dame Ouest, Montreal, Quebec H3C 1K3, Canada.
Email: patrick.saint-louis.1@ens.etsmtl.ca

Table 1. Expression of the existence of various perspectives on EA.

Description	References
Lack of 'common terminology' and publication findings based on interpretation of implicit statements, rather than on 'scientific evidence'.	Schöenherr[3]
Lack of 'shared meaning' and the existence of 'a plethora of terminology'.	Lapalme[4]
Lack of 'shared vocabulary' and 'a consensus definition'. The discourse is still rather incoherent and fragmented.	Korhonen and Poutanen[5]
Lack of 'common understanding' and 'methodological consistency'.	Simon et al.[6]
Lack of 'common definitions' and 'perspectives' and the existence of many schools of thought.	The Federation of Enterprise Architecture Professional Organizations[2]
Lack of 'shared meaning' and 'interpretation'.	du Preez et al.[7]
Lack of 'shared understanding' of organizational applications.	Rahimi et al.[8]

EA: enterprise architecture.

The research problem and literature review are presented in 'Background' section. 'Research design' section presents the research questions and the methods applied to examine these questions. The results and their discussions are presented in 'Contextualization of the findings', 'Quantitative findings' and 'Qualitative findings' sections. And 'Discussions' and 'Conclusion and future work' sections present some discussions concerning the findings and useful directions for future work.

Background

EA literature lacks uniformity of definition as well as a description of the term 'enterprise architecture' itself.[9] The definitions of EA vary in terms of 'scope and purpose'.[4] This situation can create misunderstanding and conflict regarding the role and responsibility of professionals practicing EA, especially when EA team members are not thoroughly conscious of the extent of the lack of common understanding in EA. It can also be hard to collaborate with stakeholders and other participants in such situations. Similarly, this makes it hard to provide standard and universal training to future EA practitioners. EA researchers can face difficulty effectively sharing their findings and generally being understood.

Such problems represent a few complications experienced by researchers and practitioners. This is why some have reported that EA is an 'immature practice'[7,10] suffering from a 'lack of common terminology'[3] and 'shared meaning',[4] and EA literature is facing a challenge of 'fragmented discourse'.[5] As a matter of fact, this issue concerning the terminological differences in EA has been mentioned in the publications of many researchers, even if it is not the main focus of their work. Others have investigated this issue more thoroughly and came to more accurate conclusions. To achieve this, they reviewed and analysed the EA literature and surveyed researchers and practitioners.[10–12] In a similar way of identifying various terminology and perspectives in EA, some previous works affirm the existence of three *schools of thought* in EA.[4] This work has compared EA to an Indian parable which describes how six blind men who touched an elephant for the first time perceived it very differently – depending on the part of the body they happened to touch. This comparison contributes to awareness-raising conversations concerning the various ways of approaching EA, and therefore allows for the opportunity for EA to become more mature as a field through the establishment of a common structure.

Even though a large number of studies have mentioned this lack of common understanding in EA, only a few of them have realized a deeper investigation of the problem and employed a rigorous methodology to conduct their analysis.[2–7] A few formal systematic mapping studies (SMSs) and systematic literature reviews (SLRs) also exist on EA. Moreover, the rest of this section presents some existing literature reviews on EA.

In fact,[6] conducted a state-of-the-art review from 1987 to 2010 in order to investigate the collaboration of scholars in EA management via co-authorships and its impact on the diffusion of their contributions. They also investigated the main EA research streams, their interlink and the major works to be assigned to these streams. And finally, they investigated the focus concerning specific dimensions of EA research content (layer, methodology, task and life cycle).

On the other hand,[11] used bibliographic analysis standard tools to study EA within the public administration from 1999 to 2014 and investigated the publishers and their subject areas, the authors of the publication, the correlations among the keywords, the definitions of EA in public administration, government EA programmes around the world and so on.

On the other hand,[13] conducted a SLR on EA in the public sector from 2005 to 2014, which investigated the main topics of the EA publications, their themes, their geographical distribution, the research methods used and the number of citation.

On the other hand,[14] conducted a general SLR on EA from 2000 to 2015, which investigated the publishers of the papers and their topic, the authors and the country of their affiliated organizations.

However, none of the previous literature reviews focused on the whole discipline of EA and its lack of common understanding. Consequently, there is a need for

literature reviews which further our understanding of this lack. This investigation is intended as an input that might contribute to fill this gap,[15] by conducting a SMS[16] using articles published from 1990 to mid-2018 in major engineering, computer science and management journals.

Research design

Introduction to SMS

A frequent approach used to review and analyse literature in order to 'realize a complete overview of a research area' is SMS. SMS can contribute by finding 'whether research evidence exists or not'.[17] When research evidence exists on a topic, SMS can also provide indicators of its reliability. The process involves performing a systematic classification of literature and its interpretation. The categories generated with this systematic classification are based on pertinent data that include, for example, information concerning the authors and publications – *such as authors' names, authors' affiliations, authors' country, publication sources, publication type and publication chronology* – and information concerning the research design and research techniques employed to conduct studies and generate the findings.[16] The outcome of an SMS provides mainly a complete list of publications on the topic area investigated, presented in the form of classification where distinct categories are identifiable.[18]

SLR is another methodology that has frequently been used to review and analyse the literature of a field in order to provide relevant directions for future investigations. But SMS and SLR do not analyse the literature in the same way. SMS can help to structure a research area, while SLR can help to gather and synthesize evidence.[18] SMS frequently answer a large amount of research questions. For example, this study includes nine research questions. To achieve this, SMS 'collects data from the literature with sufficient detail and summarizes them with respect to many defined categories', whereas SLR examines to what extent the research findings of each publication are consistent or inconsistent in order to 'answer only a few specific research questions'.[16] However, the results of a previous SMS can be extremely useful in order to determine appropriate areas for conducting a relevant SLR.[16]

Motivation to conduct an SMS

A systematic examination like SMS can greatly help identify elements from which the many ways to approach EA have originated or simply the existing different ways to approach EA. In fact, the use of SMS as a rigorous methodology to conduct this study will enhance its data selection, its data extraction and its analysis process. The use of SMS will also increase the reliability of this study's findings.

Definition of research questions

According to the guidelines of Kitchenham et al.[16] and Petersen et al.,[18] the first task of SMS is to 'define the research questions'. The research questions indicate the scope of the study and specify what aspect it takes or does not take into account.[16]

This SMS investigates the following nine research questions, classified in three categories as enumerated in Table 2. The intent is to identify the different ways to approach EA, to investigate which characteristics contribute to the existence of these different ways to approach EA and to understand how the EA community has become aware concerning this situation.

Conducting the search for primary studies

The second task is to create a data search strategy that can help to 'identify and locate reliable data sources which can be used to extract the information to be analyzed'.[16,18]

Because this study intends to provide a broad view of the discipline of EA, all the publications corresponding to EA should be significant to be analysed. With the objective to keep this research to a manageable size, only publications which explicitly mention EA or EA practitioners in their title were taken into account. The following search strings were appropriate to search publications:

'enterprise architecture' OR 'enterprise architectures' OR 'enterprise architect' OR 'enterprise architects' – in the Title.

Search was operated in the following electronic libraries: Compendex, Inspec, Scopus, IEEE, AIS and Google Scholar. These electronic libraries were considered because according to some previous searches, they are the libraries which have returned most of the major scientific publications with the article type selected and the search keywords used. They are also the libraries which are considered among the most relevant ones.[19]

Table 3 presents the number of articles returned by each of the electronic libraries consulted. Google Scholar was often consulted for additional search and to download the full text of the articles.

Screening articles based on inclusion/exclusion criteria

The third preoccupation of this SMS is to select only relevant data sources corresponding to the identified search strategy.[16,18] In fact, the results of each digital library were exported into BibTex (.bib) files. Software usable for SLR and SMS (StArt) were used in order to upload these data. After examining the titles, abstracts, introduction and conclusions of the identified articles, duplicate articles and articles without the aforementioned terms corresponding to EA research or practice were removed.

Table 2. Research questions and rationales.

Category	No.	Research questions	Rationales
Who? Investigates information concerning people who have conducted research, wrote publications or published in EA.	RQ1	What is the publication intensity of EA researchers/authors?	Explore how the intensity of publications of the researchers/authors can contribute to the lack of common understanding in EA.
	RQ2	What is the occupation of EA researchers/authors?	Explore how the spheres of activity of EA researchers/authors can contribute to the lack of common understanding in EA.
	RQ3	What are the patterns concerning the choice of publication venues?	Explore how publishing choices and patterns about EA research can contribute to the lack of common understanding in EA.
	RQ4	What are the academic disciplines in which EA researchers/authors have studied?	Explore how the background of EA researchers/authors can contribute to the lack of common understanding in EA.
Where? Investigates information concerning the location of people who have conducted research and wrote publications in EA.	RQ5	Where are the affiliated organizations of main article authors located?	Explore how the language and the country/continent where the affiliation organization of the authors is located can contribute to the lack of common understanding in EA.
What? Investigates information concerning what the EA publications are about.	RQ6	What are the most common topics developed?	Explore how topics of focus concerning EA publications can help identify factors that might influence the lack of common understanding in EA.
	RQ7	What perspectives on EA do the articles adopt?	Identify the different ways to approach EA in the literature, according to the overall context and focus in a given article.
	RQ8	What perspectives about EA professionals represent?	Identify the different ways to approach the professionals practicing EA, according to their mission, competence and knowledge, as presented in the literature.
	RQ9	To what extent do authors/researchers discuss the lack of common understanding within EA discuss?	Understand how the EA community has become aware of the existence of multiple ways to approach EA and why shedding light on this challenge is urgent.

EA: enterprise architecture.

Table 3. Number of articles returned by the electronic libraries.

Electronic library	Number of articles found	Particularity
Compendex	141	
Inspec	220	
Scopus	241	Language: cannot be specified
IEEE Xplore	16	Language: cannot be specified
		Type: Journal and Magazine
AIS Electronic Library	135	Language: cannot be specified
		Type: cannot be specified
Google Scholar	458	Language: cannot be specified

In addition, at the start, the articles selected were only those that were downloadable on the Internet with a licence from the authors' affiliate libraries. However, other measures were also used when possible, in order to find copies of the articles, such as loans between university libraries and email contact with the authors of non-downloadable works.

With the objective to keep this research to a manageable size, 'researchers can search only a targeted set of publications as data sources, and then restrict themselves to only one (1) publication type for example'.[16] This explains the choice to select only journal articles as data sources. Moreover, peer-reviewed articles were selected in order to stay focused on more professionally executed research.

Table 4 summarizes the complete criteria used in order to include the appropriate data sources before the search, and after reading the title, introduction and conclusion. The exclusion criteria correspond to the values that are different from those indicated in this table.

Because this study does not map a particular aspect on EA but aims to gather information concerning the lack of common understanding in EA, all the journal articles available which have met the condition indicated in Table 4 were included and no quality assessment stage was conducted.

Data extraction, analysis and classification

Another important preoccupation of SMS is to 'create a classification scheme'.[17] Capturing 'the state of the art' in EA practice and research is the objective of our scheme.

Table 4. Inclusion criteria.

No.	Criteria	Values for inclusion
1	Duplication	Non-duplicate articles
2	Language	English
3	Publication date	From 1990 to 2016
4	Document type	Journal articles
5	Document access	Full-text downloadable on the Internet or sent from the authors, in a most common format like .doc or .pdf
		Or hard copies found via loans between university libraries
6	Correspondence	Studies corresponding to the field of discipline of EA or its practitioners
7	Sources	Scientific publications (instead of practitioner contributions)
8	Format	Publications with citations and references (instead of marketing material)

EA: enterprise architecture.

Because this study intends to have findings which really describe the situation of EA, it was not important to create a predefined classification scheme. A multifaceted classification scheme was consequently developed gradually, depending on the characteristics of the data collected.

In fact, the first author read entirely each article at least once, during which relevant data were collected. Most of the data collected were extracted as found, without any specific interpretation, in a MS Excel spreadsheet, in order to be able to format them automatically and to create the corresponding categories. The first author classified each article and applied a test–retest approach. The final classification was formally discussed many times with the second author.

After the publication of a first version of this study, many modifications were made to improve the study, including additional articles being were added. The data extraction process was realized by another person in accordance with a data extraction protocol that includes the categories found in the previous version, as presented in Table 5.

The last task of this SMS – without considering the report – is to 'analyze and interpret the data extracted' in the articles.[16,18] As can be seen in the column source of Table 5, the data extraction of certain information to collect required some analysis and attribution to a category. Furthermore, after collecting all the necessary information, various processes of data processing, such as validation, sorting, analysis and classification were applied in order to summarize the data collected. In the next sections, we present the different categories found, their occurrences and their similarity/dissimilarity compared to the other categories.

Validity evaluation

In terms of descriptive validity, the data extraction protocol used to extract and derive data from the articles allows the data extraction process to be objective because this process can be always re-examined.

In terms of theoretical validity, appropriate studies could not be identified during the search for primary studies.[18] To reduce the number of articles that have been missed, an additional search was conducted. In fact, few SMS exists on EA, yet it was not possible to compare the articles identified for this mapping study to others. But it was possible to compare these articles to those identified for an SLR which intended to summarize the existing work done in EA from 2005 to 2014, found with the strings 'enterprise architecture' either in the title, abstract or keywords. However, eight new articles – found in the study by Rasti et al.,[13] in which an SLR intended to summarize the existing work done in EA from 2005 to 2014, – were added in the current study. Another strategy to reduce the bias was to conduct additional searches on Google Scholar and thus 10 articles were added. As a result, 257 articles were selected for examination. Table 6 presents the number of articles selected at each phase of the selection process.

Concerning the validity of the data extraction process, the articles were classified individually by two persons, but their classification was then reviewed and discussed. A test–retest approach was also applied on a sample because the first version of this study, which considered a limited number of articles, was previously published in a conference.

Table 7 presents a publication timeline of the 257 articles selected for examination.

Contextualization of the findings

Distribution of the articles over the years

The 257 journal articles selected for examination were published over approximately 21 years, between 1990 and mid-2018. The year 2018 is absent in Figure 1 because the search was conducted in mid-2018, and so it was not possible to include all the EA journal articles published during this year. In effect, only nine articles were found for this year.

The distribution of the articles, as presented in Figure 1, demonstrates an absence of publications for the years 1991–1996, 1998 and 2002. Compared with the number of published articles in other disciplines as new as EA, the number of EA articles published over the years is few. However, this graph is still useful as it shows how EA has gained interest over the years.

Quantitative findings

What is the experience of EA researchers/authors?

Approximately 568 first and corresponding authors, including both researchers and practitioners, have contributed to the selected articles. Approximately 9% of these

Table 5. Summary of the data extraction protocol.

No.	Data extracted	Description	Source
1	ID	A unique number used to identify each article.	Increase of 1 from the last assigned number.
2	Title	The title of the article.	Information provided from the electronic libraries.
3	Authors	The authors of the article.	
4	Publication year	The year of publication of the article.	
5	Journal	The journal which has published the article.	
6	Author affiliation	The author's affiliation institution.	
7	Publisher	The publisher of the article.	
8	Author sector	The sector of activities where the authors evolved.	The 'Author Affiliation' category is considered to determine this information.
9	Academic disciplines	The study area in which the first author has studied (when author sector is Academia).	The 'Author Affiliation' category is considered to determine this information.
10	Subject area	The subject areas of the journal which have published the article.	The 'Publisher' category is considered to find this information on the Internet.
11	Country	The country where the first author's affiliation institution is located.	This information is extracted from the article or the 'Author Affiliation' category is considered to find this information on the Internet.
12	Continent	The continent where the first author's affiliation institution is located.	The 'Country' category is considered to determine this information.
13	Language	The first language of the country where the first author's affiliation institution is located.	The 'Country' category is analysed to determine this information.
14	Topic	The main topic addressed in the article.	The abstract, introduction and conclusion of the article have been read and analysed to determine this information. When this information cannot be found in the previous parts of the articles indicated, the whole article has been read.
15	EA presence	Presence of EA in the article (some articles include EA only in their title).	Search with keywords such as: 'enterprise architecture' and 'ea' are conducted in the article to determine this information.
16	EA definition	Presence of explicit or implicit definitions of EA (or derived explicit terms as Enterprise Architecture Management) in the article.	
17	Notification of lack	Presence of notification concerning the lack of common understanding and terminology in EA in the article.	The abstract, introduction and conclusion of the article have been read and analysed to determine this information. And/or search with keywords such as: 'common', 'shared', 'meaning', 'definition', 'lack', 'understanding', 'terminology', 'agreement' and so on are conducted in the article to determine this information.
18	Other denominations of EA	Other terms used to designate EA in the article.	The abstract, introduction and conclusion of the article have been read and analysed to determine this information. When this information cannot be found in the previous parts of the articles indicated, the whole article has been read.
19	EA focus	The focus of EA as presented in the article.	
20	EA practitioner	The way to approach the practice of EA.	The 'EA Focus' category is considered to determine this information. The abstract, introduction and conclusion of the article have been read and analysed to determine this information. When this information cannot be found in the previous parts of the articles indicated, the whole article has been read.

EA: enterprise architecture.

authors contributed between 3 and 7 articles, as presented in Table 8.

Approximately 65% of the authors published only one of the articles. It would seem then that EA literature lacks publications from experienced researchers in the discipline.

What is the occupation of EA researchers/authors?

Figure 2 presents the occupation of the authors.

As seen in Figure 2, approximately 77% of the first and corresponding authors of the articles are 'students or professors' who come from schools, universities, faculties, institutes, research centres or laboratories.

Table 6. Evolution of the number of articles selected.

Step	Number of articles added	Number of articles removed
Search	279	
Application of the inclusion/ exclusion criteria		11
Document access		21
Validity evaluation	19	
Data extraction		9
Total number of articles selected	257	

Table 7. Publication timeline of the articles selected for examination.

Year	References
2018	20–28
2017	8,14,29–47
2016	48–72
2015	73–91
2014	10,92–123
2013	2,5,6,124–139
2012	4,9,140–167
2011	1,168–181
2010	182–195
2009	196–205
2008	3,206–209
2007	210–226
2006	227–243
2005	241,244,245
2004	246–254
2003	255–258
2001	259
2000	260,261
1999	262–264
1997	265
1990	266

Approximately 11% of these authors are 'professional practitioners' who come from private or public organizations, such as research agencies, government agencies and consulting firms.

Approximately 9% of these authors of the articles come from 'both professional organizations and academia institutions', and their research is based on partnerships between industry and academia.

Finally, because of a lack of information in the articles concerning the affiliation institution and no possibility of finding it on the Internet, the affiliation of 3% of these authors is considered as 'unknown'.

A large majority of the articles selected derive from the academic world. This is to be expected because this study includes only scientific articles. But why have these articles presented many different ways to approach the discipline of EA as demonstrated in the following sections? It would seem then that EA lacks agreed references to follow in the academic world.

What is the focus of EA publishers/editors?

The selected articles were published across approximately 132 journals. Approximately 23 of these journals published 43% of the articles (as presented in Table 9) and represent the most significant publications, at 3–10 articles each. The editors and publishers of these journals include Taylor & Francis, Elsevier, Cutter Consortium, Springer Frontiers and IEEE, which are among the most well-known ones in the academic sector.

Journals may cover numerous subject areas. For example, one of the journals has 37 subject areas. The blank cells in Table 9 indicate cases in which it was not possible to find information concerning the subject area of the corresponding journal.
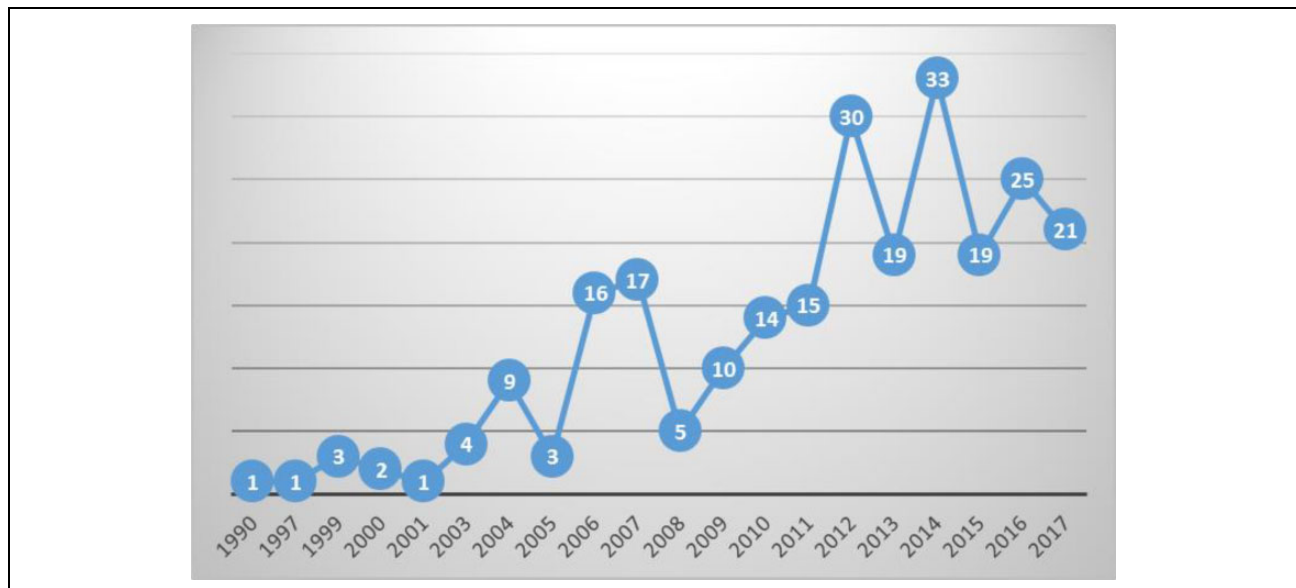
Figure 1. Journal article distribution by the publication year.

Table 8. List of authors who have contributed to more than two articles.

No.	Authors	Occurrence	No.	Authors	Occurrence
1	Närman, Per	7	26	Choi, Youngwan	3
2	Tarabanis, K	7	27	Fielt, Erwin	3
3	Ekstedt, Mathias	6	28	Foorthuis, Ralph M	3
4	Johnson, Pontus	6	29	Franke, Ulrik	3
5	Holm, Hannes	5	30	Harrell, JM	3
6	Kim, Kwangsoo	5	31	Hazen, Benjamin T	3
7	Nikpay, Fatemeh	5	32	Hinkelmann, Knut	3
8	Rouhani, Babak Darvish	5	33	Kaisler, Stephen H	3
9	Brinkkemper, Sjaak	4	34	Korthaus, Axel	3
10	Gill, Asif Qumer	4	35	Lagerstrom, R	3
11	Iyamu, Tiko	4	36	Lapalme, James	3
12	Jonkers, Henk	4	37	Lee, Jeongsoo	3
13	Kang, Dongwoo	4	38	Liu, Simon	3
14	Lankhorst, Marc M	4	39	Magoulas, Thanos	3
15	Tambouris, E	4	40	Mahrin, Mohd Naz'ri	3
16	Ahmad, Rodina Binti	3	41	Pekkola, Samuli	3
17	Alwadain, Ayed	3	42	Peristeras, V	3
18	Armour, Frank J	3	43	Pessi, Kalevi	3
19	Bernus, Peter	3	44	Quartel, Dick AC	3
20	Bos, Rik	3	45	Rosemann, Michael	3
21	Boza, Andrés	3	46	Sage, AP	3
22	Bradley, Randy V	3	47	Shaanika, Irja	3
23	Buschle, Markus	3	48	Simonsson, M	3
24	Byrd, Terry Anthony	3	49	Snoeck, Monique	3
25	Chae, Heekwon	3			
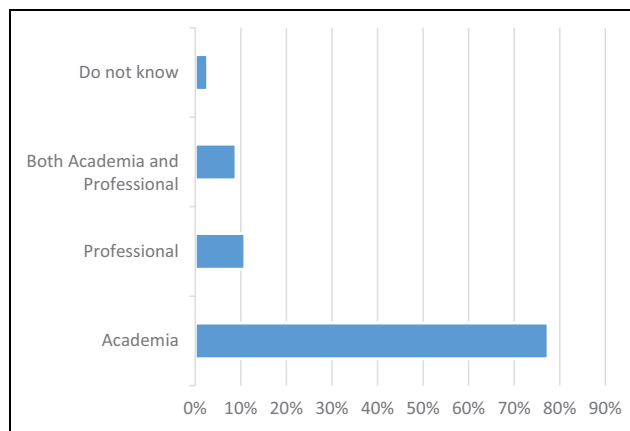
Figure 2. Occupation of the authors.

The classification of subject areas shows that a large majority of the journals correspond to subject areas related to Information Technology (i.e. computer science). It would seem that EA lacks editors/publishers dedicated specifically to EA publications.

What are the academic disciplines in which EA researchers/authors have studied?

The first authors of 87% of the selected articles came from academia. When considering the department, faculty, institute or laboratory where they conducted the research published in these articles, three main categories of study were identified.

- Information Technology (IT): This category includes articles which indicate that the first authors are studying in Information and Communication Technology. It also includes authors who is studying in corresponding fields, like Informatics, Information Systems, Software, Computer Science or Computer Engineering;
- Social and human science (SS): This category includes articles which indicate that the first authors are studying in social fields like Administration, Management, Business, Economics, Communication Logistics or Marketing; and
- Specific area of engineering (SE): This category includes articles which indicate that the first authors are studying in a precise field of engineering different than Information Technology and its corresponding fields. Authors of this category are studying, for example, in Operation Research Mechanical, Electrical, System and Industrial. This category also includes the names of study that mixed several specific fields of engineering, like Industrial Information, Supply Chain Management, Mines-Telecom and Control Systems.

The absence of enough information concerning the study area of the first authors of some articles was a reason to consider the following other categories in addition to the previous ones.

Table 9. List of editors/publishers that contributed to more than two articles.

| Journal	Publisher/editor	Total	Subject area
IT Professional Magazine (listed as 'IT Professional')	IEEE Computer Society	11	Computer Science
Enterprise Information Systems – EIS	Taylor & Francis	10	Computer Science
Information Systems Frontiers	Frontiers	9	Computer Science
Software and Systems Modeling – SoSyM	Springer	8	Computer Science Mathematics
Lecture Notes in Business Information Processing	Springer	6	Business, Management and Accounting
Government Information Quarterly	Elsevier	6	Social Sciences
Information Systems and e-Business Management – ISeB	Springer	5	Computer Science
Communications of the Association for Information Systems	AIS Electronic Library	5	Computer Science
Lecture Notes in Computer Science (including subseries *Lecture Notes in Artificial Intelligence* and *Lecture Notes in Bioinformatics*)	Springer	5	Computer Science Mathematics
Cutter IT Journal	Cutter Consortium	4	Computer Science
International Journal of Computer Integrated Manufacturing	Taylor & Francis	4	Computer Science Engineering
Expert Systems with Applications Journal	Elsevier	4	Computer Science Engineering
Information Knowledge Systems Management Journal	IOS Press	4	
International Journal of Information System Modeling and Design	IGI Publishing	4	Business, Management and Accounting Computer Science
International Journal of Computer Science Issues – IJCSI	International Journal of Computer Science Issues – IJCSI	4	Computer Science Mathematics
Annual Reviews in Control Journal (listed as 'Annual Reviews in Control')	Elsevier	3	Computer Science Engineering
Applied Soft Computing Journal	Elsevier	3	Computer Science
IFIP Advances in Information and Communication Technology	Springer	3	Decision Sciences
Journal of Object Technology	EtH Zurich	3	Computer Science
Journal of Systems and Software	Elsevier	3	Computer Science
MIS Quarterly Executive	Indiana University's Kelley School of Business	3	Economics, Econometrics and Finance
World Scientific and Engineering Academy and Society Journals	World Scientific and Engineering Academy and Society (WSEAS) Press	3	
International Journal of Advanced Manufacturing Technology	Springer	3	Computer Science Engineering

- Non-identified areas of engineering (E): This category includes articles which indicate that the first authors are studying in a general name of study that might refer to several other specialized engineering fields. Some examples of the names of study put in this category are: the Faculty of Technology Engineering and Environment, the Faculty of Science and Engineering, the Department of Computer Science and Engineering and the Faculty of Technology and Engineering;
- Other (O): This category includes articles which indicate that the first authors are studying in a field different than IT, engineering and social sciences, as presented in the previous categories. This category includes two authors, one who is studying in a School of Medicine and the other in a Center of Forest Studies.
- Absent (ABS): This category includes articles which do not indicate enough interpretative information

concerning the study area of the first authors. When this situation occurs, sometimes it is possible to find the study area of the authors on the Internet, in their other publications. But other times it is not possible to find this information.

Figure 3 presents the previous categories concerning the academic disciplines in which EA researchers/authors have studied, including a category N/A (non-applicable) for first authors who are not affiliated with an academic institution (professional) or when their sector of activities are absent.

Where are the affiliated organizations of the first EA researchers/authors located?

The article distribution by country of publication shows that the affiliated institutions of the first authors are located in 46 countries. This also shows that a large majority of the articles come from institutions located in Europe, which
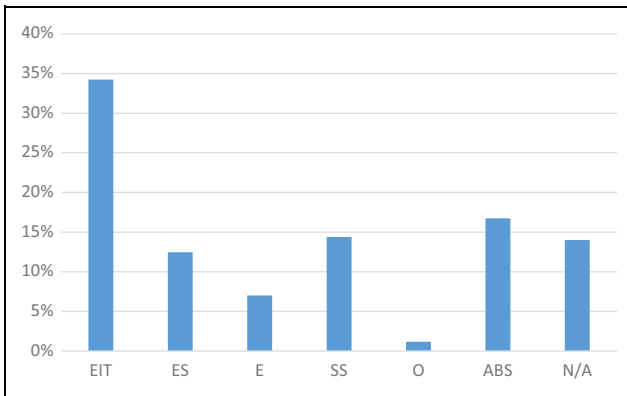
Figure 3. Academic disciplines in which EA researchers/authors have studied. Information Technology (IT), social and human science (SS), specific area of engineering (SE), non-identified areas of engineering (E), other (O) and absent (ABS).

published approximately 48% of them. America (all of North America + South America) published 11% of the articles and Asia published 30%. Finally, Africa and Oceania published the smallest number of articles, with respectively 7% and 4%.

Table 10 presents the countries that published more than two articles between 1990 and 2018. The empty cells in this table mean there is no publication which corresponds to the matching years and countries. This table also shows the increasing interest manifested in EA everywhere, with an accent in America and Europe. Particularly in the following countries: the United States, Iran, Australia, Sweden and the Netherlands, which published approximately 46% of the selected articles.

When comparing these findings to the study area of the first authors, it shows that approximately 46% of the researchers who are studying in a Social Sciences area come from an academic institution located in Europe. In fact, European academic institutions seem to be showing more and more focus on this area of study.

What are the most common topics addressed in the articles?

The title of an article is the first clue to the topics addressed in this article. In order to have a broader view of the topics addressed in the selected articles, the most repetitive single words in their titles were used to create the *word cloud* presented in Figure 4. From 'enterprise' at 268 occurrences, 'architecture' at 214 occurrences, to 'management' at 22 occurrences, and 'strategy' with 4 occurrences, this word cloud supports the previous hypothesis concerning the increasing interest of Social Science departments in EA. Especially when observing how some words related to management, like 'decision', 'structures' and 'strategy' are more and more present in the titles of the articles.

After reading and analysing the abstract, introduction and conclusion of the articles (at the very least), the

following categories presented in Figure 5 were identified in accordance with the main topic addressed in each of them.

- EA tools: This category includes articles whose central aim is to study the tools developed for EA professional to achieve EA objectives, and the tools developed for an organization according to an EA approach. The particular contexts that compose this category are focused on descriptions, languages, patterns and architecture modelling. Some EA models and EA frameworks have also been developed or evaluated in this category.

- EA application: This category includes articles in which the central aim is to describe a specific use of EA which accomplishes a beneficial activity for the progress of an organization. It also includes articles whose objective is to provide a group of specific steps to follow when an EA strategy must be built, controlled and maintained. The particular contexts that compose this category are focused on the principles that guarantee a successful application of EA, the maturity of EA practice, findings of how to get the most value from EA and successful decision-making.

- EA discipline: This category includes articles whose central aim is to describe EA as a discipline and a practice in order to make its importance clear. In fact, the particular contexts that compose this category are focused on EA practice, challenges, roles, benefits and comparison to other fields. Some other articles of this category addressed the steps required to help EA become a recognized profession. In this category, many other publications have been reviewed to analyse and summarize the EA literature. The present article can be classified into this category.

- EA measurement: This category includes articles whose central aim is to evaluate and demonstrate the performance and maturity of EA. In fact, the particular contexts that compose this category are focused on aligning business and IT, compliance, return on investment and long-term financial improvement capabilities.

- EA practitioner: This category includes articles whose central aim is to highlight the mission and role of EA practitioners. The particular contexts that compose this category are focused on exploring the development and improvement of EA skills, and the strategies applied to achieve their mission.

This section shows how the EA community is focused on studying the development of new tools, and the optimization and analysis of existing tools (frameworks, models, etc.).

Table 10. List of countries by publication occurrence.

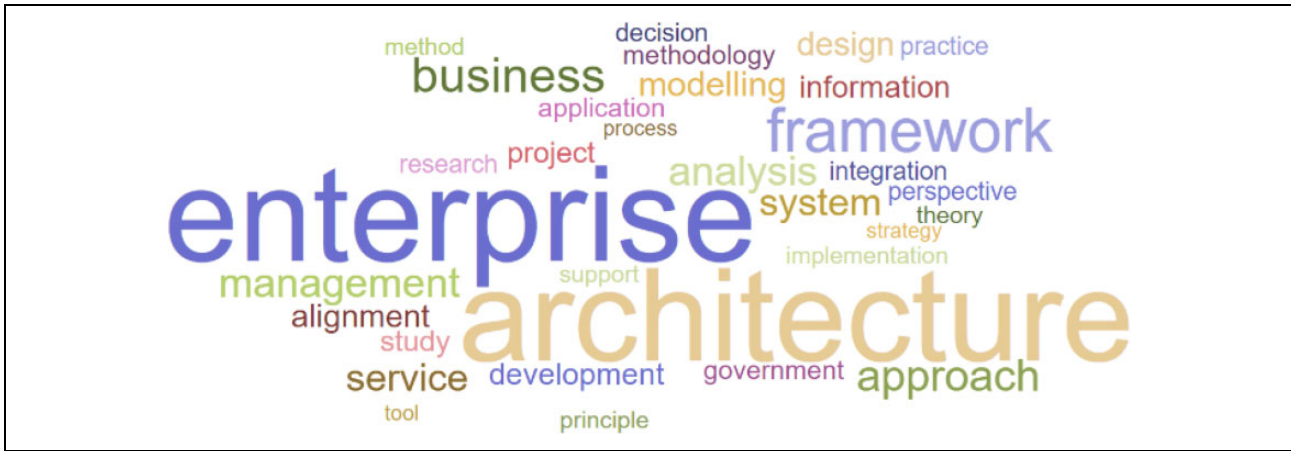| Country	|	Year/occurrences																						
		1990	1997	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total
USA		1	3	1		1		2	1	4	4	1	4	6	4	3		5		1	3		44
Iran								1		1	2			2	2	5	3	1	4	4		1	25
Australia							3											4	3	4	2	2	18
Sweden										1	2			2	2	3	1	4			1		17
Netherlands			1					4		2				1	1	4		1		1	1		14
South Korea										2				4		1			2				9
Malaysia																1		2	2	2	1		8
Germany																1	1	2	2		1		7
Greece								1			1					2		2	2		2		7
South Africa								1		1		1	1								2		7
Switzerland																1	1	2	1	1		1	7
Canada																2		2		1	1		6
Finland									1											1	3	1	6
Portugal															1		1	2	2	2			6
Belgium										1	1		1			2		1		1			5
China																2	2					1	5
Indonesia															1	1	1			2		1	5
Spain										1	1				1		1		2				5
United Kingdom						1								1	1	1		1					5
India														1				1	1		1		4
Japan																				1	1	2	4
Saudi Arabia																			1		1	2	4
Colombia												1							1		1		3
Denmark												1	1					1					3

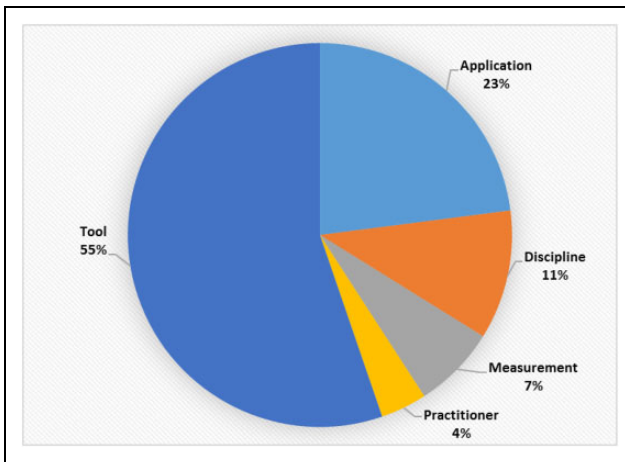**Figure 4.** Word cloud with the titles of the articles.

Figure 5. Topics addressed in the articles.

Qualitative findings

How do the articles approach EA?

Approximately 18% of the articles contain the term 'enterprise architecture' only in their title. Many of the articles explicitly used other terms to designate EA, like Information Technology, Information Systems Research, Organizational Modelling, Enterprise System Architecture, Architectural Approach and Enterprise Computing.

Many of the selected articles do not include any explicit or implicit EA definition. Researchers start talking directly about EA in these articles as if EA is a standard discipline, words or term that everyone is supposed to understand the established meaning of. Others of the selected articles do not provide personal definitions of EA but define it with one or several reference citations. Finally, just a few of the selected articles provide personal definitions of EA composed by the authors themselves, with their own words.

The significant importance of definitions in the identification of a discipline cannot ever be understated. In fact, the first question practitioners or researchers naturally ask

whenever they engage with a subject for the first time is always: 'what is this subject I am examining?'.[9] And the answer to such a question is a definition. Because of this, it is crucial to understand the meaning of EA from one article to another in order to allow people to be able to identify EA among other disciplines.

However, after reading the articles and looking at the associations they made with EA in their main sections, the following categories were extracted:

- Technological context (84%): The analysis, design, planning, implementation and other activities related to practicing EA are only focused on the 'technological context' of the organization. This category includes the conception of technological components, their evaluation, their alignment with the business and others. 'This school is techno-economic in that it aims to reduce IT costs through technology reuse and eliminating duplicate functionality'.[4]

- Sociotechnological context (9%): The analysis, design, planning, implementation and other activities for conducting EA are not focused only on the 'technological context' of the organization but also on its 'sociocultural context'. This category includes the management of people who are developing and using the technological components of the organization and their integration and participation in the decision-making process. Some references present this context as a top-down approach: 'Traditional enterprise architectures are based on topdown approach. They emphasized on consistency throughout the organization and will involve all levels of employees'.[267] It is to say that 'enterprise architecture is not only an IT issue, but a strategic and organizational challenge'.[268]

- Ecotechnological context (2%): The analysis, design, planning, implementation and other activities for conducting EA are not only focused on the

Table 11. Examples of the focus of EA.

Focus	Example	References
Technological context	This article presents a conceptual component to address the common public administrative 'problematic of matching a citizen's needs with accessible public services'. This IT component follows a 'Governance Enterprise Architecture model' and consists of a citizen's needs received as input, and a group of public administrative services provided as output. This set of services satisfy the need by employing semantic technologies and by using a public administrative service model. The proposed system architecture includes different elements, which are an application server (Apache Tomcat), a reasoner (Pellet) and a Web Ontology Language file that represents a knowledge base. The end users use a common Internet browser to access the application. The use of EA in this article contributed to building a component that is often the focus in the technological context. This study does not treat questions related to the sociocultural aspect of the people who are developing and will use this component.	210
Sociotechnological context	This article presents a case study realized in a public-sector organization. This study shows how the decision-making process of an EA development allows people to participate. In fact, the staff at all echelons and departments of this organization are involved and are free to express varied points of view concerning the business and technical concerns. Executives (senior management) take into consideration proposals from the staff, stakeholders, managers and programme components. Many communication ways to share business documents, as well as to share understanding and knowledge across this public-sector organization, were used. As part the technological aspect of EA presented in this study, it also underlines how stakeholder and staff involvement at all echelons and departments enables the improvement and agreement of the strategic orientations, work plans and other.	217
Ecotechnological context	This article describes a strategy to focus on business and process information that are necessary in order to achieve wood supply and forest management. This strategy is developed in an organization that operates in wood pulp production. A lot of people who do not share a direct relationship with the organization were actively involved during the development of this strategy, such as business experts, Information Technology managers, forest and plant supply planners, operation planners, forest certification experts and other. The objective of this strategy is also to achieve intercompany collaboration with the adoption of similar business process architectures and concepts. This strategy and the participants involved in its development show how EA is not only limited to the direct beneficiary of the organization, but also considers its environment, like compliance with standards (i.e. certification experts), the ecosystem (i.e. forest planners), society (i.e. other organizations) and more.	170

EA: enterprise architecture.

'technological and social context' of the organization but also on the 'ecosystem context'. This category includes the relationships an organization has with its environment: other organizations, the community, the government, the environment, the ecosystem, the standards (requirements, specifications, guidelines, etc.) and so on. 'Enterprise architecture should be able to cope with the fast changing business environment with ever changing needs and relations with the customer an boundaries'.[269]

Five per cent of the articles were not considered for this classification because they too explore the lack of common understanding in the discipline of EA and present many similar ways of approaching the discipline without weight placed on one over another.

Table 11 presents an example corresponding to each category of focus. This does not imply that the authors of the cited references always work within the same context. The classification presented only corresponds to cited articles. Also, none of these three contexts should be considered above the others.

How do the articles approach the professionals who practice EA?

In addition to the previous observations concerning the context of EA on which the articles focused, they do not describe in the same way the role, mission, knowledge or competence of EA practitioners. In fact, in accordance with the different way to approach the practice of EA, as observed in the articles, the following categories were extracted:

- A 'specialist' or an 'investigator' who can imagine and understand the needs of an organization, the problems it is facing and the perspectives it is following in order to find and implement the best manner to satisfy or resolve them with IT. These enterprise architects think they can help organizations choose the best solutions to meet their needs.[233]
- An 'integrator' who has the ability to join all the stakeholders together with their understandings of the needs, perspectives and problems of their organization. These enterprise architects believe that IT alone

cannot be an effective solution, but the participation and the motivation of the stakeholders in the decision-making process is crucial, and that effective solutions can be achieved through communication, negotiation and collaboration, for example.[83,217]

- A 'facilitator' capable of facilitating a good understanding of the needs of an organization, the problems it is facing and the perspectives it is following through the adaptation of these elements with the environment. Potential solutions must be adapted to the environment of the organization. These enterprise architects do not only focus on the internal environment of the organization, as the previous category does. Instead they believe that the organization can also be greatly impacted by the external environment (other organizations, the community, the government, the environment, the ecosystem, the standards, etc.), and vice versa. In fact, these enterprise architects think that IT and the social context of the stakeholders of the organization must also be accompanied by organizational adaptation to the outside world in order to take the lead in innovation and sustainability.[170]

To what extent are the EA researchers/authors aware of the lack of common understanding?

As mentioned early in this article, there is an increasing number of authors who have described a lack of common understanding in EA. The analysis of the articles conducted in this study reveals that many of these authors are aware of a challenge caused by the existence of different, and even divergent, understandings of EA. One author explains, for example, that 'EA is still a challenging concept' because there is no universal world view in EA, but several definitions of EA exist and there are various perceptions.[161] Another explains 'EA lacks semantics', and that people cannot have an exact and common understanding of EA.[186]

Some other articles are more to-the-point and affirm for example that EA suffers from ambiguous definitions of what it is or is supposed to be. Another highlights 'an absence of any consensus' concerning what EA is or supposed to do and how it is supposed function.[185] Yet another indicates 'a lack of theoretical foundation, definition, or common understanding' among researchers who have published in EA.[270] Still others address this issue by questioning the differences between the approaches of enterprise architects. For example,[99] explains how there are an increasing number of enterprise architects, 'but there is no universally accepted baseline of standards and knowledge to ensure consistent service'. And[225] explains how variation and contradiction identified in the EA definitions within the literature 'further complicates the challenges of defining the role' of EA practitioners.

Despite this increasing number of authors who have reported a lack of common understanding in the discipline of EA, few of them proposed to fully investigate, understand or resolve this challenge. However, certain studies try to generate new ways of approaching EA based on several existing definitions and concepts of EA. Certain other studies try to demonstrate how some ways of approaching EA correspond or not to the practice of EA.

Finally, another significant consideration that the articles analysed in this study reveals is the consequences of the lack of common understanding in the value of EA. Is it clear that the use and usability of EA may fully depend on 'how it is understood, defined and scoped'.[102] In effect, without the presence of concise and precise description concerning the roles that can achieve architecture success, 'architects may be viewed as providing no specific value' for organizations.[133]

Discussions

Discussions concerning the findings

Concerning the distribution of the articles over the years, the articles selected for this mapping study do not represent the total number of journal articles published in EA from 1990 to 2018. This is because of the limitation of the inclusion criteria applied, the duplication of some of the articles and the articles that are non-downloadable. Moreover, this study includes only a portion of the articles published in 2018 because the search was conducted in mid-2018. But comparisons with the articles selected in some SLR concerning a general summarizing of EA[13] – there are no other SMSs concerning a general summarizing of EA literature to be considered – show that a large majority of the published journal articles were considered in this study and then the sample is representative of the total number of publications (population).

Taking into account the previous precision, observing the distribution of the articles over the years provides useful insight into how young EA still is. For example, the highest number of journal articles published in 2014 is 33. Without a doubt, this number is small compared to the number of published articles in the field of Software Engineering for example, which is also a recent discipline of study. This argument is not intended to declare that the discipline of EA is not generated growing interest. In contrast, as indicated in the beginning of this study, the growing number of EA publications over the years, the growing number of practitioners and researchers involved in EA research and the growing number of conferences and training organized for EA are a perceptible proof of it evolution. The various topics that have been developed in EA literature and the diverse approaches and techniques that have been used to investigate these topics can also be considered as a concrete sign of the evolution of EA.

Concerning the experiences of EA researchers/authors who have published in EA (RQ1), when analysing the fact that approximately 65% of authors included have published only one of the articles, it seems that a large majority of the authors of EA literature are not experienced researchers in EA. This leads us to ask why EA researchers do not become mainly focused on EA? Are there some EA researchers/authors who mainly work on EA as their area of specialization? Do EA researchers/authors consider EA as a sub-branch of other main disciplines or as a separate branch derived from other disciplines?

Concerning the occupation of the authors (RQ2), they are predominantly students/researchers and professors/researchers, because a large majority of them are affiliated with an academic institution. A specific restriction in academic research is that new observations and argument must regularly derive from existing references. Because of this obligation, maybe there would not be so many ways of approaching EA in the literature if EA authors had agreed references to follow. This raises numerous questions, such as: Do EA researchers/authors have agreed and standard references to follow, including for example definition, terminology and world view? Why have academic authors/researchers have so many ways to approach the discipline of EA? It would be interesting to know how many of the articles are written by students/researchers with their supervisors, and how many are written only by professors/researchers, in order to evaluate which of these two scenarios present more variations (i.e. definition, terminology and world view) compared to existing references.

Concerning the academic disciplines in which researchers have studied (RQ3), at least three categories – Information Technology, specific areas of engineering and social and human sciences – were found. Undoubtedly, each of the fields from which the discipline of EA has originated has a different world view including different ways of perceiving and facing real-world problems and procuring results. What is the impact of the world view of each of these fields on the final approach that authors provide to EA?

Concerning the focus of the publishers/editors of the EA publications (RQ4), there is an absence of enough journals and editors/publishers dedicated specifically to EA. In fact, the institutions which have published the most articles are the well know publishers that often have disciplines related to IT as main subject areas. Because there are not enough publishers dedicated specifically to EA, the articles are also published here and there through various journals.

The analysis of the subject area of the institutions which have published the EA papers also shows how the Social Sciences are more and more represented in EA even though a large part of the research is conducted by researchers that have studied in IT and an Engineering area, and published by editors/publishers with a subject area and category related to the same disciplines.

Concerning the location of the first author's affiliated organization (RQ5), English is only the official language of 38% of the countries where the affiliated organizations of the first author are located, while only articles written in English were selected in this study. Because of this, would it be reasonable to consider sufficient knowledge of the English language to also be a factor favouring the existence of different ways to approach EA in the literature? Furthermore, it would be necessary to confirm the authors' languages in order to support such a hypothesis.

Despite the fact that 17% of these articles are written by first authors from the United States, only 11% of these articles are from the American continent. In fact, European researchers/authors – 48% of the articles are written by first authors from Europe – seem to have taken control of the leadership of the EA discipline.[7]

Approximately 47% of the researchers who are studying in a Social Sciences area come from a European academic institution. When observing that the majority (60%) of the articles with unknown study areas of the first author (absent 17%) also come from the European continent, it is possible to imagine that the authors of these articles are also studying in Social Sciences. If so, this will increase this category of authors who are studying in Social Science (14%) which is actually lower than the authors who are studying in IT and an Engineering area (54%). This supports the previous observation which indicated that the social and human sciences are more and more represented in EA. The word cloud shown in Figure 4 (RQ6) is further evidence which supports that the managerial context of the organization is more and more considered in EA research, even when the technological context is dominant. In effect, this aspect can be observed in the increasing use of certain words even in the titles of the articles which explicitly refer to social and human sciences.

Another aspect concerning the most common topics addressed in the articles (RQ6) concerns how the evaluation of the utilization of EA tools, either newly developed or previously existing, have been neglected in the literature of EA. It seems that there is a lack of relevant directions for future studies in EA. In effect, the majority of the publications are focused on building and studying EA tools developed to apply EA or tools derived from an EA application (EA tools 55%). But without a complete and up-to-date understanding of the practice of EA (EA practitioner 4%) – including the role of EA practitioners, their world views and their needs, for example – How will it be possible to create appropriate tools for them? Without clear evaluation (EA measurement 7%) of the performance of the existing tools – including the characteristics to measure and their importance, the metrics and the standards, for example – How will it be possible to continually improve their creation and use? Conducting more literature analyses (i.e. SLRs, SMSs and content analyses) intended to study the state of the art of EA or to explore specific challenges concerning EA could help provide relevant directions for

future studies. For example, this could help researchers to avoid fundamental work on EA tools when several existing tools have not been applied (EA application 23%) or evaluated yet. In effect, the practical aspect of EA must also play a more important role in EA research through the realization of more descriptive and experimental research which uses explicitly corresponding research methods such as opinion surveys, discourse analysis, participatory action research and design science research, for example.

Concerning the ways that the articles approach EA (RQ7), the original data collected without any interpretation prove the existence of the lack of common understanding in EA. The various definitions provided to explain what EA is, what value EA is supposed to provide organizations, how EA is supposed to be applied and the various other terms used to designate EA are some examples. The indication of this lack of common understanding in EA in more and more articles, as seen in the findings, has demonstrated how EA researchers/authors are aware of this lack (RQ9). Now, this challenge must be studied in depth in order to find more tangible findings that can help to better address it. The characteristics and assumptions discussed in the previous sections represent precisely some important characteristics which can be taken into account in order to study this lack of common understanding. Answers to the different questions generated would be very useful for a better understanding of the origins of this lack. However, these characteristics – complemented by others – are not required to be analysed individually. Many other questions must be asked in order to relate them, and many other questions must be asked concerning the methodological techniques that will allow us to find the appropriate answers. For example, the fact that more publications are focused on EA tools can be caused by the choice of the publishers to publish mainly articles in this category rather than the others. Just as it can be caused by the academic discipline in which EA practitioners have studied.

The categories found concerning how the articles approach EA (RQ7) which are the 'three major ways of approaching EA' (technological, sociotechnological and ecotechnological) are based the 'three modes of EA',[208] the 'three schools of thought on EA'[4] and the 'three distinct interlinked architectures'.[5] The difference in this study is that each of these categories is presented only according to the information extracted from the articles (contexts of the focus and the tasks). This means that other interpretation did not take place in order to provide a full description of each category (scope, assumption limit, etc.). At the first observation, it seems that the way of approaching EA is strongly connected to the discipline in which the first author has studied (technological context → IT areas; sociotechnological context → engineering areas; ecotechnological context → social and human sciences). But the findings do not confirm such an assumption because an overwhelming majority of articles correspond to the technological context.

On the other hand, the three ways the articles approach professionals practicing EA (specialist, integrator and facilitator) (RQ8) derive from the previous ways of approaching EA. Because a large portion of the articles focused on building, they have presented EA practitioners as specialists who can create, modify and optimize (i.e. tools, processes, principles, documentations and strategies) without involving all the stakeholders in the decision-making process to be sure to understand their needs and motivations (internal environment), as well as the interest of the whole community (external environment).

Building a codebook – including the specific words, expressions and wording – which identifies the particularity of the articles placed in each of the ways of approaching EA and its practitioners could be an appropriate method (content analysis) to validate these findings.

Implications for research

A large number of studies reported that many ways of approaching EA exist, even if it is not their main focus. In fact, only a few studies are completely dedicated to investigating this lack of common understanding in EA. Until this moment, the studies which are completely dedicated to studying this lack of common understanding in EA do not use a rigorous investigation and thus based their findings on primary studies selected and analysed without following specific criteria. Therefore, a survey was also conducted on this topic. But this survey used the existing models and did not leave enough opportunity to draw a complete picture of the state of the art of EA.

The situation described above shows that validity and reliability are mostly missing in the investigations which address lack of common understanding in EA, and also more investigations must be conducted. In this context, the contribution of this study is manifold.

First, it represents one of the few studies which address this problem of lack of common understanding. It confirms some previous findings and provides new insights which can be taken into account for future studies on the same and corresponding topics.

Second, compared to the few previous studies on this topic, this is the first one which analyses the literature with rigour in accordance with the guidelines of the well-known scientific method, which is SMS. This allows this study to show greater validity and reliability that researchers should consider going further. This study also provided significant insights for future research on the same topic. In fact, within the findings or even in the discussions, many new considerations which require deeper investigations were made. For example, the experiences of EA researchers, and the impact of the authors' first languages, or the discipline on which they studied, on the lack of terminology.

Third, compared to the few previous SMS in the discipline of EA concerning other topics, this study provides some new observations that can complete the existing state

of the art of EA as described in the literature. For example, no previous SMS on EA has focused on the number of articles published by each EA author/researcher, the academic disciplines in which they have studied, or their occupation when publishing. No previous SMS on EA had focused on the subject areas of the publishers of the EA publications or on the occurrences of certain words in the publication titles. But even the importance of such subjects in the context of this study, as it can be seen the findings concerning them should also be considered to show a complete presentation of the state of the art of EA. Researchers could also use this information as a starting point to summarize the EA literature with all the important details.

Fourth, compared to many previous SMSs which their predefined classification schemes in advance, this study has generated categories which emerged progressively during the data extraction. This method provides better opportunity to summarize the entire content of the sources analysed without losing the details.

Implications for practice

The lack of common understanding in EA can create misunderstandings and conflicts regarding the role and responsibility of professionals practicing EA. Especially when EA team members are not thoroughly conscious of the lack of common understanding in EA and the extent of the existing differences. It can also be hard to collaborate with stakeholders and other participants in such situations. Similarly, it can be hard to provide standard and universal training to future EA practitioners. And researchers can face difficulty when sharing their research findings and generally being understood.

The previous studies concerning the lack of common understanding have presented the most popular schools of thought on EA, while the current study has focused on the extraction of the details which can help to differentiate and link these schools of thought. This means that the information collected and analysed in this study is at a lower level and thus can be more meaningful for practitioners. In fact, this study is useful to help professionals practicing EA to be conscious of the existence of many different contexts, which could otherwise prevent EA professionals from having common terminology, understanding and perspective. This study could open many ways to help them become more tolerant of each other and collaborate better.

Taking into account the consideration of the previous sections, it is evident that this study could also help the administration staff of the organization to better know the kinds of EA professionals they need, depending on what the organization want to achieve. This study could also help human resources to be better able to evaluate candidates according to the need of the organization. In the same line of thinking, this study could motivate the integration of all the existing perspectives in the EA academic programmes, in order to provide universal training to future practitioners.

However, one point to be clarified is the importance of each of the ways of approaching EA, without any superiority of one over another, even if they seem to be divergent and conflictual sometimes. The objective is to understand the underlying assumptions of the different perspectives, beliefs and world views underlying the many ways of approaching EA and its practitioners in order to integrate them all into a shared reference. This will allow us to take them all into account when conducting research, elaborating tools, organizing training, creating job offers, implementing EA plans, projects or processes and more. In effect, this will allow enterprise architects and researchers to better collaborate even if they have different ways of approaching EA.

Conclusion and future work

This study conducted a SLR and analysed 257 journal articles published from 1990 to mid-2018 with the aim to identify, explore and classify elements that might influence the existing lack of common understanding in EA. The findings confirm that the extent to which the authors/researchers are focused on EA, the sectors in which they are evolving, the academic disciplines in which they have studied, the countries where their affiliated organizations are located, the subject areas of the journals/publishers of their publications and the way they have approached EA and its practitioners were identified as sources of variety which could be at the basis of the existing lack of common understanding in EA.

A limitation to note is that this study analysed only journal articles in order to keep it to a manageable size. Despite this limitation, the contribution of this study – which is the first SMS on the lack of common understanding in EA – is the organization of the EA literature according to three major questions concerning 'who' has been published in the literature, 'where' they have been located and 'what' their publications are about. This helps to better identify sources of variety which could be on the basis of the lack of common understanding in EA and provides practitioners and stakeholders a better understanding of this challenge. This also provides relevant directions for future studies. Due to this limitation, future studies on this topic must include other relevant data sources, such as conference articles, book chapters and more, and use other reliable methods, such as SLRs, content analyses, surveys and case studies.

Authors' note

This article is the extended version of a previous conference article. The contribution of the previous article was extended both in content and in depth. The following sections present some of the relevant modifications added in order to improve this study. Firstly, the findings of this article take into consideration the enterprise architecture (EA) journal articles published from 1990 to mid-2018, while the previous study only considered the publications from 1990 to 2014. Consequently, 257 articles were analysed in this study, while 171 articles were analysed in the previous study. To achieve this, the search string 'enterprise

architectures' (plural form) was also added to those considered in the previous study (EA, enterprise architect, or enterprise architects). Secondly, the section of research design was more detailed and includes a section for each step of the systematic mapping study applied, according to up-to-date references. Thirdly, the section of findings has been revised with the results of the new articles added and has been completed with more detailed explanations, tables and figures. Additional analysis and related findings with regards to the intensity of publications of authors that have published in EA, the subject areas and categories of the publishers/editors of the EA publications and how the articles approach EA and EA practitioners were also presented. Fourthly, the section of discussions was rewritten in a more systematic way in order to identify the discussions for each finding and to provide several critical questions which can provide relevant directions for future study concerning the existing lack of common understanding in the discipline of EA. Two sections which describe the implication of the study for researchers and practitioners were added.

Declaration of Conflicting Interests

Funding

ORCID iD

Patrick Saint-Louis   http://orcid.org/0000-0003-1230-3511

References

1. Hugoson MMA, Pessi K and Magoulas T. Enterprise architecture principles and their impact on the management of IT. *Electron Inf J Syst Eval* 2011; 14(1): 53–62.
2. Federation of Enterprise Architecture Professional Organizations. A common perspective on enterprise architecture. *Archit Gov Mag* 2013; 9: 6.
3. Schöenherr M. Towards a common terminology in the discipline of enterprise architecture. *Lect Notes Comput Sci (including Subser Lect Notes Artif Intell Lect Notes Bioinformatics)* 2008; 5472: 400–413.
4. Lapalme J. Three schools of thought on enterprise architecture. *IT Prof* 2012; 14(6): 37–43.
5. Korhonen JJ and Poutanen J. Tripartite approach to enterprise architecture. *J Enterp Archit* 2013; 9(2): 28–38.
6. Simon D, Fischbach K and Schoder D. An exploration of enterprise architecture research. *Commun Assoc Inf Syst* 2013; 32(1): 1–71.
7. du Preez J, van der Merwe A and Matthee M. Enterprise architecture schools of thought: an exploratory study. In: (eds. IEEE) *2014 IEEE 18th international enterprise distributed object computing conference workshops and demonstrations*, Ulm, Germany, 1–2 September 2014, pp. 3–12.
8. Rahimi F, Gøtze J and Møller C. Enterprise architecture management: toward a taxonomy of applications. *Commun Assoc Inf Syst* 2017; 40(1): 120–166.
9. Mentz J, Kotzé P and Van der Merwe A. A comparison of practitioner and researcher definitions of enterprise architecture using an interpretation method. *Adv Enterp Inf Syst II* 2012; 11(26): 11–25.
10. Simon D, Fischbach K and Schoder D. Enterprise architecture management and its role in corporate strategic management. *Inf Syst E-bus Manag* 2014; 12(1): 5–42.
11. Carneiro Ramos KH and de Sousa RT Jr. Bibliometric analysis enterprise architecture in the public administration. *Information* 2015; 18: 501–519.
12. Mykhashchuk M, Buckl S, Dierl T, et al. Charting the landscape of enterprise architecture management. *10 Int Tagung Wirtschaftsinformatik WI* 2011; 2: 570–577.
13. Rasti Z, Darajeh A, Raouf K, et al. Systematic literature review in the area of enterprise architecture during past 10 years. In: *International conference on knowledge-based engineering and innovation*, Tehran, Iran, 5–6 November 2015. IEEE.
14. Dang DD and Pekkola S. Systematic literature review on enterprise architecture in the public sector. *Electronic Journal of e-Government* 2017; 15(2): 132–154.
15. Saint-Louis P and Lapalme J. Investigation of the lack of common understanding in the discipline of enterprise architecture: a systematic mapping study. In: *2016 IEEE 20th International enterprise distributed object computing workshop (EDOCW)*, Vienna, Austria, 5–9 September 2016, pp. 1–9.
16. Kitchenham BA, Budgen D and Brereton OP. Using mapping studies as the basis for further research – a participant-observer case study. *Inf Softw Technol* 2011; 53(6): 638–651.
17. Petersen K, Feldt R, Mujtaba S, et al. Systematic mapping studies in software engineering. In: *12th International conference on evaluation and assessment in software engineering (EASE)*, vol. 8, University of Bari, Italy, 26–27 June 2008, pp. 1–10.
18. Petersen K, Vakkalanka S and Kuzniarz L. Guidelines for conducting systematic mapping studies in software engineering: an update. *Inf Softw Technol* 2015; 64: 1–18.
19. Dybå T, Dingsøyr T and Hanssen GK. Applying systematic reviews to diverse study types: an experience report. In: *First International symposium on empirical software engineering and measurement applying*, Madrid, Spain, 20–21 September 2007, pp. 225–234. IEEE.
20. Franke U, Cohen M and Sigholm J. What can we learn from enterprise architecture models? An experiment comparing models and documents for capability development. *Softw Syst Model* 2018; 17(2): 695–711.
21. Alzoubi YI, Gill AQ and Moulton B. A measurement model to analyze the effect of agile enterprise architecture on geographically distributed agile development. *J Softw Eng Res Dev* 2018; 6: 4.
22. Zhang M, Chen H and Luo A. A systematic review of business-IT alignment research with enterprise architecture. *IEEE Access* 2018; 6: 18933–18944.
23. Yamamoto S, Olayan NI and Morisaki S. Another look at enterprise architecture framework. *J Business Theory Pract* 2018; 6(2): 172–183.

24. Shaanika I and Iyamu T. Developing the enterprise architecture for the Namibian government. *Electronic J Inf Syst Developing Countries* 2018; 84(3): 1–11.

25. Wikusna W. Enterprise architecture model for vocational high school. *Int J Appl Inf Technol* 2018; 2(1): 0–1.

26. Haghighathoseini A, Bobarshad H and Sagha F. Hospital enterprise architecture framework (Study of Iranian University Hospital Organization). *Int Med J Inform* 2018; 114: 88–100.

27. Graeme S, Gloet M, Someh IA, et al. Achieving benefits with enterprise architecture. *J Strateg Inf Syst* 2018; 27(2): 139–156.

28. Masuda Y, Shirasak S, Yamamoto S, et al. Architecture board practices in adaptive enterprise architecture with digital platform: a case of global healthcare enterprise. *Int Enterp J Inf Syst* 2018; 14(1): 1–20.

29. Nikpay F, Ahmad R and Kia CY. A hybrid method for evaluating enterprise architecture implementation. *Eval Program Plann* 2017; 60: 1–16.

30. Bondar S, Hsu JC, Pfouga A, et al. Agile digitale transformation of enterprise architecture models in engineering collaboration. *Procedia Manuf* 2017; 11: 1343–1350.

31. Nikpay F, Ahmad RB, Rouhani BD, et al. An effective enterprise architecture implementation methodology. *Inf Syst E-bus Manag* 2017; 15(4): 927–962.

32. Karim A, Demian P, Anumba CJ, et al. An enterprise architecture framework for electronic requirements information management. *Int Inf J Manage* 2017; 37(5): 455–472.

33. Sjöberg P, Ab S and Hause M. An industrial example of using enterprise architecture to speed up systems development. An industrial example of using enterprise architecture to speed up systems development. *INCOSE Int Symposium* 2017; 27(1): 401–417.

34. Vallerand J, Lapalme J and Moïse A. Analysing enterprise architecture maturity models: a learning perspective. *Enterp Inf Syst* 2017; 11(6): 859–883.

35. Ariawan MPA, Putra PB IS and Sudarma IM. Analysis of enterprise architecture design using TOGAF framework: a case study at archival unit of faculty of agricultural technology of Udayana university. *Int J Eng Emerging Technol* 2017; 2(2): 52–57.

36. Kotusev S. Critical questions in enterprise architecture research. *International Journal of Enterprise Information Systems (IJEIS)* 2017; 13(2): 50–62.

37. Ruldeviyani Y, Wisnuwardhani E and Sucahyo YG. Designing enterprise architecture case study of the ministry of energy and mineral resources. *J Eng Appl Sci* 2017; 12(8): 2185–2188.

38. Niemi EI and Pekkola S. Enterprise architecture benefit realization: review of the models and a case study of a public organization. *Enterprise Architecture Benefit Realization* 2016; 47(3): 55–80.

39. Alshammari B. Enterprise architecture security assessment framework (EASAF). *Journal of Computer Science* 2017; 13(10): 558–571.

40. Bui Q. Evaluating enterprise architecture frameworks using essential elements. *Communications of the Association for Information Systems* 2017; 41(6): 121–149. DOI: 10.17705/1CAIS.04106.

41. Nogueira JM, Romero D, Espadas J, et al. Leveraging the Zachman framework implementation using action-research methodology – a case study: aligning the enterprise architecture and the business goals. *Enterp Inf Syst* 2013; 7(1): 100–132.

42. Alaeddini M. Leveraging business-IT alignment through enterprise architecture – an empirical study to estimate the extents. *Inf Technol Manag* 2017; 18(1): 55–82.

43. González-rojas O, López A and Correal D. Multilevel complexity measurement in enterprise architecture models. *Int Comput J Integr Manuf* 2017; 30(12): 1280–1300.

44. Niemi E and Pekkola S. Using enterprise architecture artefacts in an organisation. *Enterp Inf Syst* 2017; 11(3): 313–338.

45. Martin A, Emmenegger S and Hinkelmann K. A viewpoint-based case-based reasoning approach utilising an enterprise architecture ontology for experience management. *Enterp Inf Syst* 2017; 11(4): 551–575.

46. Kotusev S. Conceptual model of enterprise architecture management. *Int Coop J Inf Syst* 2017; 26(3): 17300011–17300036.

47. Hazen BT, Bradley RV, Bell JE, et al. Enterprise architecture: a competence-based approach to achieving agility and firm performance. *Int Prod J Econ* 2017; 193: 566–577.

48. Hinkelmann K, Gerber A, Karagiannis D, et al. A new paradigm for the continuous alignment of business and IT: combining enterprise architecture modelling and enterprise ontology. *Comput Ind* 2016; 79: 77–86.

49. Foorthuis R, van Steenbergen M, Brinkkemper S, et al. A theory building study of enterprise architecture practices and benefits. *Inf Syst Front* 2016; 18(3): 541–564.

50. Bernaert M, Poels G, Snoeck M, et al. CHOOSE: towards a metamodel for enterprise architecture in small and medium-sized enterprises. *Inf Syst Front* 2016; 18(4): 781–818.

51. Sedivy J and Borkovec R. Effective methodology of linking enterprise architect with application framework and solutions in business practice. *Appl Mech Mater* 2016; 835: 823.

52. Alwadain A, Fielt E, Korthaus A, et al. Empirical insights into the development of a service-oriented enterprise architecture. *Data Knowl Eng* 2015; 105: 39–52.

53. Lapalme J, Gerber A, Van Der Merwe A, et al. Exploring the future of enterprise architecture: a Zachman perspective. *Comput Ind* 2016; 79: 103–113.

54. Närman P, Johnson P and Gingnell L. Using enterprise architecture to analyse how organisational structure impact motivation and learning. *Enterp Inf Syst* 2014; 7575: 1–40.

55. Banaeianjahromi N and Smolander K. What do we know about the role of enterprise architecture in enterprise integration? A systematic mapping study. *J Enterp Inf Manag* 2016; 29: 140–164.

56. Safari H, Faraji Z and Majidian S. Identifying and evaluating enterprise architecture risks using FMEA and fuzzy VIKOR. *J Intell Manuf* 2016; 27(2): 475–486.

57. Vargas A, Boza A, Patel S, et al. Inter-enterprise architecture as a tool to empower decision-making in hierarchical collaborative production planning. *Data Knowl Eng* 2016; 105: 5–22.

58. Dam HK, Lê LS and Ghose A. Managing changes in the enterprise architecture modelling context. *Enterp Inf Syst* 2015; 10(6): 1–31.

59. Poorebrahimi A, Razavi F and Razavi FS. Presenting VALIT frameworks and comparing between them and other enterprise architecture framework. *Int Adv J Netw Appl* 2016; 7(4): 2805–2809.

60. Vargas A, Cuenca L, Boza A, et al. Towards the development of the framework for inter sensing enterprise architecture. *J Intell Manuf* 2016; 27(1): 55–72.

61. Lee S, Oh S and Nam K. Transformational and transactional factors for the successful implementation of enterprise architecture in public sector. *Sustainability* 2016; 8(5): 456.

62. Behrouz F and Fathollah M. A systematic approach to enterprise architecture using axiomatic design. *Procedia CIRP* 2016; 53: 158–165.

63. Lange M, Mendling J, Recker J, et al. An empirical analysis of the factors and measures of enterprise architecture management success. *Eur Inf J Syst* 2016; 25(5): 411–431.

64. Azaliah N, Bakar A, Harihodin S, et al. Assessment of enterprise architecture implementation capability and priority in public sector agency. *Procedia Comput Sci* 2016; 100: 198–206.

65. Silva N, Ferreira F, Sousa P, et al. Automating the migration of enterprise architecture models. *International Journal of Information System Modeling and Design (IJISMD)* 2016; 7(2): 72–90.

66. Nam K, Oh SW, Kim SK, et al. Dynamics of enterprise architecture in the Korean public sector: transformational change vs. transactional change. *Sustainability* 2016; 8(11): 1–18.

67. Olsen DH and Trelsgård K. Enterprise architecture adoption challenges: an exploratory case study of the Norwegian higher education sector. 2016; 100: 804–811.

68. Lecturer S and Lumpur K. Enterprise architecture development and implementation in public sector: the Malaysian perspective. *J Theoretical Appl Inf Technol* 2016; 88(1): 176–188.

69. Tow TAN, Joseph H and Frank CL. Enterprise architecture, design thinking and agile development – new strategies for large-scale enterprise IT projects. *DSTA Horizons* 2006, pp. 4–15.

70. Dinis R. Process oriented approaches in enterprise architecture for business-IT alignment. *Procedia Comput Sci* 2016; 100: 888–893.

71. Eskandari M and Nabiollahi A. A method for prioritizing qualitative scenarios in evaluating enterprise architecture using non-dominated sorting genetic algorithm II. *Int Comput J Sci Inf Technol* 2016; 8(6): 29–38.

72. Carter B, Moorthy S and Walters D. Enterprise architecture view of complex system governance. *Int Syst J Syst Eng* 2016; 7(1–3): 95–108.

73. Fasanghari M, Amalnick MS, Taghipour R, et al. A novel credibility-based group decision making method for enterprise architecture scenario analysis using data envelopment analysis. *Appl Soft Comput J* 2015; 32: 347–368.

74. Fritscher B and Pigneur Y. A visual approach to business IT alignment between business model and enterprise architecture. *Int Inf J Syst Model Des* 2015; 6(1): 1–23.

75. De Sousa RT Jr and Ramos KHC. Bibliometric analysis of enterprise architecture in the public administration. *Information* 2015; 18(2): 501–519.

76. Kaushik A and Raman A. The new data-driven enterprise architecture for e-healthcare: lessons from the Indian public sector. *Gov Inf Q* 2015; 32(1): 63–74.

77. Rouhani BD, Mahrin MNR, Nikpay F, et al. A systematic literature review on enterprise architecture implementation methodologies. *Inf Softw Technol* 2015; 62(1): 1–20.

78. Korhonen JJ, Lapalme J, Mcdavid J, et al. Adaptive enterprise architecture modelling. *J Softw* 2015; 10(5): 628–638.

79. Gill AQ. Agile enterprise architecture modelling: evaluating the applicability and integration of six modelling standards. *Inf Softw Technol* 2015; 67: 196–206.

80. Rouhani BD, Mahrin MN, Shirazi H, et al. An effectiveness model for enterprise architecture methodologies. *Int Enterp J Inf Syst* 2015; 11(2): 50–64.

81. Ghatrei S. ARIS enterprise architecture's usage reviews. *Lect Notes Softw Eng* 2015; 3(1): 57–60.

82. Muhammad K and Khan N. Augmenting mobile cloud computing through enterprise architecture: a survey paper. *Int Grid J Distrib Comput* 2015; 8(3): 323–336.

83. Shaanika I and Iyamu T. Deployment of enterprise architecture in the Namibian government: the use of activity theory to examine the influencing factors. *Electron Inf J Syst Dev Ctries* 2015; 2(1): 23–35.

84. Bernus P, Noran O and Molina A. Annual reviews in control enterprise architecture: twenty years of the GERAM framework. *Annu Rev Control* 2015; 39: 83–93.

85. Naranjo D, Sanchez ME and Villalobos J. Evaluating the capabilities of enterprise architecture modeling tools for visual analysis. *J Object Technol* 2015; 14(1): 31–32.

86. Dokhanchi A and Nazemi E. BISC: A framework for aligning business intelligence with corporate strategies based on enterprise architecture framework. *Int Enterp J Inf Syst* 2015; 11(2): 106.

87. Rocha Á and Ferrugento A. Evolution of methodological proposals for the development of enterprise architecture. *Adv Intell Syst Comput* 2015; 353: 351–359.

88. Rijo R, Martinho R and Ermida D. Developing an enterprise architecture proof of concept in a Portuguese hospital. *Procedia Comput Sci* 2015; 64: 1217–1225.

89. Candra S, Erika F and Hudiarto. The use of enterprise architecture framework for improving service quality (case study ABC state attorney). *Int Multimed J Ubiquitous Eng* 2015; 10(8): 65–72.

90. Azevedo CLB, Iacob ME, Almeida JPA, et al. Modeling resources and capabilities in enterprise architecture: a well-

founded ontology-based proposal for ArchiMate. *Inf Syst* 2015; 54: 235–262.

91. Vargas A, Boza Garcia A, Cuenca González ML, et al. Using inter-enterprise architecture as an instrument for decision-making under the arrival of unexpected events in hierarchical production planning. In: *International Journal of Engineering Management and Economics* 2015; 5(1): 73–88. Inderscience.

92. Barenji RV, Hashemipour M and Guerra-Zubiaga DA. A framework for modelling enterprise competencies: from theory to practice in enterprise architecture. *Int Comput J Integr Manuf* 2014; 28(8): 791–810.

93. Alwadain A, Fielt E, Korthaus A, et al. A critical realist perspective of enterprise architecture evolution: conditions and outcomes. *Australas Inf J Syst* 2014; 18(3): 213–226.

94. Akhigbe O, Amyot D and Richards G. A framework for a business intelligence-enabled adaptive enterprise architecture. In: *International Conference on Conceptual Modeling*, Springer, Cham, 2014, pp. 393–406.

95. Tambouris E, Kaliva E, Liaros M, et al. A reference requirements set for public service provision enterprise architectures. *Softw Syst Model* 2014; 13(3): 991–1013.

96. Gomez P, Sanchez M, Florez H, et al. An approach to the co-creation of models and metamodels in enterprise architecture projects. *J Object Technol* 2014; 13(3): 1–29.

97. Närman P, Buschle M and Ekstedt M. An enterprise architecture framework for multi-attribute information systems analysis. *Softw Syst Model* 2014; 13(3): 1085–1116.

98. Gill AQ. Applying agility and living service systems thinking to enterprise architecture. *Int J Intelligent Inf Technol* 2014; 10(1): 1–15.

99. Walrad CC, Lane M, Jeffrey W, et al. Architecting a profession. *IT Prof* 2014; 16(1): 42–49.

100. MeylianaBudiardjo EK. Building social CRM framework on enterprise architecture framework using value chain process approach. *Contemp Eng Sci* 2014; 7(13–16): 671–676.

101. Plataniotis G, De Kinderen S and Proper HA. (2014). Challenges of capturing design rationales in enterprise architecture: A case study. In: *Proceedings of the 8th Transformation & Engineering of Enterprises Workshop (TEE 2014), Held in Conjunction with the 16th IEEE Conference on Business Informatics (CBI2014)*, Geneva, Switzerland.

102. Shaanika I and Iyamu T. Developing enterprise architecture skills: a developing country perspective. *IFIP Adv Inf Commun Technol* 2014; 444: 52–61.

103. Plataniotis G, De Kinderen S and Proper HA. EA Anamnesis: an approach for decision making analysis in enterprise architecture. *Int Inf J Syst Model Des* 2014; 4(1): 75–95.

104. Chelliah PR. Elucidating the cloud enterprise architecture for smarter enterprises. *IT Prof* 2014; 16(6): 33–37.

105. Närman P, Franke U, König J, et al. Enterprise architecture availability analysis using fault trees and stakeholder interviews. *Enterp Inf Syst* 2014; 8(1): 1–25.

106. Sajid M and Ahsan K. Enterprise architecture for healthcare organizations. *World Appl Sci J* 2014; 30(10): 1330–1333.

107. Boone S, Bernaert M, Roelens B, et al. Evaluating and improving the visualisation of CHOOSE, an enterprise architecture approach for SMEs. In *IFIP Working Conference on The Practice of Enterprise Modeling*, Springer, Berlin, Heidelberg, 2014, pp. 87–102.

108. Meyer M and Helfert M. Evaluating design science outputs the case of enterprise architecture business value assessments. *Commun Comput Inf Sci* 2014; 447: 135–145.

109. Chiprianov V, Kermarrec Y, Rouvrais S, et al. Extending enterprise architecture modeling languages for domain specificity and collaboration. *Softw Syst Model* 2014; 13(3): 1–11.

110. Iacob ME, Meertens LO, Jonkers H, et al. From enterprise architecture to business models and back. *Softw Syst Model* 2014; 13(3): 1059–1083.

111. Ilin IV and Anisiforov AB. Improving the efficiency of projects of industrial cluster innovative development based on enterprise architecture model. *WSEAS Transactions on Business and Economics* 2014; 11: 757–764.

112. Hazen BT, Hanna JB and Hall DJ. Incorporating logistics enterprise architecture: a diffusion of innovation perspective. *Int Logist J Res Appl* 2014; 17(3): 179–199.

113. Löhe J and Legner C. Overcoming implementation challenges in enterprise architecture management: a design theory for architecture-driven IT management (ADRIMA). *Inf Syst E-bus Manag* 2014; 12(1): 101–137.

114. Atasheneh M, Harounabadi A and Mirabedini SJ. Performance evaluation of enterprise architecture using fuzzy sequence diagram. *Decis Sci Lett* 2014; 3: 103–108.

115. Hazen BT, Kung L, Cegielski CG, et al. Performance expectancy and use of enterprise architecture: training as an intervention. *J Enterp Inf Manag* 2014; 27(2): 180–196.

116. Cohen M. Simulation preorder semantics for traceability relations in enterprise architecture. *Lect Notes Bus Inf Process* 2014; 197: 103–117.

117. Pessi K, Hugoson MA, Magoulas T, et al. Sustainable alignment in enterprise architecture: a case study of architectural principles. *Lect Notes Bus Inf Process* 2014; 183: 214–225.

118. Aier S. The role of organizational culture for grounding, management, guidance and effectiveness of enterprise architecture principles. *Inf Syst E-bus Manag* 2014; 12(1): 43–70.

119. Bijarchian A and Ali R. Usability elements as benchmarking criteria for enterprise architecture methodologies. *J Teknol Sciences Eng* 2014; 68(2): 45–48.

120. Farwick M, Schweda CM, Breu R, et al. A situational method for semi-automated enterprise architecture documentation. *Softw Syst Model* 2014; 15(2): 397–426.

121. Houser W. Employing enterprise architecture for applications assurance. *IT Prof* 2014; 16(6): 8–11.

122. Lawall A, Schaller T and Reichelt D. Enterprise architecture: a formalism for modeling organizational structures in

information systems. *Lect Notes Bus Inf Process* 2014; 191: 77–95.

123. Carter B, Moorthy S and Walters D. System of systems engineering and enterprise architecture: implications for governance of complex systems. *Int Syst J Syst Eng* 2013; 7: 95–108.

124. Alwadain A, Fielt E, Korthaus A, et al. A comparative analysis of the integration of SOA elements in widely-used EA frameworks. *Int J Intelligent Inf Technol* 2013; 9(2): 54–70.

125. Fu-Sheng J, Huan Z and Yong W. An enterprise architecture approach based on DoDAF. *Appl Mech Mater* 2013; 284–287: 3642–3648.

126. Lehong SM, Dube E and Angelopoulos G. An investigation into the perceptions of business stakeholders on the benefits of enterprise architecture: the case of Telkom SA. *South African Bus J Manag* 2013; 44(2): 45–56.

127. Berrada M and Bounabat B. Business modeling of enterprise architecture based on multi-agent system. *Int J e-Education, e-Business, e-Management e-Learning* 2013; 3(6): 472–476.

128. Sutherland S. Convergence of cloud computing, service oriented architecture and enterprise architecture. In: *The Third International Conference on Digital Information Processing and Communications. The Society of Digital Information and Wireless Communication* 2013; 493–500.

129. Hadi K, Larry W and Peter B. Enterprise architecture cybernetics for global mining projects: reducing the structural complexity of global mining supply networks via virtual brokerage. *Adv Mater Res* 2013; 634–638(1): 3339–3345.

130. Rajabi Z, Minaei B and Ali SM. Enterprise architecture development based on enterprise ontology. *J Theor Appl Electron Commer Res* 2013; 8(2): 85–95.

131. Clarke M, Hall JG and Rapanotti L. Enterprise architecture: a snapshot from practice. *Int IT J Bus Alignment Gov* 2013; 4(1): 1–10.

132. Alaeddini M and Salekfard S. Investigating the role of an enterprise architecture project in the business-IT alignment in Iran. *Inf Syst Front* 2013; 15(1): 67–88.

133. Kamoun F. Rethinking the role of enterprise architecture during times of economic downturn: a dynamic capabilities approach. *J Inf Technol Manag* 2013; XXIV(1): 26–48.

134. Helfert M, Doucek P and Maryska M. The 'enterprise architect' – a new approach to business informatics management. *Qual Innov Prosper* 2013; 17(1): 67–87.

135. Abraham R, Tribolet J and Winter R. Transformation of multi-level systems – theoretical grounding and consequences for enterprise architecture management. *Lect Notes Bus Inf Process* 2013; LNBIP 146: 73–87.

136. NäRman P, Holm H, Ekstedt M, et al. Using enterprise architecture analysis and interview data to estimate service response time. *J Strateg Inf Syst* 2013; 22(1): 70–85.

137. Marahel A, Harounabadi A and Mirabedini SJ. Using formal model of fuzzy for performance evaluation of enterprise architecture. *World Appl Sci J* 2013; 28(11): 1802–1808.

138. Sembiring J, Triono RNE and Sahri M. Designing IT personnel hard competencies model in the enterprise

architecture case study: forestry research and development agency of Indonesia. *Procedia Technol* 2013; 11(Iceei): 877–881.

139. Zheng T and Zheng L. Examining e-government enterprise architecture research in China: a systematic approach and research agenda. *Gov Inf Q* 2012; 30: S59–S67.

140. Zandi F and Tavana M. A fuzzy group multi-criteria enterprise architecture framework selection model. *Expert Syst Appl* 2012; 39(1): 1165–1173.

141. Lakhdiss M and Bounabat B. A new content framework and metamodel for enterprise architecture and IS strategic planning. *Int Comput J Sci Issues* 2012; 9(2–2): 253–258.

142. Rouhani BD and Nikpay F. Agent-oriented enterprise architecture: new approach for enterprise architecture. *Int Comput J Sci Issues* 2012; 9(6): 331–334.

143. Magoulas T and Hadzic A. Alignment in enterprise architecture: a comparative analysis of four architectural approaches. *Electron J* 2012; 15(1): 88–101.

144. Quartel D, Steen MWA and Lankhorst MM. Application and project portfolio valuation using enterprise architecture and business requirements modelling. *Enterp Inf Syst* 2012; 6(2): 189–213.

145. Holm H, Buschle M, Lagerström R, et al. Automatic data collection for enterprise architecture models. *Softw Syst Model* 2012; 13(2): 825–841.

146. Burkett JS. Business security architecture: weaving information security into your organization's enterprise architecture through SABSA®. *Inf Secur J A Glob Perspect* 2012; 21(1): 47–54.

147. Janssen M, Klievink B, Janssen M, et al. Can enterprise architectures reduce failure in development projects? *Transform Gov People, Process Policy* 2012; 6(1): 27–40.

148. Najafi E and Baraani A. CEA framework: a service oriented enterprise architecture framework (SOEAF). *J Theor Appl Inf Technol* 2012; 40(2): 162–171.

149. Foorthuis R, Hofman F, Brinkkemper S, et al. Compliance assessments of projects adhering to enterprise architecture. *J Database Manag* 2012; 23(2): 44–71.

150. Liu C, Li L and Huang Y. Construction of the agricultural emergency logistics information service system based on the enterprise architecture. *J Converg Inf Technol* 2012; 7(17): 364–372.

151. Rajabi Z and Abade MN. Data-Centric enterprise architecture. *Int Inf J Eng Electron Bus* 2012; 4(4): 53–60.

152. Smith HA, Watson RT and Sullivan P. Delivering an effective enterprise architecture at Chubb insurance. *MIS Exec Q* 2012; 11(2): 75–82.

153. AlSoufi Ali. National enterprise architecture framework: case study of EA development experience in kingdom of Bahrain. *Igi-Global Com* 2012; 4(1): 1–26.

154. Bradley RV, Pratt RME, Byrd TA, et al. Enterprise architecture, IT effectiveness and the mediating role of IT alignment in US hospitals. *Inf Syst J* 2012; 22(2): 97–127.

155. Scherer S and Wimmer MA. E-participation and enterprise architecture frameworks: an analysis. *Inf Polity* 2012; 17(2): 147–161.

156. Tambouris E, Zotou M, Kalampokis E, et al. Fostering enterprise architecture education and training with the enterprise architecture competence framework. *Int Train J Dev* 2012; 16(2): 128–136.

157. Rodrigues A and H O'Neill. Framework based on benefits management and enterprise architecture. *Inf Resour Manag J* 2013; 25(2): 34–51.

158. Lê LS and Wegmann A. Hierarchy-oriented modeling of enterprise architecture using reference-model of open distributed processing. *Comput Stand Interfaces* 2012; 35(3): 277–293.

159. Rouhani BD and Kharazmi S. Presenting new solution based on business architecture for enterprise architecture. *Int Comput J Sci Issues* 2012; 9(3): 207–211.

160. Medini K and Bourey JP. SCOR-based enterprise architecture methodology. *Int Comput J Integr Manuf* 2012; 25(7): 594–607.

161. Janssen M. Sociopolitical aspects of interoperability and enterprise architecture in e-government. *Soc Sci Comput Rev* 2012; 30(1): 24–36.

162. Kalampokis E, Tarabanis K, Tambouris E, et al. The enterprise architecture competence framework. *Int J Learning Technol* 2012; 7(1): 79–94.

163. Närman P, Holm H, Höök D, et al. Using enterprise architecture and technology adoption models to predict application usage. *J Syst Softw* 2012; 85(8): 1953–1967.

164. Giachetti RE. Procedia computer science a flexible approach to realize an enterprise architecture. *Procedia Comp Sci* 2012; 8: 147–152.

165. Alsoufi A. Bahrain national enterprise architecture framework: a platform towards a GCC EA initiative. *GSTF J Computing (JoC)* 2012; 2(1): 73–80.

166. Cui Z and Weston RH. Enterprise and simulation modelling in enterprise architecture execution. *Int Ind J Syst Eng* 2012; 12(4): 429–448.

167. Ali ZA and Elnaz B. The phenomenon of Information technology and enterprise architecture of electronics city. *Life Sci J* 2012; 9(4): 1–7.

168. Shah H and Golder P. ADaPPT: Enterprise architecture thinking for information systems development. *Int Comput J Sci Issues* 2011; 8(1): 1–7.

169. Razavi M, Aliee FS and Badie K. An AHP-based approach toward enterprise architecture analysis based on enterprise architecture quality attributes. *Knowl Inf Syst* 2011; 28(2): 449–472.

170. Marques AF, Borges JG, Sousa P, et al. An enterprise architecture approach to forest management support systems design: an application to pulpwood supply management in Portugal. *Eur For J Res* 2011; 130(6): 935–948.

171. Kamogawa T and Okada H. Comparative advantage model founded on enterprise architecture in Japanese firms. *Int Bus J Inf Syst* 2011; 7(3): 341.

172. Närman P, Holm H, Johnson P, et al. Data accuracy assessment using enterprise architecture. *Enterp Inf Syst* 2011; 5(1): 37–58.

173. Šaša A and Krisper M. Enterprise architecture patterns for business process support analysis. *J Syst Softw* 2011; 84(9): 1480–1506.

174. Engelsman W, Quartel D, Jonkers H, et al. Extending enterprise architecture modelling with business goals and requirements. *Enterp Inf Syst* 2011; 5(1): 9–36.

175. Tamm T, Seddon PB, Shanks G, et al. How does enterprise architecture add value to organisations? *Commun Assoc Inf Syst* 2011; 28(1): 141–168.

176. Mikaelian T, Nightingale DJ, Rhodes DH, et al. Real options in enterprise architecture: a holistic mapping of mechanisms and types for uncertainty management. *IEEE Trans Eng Manag* 2011; 58(3): 457–470.

177. Glazner CG and Glazner CG. Enterprise transformation using a simulation of enterprise architecture of enterprise architecture. *J Enterprise Transform* 2011; 8289: 231–260.

178. Khayami R. Qualitative characteristics of enterprise architecture. *Procedia Comput Sci* 2010; 3: 1277–1282.

179. Rosen M. Enterprise architecture for the cloud. *Cut IT J* 2011; 24(7): 17–22.

180. Bradley RV, Pratt RME, Byrd TA, et al. The role of enterprise architecture in the quest for IT value. *MIS Exec Q* 2011; 10(2): 73–79.

181. Dube MR and Dixit AK. Comprehensive measurement framework for enterprise architectures. *Int Comput J Sci Inf Technol* 2011; 3(4): 71–92.

182. Zandi F and Tavana M. A group evidential reasoning approach for enterprise architecture framework selection. *Int Inf J Technol Manag* 2010; 9(4): 468–483.

183. Marich MJ, Schooley BL and Horan TA. A normative enterprise architecture for guiding end-to-end emergency response decision support. *Int Inf J Syst Cris Response Manag* 2010; 2(2): 1–17.

184. Kang D, Lee J and Kim K. Alignment of business enterprise architectures using fact-based ontologies. *Expert Syst Appl* 2010; 37(4): 3274–3283.

185. Harrell JM and Sage AP. An enterprise architecture methodology to address the enterprise dilemma. *Inf Knowl Syst Manag* 2010; 9(3/4): 211–237.

186. Kang D, Lee J, Choi S, et al. An ontology-based enterprise architecture. *Expert Syst Appl* 2010; 37(2): 1456–1464.

187. Bruls W, Van Steenbergen M, Foorthuis R, et al. Domain architectures as an instrument to refine enterprise architecture. *Communic Assoc Inf Syst* 2010; 27(27).

188. Booch G. Enterprise architecture and technical architecture. *IEEE Softw* 2010; 27(2): 96–96.

189. Harrell J and Sage A. Enterprise architecture and the ways of wickedness. *Information, Knowledge Syst Manag* 2010; 9(2010): 197–209.

190. Jahani B, Javadein SRS and Jafari HA. Measurement of enterprise architecture readiness within organizations. *Bus Strateg Ser* 2010; 11(3): 177–191.

191. Ghani I, Lee CY, Juhn SH, et al. Semantics-oriented approach for information interoperability and governance: towards user-centric enterprise architecture management. *J Zhejiang Univ Sci C* 2010; 11(4): 227–240.

192. Kamogawa T. Structural models that manage IT portfolio affecting business value of enterprise architecture. *IEICE TRANSACTIONS on Information and Systems* 2010; 93(9): 2566–2576.

193. Harrell J and Sage A. Extending the Friedman-Sage systems engineering case study framework for enterprise architecture case study research. *Information, Knowledge, Syst Manag* 2010; 9: 239–257.

194. Rai A, Venkatesh V, Bala H, et al. Transitioning to a modular enterprise architecture: drivers, constraints, and actions. *MIS Exec Q* 2010; 9(4): 197–212.

195. Iyamu T. Theoretical analysis of strategic implementation of enterprise architecture. *Int Actor J-Network Theory Technol Innov* 2009; 2(3): 17–32.

196. Shirazi HM, Rouhani BD and Shirazi MM. A framework for agile enterprise architecture. *Int Intell J Inf Technol Appl* 2009; 2(4): 182–186.

197. Lagerström R, Franke U, Johnson P, et al. A method for creating enterprise architecture metamodels – applied to systems modifiability analysis. *Int Comput J Sci Appl* 2009; 6(5): 89–120.

198. Khan KM and Gangavarapu NM. Addressing cloud computing in enterprise architecture: issues and challenges. *Cut IT J* 2010; 22(11): 27–33.

199. Schuck TM. An extended enterprise architecture for a network-enabled, effects-based approach for national park protection. *Syst Eng* 2009; 13(3): 209–216.

200. Smith P and Harris R. Applying enterprise architecture: seven principles for making it work. *Cut IT J* 2009; 22(11): 6–12.

201. Gøtze J, Christiansen PE, Mortensen RK, et al. Cross-national interoperability and enterprise architecture. *Informatica* 2009; 20(3): 369–396.

202. Huang T, Shenoy PJ, Sinha R, et al. Development of the lymphoma enterprise architecture database: a caBIG(™) silver level compliant system. *Cancer Inform* 2009; 8: 45–64.

203. Velitchkov I. Enterprise architecture metrics in the balanced scorecard for IT. *Isaca J* 2017; 3: 1–6.

204. Kemp P. Whither enterprise architecture? *ITNOW Computing J* 2009; 51(2): 20–21.

205. De Vries M and Van Rensburg ACJ. Evaluating and refining the 'enterprise architecture as strategy' approach and artefacts. *South African Ind J Eng* 2008; 20(1): 31–44.

206. Møller C, Chaudhry SS and Jørgensen B. Complex service design: a virtual enterprise architecture for logistics service. *Inf Syst Front* 2008; 10(5): 503–518.

207. De Vries M and Van Rensburg ACJ. Enterprise architecture – new business value perspectives. *South African Ind J Eng* 2008; 19(1): 1–16.

208. Doucet G, Gotze J, Saha P, et al. Coherency management: using enterprise architecture for alignment, agility, and assurance. *J Enterp Archit* 2008; 4(2): 1–12.

209. Wilbanks L. This old house using enterprise architecture to upgrade old IT systems. *IT Prof* 2007; 10(2): 63–64.

210. Goudos SK, Peristeras V and Tarabanis K. A semantic web approach for mapping citizen profiles to public administration services based on Governance Enterprise Architecture (GEA) model. *WSEAS Trans Inf Sci Appl* 2007; 4(6): 1283–1289.

211. Gammelgård M, Simonsson M and Lindström Å. An IT management assessment framework: evaluating enterprise architecture scenarios. *Inf Syst E-bus Manag* 2007; 5(4): 415–435.

212. Riempp G and Gieffers-Ankel S. Application portfolio management: a decision-oriented view of enterprise architecture. *Inf Syst E-bus Manag* 2007; 5(4): 359–378.

213. Chatterji BS. Bridging business and IT strategies with enterprise architecture: realising the real value of business-IT alignment. *Inf Syst J*. American Medical Informatics Association, 2007, vol. 2007, p. 573–577.

214. Oster S, Langella S, Hastings S, et al. caGrid 1.0: a Grid enterprise architecture for cancer research. *AMIA Annu Symp Proc* 2007; 573–577.

215. Chae H, Choi Y and Kim K. Component-based modeling of enterprise architectures for collaborative manufacturing. *Int Adv J Manuf Technol* 2007; 34(5-6): 605–616.

216. Johnson P, Lagerström R, Närman P, et al. Enterprise architecture analysis with extended influence diagrams. *Inf Syst Front* 2007; 9(2-3): 163–180.

217. Gregor S, Hart D, Martin N, et al. Enterprise architectures: enablers of business strategy and IS/IT alignment in government. *Inf Technol People* 2007; 20(2): 96–120.

218. Kummer K. Implementing the federal enterprise architecture records management profile. *Sci Comput* 2007; 24(2): 28–30.

219. Braun C and Winter R. Integration of IT service management into enterprise architecture. *Proc ACM Symp Appl Comput*. ACM, 2007, pp. 1215–1219.

220. Hamlett N. IT outsourcing impacts on enterprise architecture. *IT Prof* 2007; 9(2): 34–40.

221. Pulkkinen M, Naumenko A and Luostarinen K. Managing information security in a business network of machinery maintenance services business – enterprise architecture as a coordination tool. *J Syst Softw* 2007; 80(10): 1607–1620.

222. Goethals FG, Lemahieu W, Snoeck M, et al. The data building blocks of the enterprise architect. *Futur Gener Comput Syst* 2007; 23(2): 269–274.

223. Guijarro L. Interoperability frameworks and enterprise architectures in e-government initiatives in Europe and the United States. *Gov Inf Q* 2007; 24(1): 89–101.

224. Shah H and El Kourdi M. Frameworks for enterprise architecture. *IT Prof* 2007; 9(5): 36–41.

225. Strano C and Rehmani Q. The role of the enterprise architect. *Inf Syst E-bus Manag* 2007; 5(4): 379–396.

226. Cardwell G. The influence of enterprise architecture and process hierarchies on company success. *Total Qual Manag Bus Excell* 2006; 19(1-2): 47–55.

227. Lindström Å, Johnson P, Johansson E, et al. A survey on CIO concerns – Do enterprise architecture frameworks support them? *Inf Syst Front* 2006; 8(2): 81–90.

228. Wilkinson M. Designing an 'adaptive' enterprise architecture. *BT Technol J* 2006; 24(4): 81–92.

229. Konkol S and Kiepuszewski B. Enterprise architecture agility: roadmapping with EARM. *Cut IT J* 2006; 19(3): 10–15.

230. Kambhampaty S and Chandra S. Enterprise architecture definition framework for IT service providers. *Int Fed Inf Process* 2006; 205: 261–272.

231. Kozina M. Evaluation of ARIS and Zachman frameworks as enterprise architectures. *J Inf Organ Sci* 2006; 30(1): 115–136.

232. Zuiderhoek B, Otter A, Bos R, et al. Framework for Dutch municipalities to ensure business IT alignment using enterprise architecture. *Proc Eur Conf e-Government, ECEG* 2006; 457–466.

233. Garg A, Kazman R and Chen HM. Interface descriptions for enterprise architecture. *Sci Comput Program* 2006; 61(1): 4–15.

234. Goethals FG, Snoeck M, Lemahieu W, et al. Management and enterprise architecture click: the FAD(E)E framework. *Inf Syst Front* 2006; 8(2): 67–79.

235. Balabko P and Wegmann A. Systemic classification of concern-based design methods in the context of enterprise architecture. *Inf Syst Front* 2006; 8(2): 115–131.

236. Rico DF. A framework for measuring ROI of enterprise architecture. *J Organ End User Comput* 2006; 18(2): 350.

237. Assimakopoulos NA and Riggas AN. Designing a virtual enterprise architecture using structured system dynamics. *Hum Syst Manag* 2006; 25(1): 13–29.

238. Kim JW, Kwon JH, Kim YG, et al. EAFoC: enterprise architecture framework based on commonality. *J Comput Sci Technol* 2006; 21(6): 952–964.

239. Subramanian N, Chung L and Song Y. Propagatory framework: an NFR-based framework for establishing traceability between enterprise architectures and system architectures. *Int Comput J Inf Sci* In: *Software Engineering, Artificial Intelligence, Networking, and Parallel/Distributed Computing, 2006. SNPD 2006. Seventh ACIS International Conference on*, 2006, pp. 21–28. IEEE.

240. Jonkers H, Lankhorst MM, Ter Doest HWL, et al. Enterprise architecture: management tool and blueprint for the organisation. *Inf Syst Front* 2005; 8(2): 63–66.

241. Ylimäki T and Halttunen V. Method engineering in practice: a case of applying the Zachman framework in the context of small enterprise architecture oriented projects. *Information, Knowledge, Syst Manag* 2006; 5: 189–209.

242. Boh WF and Yellin DM. Using enterprise architecture standards in managing information technology. *J Manag Inf Syst* 2008; 23(3): 163–207.

243. Choi Y, Kang D, Chae H, et al. An enterprise architecture framework for collaboration of virtual enterprise chains. *Int Adv J Manuf Technol* 2005; 35(11–12): 1065–1078.

244. Ohren OP. An ontological approach to characterising enterprise architecture frameworks. *IFIP Advances in Information and Communication Technology* 2005; 183: 131–141.

245. Parsons RJ. Enterprise architects join the team. *IEEE Softw* 2004; 22(5): 16–17.

246. Peristeras V and Tarabanis K. Advancing the government enterprise architecture – GEA: the service execution object model. *Electron Gov* 2004; 3183: 476–482.

247. Van Buuren R, Jonkers H, Iacob ME, et al. Composition of relations in enterprise architecture models. *Graph Transform Proc* 2004; 3256: 39–53.

248. Bellman B and Rausch F. Enterprise architecture for e-Government. *Electron Gov* 2004; 3183: 48–56.

249. Lankhorst MM. Enterprise architecture modelling – the issue of integration. *Adv Eng Informatics* 2004; 18(4): 205–216.

250. Hoogervorst J.Enterprise architecture: enabling integration, agility and change. *Int Coop J Inf Syst* 2004; 13(3): 213–233.

251. North E, North J and Benade S. Information management and enterprise architecture planning – a juxtaposition. *Probl Perspect Manag* 2004; 2(4): 166–179.

252. Iyer B and Gottlieb R (2004). The four-domain architecture: an approach to support enterprise architecture design. *IBM Systems Journal*, 43(3): 587–597.

253. Mohajerani M and Moeini ALI. Using enterprise architecture framework to design network security architecture. *WSEAS Trans Commun* 2003; 3(2): 688–693.

254. Jonkers H, Lankhorst M, Van Buuren R, et al. Concepts for modelling enterprise architectures. *Int Coop J Inf Syst* 2004; 13(3): 257–287.

255. Noran O. An analysis of the Zachman framework for enterprise architecture from the GERAM perspective. *Annu Rev Control* 2000; 27(2): 163–183.

256. Bernus P. Enterprise models for enterprise architecture and ISO9000:2000. *Annu Rev Control* 2003; 27(2): 211–220.

257. Ribeiro-Justo GR and Karran T. Modelling organic adaptable service-oriented enterprise architectures. In: *OTM Confederated International Conferences "On the Move to Meaningful Internet Systems"*, Springer, Berlin, Heidelberg, pp. 123–136.

258. Morganwalp JM and Sage AP. Enterprise architecture measures of effectiveness. *Int Technol J Policy Manag* 2003; 4(1): 81.

259. Armour FJ and Kaisler SH. Enterprise architecture: agile transition and implementation. *IT Prof* 2001; 3(6): 30–37.

260. Peristeras V and Tarabanis K. Towards an enterprise architecture for public administration using a top-down approach. *Eur Inf J Syst* 2000; 9(4): 252–260.

261. Boster M, Liu S and Thomas R. Getting the most from your enterprise architecture. *IT Prof* 2000; 2(4): 43–51.

262. Armour FJ, Kaisler SH and Liu SY. Building a enterprise architecture step by step. *IT Prof* 1999; 1(4): 31–39.

263. Fingar P. Enterprise architecture for open e-commerce. *Compon Strat* 1999: 32: 44–48.

264. Armour FJ, Kaisler SH and Liu SY. A big-picture look at enterprise architectures. *IT Prof* 1999; 1(1): 35–42.

265. Zachman JA.Enterprise architecture: the issue of the century. *Database Program Des Mag* 1997; 10(3): 44–53.

266. Richardson GL, Jackson BM and Dickson GW. A principles-based enterprise architecture: lessons from Texaco and Star Enterprise. *MIS Q* 1990; 14(4): 385–403.

267. Vella R, Chattopadhyay S and Mo JPT. Six sigma driven enterprise model transformation. *Int Eng J Bus Manag* 2009; 1(1): 1–8.

268. Nota G, Bisogno M and Saccomanno A. A service-oriented approach to modeling and performance analysis of port community systems. *Int Eng J Bus Manag* 2018; 10(132): 1–17.

269. Chattopadhyay S and Mo JPT. Modelling a global EPCM (Engineering, Procurement and Construction Management) enterprise. *Int Eng J Bus Manag* 2010; 2(1): 1–8.

270. Sayeb Y, Ayba M and Ben Ghezela H. Extending enterprise architecture modeling languages: application to requirements of information systems urbanization. *Lect Notes Inf Theory* 2015; 3(1): 8–13.