

# A systematic mapping study on Enterprise Architecture for the Education domain: Approaches and Challenges

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**Abstract**— Nowadays, education is called upon to fulfill its mission in complex and fast-changing environments. According to the OECD, globalization, democracy issues, security risks, ageing societies and modern cultures are the global mega-trends affecting the way education deploys its functions. Enterprise Architecture (EA), as a key enabler of strategy formulation and business-IT alignment, could play a central role in helping ministries and educational organizations develop their full IT strategy and gain a competitive advantage. In this perspective, a systematic EA mapping study was conducted on major research databases, academic journals and conference proceedings, in order to identify the major approaches and challenges of EA in the education domain. A total amount of 60 articles from the past 10 years were found and analyzed (e.g. the EA lifecycle phase of each initiative). Our analysis reveals that most research focuses on the development of EA for Higher Education Institutions, while the primary, secondary education and lifelong learning are almost ignored. A notable research gap is also uncovered, namely, the small number of articles focusing on EA implementation and assessment even in the educational systems of countries considered pioneers in the field.

**Keywords**— Enterprise Architecture, Education, Mapping Study

## I. INTRODUCTION

According to Zachman, “in the 21st Century, it (EA) will be the determining factor, the factor that separates the winners from the losers, the successful and the failures, the acquiring from the acquired, the survivors from the others” [1]. As an enabler of a holistic view of organizations [2], EA minimizes the risk of handling obsolete IS and enhances business and IT alignment maturity [3]. Concerning the education domain, [4] states that several empirical studies rank “business/IT alignment maturity in education as the lowest compared with several other industries”. Thus, inducing a considerable waste of resources at the expense, for example, of research and innovation [5]. Similarly, the level of EA maturity in countries which have applied EA projects in the educational domain is also considered low [6].

Although there is an urgent need for active involvement of educational organizations in the field, EA research in this domain is underdeveloped. According to [7], “EA research seems to lack studies on many important lines of governmental activities, such as [...] education”, while [8] argues that the educational sector has not followed developments in the field. Aware of this lack of studies, researchers call for more research on EA for the education domain [7], [9]. However, despite the increasing number of articles focusing on EA development and implementation in the educational domain, there has not been a systematic mapping study including all levels of education (primary, secondary, tertiary and lifelong learning). Even though there are studies, such as [10] and [11], summarizing the accumulated knowledge they are mostly focused on specific issues (e.g. Enterprise Architectures and Models) and educational levels (e.g. Higher Education Institutions (HEIs)).

Our mapping study intends to bridge this gap; in line with [12], we intend to provide a wide overview of the state-of-the-art in EA research for all education levels, to gain an insight into the core approaches taken and the challenges that remain, to identify the main research gaps, as well as to make some recommendations for future work.

The main research questions driving our study are:

*RQ1*: Why develop an EA in the Education domain?

*RQ2*: What is the scope of the current EA initiatives?

*RQ3*: What are the main challenges to be faced?

*RQ4*: What are the benefits of EA implementation?

The rest of the paper is structured as follows. Section II develops the foundation and the scope of our research. Section III analyzes the methodology of our study. Section IV outlines our results, while in Section V conclusions, study limitations, research gaps and recommendations for future work are presented.

## II. FOUNDATION AND SCOPE

Bernard A. Scott [13] defines EA as “The analysis and documentation of an enterprise in its current and future states from an integrated strategy, business, and technology perspective”. According to this definition, EA captures the

business and IT essentials of an enterprise, providing a holistic view of the stakeholders. While outlining the whole enterprise, it also facilitates the realization of its strategic intentions by encompassing strategy, business and technology. Therefore, as “a coherent whole of principles, methods, and models”, EA “facilitates the translation from corporate strategy to daily operations”, according to Marc Lankhorst et al. [14].

EA has emerged over recent years in the Education domain as “a strategic framework that can provide the structure, plan and processes to achieve an education agency’s vision and goals by aligning its business and program side with information technology (IT)” [15]. Hence, EA Reference Architectures and Models have been developed worldwide, mainly for the needs of HEIs [11]. As an enabler of business-IT alignment, EA has been viewed by education stakeholders as a promising method for “more effective change management, more planning for sustainability, more efficient IT operations, better return on investment and faster, simpler and cheaper procurement” [15].

Although literature reviews have been conducted for different business domains (e.g. healthcare [16], public sector [7]), none have focused on the educational sector as a whole. Our study aims to collect and categorize the scientific knowledge in the field of EA for the education domain. Following the suggestion of [17], a mapping study has been conducted over the last 10 years (2010-2020), in order to identify the papers published in academic journals and conference proceedings, whose main focus is the study and practice of EA for the needs of all levels of education, according to the definition of [18]. The scope of our research is also extended to lifelong learning, given that in our ageing societies lifelong learning will have an important role to play [19]. By presenting a systematic mapping study for the education domain, we intend to help all education stakeholders (e.g. ministries, decision-makers, researchers) be aware of the main challenges of EA, as well as the potential dynamics of EA in the education domain.

### III. METHODOLOGY

#### A. Literature selection process

We applied Webster’s and Watson’s concept-centric method [20], as the appropriate method to identify and synthesize the relevant literature conceptually, as well as to point out the main results of our study.

Firstly, we used the following concept-keyword combinations (“enterprise architecture”) AND (education OR “higher education institution\*” OR universit\* OR school\* OR college\* OR “lifelong learning”) in order to cover the broad scope of our study. Thereafter, a literature search was conducted in the databases and sources of major publishers (e.g. Springer, HAL, IEEE, Elsevier) and content providers (e.g. BASE, Springer, Scopus, Business Source Complete, OpenAIRE, Science Direct) through the EBSCO Discovery Service (EDS).

From a total number of 8969 results, 6024 were excluded as not conforming to our inclusion criteria in terms of language (English), time frame (2010-2020) and source type (academic journals and conference materials). 993 papers whose full text was not accessible were also excluded. Then, judging by title and abstract, 1900 papers were rejected as irrelevant to the EA field or approaching other EA topics (e.g. EA implementation, EA adoption, EA in the health domain). Among papers involving EA for the public sector, only [9], [21] and [22] were added because of their main focus on the education domain. After removing 17 duplicate matches, 35 papers were selected. Thereafter, a backward search was implemented by reviewing citations in the articles identified, resulting in a further 10 papers. Additionally, we used Scopus and Google Scholar for a forward search identifying articles citing the key articles. As a result, a further 15 papers were added. Finally, our literature selection process resulted in a set of 60 papers (Fig.1). Our query was completed on 9th of May 2020.

#### B. Mapping study’s organizing framework

Analyzing the selected papers, the core concepts are identified and a concept matrix for each paper is compiled.

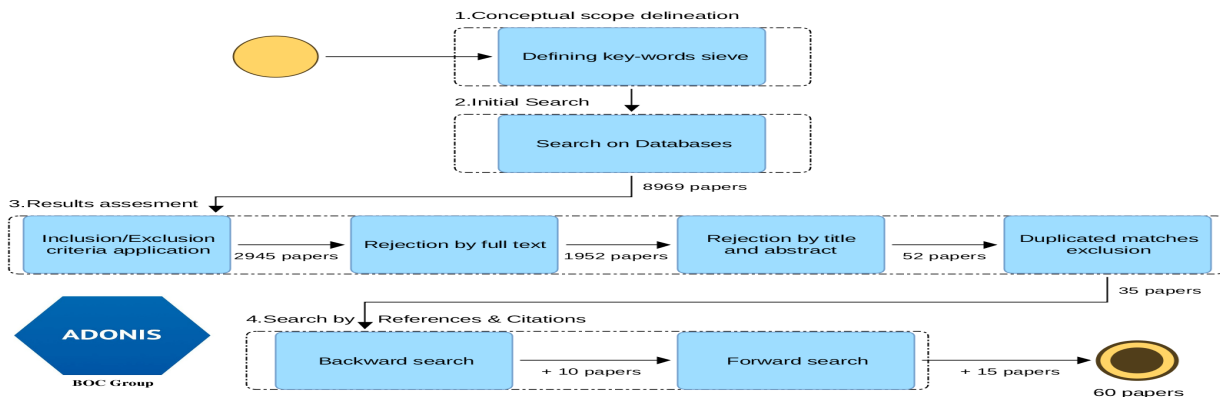


Fig. 1 Literature selection process using BPMN



Figure 2 The mapping study's organizing framework

These key concepts are then grouped based on the EA lifecycle [21], resulting in the organizing framework of our study (Fig. 2). Therefore, a concept matrix is compiled including the most important concepts. Tables and figures are also used as an efficient way to communicate the major findings of our research.

Our concept matrix is formulated, as illustrated in Fig. 3. Based on this the selected papers are categorized into one or more phases of the EA lifecycle. Papers addressing issues relevant to the preparation of educational organizations and to initial strategic activities are categorized into the “EA Strategy Formulation” category. Papers relating to the development of an EA for educational organizations are included in the “EA Development” category, while papers involving issues relevant to the transition to the target architecture and to EA governance are categorized under the “EA Implementation” category. Finally, papers relating to EA implementation benefits, as well as EA practice issues, are categorized into the “EA Assessment” category.

#### IV. RESULTS

##### A. Historical and geographical distribution

As shown in Fig. 4, there is a remarkable increase of published studies originating from Asian countries over the years 2017-2019, while the number of European and American studies remain relatively stable during the last decade. Concerning the geographical distribution, resulting from the home countries of the first authors, Fig. 5 depicts an

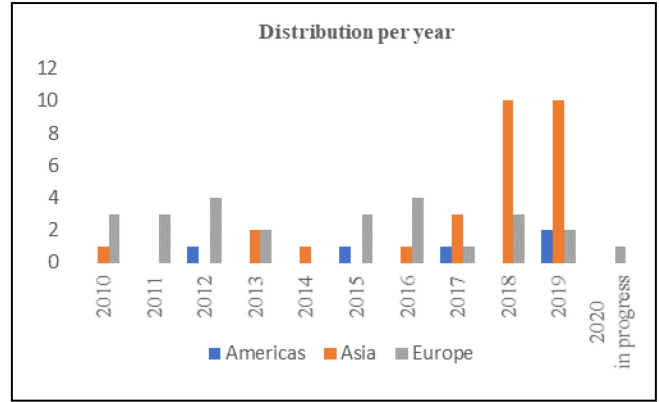


Figure 4 Year-wise distribution of selected papers

Asian dominance with 28 papers (47,46%) and a strong contribution of Indonesia (22 papers). The rest of the Asian papers are provided by Bahrain (1 paper), China (1), Malaysia (2 papers) and Saudi Arabia (2 papers). 26 papers (44,07%) originate from Europe, more specifically from Finland (9 papers), UK (7 papers), Spain (3 papers), Norway (3 papers), Denmark (2 papers), Portugal (1 paper) and Poland (1 paper). The contributions by North and South American countries is relatively weak (8,47%) with 5 papers provided by Brazil, Canada, Ecuador, Colombia and USA. We also observe a notable lack of studies from countries which have already developed and applied EAs in the education domain, such as the Netherlands and Australia.

##### B. Educational Level Scope

Fig. 6 shows a clear focus of authors on tertiary education (86,67%), while only [22], [23], [24], [25], [26], [27] and [28] involve issues relating to primary and secondary education. Lifelong learning is not considered by any author. This emphasis on tertiary education could be attributed to the challenges (e.g. student recruitment, funding) faced by the HEIs which are evolving in competitive and fast changing environments. As will be presented below, for many authors, EA is perceived as a strong enabler of strategy formulation, decision-making and change management.

##### C. Concept Analysis

Based on the concept matrix of our study, the conceptual

Case	Authors /Date	EA Strategy Formulation					EA Development					EA Implementation		EA Assessment		
		EA Drivers	EA Value	Roadmaps	Frameworks	EA Principles	What	How	Where	Who	When	Why	Implementation Barriers	Implementation Guidelines	Benefits Analysis	Practice Issues
C1	.....												X	X		
C2	.....						X									

Figure 3 The mapping study's concept matrix

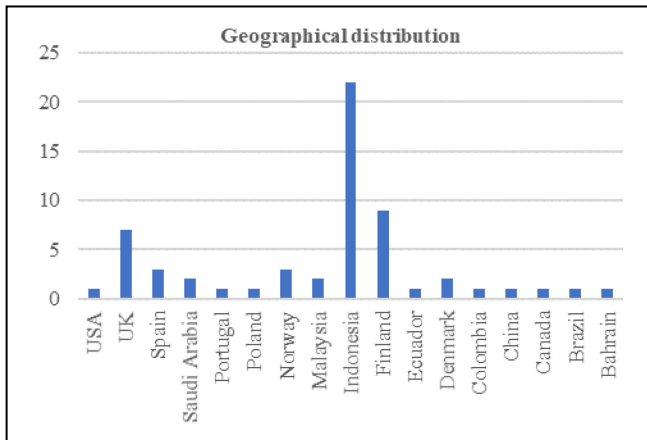


Figure 5 Geographical distribution of papers

scope of the identified cases is depicted in Fig. 7, while Fig. 8 summarizes the number of papers dealing with each concept that we have defined. As shown, the majority of authors (65,38%) originating from European countries, especially from Finland, Norway and UK, focus on issues related to EA implementation and assessment. It seems to be justified by the fact that the above cited European countries have already developed EA's for the sector of education and faced issues and challenges resulting from EA implementation. On the other hand, in line with our statement that there is a relatively recent Asian stream towards the development of EA, the majority of Asian authors (96,43%) formulate the strategic guidelines and/or develop specific segment architectures.

#### 1) EA Drivers

As part of the concept analysis, internal and external conditions having a critical impact on educational organizations as well as motivating them to develop an EA, are analyzed. Data inconsistency and redundancy [29], [30], lack of interoperability [10], IT-Business complexity [31] and non-integrated IS [32] affect internal function of educational organizations and cause several problems, such as increased cost [32], low quality of information and services [33], as well as failed strategic decisions [34]. Furthermore, external conditions, e.g. modern highly

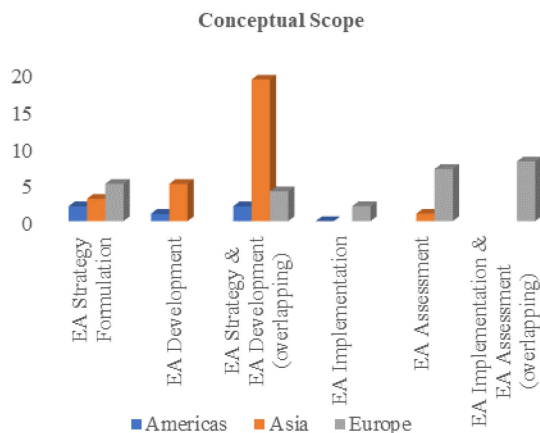


Figure 7 Conceptual scope of papers

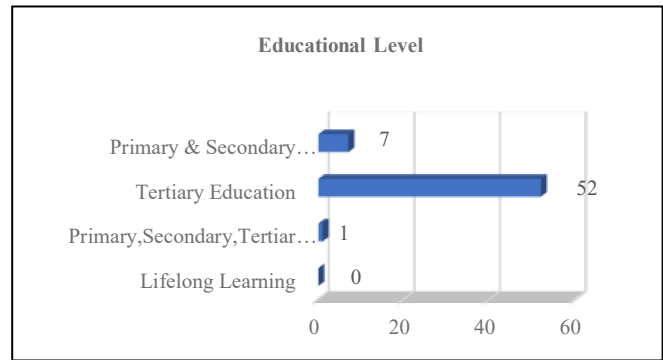


Figure 6 Educational Level Scope

competitive environments [35], need to respond to fast changes and to new requirements [36], digitalization, pressure for efficient IT systems and imposed governmental regulations [30] force educational organizations to be more flexible and optimize their IT performance.

#### 2) EA Value

Developing an EA is considered as appropriate way to improve the quality of educational services and to adapt to the fast-changing environment. More specifically, EA provides a holistic understanding of educational organizations thanks to the depiction of Business-IT interdependencies [32], modelling and visualization of the entire organization [37], as well as the development of a common understanding between different stakeholders [30]. By standardizing the organizational processes [35] and producing an integrated vision of the Business-IT strategy [38], EA is conceived as an enabler of Business-IT alignment [39] implementing the development of integrated IS [30], [33], enhancing interoperability [10], [40] and improving IT performance [34], [37]. Moreover, its crucial role results from the support of strategy formulation [32], [25] [41], [39] resource integration [42], decision making [36] and change management [38], [43], as well as from the establishment of adequate controls [37] and the optimization of knowledge management [30].

#### 3) Roadmaps

Taking into account the expected benefits of the development of EA for the education domain, authors propose roadmaps for the adoption of EA and highlight the importance of the initial steps. First of all, top management commitment and involvement of the whole organization are considered as basic prerequisites for EA implementation [10], [37], [27], [29]. Secondly, defining clear strategic goals, improving the knowledge and competence of human resources, developing a plan and establishing a management and control structure are critical factors for change management and guarantee compliance to the project [10], [29], [29], [37]. Thirdly, the description of the baseline and target architectures, as well as the development of a clear transition plan, are of great importance [10], [27], [29], [37].

#### 4) EA Frameworks & Methods

The selection of the appropriate EA Framework is also considered by the authors as a critical stage of the roadmap. [44], [37] propose a set of selection criteria, while [10], [44],

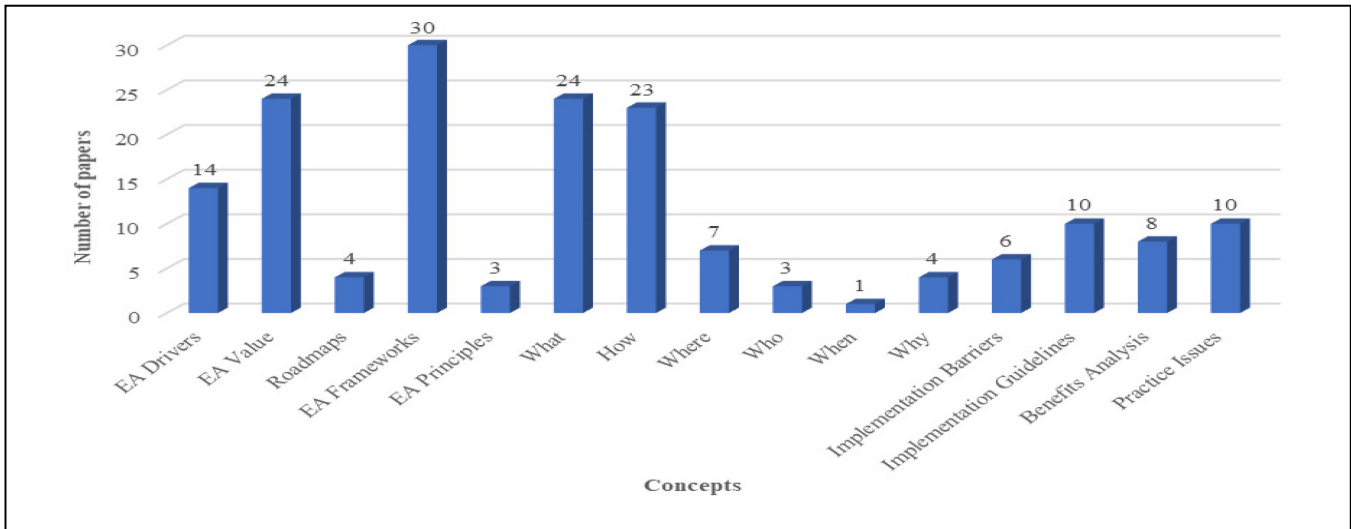


Figure 8 Number of papers dealing with each concept

[34], [37], [36], [38] make a comparative analysis of the known EA frameworks and tools. Focused on the needs of Higher Education Institutions (HEIs), [44] proposes TOGAF as the most suitable framework, [36], [38], [45] develop a lightweight EA method, called LEAP, [46] creates a Vocational Education Enterprise Architecture Framework (VEEAF), [34] proposes a method based on the Architecture Development Method (ADM) of TOGAF, [37] suggests a hybrid specialized framework for higher education, while [11] proposes an in-depth analysis of the Enterprise Reference Architectures (ERAs) and Reference Models (RMs) developed for HEIs. Reference [47] presents the frameworks, models and tools used in HEI's internationally. Among authors developing an EA in their studies, [31], [33], [41], [48] select TOGAF, [27], [29], [24], [49], [50], [51] Enterprise Architecture Planning (EAP), [52] the Scott A. Bernard framework, [53] the Mobile Enterprise Architecture (MEA).

##### 5) EA Principles

References [31] and [33] define the principles to be met, as guidelines for the deployment of their proposed EA. Based on TOGAF, [31] develops the principles of availability, compatibility, accessibility, standardization, integrity, security, reliability, optimization, accuracy, effectiveness and efficiency for the proposed IT architecture, while [34] categorizes the EA principles by architecture layer.

##### 6) Architectures

Authors developing an EA for the education domain principally aim to overcome the problem of isolated "legacy" systems, to propose an integrated IT infrastructure and therefore, to optimize the quality of services [31], [33], [4], [52], [32], [27], [29], [24], [23]. There are also authors [38], [45] configuring the existed EA to new requirements, hence maximizing IT flexibility, while [30] aims at knowledge digitalization and the support of decision making. With the exception of [54] which develops Reference Architecture Models for the Colombian Higher Education, other cases

focus on specific educational organizations and conduct "segment architectures" for one or more Zachman abstractions (e.g. who, what, how etc.) [1].

More specifically, [33], [31], [32], [29], [27], [26], [49], [48], [55], [41], [22] compose the organization's value chain diagram and analyze the main and support activities, as the critical starting point for the development of an integrated and aligned IT infrastructure to be applied. [33] goes further by developing a functional decomposition diagram where the core activities are decomposed into smaller activities. Decomposing the formulated value chain diagrams, authors model processes related to activities of greater importance, like "New Student Enrollment" [52], "New Student Admissions" [33], [27], the "Learning Process" [26], [56] and the process of recruitment [32]. Reference [57] establishes a business process reference model for universities, while [58] proposes a high level meta-model ensuring the coherence of models to be developed. On the basis of the cited value chain diagrams, [27], [29], [24], [49], [48], [55], [41] produce a list of candidate data entities, assigned to the business functions, as the basis for the development of an integrated IT infrastructure. Using E-R diagrams, [26], [29] produce data classes of different areas of the relevant organizations.

Being aware of the importance of an integrated and aligned IT blueprint for educational organisations, authors focus on the mapping of the existing IS, as well as proposing the integrated IS to be implemented in the future [31], [4], [52], [27], [29], [24], [48], [55]. Along these lines, unified IS Reference Models for HEIs are developed as instruments for the development of integrated and totally aligned IS in the field [31], [4], [32], [40]. Reference [32] develops a schema for IT and Business Process alignment in Higher Education. Based on use Case and class diagrams, new systems to be developed are also described in [52], [56], [49], [48]. In [49], [49] proposals are formulated with respect to the development of a technology infrastructure compatible with the strategy of organizations. [30] proposes a hybrid

infrastructure, as a knowledge system, based on a educational data warehouse (EDW) repository and an EA repository, in order to achieve the optimal potential of knowledge digitalization. In line with [59], [60] proposes a Service Oriented Architecture (SOA) System Architecture for the development of an ecosystemic and interconnected, modern platform for higher education including eLearning services. Reference [25] models the needs and the requirements of the Danish public schools stakeholders, in order to stimulate the use of Open Data as an educational resource. Likewise, authors describe the strategic intentions and goals of the studied organizations, as in [31], [53], while [27], [52], [48], [53], [61], [62] model the proposed architecture and technology infrastructure.

#### 7) *Implementation Barriers*

Taking into account the huge amount of resources, in terms of money, time, and people, invested by governments or educational organizations, [63] emphasizes the need for the successful implementation of EA projects. More specifically, [64], [9], [65] present the knowledge accumulated during the implementation phase for the Norwegian HEIs and UK universities, and conduct an in-depth analysis of the factors which have hampered the process.

More specifically, [64] points out the lack of an overarching governing body coordinating the initiatives, as well as the lack of an agreement on a vision. Similarly, [9] focuses on the low level of coordination of the Norwegian HEIs caused by the autonomous way they deploy their functions. Given that the EA projects require the maximal commitment of the whole organization, it is easy to understand that the autonomy of the organizational units is a major obstacle to the implementation of a common architecture, thus causing the continued use of complex and fragmented legacy systems. Furthermore, the EA initiatives are often harmed by the competition amongst educational units on student recruitment and funding, as well as by financial issues (e.g. budget management, difficulty to predict the ICT project's costs and existing large investments in legacy systems). [64] also refers small units, which focus on their daily operations, have difficulties following such strategic initiatives.

A critical factor, causing several governance issues and obstacles in the process of EA implementation is the lack of EA understanding across the organizational units. According to [64], [9], [65], [66] the limited EA knowledge of top management and other stakeholders (e.g. business managers, subject matter experts) is considered as a source of resistance and affects the efficiency of management initiatives, which are prerequisites for the success of EA projects. Doubts about who is responsible for taking control, vague and not detailed goals and strategies, over-general guidelines, unclear and competing approaches, are some governance issues related to limited EA understanding. Likewise, the late introduction of the enterprise architects into the projects confirms the limited EA knowledge. Furthermore, the lack of appreciation of the value and benefits of EA definitely affects the level of top management and stakeholders' commitment, and thus, the efficiency of their strategic and

daily initiatives. Similarly, by producing a conceptual model of resistance to EA adoption processes (REAP), [67] considers lack of EA knowledge as the principal source of resistance.

#### 8) *Implementation Guidelines*

Being aware of the importance of the transition phase and the risks of implementation, several authors present guidelines for the initiatives to be undertaken. [27], [29], [9], [68], [65] point out the importance of top management commitment and support from all the stakeholders, while [65] underlines the critical impact of key issues, such as institutional readiness. In this perspective, EA value appreciation is called upon to play the predominant role. Explaining to stakeholders (e.g. top management, decision makers, employees) the perceived benefits of EA not only for the educational organizations' prosperity, but also for themselves, is considered as the most effective way to achieve commitment of the whole organization and to overcome the sources of resistance [9].

Given that EA implementation is often accompanied by organizational changes [9], [66] underline the importance of communicating well the governance arrangements and decisions, as well as the need for evaluation of the current financial model. Similarly, [37], [27], [29], [65] emphasize the impact of factors, like the development, agreement and approval of a roadmap and implementation plan. They, also, focus on the availability of Standard Operations Procedure (SOP) and the adequacy of resources, technology, and infrastructure, while [63],[69] focus on a set of clear goals.

Taking into consideration that EA implementation is a technical procedure demanding a high level of specialized knowledge, [27], [29], [9], [65], [66] underline the role of training, as well as the need for effective communication skills between business and IT. Educational organizations aiming at implementing EA projects should be involved first of all in training leaders and top managers, and afterwards in developing the skills and knowledge of their employees [9]. In their approach, the more top managers and decision makers have a broad and deep knowledge of EA the more efficient will their governance style be.

#### 9) *Benefits Analysis*

The implementation of EA in educational organizations is considered as a large-scale change process requiring a solid strategic plan, as well as a high-level of commitment and coordination [65]. Its success depends on the achievement of the stated goals and can be measured both from the individual stakeholder's and from the organization's point of view [63].

In our mapping study cases focusing on the realization of the stated goals and benefits of EA for the sector of education are identified. Some cases refer to Finnish HEIs, where EA projects (Kartturi 2011, Peppi ecosystem projects 2010-2016) have been launched [70], [69], [67]. According to participants, the projects were successful and the HEIs have benefited greatly across all levels of their architecture (business, data, application, technology). Business-IT alignment, process improvement, enhancement of IS interoperability and data integration could be considered as the core benefits resulting from the implementation of EA.

More specifically, all desired educational functional areas were covered, the quality of documentation was improved and large-scale reporting was enabled. Comprehension of the whole organization's function, as well as optimization of their systems architecture, freed the HEIs from obsolete systems and manual work was reduced. Similarly, IT services became user-friendly. At the data level, master data management and integration management are also reported as important practical benefits [68], [69], [70]. Similarly, [71] refers to the tangible benefits, resulting from the application of EA pilots in UK universities, such as data standardization, process improvement and development of more user-friendly programme specifications. Moreover, [72] refers to the positive impact of EA projects on the initiatives of a Portuguese public university in the area of e-Governance.

#### 10) EA Practice Issues

Although the above cited benefits are obvious, researchers have several doubts concerning the total integration of EA in the common practice of educational organizations [73]. According to [6], "[...] the current EA maturity in Finnish HE sector is still low. Practically all HEIs have achieved the partial level but only 50% of the HEIs have achieved the defined level". The situation seems to be similar for the Norwegian HEIs, according to [64], remarking that "[...] the sector is somewhat immature yet, both at the top management and at the organizational level. [...] It was clear that the EA maturity was low. A clear symptom of this is that architecture initiatives were only located at the CIO level". Similarly, while EA helped UK universities increase the maturity level of Business-IT alignment, [74] states that EA is not being "adequately understood by the academy". Regarding the experimental use of the Colombian EA model for HE, [54] states that "[...] the results of the experimental period implies that the culture of all stakeholders in higher education is still not prepared for the proposed changes".

As the desired level of maturity has not been achieved, authors carry out a search of the root causes of the problem. The lack of EA knowledge and understanding seems to be a major factor causing the low level of EA integration [64], [6]. EA is not properly understood [6], [73] and there is also no common perception of the concept by the stakeholders [28]. Indeed, a study conducted on the use of EA in the Finnish basic education system reveals that EA is not commonly understood and perceived by the main educational stakeholders (ICT community, teachers, administrative officials) due to their different knowledge backgrounds and assumptions [28]. Lack of training and EA skills [6], resistance to change [54], [73] and failures in EA governance [9] are also root causes hampering the total integration of EA in the common practice of educational organizations.

In order to achieve higher levels of maturity, [64] emphasizes the major role of the engagement and commitment of top management by increasing the awareness of EA and its benefits, as well as the role of EA training [6]. Developing an ecosystemic approach to EA projects which

includes all of the educational community [54] and using the REAP model [67] could also help mitigate resistance to change, while [8] proposes a model for the measurement of the effectiveness of EA, in order to identify factors affecting the process of adoption. Similarly, conducting EA evaluation through a holistic perspective (strategy, business and technology) engaging all stakeholders could help educational organizations integrate EA in their practice and improve the efficiency of EA projects [75].

## V. CONCLUSIONS AND FUTURE WORK

### A. Conclusions

EA is called to help educational organizations gain competitive advantage in challenging and fast-changing environments. Being aware of the potential benefits of its use in the field of education, countries have developed and implemented their own EAs for the educational sector, while the number of researchers and practitioners involved in the field has increased over recent years.

In this paper, we aim to collect and categorize the scientific knowledge in the field including all educational levels (primary, secondary education, lifelong learning). For this purpose, a total amount of 60 articles from the past 10 years were found and analyzed through a concept centric approach. In the literature we found a clear emphasis on tertiary education, while primary, secondary education and lifelong learning are almost ignored.

According to the results of our analysis, data inconsistency and redundancy, lack of interoperability, IT-Business complexity and non-integrated IS seem to be major challenges motivating researchers to formulate EA strategies and to develop segment architectures for their educational organizations. Again from the results, EA is proposed as the most appropriate method to develop an integrated IT landscape, and thus improve the quality of educational services. However, implementing EA projects is reported to be a high-risk task and EA initiatives have already been hampered by factors like lack of top management commitment and lack of EA knowledge. Most researchers point out the important role of commitment of the whole organization, EA value appreciation and EA training for the successful implementation of EA projects. Despite the benefits realized for educational organizations (e.g. process improvement, enhancement of IS interoperability and data integration), the level of EA maturity seems to be low and researchers emphasize the major role of top management and EA knowledge, as well as the need for more training.

### B. Study Limitations

The limitations of our literature review are related to the range of years selected, as well as the type of literature cases identified. Indeed, it is noted that our study covers the past 10 years (2010-2020), in order to present an overview of recent developments. As a result, we might have missed some papers which could shed light on critical issues of our analysis. Moreover, only papers in English published in academic journals and conference materials are included in our literature review. White papers, papers in other

languages and governmental documents (e.g. laws, reports) were also not included.

### C. Research Gaps

The investigation of the 60 cases uncovered some research gaps. Firstly, EA research for the education domain is heavily focused on tertiary education. Less attention is given to the primary and secondary education, while lifelong learning is ignored. Secondly, literature is mainly focused on the theoretical analysis of EA issues (e.g. expected benefits, framework selection, implementation guidelines), while there is a notable lack of studies providing insights from countries which have already implemented their EAs in education. Thirdly, current literature seems to be country-oriented and does not take into account the global megatrends shaping education, thus limiting their scope and not addressing the critical impact expected on education organizations and their architectures in the future.

### D. Future Work

Based on the identified gaps, future research should also be conducted for the organizations of primary and secondary education, as well as for lifelong learning, which is closely related to the labor market. Moreover, researchers originating from countries considered pioneers in the field of EA should give more empirical insight by providing information about the use of EA in their educational organizations. Finally, the major trends affecting the future of education should be an important starting point for the development of renovated EAs for the education domain.

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