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Review

Enterprise Architecture Approach for Project Management and Project-Based Organizations: A Review

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Abstract: Project-based organizations (PBOs) derive income from conducting projects for their clients. Maintaining the most effective and efficient project governance style is an ongoing process for these organizations as the context continuously changes. Enterprise architecture (EA) is a systemic approach that supports organizations in modeling and describing themselves in different layers, such as strategy, business, application, and technology. This literature review describes the current state of EA usage in improving and quickly revising project management governance in PBOs to benefit practitioners and researchers for an integrated view of EA, PM, and PBO, and identification of future research gaps. This review used an EA model composed of layers as an analytical framework. The extracted bibliometric and content data from selected articles were processed using the VOSviewer tool for identifying and understanding the relationships between main concepts through network mapping. The selected articles are oriented to internal organization projects, mainly in information technology (IT). The need to align projects with business is highlighted, with EA positioned as a governance tool. It was found that application of EA in PBOs is rare. A trend toward using popular PM and EA frameworks, such as PMBOK and ArchiMate, was observed.

Keywords: project-based organizations; PBO; project management; enterprise architecture; business process management

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1. Introduction

Organizations and projects are important aspects of modern socioeconomic life. Managers devote significant time and effort to improving operations. Their initiatives are often implemented through projects [1]. In the last thirty years, the PM field has evolved considerably [2], with increased visibility and relevance [3]. In conventional organizational theory, projects were conceived as specific activities in a permanent organization (parent company). However, the focus is now on the project concept, its complexity, and the executive team that supports it. In this context, a project is conceived as a temporary organization [1]. Some organizations partially or completely sustain their value through projects and their respective temporary organizations, project-based organizations (PBOs) [4–6]. PM is a core competence in PBOs [7]. The study of PBOs has focused on specific domains in a PBO context, including resource management, portfolios, programs, and knowledge management. The study of holistic design in PBOs is still in its early stages [8].

PBO design has been primarily approached from an organizational development perspective [4]. The Star Model is a widely accepted PBO design guideline that uses this approach [5]. The model adapts Galbraith's framework for organizational design [9] and considers the development and alignment of five components: Strategy, processes, behavior, human resources, and structure. This approach has the advantage of establishing the

interdependence of these components and a holistic view of PBO design. Other approaches address these components independently [8].

For organizational design from a systems-thinking perspective, enterprise architecture (EA) is an alternative for modeling, analyzing, and designing an organization [10–12]. EA presents a coherent set of principles, methods, and models to design a company structure using components, considering their business processes, information systems, and IT infrastructure [13,14]. Interest in EA has increased in recent years. Organizations continue to discover challenges in the field regarding the development and implementation of EA [15–17]. The use of EA as a management tool has several benefits, as an instrument allowing companies to evaluate, adjust, and align policies and systems to achieve business objectives [18,19]. EA is also recognized as a tool that facilitates digital transformation, a trend affecting process transformation and sustainable business development [20,21]. However, EA is still expanding as a formally adopted management discipline in organizations worldwide [22]. The value of EA to an organization is not always evident. The perception is that EA is a technical discipline, not a business discipline. Thus, professionals and executives are often reluctant to use EA [13].

To help position EA as a business management tool, PBO design integrated with PM practices can help construct a perspective including systems thinking and current PBO design and management knowledge. It is helpful to consider that organizations have become more integrated into a systems approach for more successful transformations [23]. First, it is necessary to review the literature concerning EA in PM and PBOs to understand what has been accomplished. This study considers the following research questions:

- RQ1: What are the current state and key dimensions of EA approaches for PM? This question concerns research that formally applies EA to PM. The main contributions of these studies are discussed.
- RQ2: What are the current state and key dimensions of EA approaches for PBO design? This question concerns research that formally applies EA to PBO design. The main contributions of these studies are discussed.
- RQ3: What are the tendencies of frameworks in EA application in PM and PBOs? This question seeks to identify frameworks used in studies of EA, PM, and PBOs over time.
- RQ4: How integrated are the EA, PM, and PBO domains? This question seeks to holistically assess how the EA, PM, and PBO domains are integrated in the literature.
- RQ5: What are the main challenges in PM practices with EA presented as an alternative solution? This question seeks to recognize the main challenges in applying EA in the PM domain.

This study aims to determine the state of the art of EA application in PM and PBOs. As such, the findings in the literature are synthesized and summarized using a methodology combining a bibliometric review and a systematic literature review [24]. Fifty-nine articles were selected for review from PM journals and engineering management.

A review of the articles was conducted using the EA model conceived in [25], using an analytical framework with four component layers: Strategy, business, application, and technology. Bibliometric and content data were processed through co-occurrence maps and frequency graphs to guide the analysis.

The review indicated no EA applications in PBOs, although some isolated EA components were identified in some papers. In contrast, applications of EA were found in PM. These studies focused on the alignment of local projects with the organization and PM activities in business processes, most focused on IT projects. PM and EA frameworks were identified in the reviewed articles, indicating strong adherence to PMI standards and use of ArchiMate (EA modeling language proposed by The Open Group (OMG) based on IEEE 1471 standard for describing software-system architecture [25]).

This paper is organized as follows. Section 2 presents the materials and methods used in this research. Section 3 presents the results and a discussion. The conclusions, research questions, and future research directions are presented in Section 4.

2. Research Method and Article Selection Process

2.1. Research Method

EA applications in PM and PBO design were identified, including the level of integration between these domains. To achieve this objective, a three-stage method was developed according to [26], as shown in Figure 1.

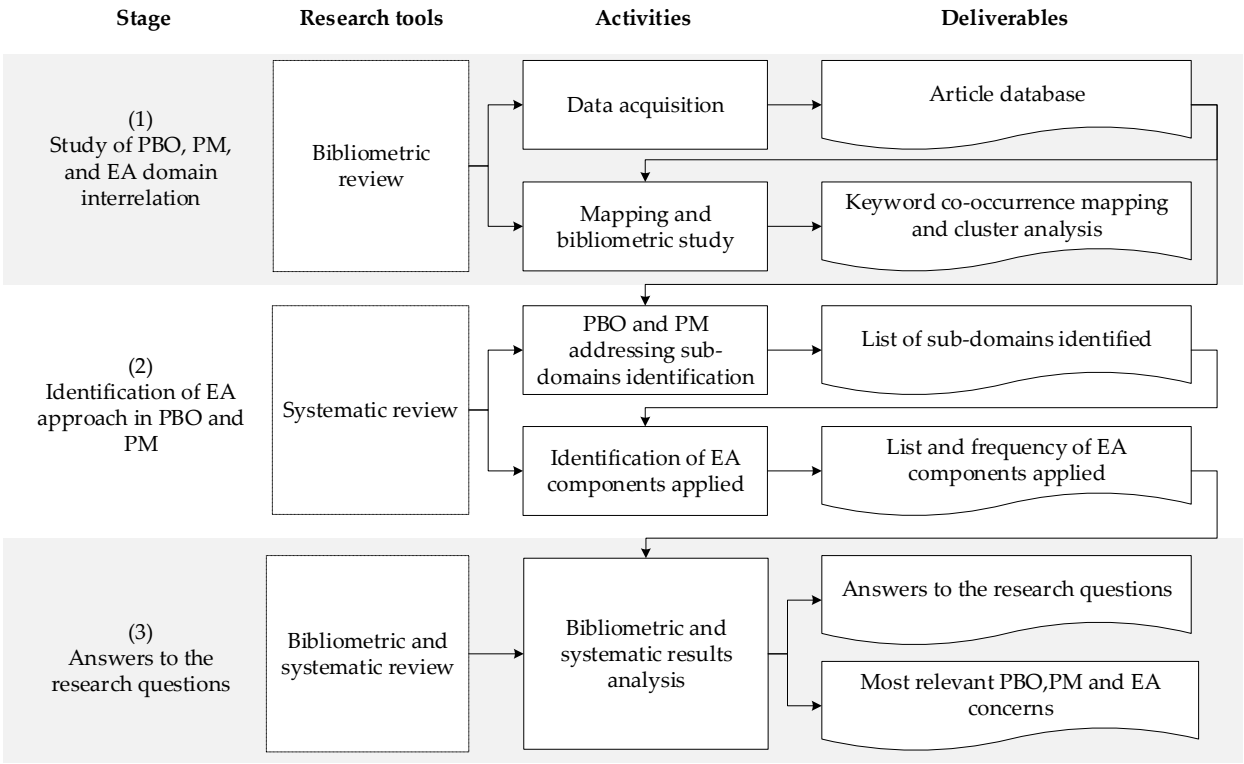

Figure 1. Research method.

The first stage seeks to understand the interrelation between PBO, PM, and EA domains. To achieve this objective, an analysis was developed from a meta-based perspective using bibliometric data obtained from an extraction protocol proposed by [27] and adapted by [28]. The analysis was complemented with a bibliometric data analysis, allowing visualization of structural and dynamic aspects of scientific research [29]. These techniques allow the mapping of bibliometric data, providing a graphical visualization of the study domains and their relationships [30]. The outputs of this stage are the selected articles and bibliometric data extracted and mapped. The second stage focuses on understanding how the components of EA relate to aspects of the PBO and PM domains through a systematic literature review (SLR) method from a content-based perspective. The content was extracted and structured from successive readings of the articles, according to [27,28]. In this stage, the main layers of the ArchiMate language are considered as EA components [25]: (1) Strategy, (2) Business, (3) Application, (4) Technology. The strategy layer (1) considers capabilities, resources, and the course of action required to model the strategy of the organization. The business layer (2) considers the business processes, services, functions, and events of the business units. The application layer (3) considers the software supporting business components with application services. The technology layer (4) considers the hardware and infrastructure communication required to run the applications [25]. Some papers could also have a cross-cutting relationship to the four layers of architecture. These articles are then associated with a fifth typology referred to in this study as (5) "all EA layers".

The deliverables obtained in this stage are the EA-PBO-PM sub-domains identification and the understanding of how the EA components are applied in these domains and sub-domains. PBO and PM domain characteristics were obtained by data extraction using

the framework proposed by [31]. Their application begins with initial familiarization from reading the articles, identifying initial codes, and transforming them into potential themes. Similarities between the themes are identified to define the main dimensions, as presented in Table 2, further on.

The third stage integrates the developed bibliometric and systematic reviews, highlighting key areas to ensure in-depth research, according to [32]. Then, the results are analyzed to respond the research questions and identify the most relevant PBO, PM, and EA concerns.

2.2. Article Selection Process

To the best of the authors' knowledge, no SLR of the EA approach for an integrated view of PBO and PM design has been conducted. No SLRs were found regarding EA application to PM in general. However, the study by Miterev et al. [8] is considered a related work, with a review of PBO design from an organizational design perspective. Our study was conducted from a systems-thinking perspective. In response to the research questions, relevant documents were investigated according to the structure and keywords in Table 1. The PBO keywords correspond to those found in the literature, as summarized in [4]. The EA keywords pertain to topics that are elements of or related to EA. Some of these topics were synthesized in [33].

Table 1. Keywords and Boolean operator used to search relevant articles.

Keyword/Terms	Boolean Operator	Keyword/Terms
Project-based organization (PBO)		Enterprise Architecture (EA)
Project-based firm		Architecture
Multi-project firm		Business process architecture (BPA)
Project-intensive firm	AND	Business process management (BPM)
Project-oriented organization		Design
Project-based company		Governance
Project management		Landscape
		Structure
		Map

In selecting relevant documents for this study, certain inclusion criteria were met. If the documents met at least one exclusion criterion (EC), they were discarded. The exclusion criteria were: (EC1) Repeated document, and (EC2) The article does not report an EA application in a PBO or PM domain.

A total of 347 papers were identified using the search string, including duplicates. The articles were obtained between August–November 2021. After application of exclusion and inclusion criteria, 59 articles remained. The following search engines were used: (1) Scopus, (2) Web of Science (WoS), (3) ResearchGate. The article selection process is shown in Figure 2.

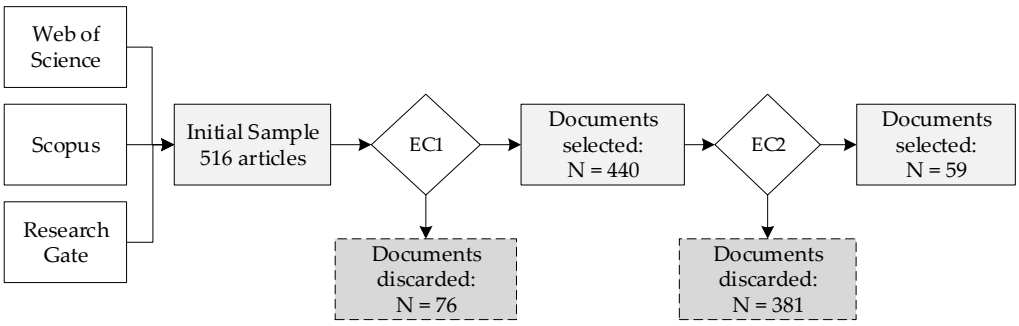

Figure 2. Document selection flowchart.

The data extraction form used in this research is presented in Table 2. The metadata was obtained using DEM1–DEM7. Content-based data were extracted using DEC8–DEC15 and answered the research questions in Section 3.2.

Table 2. Data extraction form.

ID	Approach	Field	Question	Value
DEM1	Meta-perspective	Title	What is the name of the approach?	Name
DEM2	Meta-perspective	Authors	Who are its authors?	Author list
DEM3	Meta-perspective	Year	What is its publication year?	Year
DEM4	Meta-perspective	Country	What is the first author's country?	Country
DEM5	Meta-perspective	Journal	What is the journal?	Journal name
DEM6	Meta-perspective	Type	What is the publication vehicle name?	Conference paper OR journal OR thesis OR book chapter
DEM7	Meta-perspective	Citation count	How many citations does the work have according to InCites Citation Report, Scimago Journal and Country Rank, or Research Gate?	Number
DEC8	Content-based perspective	PM Focus	What is the PM focus of the article?	Data extracted from successive readings of articles (project scope, PMIS, project control)
DEC9	Content-based perspective	Relation to EA	What is the main approach with EA components?	Strategy OR/AND Business OR/AND Application OR/AND Technology OR/AND All EA layers
DEC10	Content-based perspective	Framework, standard, or language reference	What EA–PM frameworks, standards, or language are used in the article?	Data extracted from successive readings of articles (PMBOK, PRINCE, TOGAF, ArchiMate, Zachman)
DEC 11	Content-based perspective	Type of PBO identified	What type of PBO is identified?	Internal OR external
DEC 12	Content-based perspective	Integration	Does the article holistically integrate EA, PM, and PBO domains?	Domains integrated: EA/PM, EA/PBO, EA/PM/PBO
DEC 13	Content-based perspective	Complementary information	What additional relevant information is provided?	(Dis)advantages, emphasis, others
DEC 14	Content-based perspective	Needs addressed	What are the needs of the EA application?	Data extracted and generalized from successive readings of articles (establishing project policies, communication problems, connecting Agile with EA, projects affecting EA)
DEC 15	Content-based perspective	Challenges identified for future research	What challenges are proposed for future research?	Data extracted and generalized from successive readings of articles (case study, architect–project manager integration, adding complexity)

3. Results

In this section, the bibliometric and content data are processed and analyzed using the research method described in Section 2.

3.1. Annual Quantitative Distribution of Literature

Meta-perspective findings for bibliometric analysis were summarized using descriptive statistics. Figure 3 shows the distribution of the 59 selected articles by year.

The oldest article is from 1996 and takes a process approach to PM [34]. The years with the greatest productivity were 2010, 2018, and 2021, with six, seven, and 13 articles, respectively. Since 2005, there has been constant development in the field, with at least one article per year. A growth trend is observed over time.

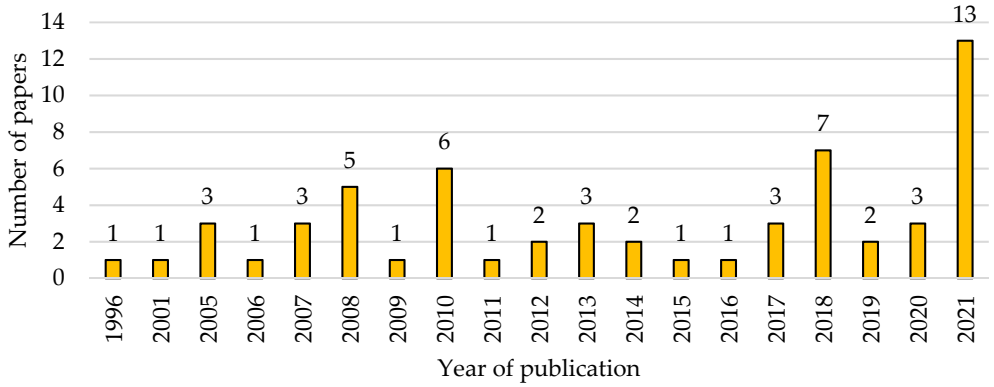

Figure 3. Number of relevant articles published from 1996 to 2021.

3.2. Country Distribution of Selected Articles

The articles are from 23 nations (primary author country of origin), as shown in Figure 4.

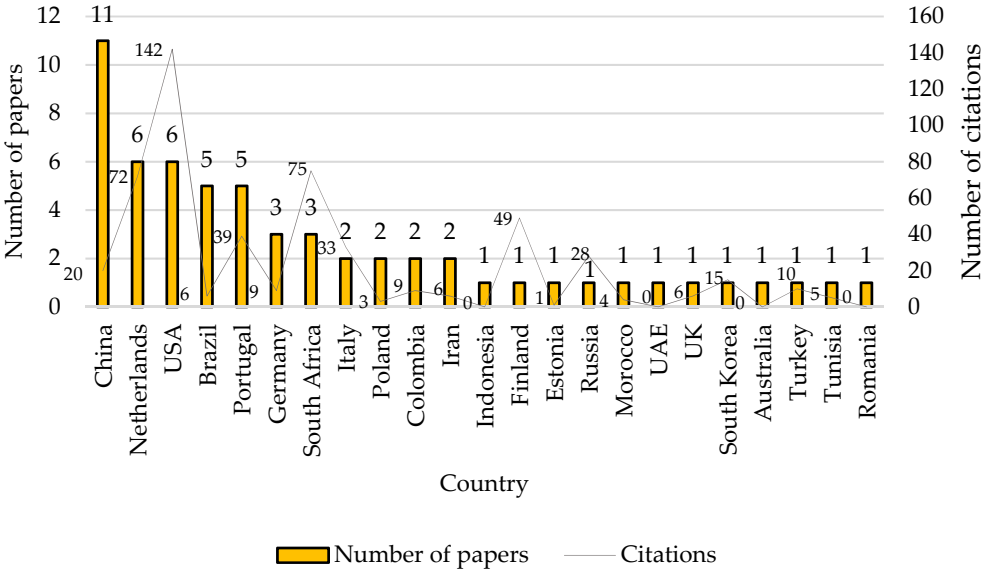

Figure 4. Productivity by country: Number of papers and citations.

The top five countries by number of papers are China, the Netherlands, US, Brazil, and Portugal. The top five countries by number of citations are the US, South Africa, the Netherlands, Finland, and Portugal.

3.3. Quantitative Analysis of Main Journals and Conferences

Of the 59 articles, most were conference papers, followed by journal papers (31), as shown in Figure 5. One book chapter and one doctoral thesis were selected.

The 59 selected papers come from 51 different sources, mainly covering the disciplines of project management, engineering management, and computer engineering. Table 3 shows the journals that group more than one article. The first journal focuses on PM. The second extends this field of knowledge to IT. The remaining sources correspond to conference papers focused on computer engineering.

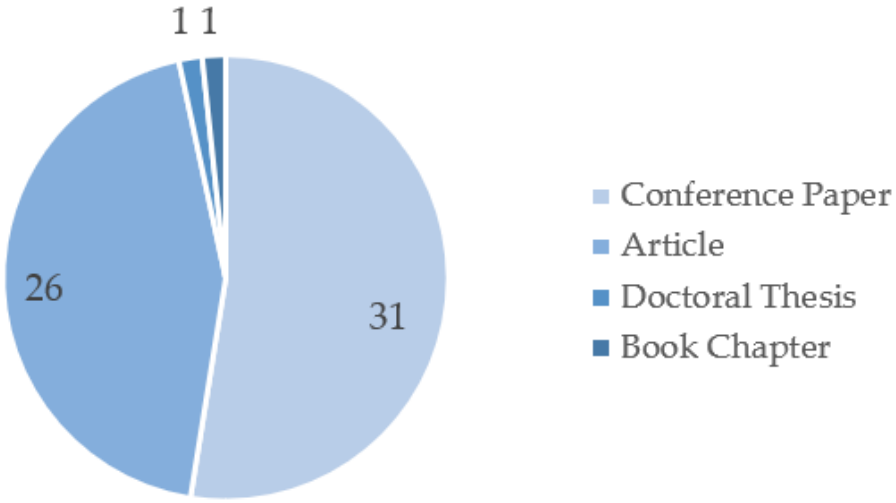

Figure 5. Distribution of papers by type.

Table 3. Sources with two or more papers.

Source (Journal/Conference)	No. of Papers
International Journal of Project Management	4
ACM International Conference Proceeding Series	2
International Journal of Information Technology Project Management	2
Procedia Computer Science	2
Lecture Notes in Business Information Processing	2
IFIP International Federation for Information Processing	2

3.4. Keyword Co-Occurrence Analysis

There were a total of 186 different author–keywords in the selected articles. After a standard coding process ('project' was grouped with 'projects', 'business process management' with 'BPM', etc.), a total of 181 keywords remained. The bibliometric metadata was processed in VOSviewer to produce a co-occurrence map. The minimum occurrence value was two keywords, meaning that a keyword appears on the map when two papers cite it. With this parameterization, the number of keywords was reduced to 25. The resulting map shows five clusters (represented in green, purple, blue, red, and yellow), as shown in Figure 6. A larger label and circle indicate greater element weight. The distance between two keywords roughly indicates their co-occurrence relationship. The closer the keywords are, the stronger their relationship [35]. Table 4 shows keywords with more than three occurrences, part of Figure 6.

Table 4 summarizes the top keywords in Figure 6 and their occurrences, links, and weight. The 'number of occurrences' value means that there are n-papers that mention a keyword. The 'Links' column describes the number of connections between keywords (the keyword is addressed in a paper with another term together quantity times the number of 'links'). The 'Total Link Strength' column indicates the weight of these links [26]. For instance, in the case of the 'governance' term, there is a 'number of occurrence equal' to three and 'links' equal to nine. It means three papers mention this term, and this term is connected nine times with others (for instance, project management or roles in this case, as shown in Figure 6). If the term does not have a link, it will appear as a point on the map.

Clustering of keywords generates five clusters: (1) Green: Enterprise architecture (EA), (2) Purple: Project management (PM), (3) Blue: Business process management (BPM), (4) Yellow: Project components, (5) Red: Mix of architecture components.

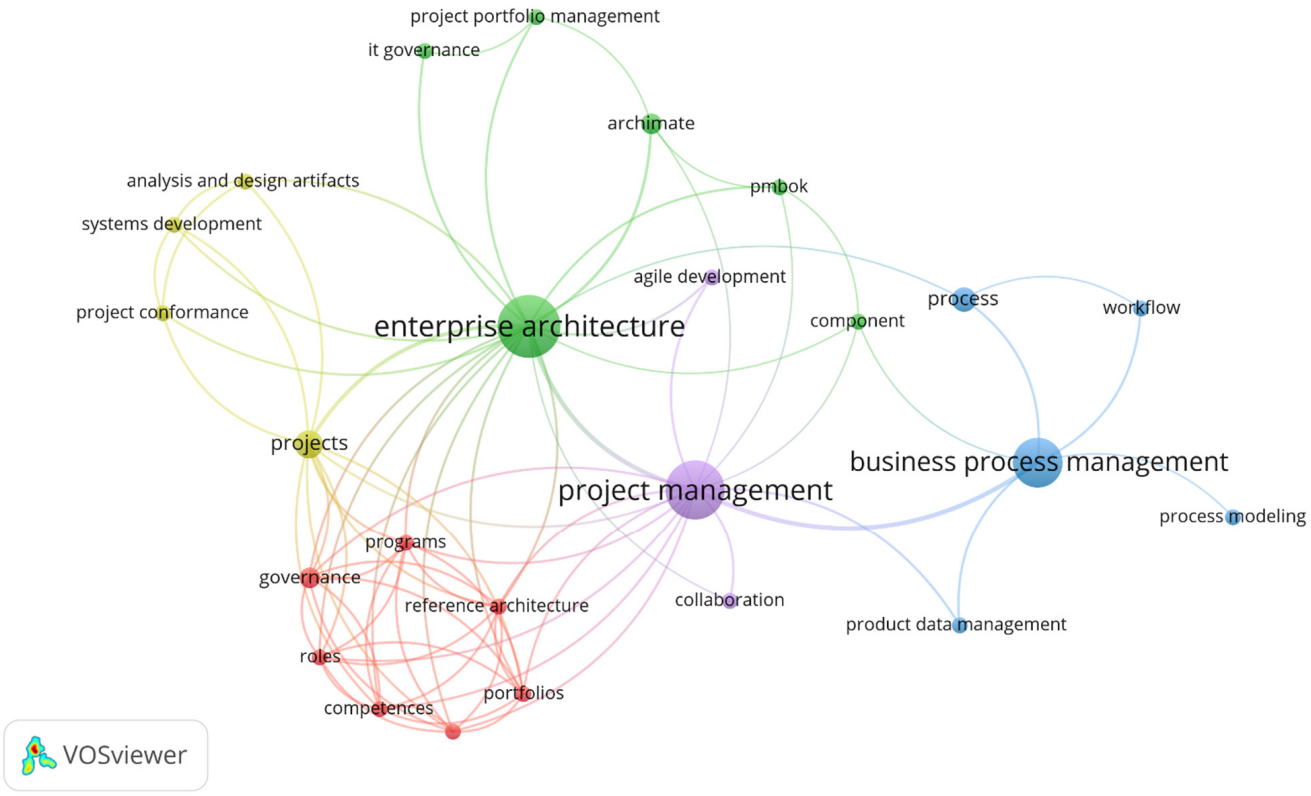

Figure 6. Keyword co-occurrence map.

Table 4. Keywords in selected papers with three or more occurrences.

n	Keyword	Occurrences	Links	Total Link Strength
1	enterprise architecture	19	20	46
2	project management	17	16	39
3	business process management	13	6	15
4	projects	5	12	27
5	process	4	3	4
6	governance	3	9	18

Figure 7 presents the bibliometric information in Figure 6 by article year. Darker colors represent the oldest, and lighter colors represent the most recent articles.

Each of the five generated clusters in Figure 6 is analyzed in the following sections.

3.4.1. Enterprise Architecture

In Figure 6, the EA cluster (Green in Figure 6) has the greatest weight of the five clusters. The keywords in this domain are 'project portfolio management', 'IT governance', 'PMBOK', and 'ArchiMate'. The last two keywords correspond to widely used frameworks in the literature. PMBOK is considered the most popular PM standard [36]. ArchiMate is a widely accepted language for modeling EAs [37,38]. The concept of IT governance is highlighted in this cluster, reflecting the orientation to IT projects in EA applications and the use of EA as a management tool to align the technological components of an organization [13,18].

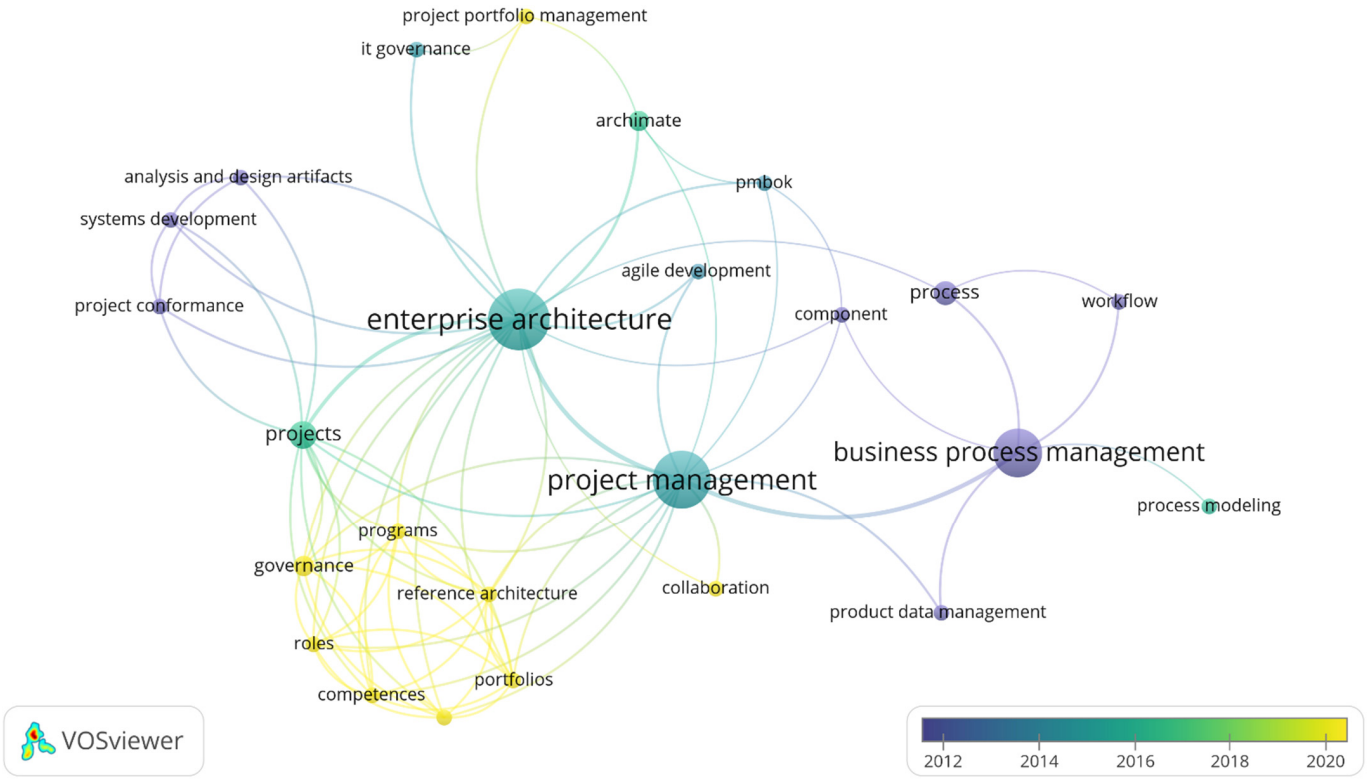

Figure 7. Keyword co-occurrence map by year of citation.

3.4.2. Project Management

In Figure 6, the PM cluster (Purple in Figure 6) is directly connected with the EA and BPM clusters. There is a link between PM and BPM at the beginning of the research time window. The PM cluster has the second greatest weight in the map. The main keywords in this group are 'collaboration' and 'Agile development', which connect the PM and EA clusters. This relationship is visible in an organization's adherence to Agile approaches through projects. Agile methodologies have their origins in IT [39]. However, there is concern regarding the relationship between EA and Agile approaches. Agile tends to neglect the architectonic design of information systems [40], challenging the flexibility and agility of an organization (and the EA) when it must adapt to environmental changes [41].

3.4.3. Business Process Management

In Figure 6, the main keywords in the blue cluster are 'process', 'workflow', 'process modeling', and 'product data management' (Blue in Figure 6). The BPM cluster is mainly connected with the PM cluster. The process concept has been widely implemented in PM practices to articulate activities and artifacts, as in PM standards such as PMBOK [42] and PM2 [43]. The PMBOK standard describes its body of knowledge in five process groups broken down into 49 processes.

3.4.4. Project Components

In Figure 6, the main keywords in the yellow cluster are 'project conformance' (Yellow in Figure 6), 'systems development', and 'analysis and design artifacts'. This cluster is connected to the EA cluster and to the architecture components cluster (red). The interrelated concepts in this cluster reflect the organizational concern for projects with an existing EA and components affected by changes produced by such projects [44–47]. To maintain the alignment of architecture components after the project, the project must be pre-aligned to the EA [47].

3.4.5. Architecture Components

In Figure 6 (Red in Figure 6), the main keywords in the red cluster are 'programs', 'governance', 'reference architecture', 'portfolios', 'layers', 'competencies', and 'roles'. These concepts are included in the most current publications (Figure 7). The concept of governance connects with all cluster keywords. Governance has gained relevance in PM domain research. In the projects domain, governance refers to interactions between project participants and mechanisms that affect engagement between stakeholders and the project [48,49]. In the EA domain, governance is recognized as internal directives for enforcing plans and principles outlined in the EA and ensuring that projects that affect the EA are properly integrated [18]. With multiple projects, as the complexity between them increases, a management tool is required [50]. It has been shown that using a reference architecture helps align an organization's components and projects, effectively managing the project [51].

3.5. Content-Based Data Perspective Analysis

This section presents a systematic analysis of the 59 selected papers based on mapping of referenced EA layers and the main concepts of PBO and PM found by extracting data from Table 2.

3.5.1. Main PM Concepts Related to EA Layers

A co-occurrence map was developed from the extraction of the main focus of the articles in the PM domain (The DEC8 data, obtained with the form described in Table 2) with EA component layers (The DEC9 data obtained, according to Table 2). Every paper was labeled regarding one or more EA layers and PM focus, then developing a co-occurrence map. Figure 8 shows the relationship between the five EA layers and nine concepts in the PM domain.

Fourteen concepts were extracted, as shown in Figure 8. The metrics are presented in Table 5. The concepts highlighted with a red ellipse in Figure 8 correspond to the EA layers. The first three concepts in Table 5 represent the most weighted concepts from the blue, red, and green clusters generated.

Figure 8 shows that three clusters are formed for the mapped concepts: (1) EA business layer (blue), (2) EA application layer (red), (3) EA project management (green). The number of connections and weights for these three clusters are analyzed below.

EA Business Layer Cluster (Blue)

The blue cluster has the greatest weight, consisting of 'strategy', 'project governance', and 'the general approach of PM'. The business layer is the most common in the selected articles (in 31 of the 59 selected articles).

This cluster reflects the concern of researchers for adopting PM practices into the business as a whole to achieve these objectives. Aligning projects with the strategy and achieving their benefits is an objective of organizations that develops internal projects [52]. Moreover, PMBOK defines the portfolio as a strategical viewpoint of projects. This concern has been achieved in the literature by the work of Cordeiro et al. [51,53], developing an architecture for balancing the time-cost-quality project constraints with the desired benefits. The above is proposed as a governance instrument by verifying deviations and detecting the architecture portfolio-program-project (PPP) model that best suits the context of an organization [51,53].

The business layer is related to a general approach of PM, considering how the PM practices affect processes, roles, functions, and events. On the one hand, Peng et al. [54] relate the business model with the PM organizations' activities through architecture models. On the other hand, Cui et al. [55] focus on the roles in multi-enterprise environments for the compliance of services and functions. This proposal is based mainly on models of processes and some relationships with applications.

Also in this group are 14 papers that use business process modeling notation (BPMN) to model business processes. Process design has become a research topic of interest from

different perspectives. The relationship between BPM and PM domains has been studied holistically [56], and the PMBOK framework has been translated into a BPMN language to integrate PM activities with those of the business more efficiently [57]. Another application approach is from the PM to the BPM domain. PM practices have been formalized to develop BPM projects using PMBOK [58] and aligning projects to IT governance standards such as COBIT [59].

Project management and business processes have one common component that can be leveraged (tasks) [34].

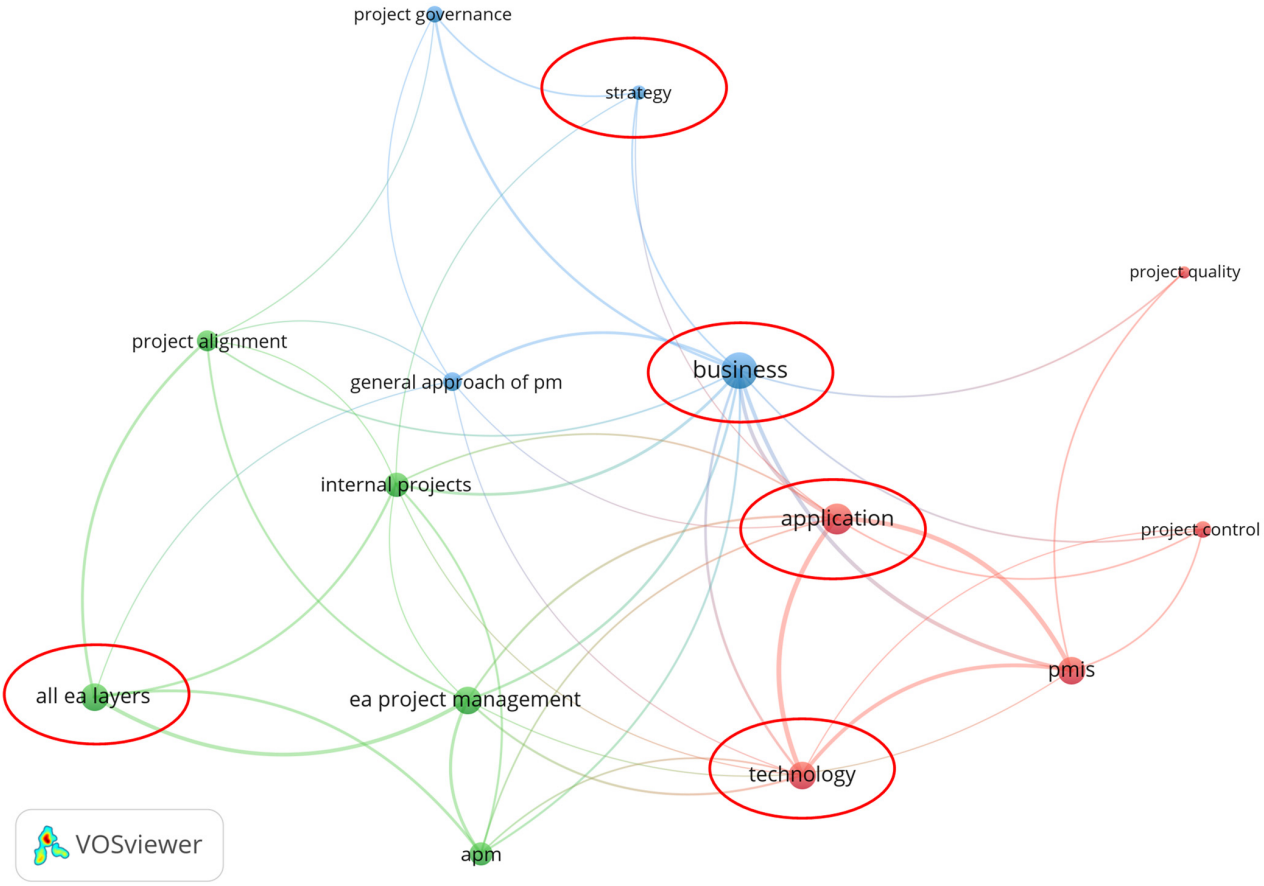

Figure 8. Co-occurrence map of the main focus of PM domain in terms of EA layers.

Table 5. Main focus of PM domain in terms of EA layers extracted from selected papers.

n	Focus	Occurrences	Links	Total Link Strength
1	business	31	12	50
2	application	21	9	46
3	EA project management	16	8	30
4	PMIS (project management information systems)	16	6	36
5	technology	15	8	35
6	all EA layers	15	5	24
7	internal projects	11	8	18
8	APM (Agile project management)	10	6	21
9	project alignment	7	6	13
10	general approach of PM	6	6	10
11	project governance	4	4	8
12	project control	4	4	7
13	strategy	3	4	6
14	project quality	2	2	4

EA Application Layer Cluster (Red)

Twenty-one papers are related to the EA application layer. This cluster is related to the EA technology layer and PM concerns such as 'PMIS' (project management information systems), 'project control', and 'project quality'. The relationship between these concepts can be explained by the need for automated support for PM activities. Automating through PMIS facilitates planning, evaluation, communication, documentation, and reuse of project information [34]. PMIS proposals are based on an EA framework such as the Department of Defence Architecture Framework (DoDAF) [60] and Unified Modeling Language (UML) [61]. PMIS was also developed by integrating BPM workflows with the Open Project application for scheduling [62] and project control [63,64]. It is known that using a process perspective in PM positively influences productivity and improves communication between project participants [63], collaboration, and information flow [58]. For project quality assurance, a PMIS proposal based on ISO 9000 [65] and a PMIS connected with the collaborative environment of architecture, engineering, and construction (AEC) industry projects were found [66]. Likewise, in manufacturing quality management, a process perspective continuously improves quality [65].

EA Project Management Cluster (Green)

The green cluster concentrates all EA layers and PM concerns, including project alignment, internal projects, APM (Agile project management), and EA project management. This group contains 15 of the 59 selected papers, highlighting the need to align internal projects with the organization, with EA as the tool for this purpose [67]. Alignment can be achieved with a pre-existing EA, as in studies by Ralph Foorthuis [44–47]. Since 2007, he has investigated how internal projects (mainly IT projects) should be coupled to an existing EA to properly integrate the project. For IT projects, the EA approach has been extended with organization of artifacts produced by projects, highlighting at the portfolio level [68], as with Foorthuis, the importance of aligning these artifacts with the company, from strategy to infrastructure.

The green cluster is also strongly linked to the EA project management cluster, considering that project management for this type of project is predominantly transversal to all EA layers.

3.5.2. EA and PM Languages and Standards

The languages and standards used in the selected papers were extracted using the form in Table 2. All findings were mapped through their co-occurrences, as shown in Figure 9.

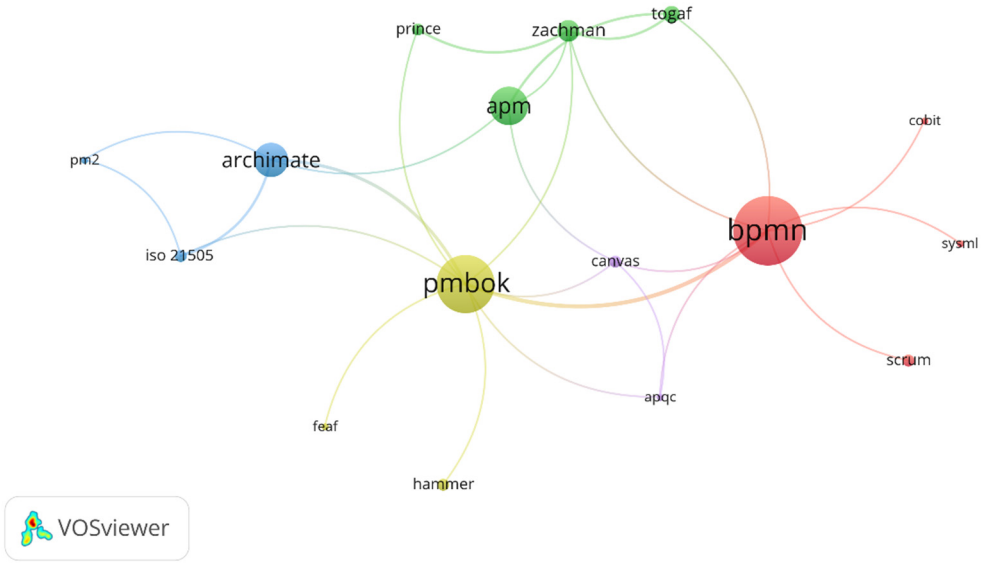

Figure 9. Co-occurrence map of EA and PM languages and standards.

The map in Figure 9 contains 17 findings in five clusters. The number of occurrences, number of links, and weight are presented in Table 6.

Table 6. PM and EA languages and standards used in selected papers.

Language/Standard	Domain	Description	Occurrences	Links	Total Link Strength
BPMN	EA	BPMN: This language is widely used for its expressiveness, semantics, and simplicity [69]	16	8	12
PMBOK	PM	Body of knowledge for project management [40]	13	9	15
APM	PM	Agile project management is an emerging approach used mainly in the IT industry [70]	8	4	5
ArchiMate	EA	EA modeling language [25]	7	4	7
Zachman	EA	The first EA framework proposed by Zachman in the 1980s [71]	4	5	7
TOGAF	EA	Architecture framework providing methods and tools for developing and maintaining an EA [72]	3	3	5
CANVAS	EA	Management tool for designing business models, structured in nine components: Customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure [73]	2	4	4
ISO 21505	PM	Guidance for project, program, and portfolio governance [74]	2	3	4
PRINCE	PM	Projects in Controlled Environments is a method for project management based on processes [75]	2	2	3
Hammer	EA	Maturity model for business process management proposed by Michael Hammer [76,77]	2	1	1
Scrum	PM	Methodology developed from technology-based companies, suitable for projects requiring speed and flexibility. Its main components are the product backlog (user requirements) and the sprint backlog (items for completing each sprint) [78]	2	1	1
APQC	EA	Taxonomy of business process for different industries, useful for addressing a common language, organizing, and mapping processes [79]	1	3	3
PM2	PM	PM methodology developed by the Centre of Excellence in Project Management of the European Commission created for EU institutions using [80]	1	2	2
COBIT	EA	Control Objectives for Information and Related Technologies is a framework for developing, implementing, and improving IT governance and management [81,82]	1	1	1
FEAF	EA	Federal Enterprise Architecture Framework is a tool developed to help US government planners address a common language. This standard is structured in five domains: Strategy, business, data applications, infrastructure, and security [83,84]	1	1	1
SYSML	EA	Systems Modeling Language, proposed by OMG (Object Management Group) as a general language for systems engineering [85]	1	1	1

In Figure 9 and Table 6, the most heavily weighted findings per cluster are (1) BPMN (red), (2) PMBOK (yellow), (3) APM (green), (4) ArchiMate (blue), (5) CANVAS (purple).

PMBOK and BPMN are strongly connected. There is a relationship regarding the process approach for managing PM activities. In Figure 10, the relationship between PMBOK and BPMN is located early in the research time window. These clusters are also connected using the CANVAS model [86,87], APQC reference process framework [87], and Agile Project Management (APM) [40,86,88]. Over time, the relationship turned to EA, beginning

with Zachman's EA framework [89–91] and later the ArchiMate language [51,53,92–95] and the TOGAF framework [91,96].

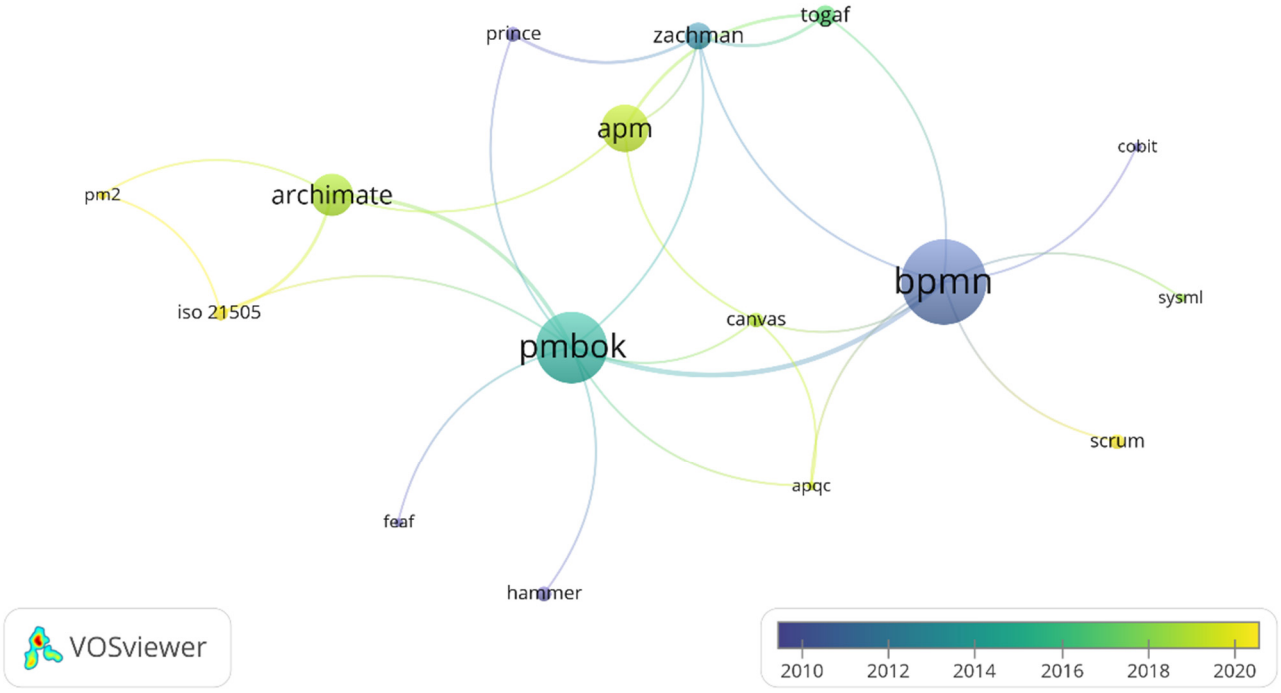

Figure 10. Co-occurrence map of EA and PM languages and standards by citation year.

With PMBOK, PM PRINCE standards are displayed, indicating that these standards are most commonly used by researchers and practitioners [97,98].

3.5.3. Type of Projects Studied in Selected Articles

According to the data extraction form in Table 2, the types of projects studied in the selected articles are shown in Figure 11:

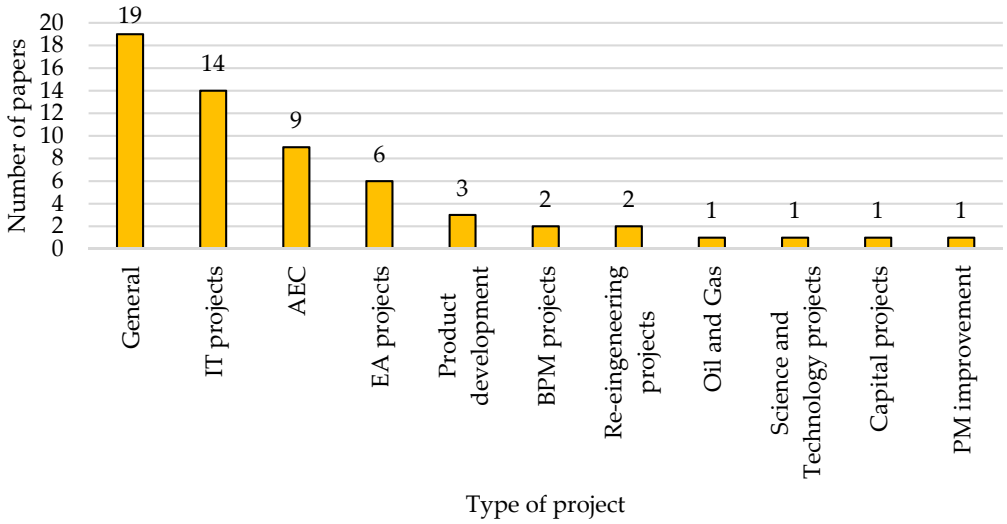

Figure 11. Types of projects studied in selected articles.

The types of projects displayed in Figure 11 are also described in Table 7.

Table 7. Description of each type of project displayed in Figure 11.

Type of Project	Description
General	Applications of EA to a general viewpoint of projects and not the specified type of project, e.g., [51,93]
IT Projects	Applications of EA on IT projects or IT project management needs, e.g., [23,96].
AEC	Architecture, Engineering, and Construction projects [99,100].
EA projects	Focus on EA projects and the PM practices for improving them [45,101].
Product development	EA is used to improve the product lifecycle and development through projects [54,61,102].
BPM projects	Focus on BPM projects and the PM practices for improving them [58,59].
Re-engineering projects	Focus on re-engineering the organization and understanding the PM practices for achieving the project's objective. Articles take advantage of the models offered by EA [86,103].
Oil and gas	Managing the data complexity on Oil and Gas projects [104].
Science and technology projects	Proposing an integrated data-business model for Science and Technology projects funded by the government [105].
Capital projects	Managing the complexity of city asset improvement projects [106].
PM improvement	Improvement of PM practices applying the business layer and BPM [63].

Figure 11 shows the application of EA with a general view of PM, and its application in IT and AEC projects. Organizations in the AEC industry generate most of their income from projects for external clients and can be classified as PBOs according to the criterion in [4]. EA applications are found in these articles. Only one article explicitly acknowledges the concept of PBO [107]. The uses of EA in this group focused on project scope control [58], the strategy of the organization [90], collaboration networks in AEC projects [66], the organizational maturity of project management [107], and project governance [87].

3.5.4. Type of PBO Addressed

The selected articles used different approaches and EA intensities in their projects. The articles do not directly refer to PBO, except for [64]. However, it is possible to identify whether the focus of the projects is the organization (internal projects) or external clients. In terms of project type and PBO in the articles, 45 were internal PBOs, 14 were external PBOs (Figure 12).

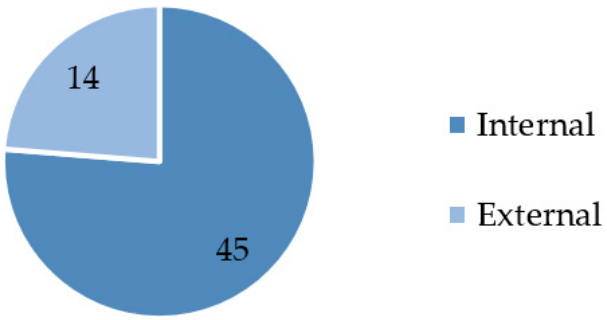

Figure 12. Distribution of papers in terms of PBO type.

3.5.5. Integration of PM, PBO, and EA Domains

The selected articles were classified according to the level of generalization of the PM, PBO, and EA study and whether integration between these domains could be identified. Thirty-one articles indicate a holistic relationship between domains, as shown in Figure 13.

Two articles applied EA in organizations that can be considered as PBOs, but do not explain the conceptual integration. Management tools such as EA, Capability Maturity Model Integration (CMMI), PMBOK, and PRINCE have been studied for claims not adequately addressed in the AEC industry [90]. Use of these standards and an architecture approach help this industry achieve strategic objectives [90,108]. It is confirmed again in this study that joint application of the concepts surveyed in the literature is mainly found in IT projects.

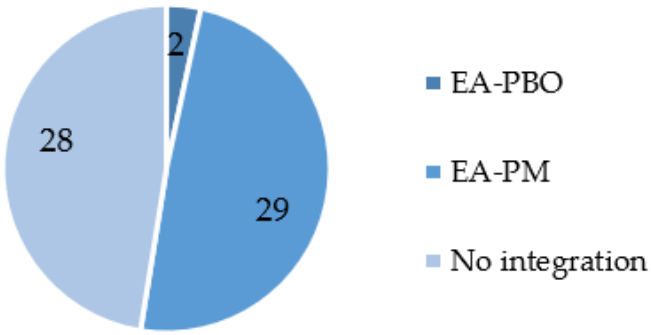

Figure 13. Distribution of papers in terms of EA-PM-PBO integration.

Twenty-nine articles generally addressed EA with PM. This includes the work of Foorthuis, who investigated the conformity of project artifacts with an existing EA [44–47]. At the project portfolio level (PPM), connections between EA and PPM were identified, with the need to align these domains with the business [51,68,92]. However, EA and PPM rarely appear related in the literature and connections between EA and PM have not been analyzed [68]. A building block toward integrating EA with PM was developed [68] but is still pending for cases scaling the EA approach. There are two articles in this group with greater generalization in the analysis of EA and PM domains. A model integrating the FEAF and PMBOK frameworks for developing EA projects was proposed [67]. A description of the body of knowledge of the PMBOK framework in ArchiMate language was developed [95]. However, only the main concepts of the PMBOK were considered, leaving alignment of motivation layer concepts at different levels of company, projects, and process for future research [95].

4. Discussion

This research has described the current application of EA on PBO and PM domains and gives an overview of the integration between these domains. From a bibliometric perspective, it is possible to identify the increasing productivity of research in the studied field. Northern hemisphere countries concentrate most of the articles, coinciding with the origin of the main EA and PM standards cited in the literature. Most of the selected articles are conference papers. Understanding that these kinds of articles are works in the process of maturing, this situation can be seen as an opportunity for the research field to take current knowledge to the next level. The above could confirm that the systems thinking in PBO and PM are still in their early stages.

Processing the keywords of selected papers—using the data extraction form described in Table 2—through co-occurrence maps, clusters and interrelationships can be identified, as shown in Figures 6 and 7. The three most weighted concepts are EA, PM, and BPM, with PM as a central cluster. It can be seen that early researchers addressed the PM–BPM relationship. Over time, research interest expanded to include EA, culminating in EA–PM components such as governance, layers, portfolio, and programs. This trend is observed in the PM domain. In the first six versions of the PMBOK framework, knowledge was structured in 'processes' [42] and hierarchical composition of PM knowledge [104]. However, the recent 7th version of PMBOK deploys knowledge through systemically interrelated 'domains' [52,109].

The content data extracted (using the form of Table 2) were processed for five types of analyses in Section 3.5: (1) the relationship through EA layers and PM focuses identified in selected papers. The 'business' layer in an EA is most often addressed in the articles. The above was also reflected in the keyword analysis (Figure 6), with the management of business processes (BPM) as activities within an EA. The work of Werewka [95] is highlighted in the blue cluster (Figure 8), which describes a part of PMBOK 6th edition through an EA model and using the business layer ArchiMate artifacts. As the author mentions, the PMBOK content is best represented through the concepts of business and

strategy layers. Moreover, the business layer of an EA is composed of processes. BPM approach is an effective tool for process-oriented organizations allowing for improved performance through sustained application [110]. PM field has also taken advantage of this and has extended its knowledge from a process perspective, as has already been mentioned with the case of the PMBOK. 'Application' and 'Technology' are also most linked layers with other PM concepts (e.g., PMIS, project control and project quality), mainly covering the need for supporting and automating PM activities. EA brings the language and the structure for modeling the relationship with PM activities from a high level (e.g., task) to a low level (e.g., data architecture). These relationships would reinforce the idea that EA helps organizations to facilitate their digital transformation process, thanks to the integration of its components organizations (from strategy to data), and allow a better understanding of them even as complexity increases [20,111,112]. (2) The EA and PM languages and standards were analyzed through their connections (Figure 9). PMBOK, as a PM standard and BPMN and ArchiMate as an EA language, are the most used on the selected papers and confirm their wide acceptance again, as shown in Section 3.4.1. (3) The type of projects mentioned in elected papers were analyzed regarding their frequency. In this case, it was expected that EA applications would mainly focus on IT projects. However, the interest of the AEC industry is surprising because of the attention they have given to EA as a management tool. This relationship can be explained by the current need for digitalization of the AEC sector, characterized by its artisanal processes on site and occupying last place in productivity compared to other sectors [113]. (4) Selected articles do not directly refer to PBO. This situation would, in principle, show that no EA on PBO has been applied. However, the term PBO might not be fully diffused. Then, alternatively, by analyzing the type of organization mentioned in the articles or where EA is expected to be applied, it is possible to infer the type of PBO alluded to. Therefore, it is observed that EA is mainly being applied (45 out of 59 articles) from an internal PBO perspective, i.e., for projects that are developed within an organization for internal objectives. The rest of the articles focus on offering projects to external clients. This point becomes relevant because some of these articles consider a pre-existing EA to connect projects and their results. It is a coincidence that in the group of external PBOs, we find the AEC industry, which is not characterized by being managed through EA as a business but has been approaching EA as a tool to improve the performance of their projects and facilitate their management. (5) The analysis of EA-PM-PBO integration has a pure systemic objective for understanding the representations of PM knowledge or practices from an EA perspective. The findings confirm the statement of [68] regarding the lack of integration between these domains and the articles presenting some connections focused on specific PM sub-domains or applying a specific layer of EA. However, there is no complete integration between all layers of an EA and, for example, all PM bodies of knowledge.

The challenges and future research were identified on selected papers and extracted and mapped, as shown in Figure 14.

Figure 14 contains five clusters. The green cluster (1) is the most heavily weighted. Increasing complexity and study scope in current papers are identified as challenges for future research. Many studies start with simplified models for a proof of concept (POC). Authors have highlighted the need for business analysis automation tools for more complex models [60,93,95,114–117]. The red cluster (2) is the second most heavily weighted. Authors in this group have emphasized developing a case study to validate proposals [68,100,114,118]. A theoretical approach is a constant in these articles. Regarding the POC approach of the proposals, authors mentioned the need to increase the analysis scope, such as extending the EA application to other EA layers [45,65] and measuring the proposal performance in actual conditions [57,119]. Another concern in this cluster is the trend to rigidise EA applications. A proper mix using the Agile approach may produce a more flexible EA [51,53]. The blue cluster (4) indicates author concerns regarding practical application of their proposals. For better proposal applicability in organizations (models, reference architectures), greater standardization of practices and generalization are required

to facilitate integration [34,94]. These concerns must be considered simply as means for use [62,86,120].

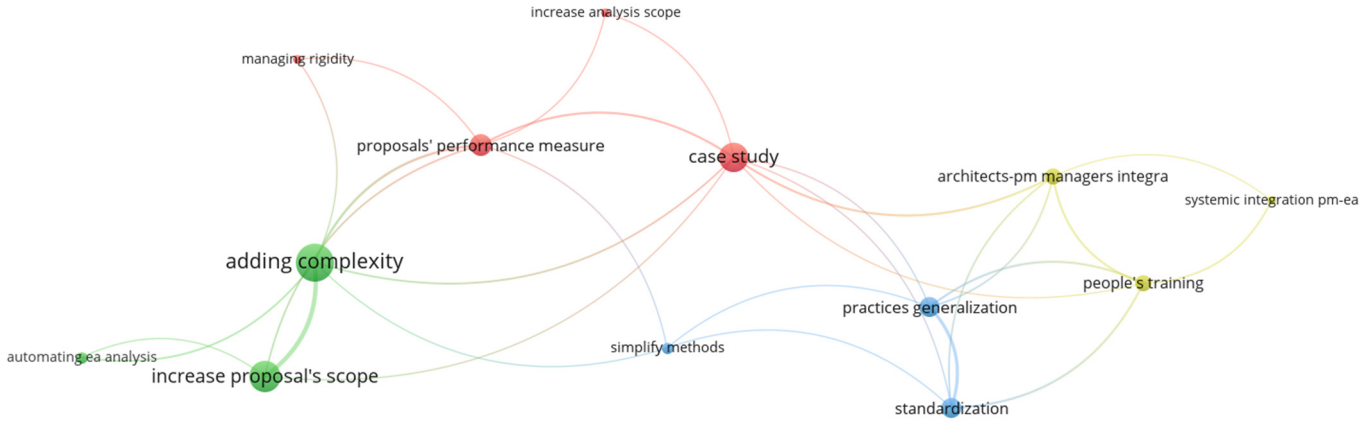

Figure 14. Challenges identified for future research and co-occurrence mapping of findings.

The yellow cluster (5) reflects the challenge for EA and PM integration, which must be systemic to achieve interoperability between project and organization [23]. There must also be integration and collaboration between project managers and EA to achieve better coupling of solutions with the organization [121]. Thus, training of project managers and architects is a concern in this cluster.

PM needs to be filled through the application of EA in the selected articles were identified and mapped through co-occurrence, as shown in Figure 15.

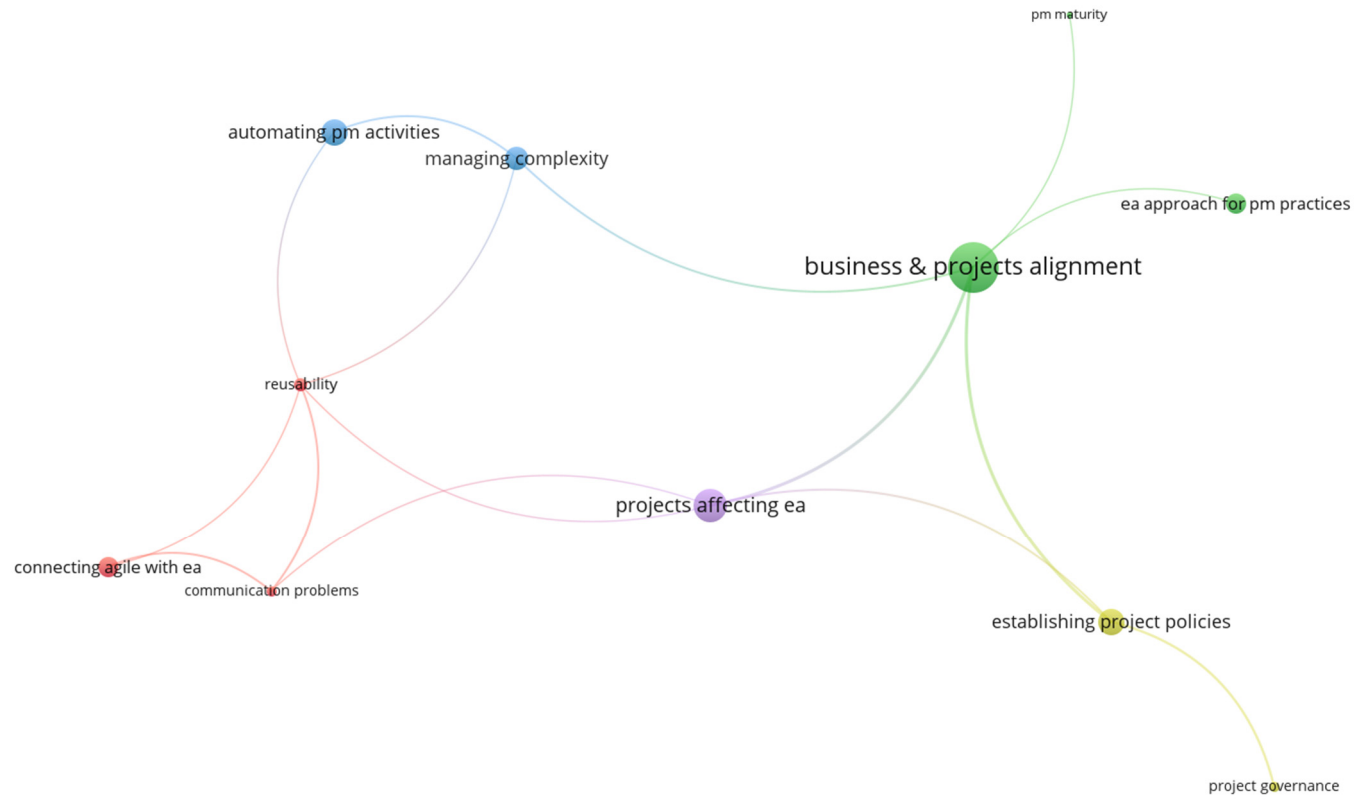

Figure 15. Co-occurrence map of needs identified in selected articles.

Figure 15 shows that EA application needs consist of five clusters. The green cluster (1) considers business and project alignment, the most heavily weighted EA application. In developing internal projects, requirements and outcomes must be aligned and integrated

with the organization for successful achievement of business goals through the project [121]. EA provides the resources and tools to translate strategy and project objectives into daily operations [93]. In the green cluster, the use of EA is identified for improving PM practices [57] and PM maturity [107], reflecting that EA promotes organizational maturity to complete projects and improve performance [106].

The second most heavily weighted cluster is purple (2) in Figure 15. This cluster contains a study about how project development affects an existing EA. This concern was addressed by Foorthuis [44–47], who proposed a framework for coupling a local project to the EA, known as the Project Conformance Framework (PCF) [45] to achieve conformance between the project and the EA, considering all of their components, including artifacts, relationships, and processes.

Application of EA (3) to establish project policies is the third most heavily weighted cluster (yellow) in Figure 15. This concern is related to the use of EA for project governance, reflecting the organizational need for a decision-making and management framework with transparency, accountability, and well-defined roles [122]. EA provides tools for establishing policies and governance statements for managing projects and their relationship to the organization.

The blue cluster (4) connects the need to use EA to automate PM activities and manage project complexity. Some projects are developed by combining different organizational components, creating an organizational challenge in managing complex environments [117,123]. EA helps to reduce and manage project complexity with detailed understanding and discretization of organizational and project components and their relationships [60]. Automation of PM activities goes hand-in-hand with complexity management. Using PM automation tools such as PMIS makes PM tasks more sustainable, allows for better decision-making, and increases the chances of project success [99].

The red cluster (5) indicates the use of EA for the reuse of organizational components and knowledge, managing communication problems, and connecting EA with Agile. This cluster reflects the dynamism that organizations face today, with market changes and constant reconfiguration [102]. Organizational sustainability requires a representative architecture to sustain business decisions and transformation projects to maintain market competitiveness [92]. Agile methods have been used for projects with significant adherence in rapidly changing environments [124]. Thus, this cluster indicates researcher concern in using EA and the Agile approach for organizational transformation. Combining EA and Agile is a challenge. Agile allows flexibility, and EA provides consistency and long-term focus. These benefits sometimes oppose each other [40].

Finally and regarding the research questions, in response to RQ1, '*What are the current state and the key dimensions of EA approaches for PM?'*, it was found that the key dimensions in applying EA in the PM domain are focused on the business layer. The process perspective facilitates application of PM practices, mainly in early research stages. The use of EA as a tool for project governance is also visualized. In different types of projects in the articles, the need for aligning projects, artifacts, and products with the layers of technology and infrastructure of the organization at the strategic level is highlighted. Most of the referred projects were related to IT.

In response to RQ2, '*What are the current state and the key dimensions of EA approaches for PBO design?*', the main finding was that there are no explicit applications of EA. However, it can be inferred that organizations classifiable as PBOs were considered, with the AEC industry appearing in five articles. The application of EA layers has gained research interest in this industry, relieving the need for coordination between different actors in AEC projects. For instance, one case in the AEC industry identified connections between structural engineering and architecture specialties. Such specialties must be properly integrated to achieve the project objectives [57]. EA was positioned as an alternative solution.

In response to RQ3, '*What are the tendencies of using frameworks in the application of EA in PM and PBO*?', some trends have been identified in PM and EA frameworks. The

main PM framework in the selected articles was PMBOK, confirming its position as the most popular PM standard among researchers and professionals. From an architectural perspective, BPMN is the most-used modeling language (for processes) in the selected articles. ArchiMate is recognized as the most widely used EA language.

Regarding the level of integration between EA, PM, and PBO domains, objects of RQ4, '*What is the level of integration between the EA, PM, and PBO domains?'*, 31 articles considered these domains from a holistic perspective. However, not all were integrated as such. Integration was concentrated between EA and PM domains for individual projects and portfolios. Of these articles, two stand out with a higher generalization level, relating to the FEAF–PMBOK and ArchiMate–PMBOK frameworks.

In response to RQ5, '*What are the main challenges in PM practices where EA is presented as an alternative solution?'*, there were gaps filled by selected papers. The main PM need with the EA approach is alignment between projects and business. EA is considered a governance tool for management. Proper connection of projects and their outcomes with the organization is a concern highlighted in the articles.

5. Conclusions

A literature review was conducted analyzing bibliometric and content information through a systematic review. Of 516 articles found using a keyword group, 59 articles were selected for review. From a meta-based perspective, the works relating EA with PBO or PM domains date from 1996. Since 2005, there has been at least one article per year. An increasing trend was identified and 2021 produced the most articles. The selected works originated mainly from Asia, Europe, and North America, conference papers in most cases. The selected works were categorized in five clusters based on the analysis of co-occurrence of article keywords. EA, PM, and BPM were the most heavily weighted and connected clusters. Over time, this map reflects that in the early stages, PM used a process approach for displaying knowledge (PMBOK 1st–6th editions). It has been demonstrated that a business process approach produces better productivity, quality communication, collaboration, and more efficient information flows in projects. At present, the tools are disseminated in architectural components interconnected in a domain approach (PMBOK 7th edition). PMBOK 7th edition [52] indicates the importance of systems thinking for PM knowledge, understanding, application, and emerging Agile approaches for flexible PM.

Future research could focus on adding complexity to EA solution proposals for PM. However, the authors reported that automation tools must accompany this objective to facilitate design and analysis. Other challenges identified include the continuing study of EA and PM integration, which must be developed at a conceptual level and between people, such as project managers and enterprise architects. There is an understanding of the benefits of EA for project success, but authors report that sometimes EA adds rigidity. For this issue, Agile is considered an alternative solution, connecting the benefits of EA with the flexibility of Agile.

EA has mostly been applied in IT. The origin of EA is related to IT. The Agile perspective was born from the same field. It seems that the IT sector can anticipate behavior in other sectors, visualizing how industries such as AEC have historically conducted their projects using traditional PM approaches and original IT practices to improve their results.

The world is becoming increasingly digital. Coexistence of people and technology is becoming more intense. Digital transformation is no longer the exclusive concern of the IT sector. Digitalization needs permeate all types of activities, organizations, and projects. Harmonious coexistence with technology as it becomes more complex requires systemic thinking to understand, manage, and improve it. As a management tool with a systemic perspective, EA is considered in different industries and seems to be a means of integrating organizations and developing projects in the digital era.

This study is expected to contribute to researchers and practitioners systemically considering EA and PM domains and demonstrate the value of using EA in project management. From a practical perspective, this article indicates trends such as concerns in

using EA and the need for collaboration between project managers and architects. From a research perspective, this article demonstrates that EA is connected to the digital transformation trend and that further development is required to improve the use of EA in more complex environments.

Application in the PBO domain is still a challenge and future research should consider the architecture that characterizes this type of organization.

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References

1. Lundin, R.A.; Söderholm, A. A theory of the temporary organization. *Scand. J. Manag.* **1995**, *11*, 437–455. [CrossRef]
2. Wawak, S.; Woźniak, K. Evolution of project management studies in the XXI century. *Int. J. Manag. Proj. Bus.* **2020**, *13*, 867–888. [CrossRef]
3. Fernandes, G.; Ward, S.; Araújo, M. Improving and embedding project management practice in organisations—A qualitative study. *Int. J. Proj. Manag.* **2015**, *33*, 1052–1067. [CrossRef]
4. Miterev, M.; Mancini, M.; Turner, R. Towards a design for the project-based organization. *Int. J. Proj. Manag.* **2017**, *35*, 479–491. [CrossRef]
5. Turner, R.; Miterev, M. The organizational design of the project-based organization. *Proj. Manag. J.* **2019**, *50*, 487–498. [CrossRef]
6. Puranam, P.; Alexy, O.; Reitzig, M. What's "new" about new forms of organizing? *Acad. Manag. Rev.* **2014**, *39*, 162–180. [CrossRef]
7. Huemann, M. Benchmarking the PM-competence of project-oriented organistions. In Proceedings of the IPMA World Conference London, London, UK, 22–25 May 2000.
8. Miterev, M.; Turner, J.R.; Mancini, M. The organization design perspective on the project-based organization: A structured review. *Int. J. Manag. Proj. Bus.* **2017**, *10*, 527–549. [CrossRef]
9. Galbraith, J. *Designing Your Organization*; Bass, J., Ed.; Wiley: Hoboken, NJ, USA, 2007; ISBN 9780787994945.
10. Aler, S.; Riege, C.; Winter, R. Enterprise architecture—Literature overview and current practices. *Wirtschaftsinformatik* **2008**, *50*, 292–304. [CrossRef]
11. Gorkhali, A.; Xu, L. Da Enterprise architecture, enterprise information systems and enterprise integration: A review based on systems theory perspective. *J. Ind. Integr. Manag.* **2019**, *4*, 1950001. [CrossRef]
12. Tao, Z.G.; Luo, Y.F.; Chen, C.X.; Wang, M.Z.; Ni, F. Enterprise application architecture development based on DoDAF and TOGAF. *Enterp. Inf. Syst.* **2017**, *11*, 627–651. [CrossRef]
13. Lankhorst, M. *Enterprise Architecture at Work*, 4th ed.; Springer: Berlin, Germany, 2009; ISBN 9783662539323.
14. Kotusev, S. Enterprise architecture and enterprise architecture artifacts: Questioning the old concept in light of new findings. *J. Inf. Technol.* **2019**, *34*, 102–128. [CrossRef]
15. Al-Kharusi, H.; Miskon, S.; Bahari, M. Enterprise architecture development approach in the public sector. *Int. J. Enterp. Inf. Syst.* **2018**, *14*, 124–141. [CrossRef]
16. Niemi, E.I.; Pekkola, S. Enterprise architecture benefit realization: Review of the models and a case study of a public organization. *Tamp. Univ. Technol.* **2016**, *47*, 55–80.
17. Iyamu, T. Understanding the complexities of enterprise architecture through structuration theory. *J. Comput. Inf. Syst.* **2019**, *59*, 287–295. [CrossRef]
18. Shanks, G.; Gloet, M.; Asadi Someh, I.; Frampton, K.; Tamm, T. Achieving benefits with enterprise architecture. *J. Strateg. Inf. Syst.* **2018**, *27*, 139–156. [CrossRef]
19. Perez-Castillo, R.; Ruiz, F.; Piattini, M.; Ebert, C. Enterprise architecture. *IEEE Softw.* **2019**, *36*, 12–19. [CrossRef]

20. Masuda, Y.; Zimmermann, A.; Bass, M.; Nakamura, O.; Shirasaka, S.; Yamamoto, S. Adaptive enterprise architecture process for global companies in a digital IT era. *Int. J. Enterp. Inf. Syst.* **2021**, *17*, 21–43. [CrossRef]
21. Kutnjak, A. Covid-19 accelerates digital transformation in industries: Challenges, issues, barriers and problems in transformation. *IEEE Access* **2021**, *9*, 79373–79388. [CrossRef]
22. Lapalme, J.; Gerber, A.; Van Der Merwe, A.; Zachman, J.; De Vries, M.; Hinkelmann, K. Exploring the future of enterprise architecture: A Zachman perspective. *Comput. Ind.* **2016**, *79*, 103–113. [CrossRef]
23. Sousa, P.; Lima, J.; Sampaio, A.; Pereira, C. An approach for creating and managing enterprise blueprints: A case for IT blueprints. In *Advances in Enterprise Engineering III: 5th International Workshop, CIAO! 2009, and 5th International Workshop, EOMAS 2009, held at CAiSE 2009, Amsterdam, The Netherlands, 8–9 June 2009.*; Albani, A., Barjis, J., Dietz, J.L.G., Eds.; Springer: Amsterdam, The Netherlands, 2009; pp. 70–84.
24. Donthu, N.; Kumar, S.; Mukherjee, D.; Pandey, N.; Marc, W. How to conduct a bibliometric analysis: An overview and guidelines. *J. Bus. Res.* **2021**, *133*, 285–296. [CrossRef]
25. The Open Group The ArchiMate®Specification. Available online: https://www.opengroup.org/archimate-home (accessed on 7 June 2022).
26. Galaz-Delgado, E.I.; Herrera, R.F.; Atencio, E.; La Rivera, F.M.; Biotto, C.N. Problems and challenges in the interactions of design teams of construction projects: A bibliometric study. *Buildings* **2021**, *11*, 461. [CrossRef]
27. Houy, C.; Fettke, P.; Loos, P.; Houy, C.; Fettke, P.; Loos, P. Empirical research in business process management – analysis of an emerging field of research. *Bus. Process Manag. J.* **2011**. [CrossRef]
28. Gonzalez-Lopez, F.; Bustos, G. Integration of business process architectures within enterprise architecture approaches: A literature review. *EMJ—Eng. Manag. J.* **2019**, *31*, 127–140. [CrossRef]
29. Cobo, M.J.; López-Herrera, A.G.; Herrera-Viedma, E.; Herrera, F. Science mapping software tools: Review, analysis, and cooperative study among tools. *J. Am. Soc. Inf. Sci. Technol.* **2011**, *62*, 1382–1402. [CrossRef]
30. van Eck, N.J.; Waltman, L. Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics* **2010**, *84*, 523–538. [CrossRef]
31. Clarke, V.; Braun, V. Thematic analysis. *J. Posit. Psychol.* **2017**, *12*, 297–298. [CrossRef]
32. Yin, X.; Liu, H.; Chen, Y.; Al-Hussein, M. Building information modelling for off-site construction: Review and future directions. *Autom. Constr.* **2019**, *101*, 72–91. [CrossRef]
33. Gonzalez-Lopez, F.; Bustos, G. Business process architecture design methodologies—A literature review. *Bus. Process. Manag. J.* **2019**, *25*, 1317–1334. [CrossRef]
34. Shih, H.M.; Tseng, M.M. Workflow technology-based monitoring and control for business process and project management. *Int. J. Proj. Manag.* **1996**, *14*, 373–378. [CrossRef]
35. Van Eck, N.J.; Waltman, L. *VOSviewer Manual*; VOS Viewer: Leiden, The Netherlands, 2021.
36. Fitsilis, P.; Gerogiannis, V.; Anthopoulos, L. Ontologies for Software Project Management: A Review. *J. Softw. Eng. Appl.* **2014**, *7*, 1096–1110. [CrossRef]
37. Buchalcevova, A. Using ArchiMate to model ISO/IEC 29110 standard for very small entities. *Comput. Stand. Interfaces* **2019**, *65*, 103–121. [CrossRef]
38. Kotusev, S. TOGAF-based enterprise architecture practice: An exploratory case study. *Commun. Assoc. Inf. Syst.* **2018**, *43*, 321–359. [CrossRef]
39. Papatheocharous, E.; Andreou, A.S. Empirical evidence and state of practice of software agile teams. *J. Softw. Evol. Process.* **2014**, *26*, 855–866. [CrossRef]
40. Van Wessel, R.M.; Kroon, P.; de Vries, H.J. Scaling Agile Company-Wide: The Organizational Challenge of Combining Agile-Scaling Frameworks and Enterprise Architecture in Service Companies. *IEEE Trans. Eng. Manag.* **2021**, 1–21. [CrossRef]
41. Ragin-Skorecka, K. Agile Enterprise: A Human Factors Perspective. *Hum. Factors Ergon. Manuf.* **2016**, *26*, 5–15. [CrossRef]
42. PMI. *A Guide to the Project Management. Body of Knowledege*, 6th ed.; The University of Pennsylvania Press: Philadelphia, PA, USA, 2017.
43. Comisión Europea. *Metodología de Gestión de Proyectos*; Publicaciones de la UE: Brussels, Luxemburg, 2021; ISBN 9789276313816.
44. Foorthuis, R.; Brinkkemper, S. Best practices for business and systems analysis in projects conforming to enterprise architecture. *Int. J. Enterp. Model. Inf. Syst. Archit.* **2008**, *3*, 36–47.
45. Foorthuis, R.; Brinkkemper, S.; Bos, R. An artifact model for projects conforming to Enterprise Architecture. *Lect. Notes Bus. Inf. Process.* **2008**, *15*, 30–46. [CrossRef]
46. Foorthuis, R.; Brinkkemper, S. A framework for local project architecture in the context of enterprise architecture. *J. Enterp. Archit.* **2007**, *3*, 51–63.
47. Foorthuis, R. *Project Compliance with Enterprise Architecture*; Utrecht University: Utrecht, The Netherlands, 2014.
48. Derakhshan, R.; Turner, R.; Mancini, M. Project governance and stakeholders: A literature review. *Int. J. Proj. Manag.* **2019**, *37*, 98–116. [CrossRef]
49. Turner, R. *How Does Governance Influence Decision Making on Projects and in Project—Based Organizations ?* White Rose University Press: York, UK, 2020.
50. Stumpe, F.; Katina, P.F. A cybernetic ontology for project management. *Int. J. Syst. Syst. Eng.* **2017**, *8*, 42–73. [CrossRef]

51. Cordeiro, G.; Vasconcelos, A.; Fragoso, B. Project, program, portfolio governance model reference architecture in the classic approach to project management. In Proceedings of the ICEIS 2020—22nd International Conference on Enterprise Information Systems, Prague, Czechia, 5–7 May 2020; pp. 619–630.
52. PMI. *A Guide to the Project Management Body of Knowledge (PMBOK®Guide)*, 7th ed.; Project Management Institute: Newtown Square, PA, USA, 2021.
53. Cordeiro, G.; Vasconcelos, A.; Fragoso, B. *Reference Architecture for Project, Program and Portfolio Governance*; Springer: Cham, Switzerland, 2021; pp. 804–832.
54. Peng, W.-L.; Lu, R.; Liu, Z. Process management of product design projects and its realization. *Jisuanji Jicheng Zhizao Xitong/Computer Integr. Manuf. Syst.* **2008**, *14*, 89–95.
55. Cui, W.; Meng, X.; Liu, S. A Service-Oriented Architecture of Virtual Enterprise for Manufacturing Industry. In Proceedings of the 2010 14th International Conference on Computer Supported Cooperative Work in Design, Shanghai, China, 14–16 April 2010.
56. Kluska, R.A.; Lima, E.P. De Correlation process in content analysis for a BPM modeling project. In Proceedings of the 22nd International Conference on Production Research, Paraná, Brazil, 28 July–1 August 2013.
57. Aquere, A.L.; Lima, R.M. Project management: Integrating architecture and structural engineering design processes. In Proceedings of the First International Conference on Structures and Architecture (ICSA 2010), Guimaraes, Portugal, 21-23 July 2010; CRC Press: Boca Raton, FL, USA, 2010.
58. Lückmann, P.; Feldmann, C.; Lückmann, P.; Feldmann, C. Success Factors for Business Process Improvement Projects in Small and Medium Sized Enterprises—Empirical Evidence. *Procedia Comput. Sci.* **2017**, *121*, 439–445. [CrossRef]
59. Zur Muehlen, M.; Ho, D.T. Risk Management in the BPM Lifecycle. In *Proceedings of the Lecture Notes in Computer Science*; Springer: Berlin, Germany, 2005.
60. Browning, T.R. Managing complex project process models with a process architecture framework. *Int. J. Proj. Manag.* **2014**, *32*, 229–241. [CrossRef]
61. Wuliang, P. A Project Management System for Product Development. In Proceedings of the Proceedings—3rd International Symposium on Information Processing, Berkeley, CA, USA, 26–27 April 2004; pp. 78–82.
62. Enrique, J.; Alarc, A.C. Alternative Interoperability Between BPMn and Project Management Tools. In Proceedings of the 13th International Conference, KMO 2018, Žilina, Slovakia, 6–10 August 2018. [CrossRef]
63. Costa do Carmo, W.; Bessa Albuquerque, A. Project Management suported by Business Process Management: A Case Study in a Brazilian Justice Organization Welkey. In Proceedings of the 2014 9th International Conference on the Quality of Information and Communications Technology Project, Guimaraes, Portugal, 23–26 September 2014.
64. Jallow, A.K.; Demian, P.; Anumba, C.J.; Baldwin, A.N. An enterprise architecture framework for electronic requirements information management. *Int. J. Inf. Manag.* **2017**, *37*, 455–472. [CrossRef]
65. Peng, W.; Lu, R.; Wang, C. An enterprise-wide project quality management system in manufacturing industry. *IFIP Int. Fed. Inf. Process.* **2008**, *255*, 1335–1346. [CrossRef]
66. Menzel, K.; Keller, M. Distributed model management for collaborative networks in AEC. *IFIP Int. Fed. Inf. Process.* **2006**, *224*, 245–252.
67. Anajafi, F. Developing effective Project Management for Enterprise architecture projects. In Proceedings of the 2010 2nd International Conference on Software Technology and Engineering, San Juan, PR, USA, 3–5 October 2010.
68. Gellweiler, C. Connecting enterprise architecture and project portfolio management: A review and a model for IT project alignment. *Int. J. Inf. Technol. Proj. Manag.* **2020**, *11*, 99–114. [CrossRef]
69. Zarour, K.; Benmerzoug, D.; Guermouche, N.; Drira, K. A systematic literature review on BPMN extensions. *Bus. Process. Manag. J.* **2019**, *26*, 1473–1503. [CrossRef]
70. Conforto, E.C.; Amaral, D.C.; da Silva, S.L.; Di Felippo, A.; Kamikawachi, D.S.L. The agility construct on project management theory. *Int. J. Proj. Manag.* **2016**, *34*, 660–674. [CrossRef]
71. Zachman, J.A. A framework for information systems architecture. *IBM Syst. J.* **1999**, *38*, 454–470. [CrossRef]
72. The Open Group. *The TOGAF Standard—Version 9.2*; British Computer Society: Singapore, 2018.
73. Salwin, M.; Jacyna-Gołda, I.; Kraslawski, A.; Waszkiewicz, A.E. The use of business model canvas in the design and classification of product-service systems design methods. *Sustainability* **2022**, *14*, 4283. [CrossRef]
74. Preview, T.S. *Project, Programme and Portfolio Management—Guidance on Governance*; International Organization for Standardization: Geneva, Switzerland, 2017; Volume 2017, pp. 1–20. ISBN 978 0 580 86828.
75. Group, I. PRINCE: PRoject IN Controlled Environments. Available online: https://www.prince2.com/uk/prince2-methodology (accessed on 8 June 2022).
76. Hammer, M. The process audit. *Harv. Bus. Rev.* **2007**, *85*, 111. [PubMed]
77. Dave, B. Business process management—A construction case study. *Constr. Innov.* **2017**, *17*, 50–67. [CrossRef]
78. Jiménez, V.; Afonso, P.; Fernandes, G. Using agile project management in the design and implementation of activity-based costing systems. *Sustainability* **2020**, *12*, 10352. [CrossRef]
79. APQC APQC Process classification framework (PCF). Available online: https://www.apqc.org/resource-library/resource-listing/apqc-process-classification-framework-pcf-cross-industry-excel-10 (accessed on 8 June 2022).
80. European Comission. *PM2 Project Management Standard*; Publications Office of the European Union: Luxembourg; Brussel, Belgium, 2021; ISBN 978-92-76-31380-9.

81. Solana-González, P.; Vanti, A.A.; García Lorenzo, M.M.; Bello Pérez, R.E. Data mining to assess organizational transparency across technology processes: An approach from it governance and knowledge management. *Sustainability* **2021**, *13*, 10130. [CrossRef]
82. ISACA. *A Business Framework for the Governance and Management of Enterprise IT*, 5th ed.; ISACA: Rolling Meadows, IL, USA, 2012; ISBN 9781604202373.
83. US Federal Government. *The Common Approach to Federal Enterprise Architecture*, 1st ed.; US Federal Government: Washington, DC, USA, 2012.
84. CIO. *Federal Enterprise Architecture Framework*, 2nd ed.; US Federal Government: Washington, DC, USA, 2013; ISBN 10580530.
85. OMG. *OMG Systems Modeling Language (SysML)*; OMG: Needham, MA, USA, 2019.
86. Falcone, D.; Di Bona, G.; Silvestri, A.; Forcina, A.; Belfiore, G.; Petrillo, A. An integrated model for an advanced production process—Agile Re-engineering Project Management. *IFAC-PapersOnLine* **2018**, *51*, 1630–1635. [CrossRef]
87. Costa, L.; Barbosa, M.B.A.; Baldam, R.D.L.; Coelho, T.D.P., Jr. Challenges of process modeling in architecture and engineering to execute projects and public works. *J. Constr. Eng. Manag.* **2019**, *145*, 05018015. [CrossRef]
88. Saragih, L.R.; Dachyar, M.; Zagloel, T.Y.M. Implementation of telecommunications cross-industry collaboration through agile project management. *Heliyon* **2021**, *7*, e07013. [CrossRef]
89. Branch, S. Designing Enterprise Operating System with PRINCE2 Framework. In Proceedings of the 2010 International Conference on Computer and Communication Technologies in Agriculture Engineering, Chengdu, China, 12–13 June 2010.
90. Ireland, V. Some neglected variables in construction management research contributing to a competitive advantage research approach. In Proceedings of the CME 2007 Conference—Construction Management and Economics: "Past, Present and Future", Reading, UK, 16–18 July 2007; pp. 837–851.
91. Rojas, L.M.; Llamosa, R. Processes of Organizational Leadership in Enterprise Architectures. *UIS Ing.* **2016**, *15*, 52–59. [CrossRef]
92. Werewka, J. Developing Conformance Between Project Management and Enterprise Architecture Governance on the Basis of a PMBOK Case. In Proceedings of the International Conference on Information Systems Architecture and Technology, NYSA, Poland, 16–18 September 2018. [CrossRef]
93. Sousa, P.; Carvalho, M. Dynamic Organization's Representation. *Linking Project Management with Enterprise Architecture.* **2018**, *2*, 170–174. [CrossRef]
94. Costa, J.; Vasconcelos, A.; Fragoso, B. An enterprise architecture approach for assessing the alignment between projects and goals. *Int. J. Inf. Technol. Proj. Manag.* **2020**, *11*, 55–76. [CrossRef]
95. Quartel, D.; Steen, M.W.A.; Lankhorst, M.M. Application and project portfolio valuation using enterprise architecture and business requirements modelling. *Enterp. Inf. Syst.* **2012**, *6*, 189–213. [CrossRef]
96. Ilyin, I.V.; Grigoreva, A.A.; Zapivakhin, I.M. Architectural Solution as a tool for planning and approval of changes in projects for information systems implementation and customization. *Bus. Inform.* **2017**, *2*, 68–78. [CrossRef]
97. Sobieraj, J.; Metelski, D.; Nowak, P. PMBoK vs. PRINCE2 in the context of Polish construction projects: Structural equation modelling approach. *Arch. Civ. Eng.* **2021**, *67*, 551–579. [CrossRef]
98. Felipe Sanchez-Arias, L.; Solarte-Pazos, L. The body of knowledge of the Project Managmenent Institute—PMBOK Guide, and the especifities of Project Management—A critical review. *Innovar-Rev. Cienc. Adm. Y Soc.* **2010**, *20*, 89–100.
99. Choi, J.; Ha, M. Validation of project management information systems for industrial construction projects. *J. Asian Archit. Build. Eng.* **2021**, 1–12. [CrossRef]
100. Udokwu, C.; Norta, A.; Wenna, C. Designing a Collaborative Construction-Project Platform on Blockchain Technology for Transparency, Traceability, and Information Symmetry. In Proceedings of the 2021 2nd Asia service sciences and software engineering conference, Macau, Macao, 24–26 February 2021. [CrossRef]
101. Benade, S.J.; Pretorius, L. System architecture and Enterprise Architecture: A Juxta Position? *S. Afr. J. Ind. Eng.* **2011**, *23*. [CrossRef]
102. Zhou, L.; Weiwei, L. Research on the reconfiguration of product development project. In Proceedings of the Chinese Control and Decision Conference, Shandong, China; 2008; pp. 1679–1682.
103. De Felice, F.; Petrillo, A.; Silvestri, A. Relocation of production processes towards low-cost countries through the project management & process reengineering performance model. *Bus. Process. Manag. J.* **2015**, *21*, 379–402. [CrossRef]
104. Alsaeedi, A.A.A.S.; Elabrashy, M.M.M.; Alzeyoudi, M.A.; Albadi, M.M.; Soni, S.; Isambertt, J.; Tripathi, D.; Shah, A. Big Data IAOM Project Management and Workflow Automation in a Giant Gas Field Digitization Drive. In Proceedings of the Abu Dhabi International Petroleum Exhibition & Conference, Society of Petroleum Engineers, Dallas, TX, USA, 17 November 2021.
105. Wang, Z.; Wang, D.; Li, Q. Data Visualization on the Life Cycle of Science and Technology Projects. In Proceedings of the 2021 IEEE 6th International Conference on Cloud Computing and Big Data Analytics (ICCCBDA), Chengdu, China, 24–26 April 2021. [CrossRef]
106. Nalewaik, A.; Rose, C. An enterprise architecture approach to project optimization. *AACE Int. Trans.* **2012**, *3*, 1742–1752.
107. Johnson, R.D. Project-based organizational maturity in architecture, engineering, and construction: A theoretical premise for practical purposes. In *Developing Organizational Maturity for Effective Project Management*; IGI Global: Hershey, PA, USA, 2018; pp. 55–77. [CrossRef]
108. Ayyagari, M.R.; Atoum, I. CMMI-DEV Implementation Simplified A Spiral Software Model. *Int. J. Adv. Comput. Sci. Appl.* **2019**, *10*, 445–450.

109. Faraji, A.; Rashidi, M.; Perera, S.; Samali, B. Applicability-Compatibility Analysis of PMBOK Seventh Edition from the Perspective of the Construction Industry Distinctive Peculiarities. *Buildings* **2022**, *12*, 210. [CrossRef]
110. Ubaid, A.M.; Dweiri, F.T. Business process management (BPM): Terminologies and methodologies unified. *Int. J. Syst. Assur. Eng. Manag.* **2020**, *11*, 1046–1064. [CrossRef]
111. Masuda, Y.; Zimmermann, A.; Viswanathan, M.; Bass, M.; Nakamura, O.; Yamamoto, S. Adaptive enterprise architecture for the digital healthcare industry: A digital platform for drug development. *Information* **2021**, *12*, 67. [CrossRef]
112. Julia, K.; Kurt, S. How Digital Transformation affects Enterprise Architecture Management—A case study. *Int. J. Inf. Syst. Proj. Manag.* **2018**, *6*, 5–18. [CrossRef]
113. Muñoz-La Rivera, F.; Mora-Serrano, J.; Valero, I.; Oñate, E. Methodological-Technological Framework for Construction 4.0. *Arch. Comput. Methods Eng.* **2021**, *28*, 689–711. [CrossRef]
114. Ait-Lamallam, S.; Yaagoubi, R.; Sebari, I.; Doukari, O. Extending the ifc standard to enable road operation and maintenance management through openbim. *ISPRS Int. J. Geo-Inf.* **2021**, *10*, 496. [CrossRef]
115. Júnior, P.S.S.; Barcellos, M.P.; Falbo, R.D.A.; Almeida, J.P.A. From a Scrum Reference Ontology to the Integration of Applications for Data-Driven Software Development. *Inf. Softw. Technol.* **2021**, *136*, 106570. [CrossRef]
116. Wang, D.; Li, Q.; Xu, C.; Wang, P.; Wang, Z. Research of Data Warehouse for Science and Technology Management System. In Proceedings of the 2021 International Conference on Service Science (ICSS), Xi'an, China, 14–16 May 2021. [CrossRef]
117. Denicol, J.; Davies, A.; Pryke, S. The organisational architecture of megaprojects. *Int. J. Proj. Manag.* **2021**, *39*, 339–350. [CrossRef]
118. Zhang, K.; Zhang, X. Research on the overall architecture design of project management information system based on SOA. In Proceedings of the 2021 International Conference on Service Science (ICSS), Dalian, China, 24–26 September 2021. [CrossRef]
119. Wannes, A.; Ghannouchi, S.A. KPI-Based Approach for Business Process Improvement. *Procedia Comput. Sci.* **2019**, *164*, 265–270. [CrossRef]
120. Madison, J. Agile and architecture Agile—Architecture Interactions. *IEEE Softw.* **2010**, *27*, 41–48. [CrossRef]
121. Van der Merwe, A.P. Project management and business development: Integrating strategy, structure, processes and projects. *Int. J. Proj. Manag.* **2002**, *20*, 401–411. [CrossRef]
122. Müller, R.; Pemsel, S.; Shao, J. Organizational enablers for project governance and governmentality in project-based organizations. *Int. J. Proj. Manag.* **2015**, *33*, 839–851. [CrossRef]
123. Vaz-Serra, P.; Edwards, P.; Aranda-Mena, G. An early-stage project complexity assessment tool for the AEC industry. *Constr. Innov.* **2022**, *22*, 242–262. [CrossRef]
124. Uludag, O.; Putta, A.; Paasivaara, M.; Matthes, F. Evolution of the Agile Scaling Frameworks. In Proceedings of the Agile Processes in Software Engineering and Extreme Programming (XP 2021), Virtual Event, 14–18 June 2022; Gregory, P., Lassenius, C., Wang, X., Kruchten, P., Eds.; Springer International Publishing: Cham, Switzerland, 2021; Volume 419, pp. 123–139.