A Systematic Review of Business-IT Alignment Research With Enterprise Architecture

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ABSTRACT Because of the dynamic environments of business and IT, achieving any alignment between the two fields has become challenging. In view of its multiple viewpoints and artifacts, the discipline of enterprise architecture (EA) is often regarded as an effective methodology to deal with business-IT alignment (BITA) issues, and thus has attracted plenty of research. This article conducts a systematic literature review of BITA research using EA. Six questions are answered through 5W1H (When, Who, What, Why, Where, How) analysis; these questions aim to acquire a thorough understanding of BITA from the perspective of EA, to discover weak points in the status quo, and to identify future research directions.

INDEX TERMS Business-IT alignment, enterprise architecture, 5W1H, review.

I. INTRODUCTION

For almost three decades, practitioners, academics, consultants, and research organizations have identified "attaining alignment between IT and business" as a pervasive problem. Is it as difficult as drawing "a line in the sand"? Although we have seen improvement, there are reasons why alignment is a persistent issue.

-Jerry Luftman, 2007.

The payback for enterprise IT architecture efforts is strategic alignment between IT and the business... Ultimately, enterprise architecture leads to "happy surprises".

-Jeanne W. Ross, 2003.

The discipline of business-IT alignment (BITA) has evolved enormously since Henderson and Venkatraman ignited its flame in 1993 [1]. Approaches, models, and techniques of BITA have sprung up in different forms since then, driven both by practitioners and academics. In particular, several influential BITA models have been created [1]–[3], all aimed at promoting best practices in the field of BITA.

In general, BITA aligns business to IT and applies IT to support business across each domain in an organization [4]. In recent years, the environments of business and IT demand agility and flexibility to meet stakeholders' expectations. It becomes important to align business and IT quickly, efficiently and continuously. BITA is not just an "end state," but a journey that does not unfold in predictable ways [5]. It is crucial to explore sustainable ways to achieve and maintain BITA.

Enterprise Architecture (EA) is widely acknowledged as such a method [6]–[8]. EA is a structured and aligned collection of plans for the integrated representation of a given business and IT landscape, in past, current and future states [9]. It is a comprehensive tool for achieving and maintaining BITA [7]. So far, there have been quite a lot of BITA studies conducted with EA, separately from EA frameworks, EA artifacts, and EA meta-models. However, it is difficult to induce and summarize these studies because they are scattered across various fields.

To this end, this article reflects on the past developments and then documents the current state of BITA research using EA, a field which has not been studied before. One hundred and eleven contributions have been gathered from several data sources using specific keywords and criteria. The comprehensive picture of the entire research field is analyzed with regard to the network positions of their respective authors and publications, as well as to the content and principal themes. Our primary method for exploring this picture is 5W1H (When, Who, What, Why, Where, How) analysis— a method of asking questions about a process or a problem for all of the literature under consideration. Each publication is analyzed with the 5W1H method, which allows us both to induce findings and to produce novel insights into BITA research using EA. The method aims to counteract tendencies of dispersion, and also to help scholars assess certain contributions in relation to developments within the overall research field.

Following this introduction, the remainder of this article is structured as follows. The next section surveys past research

on the state of BITA and EA. The subsequent section introduces the literature selection method and content analysis method of this article. The fourth section represents detailed research results of the six questions on 5W1H. The fifth section summarizes our findings from implications, limitations and future research. The penultimate section compares the review process of this paper with guidelines for conducting literature reviews. The final section serves as the conclusion of this paper.

II. RELATED WORK

Multiple comprehensive literature reviews of BITA exist, all share some similarities. BITA definitions, BITA measures, and BITA models were often discussed in these reviews [10]–[13]. The relationships between BITA and company performances were demonstrated [2], [14]. Multiple BITA domains such as strategic, structural, and social also involved [10], [11]. Throughout the above literature reviews, embracing various changes of business and IT is the most important challenge for sustaining BITA, which helps make an organization more flexible and efficient. Multiple techniques were recommended for dealing with BITA issues, such as business process management, EA, ontology, and so on.

EA is defined as the "fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution" [15]. Enterprise architects seek to align enterprise processes and structure with their supporting IT systems so that enterprises can flourish in their environments [16]. Multiple EA reviews were conducted varying with different research scopes, such as EA framework, EA practice, or EA management. For example, Schekkermann [17] and Schönherr [18] provided detailed overviews of existing EA frameworks such as Zachman, FEAF, TOGAF, and DoDAF. Esswein and Weller [19] compared different EA frameworks and concluded their broad and comprehensive characters. Buckl *et al.* [20] and Mykhashchuk *et al.* [21] studied the state of art of EA management. Simon *et al.* [22] concluded EA research by the co-author analysis, co-citation analysis, and content analysis. According to the implications of EA in the above reviews, the BITA seems to be an instinct of EA development, and the evolution process from as-is EA to to-be EA can be used to satisfy the dynamic requirements of BITA. As Ross said, BITA is the payback for EA efforts [23].

It is widely acknowledged that intimate connections exist between the research of BITA and that of EA [16]–[20]. Some scholars argued that EA is an effective tool to achieve and maintain BITA; some scholars deem BITA as a sub-goal of EA development. Plenty of association studies have discussed from various viewpoints such as EA design, EA evolution, and BITA measurement. Nevertheless because of the literature's dispersity, it is difficult to understand and integrate them thoroughly. Exploring a systematic review of BITA research using EA helps counteract tendencies of dispersion and induce research mainstreams.

III. RESEARCH METHOD

In this section, we first explain the literature collecting and screening method of this article; we then introduce the literature analysis method–5W1H, and identify six research questions.

A. LITERATURE COLLECTING AND SCREENING

In order to ensure that the literature gathered truly addresses combining BITA with EA, proper data sources, keywords, and criteria should be determined first.

At first, we selected data libraries such as IEEE Xplore, ACM Digital Library, Science Direct, Google Scholar, and conferences such as the International Conference on Advanced Information Systems Engineering, the Enterprise Distributed Object Computing Conference, the Hawaii International Conference on System Sciences, and the International Conference on Information Systems.

Next, a keyword search of titles and abstracts were used to find relevant articles in the above sources. Keyword combinations took examples from three distinct categories: keywords on alignment contents, including "business and IT," "strategy," "business," and "IT;" keywords on alignment expressions, including "alignment," "fit," "suit," "synergy," and "coherency;" keywords on architecture, including "enterprise architecture," "business architecture," and "organization architecture." The three kinds of keywords ensure the integrity for collecting BITA research using EA. The keywords for searching should combine at least one term in each kind.

Finally, in order to remove studies that only mention BITA and EA inpassing, several criteria were considered for further screening: the inclusion of the definition of BITA; the inclusion of the definition of EA; a discussion of the relationship between BITA and EA; and conclusions that follow from combining BITA with EA.

Given the above scopes and constraints, one hundred and thirty-two papers were collected through keyword-based searching in the last 15 years ranging from 2002 to 2016 (but excludes 2017, since our document collection was in mid-2017). After performing a personal screening with the above criteria, 21 papers were removed and 111 papers were finally acquired.

B. PAPER ANALYSIS

The next step was to determine an analysis method to study the 111 papers and to identify the research questions of this article. The 5W1H (when, who, what, where, why, how) analysis method was selected to ask critical questions about six aspects of each paper. It demanded the collection of the following essential information: when the paper was published; who wrote the paper; what research question the paper addressed; the research area of the paper; why it was written; and how to address the research question of the paper.

Through analyzing each paper's 5W1H, overall trends were concluded. Six questions were answered in this article, which corresponded to the six aspects of 5W1H:

RQ1: What are the numbers of included papers per year?

RQ2: What does the co-authorship network look like?

RQ3: What are the main research questions and their numbers?

RQ4: What are the core research areas and their numbers?

RQ5: What are the primary research motivations and challenges?

RQ6 What are the main models, techniques, and ideas to address BITA with EA?

We argued that a thorough understanding of the state of the current literature surrounding the study of BITA using EA would be extracted after answering these six questions. The results of the six questions are listed in the next section.

IV. Results

After analyzing each paper's 5W1H, one hundred and eleven papers were input into a database that captured the titles, authors, years of publication, research questions, research domains, research motivations, research challenges, research models, and techniques. Comparatively analyzing each paper and classifying the similar terms, we acquired the results of the above six questions.
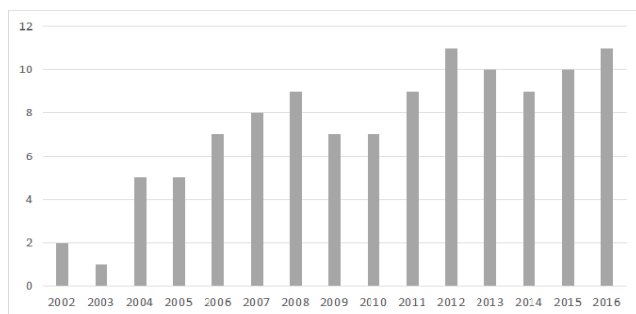

FIGURE 1. Numbers of included papers per year.

A. "WHEN" ANALYSIS

This section aims to answer the RQ1. Figure 1 shows the number of papers in the last 15 years from 2002 to 2016. Several findings were discovered from Figure 1.

First, the number of studies combining BITA with EA represents an overall rising trend. Although the rising is not evident and descending exists in several years, it cannot be denied that the numbers are gradually increasing.

Second, the rising trend in the middle and late 2000s is relatively obvious, which is accordant with the EA research. Simon *et al.* [22] demonstrated that there was a dramatical trend rise of EA research after 2003. Multiple versions of EA frameworks were issued in this period, such as DoDAF V1.0, V1.5, V2.0, TOGAF V9, the new version of Zachman framework, Gartner, FTF, FSAM, and MoDAF. We argue that the increasing EA research in this period makes the combination of BITA and EA more receivable.

Third, the numbers in recent years are stable (around ten per year). The difficulties in BITA practices and EA practices

hindered the combination of them. Ullah pointed out existing BITA techniques that have failed to capture the real benefits of alignment and the alignment process were addressed negatively [13]. Chan and Reich [10] argued that dynamic environment changes make the combination of BITA and EA more difficult in practice. Similarly from the EA side, it is difficult to apply EA development and evolution in practice [22]. Therefore, more attention should be paid to deal with the challenges above.

B. "WHO" ANALYSIS

This section aims to answer the RQ2: explores the co-authorship relationships of the 111 studies.

The co-authorship network is supposed to provide the basis for extracting research collaboration, since it basically shows what authors (nodes) cooperate with one another (represented by an edge) and in what frequency (captured by the edge's weight) [24]. Since it represents an indicator of research collaboration, the research communities relating BITA with EA can be identified from the network. The Gephi tool is adopted to develop the co-authorship network. Gephi visualizes structures that emerge from any interaction as networks and allows a quantitative diagram analysis such as average degree, average weighted degree, network diameter, graph density, and average clustering coefficient.

The co-authorship network comprises 245 nodes and 483 edges in this paper. The average degree centrality is 3.943 and the network diameter is 4, indicating a rather low level of research collaboration. The lack of collaboration can also be evidenced by the overall graph density (indicator for the level of connectedness of a network) of 0.016 and the graph modularity (indicator for the presence of community structures) of 0.852, suggesting a rather fragmented picture overall.

Applying the algorithm of Fruchterman and Reingold [25] allows us to come to an untangled placement of nodes and thus visualize clusters within the overall network graph [22]. This picture became even more clear when filtering edges by a minimum weight of 3 and nodes by a minimum degree of 1. The simplified co-authorship network is shown in Figure 2.

As a result, several clusters looking like clique structures appeared in Figure 2. Respectively, scholars in the upper left cluster come from KTH Royal Institute of Technology; scholars in the upper right cluster come from the University of Lisbon; scholars in the middle left cluster are from the University of St. Gallen; scholars in the middle cluster come from the School of Communication and Computer Science; scholars in the middle right cluster come from Link Consulting SA & IST/DEI in Portugal; the bottom cluster's scholars are from the University of Twente and the BiZZ design institute in the Netherlands. Given the results filtered by min-edge weight and min-degree, the research collaborations happened frequently inside the universities or institutes themselves. The bottom cluster is the only exception because the authors have developed similar research when they were colleagues at the Telematica Institute.
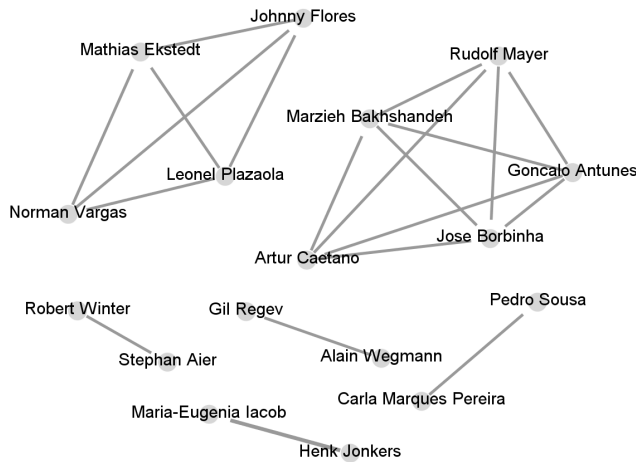
FIGURE 2. The co-authorship network (filtered by a min-edge weight of 3 and min-degree of 1).

Overall, the research collaborations are inadequate due to the multiple separate clusters in Figure 2. Research approaches were scattered within the different communities. For the scholars studying BITA with EA, it is necessary to pursue a totally mutual understanding and method consistency in the future.

C. "WHAT" ANALYSIS

This section aims to answer the RQ3: concludes the main research streams of the included papers.

The research question(s) of each publication may be similar or different. Distinguishing all the research questions of the samples helps understand the research trends of combining BITA with EA. From the results, EA methods have been applied to every phases of BITA research. Four primary categories were extracted.

1) WHAT ARE THE RELATIONSHIPS BETWEEN BITA AND EA?

The relationships between BITA and EA have been elaborated in multiple publications. Alaeddini and Salekfard [26] discussed EA's positive effects for BITA on the basis of practical projects in Iran; Parchami [27] explained the relationships between EA frameworks and BITA; Bradley *et al.* [28] pointed out EA maturity has a positive influence on BITA and combining them will achieve a higher enterprise agility. Generally speaking, questionnaires, literature surveys, and models' comparison are the most common methods to discuss this issue.

2) HOW DOES EA HELP ACHIEVE BITA?

This question mainly proposes EA methods to realize BITA. Zarvic and Wieringa [29] compared different EA frameworks for dealing with BITA and proposed an integrated framework; Iacob *et al.* [30] extended Archimate modeling language to address the BITA problems; Wegmann *et al.* [16] proposed a "systemic enterprise architecture methodology" to model the BITA. In general, new EA frameworks or EA models were often proposed in this phase.

3) HOW DOES EA HELP MEASURE BITA?

This question focuses on measuring BITA on the basis of EA viewpoints and artifacts. Plazaola and his colleagues assessed BITA with EA data which are collected from artifacts of Zachman's framework [31]–[33]. To measure the misalignment between business and information systems (IS), Carvalho and Sousa proposed a "medical sciences" approach [34], [35]. Besides, Elhari and Bounabat developed an EA platform to measure the BITA level with Luftman's maturity model [36].

4) HOW DOES EA HELP MAINTAIN BITA?

BITA is a continuous process to address the dynamic business or IT environment. Some scholars explored dynamic EA governance mechanisms to maintain BITA. For example, Chen [37] applied SOA in traditional EA frameworks and discussed how to reply each kind of changes to regain BITA . IBM combined business process management (BPM), SOA, and EA, and explained different adoption patterns in each BITA situation [38]. Fischer *et al.* [39] proposed an EA maintenance process to improve mutual communications for governing BITA.

In summary, the above four categories include all of the research questions in collected publications. Some of them included more than one category. For example, the research conducted by Chen involved both the second question and fourth question. Figure 3 shows the numbers of the four categories.
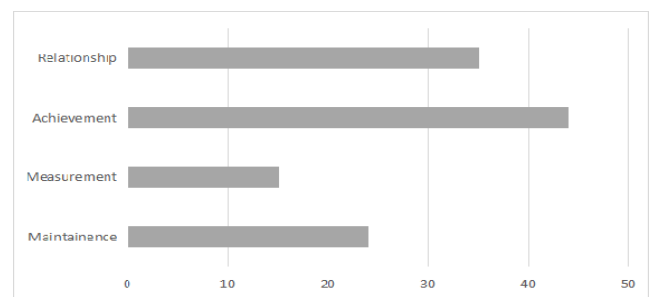

FIGURE 3. Statistical number of four main research questions.

In Figure 3, the numbers of the first two categories far exceed that of the last two categories. The second question attracted the most attention while the third question attracted the least. This can be explained that quite a lot of BITA measurement studies exist in the BITA domain rather than relating BITA to EA. For example, Trienekens *et al.* [40] proposed a detailed measurement framework with five alignment factors; Gerow *et al.* [41] unified six type alignments and measured them with a survey. The fourth category (BITA maintenance) is difficult in addressing different kinds of changes, which have acquired much emphasis in recent years. For example, Baker *et al.* [42] argued there exists two primary perspectives on alignment: alignment as an end state and alignment as a process. Chan and Reich [10] pointed out work that links these two perspectives is likely to be the most difficult but
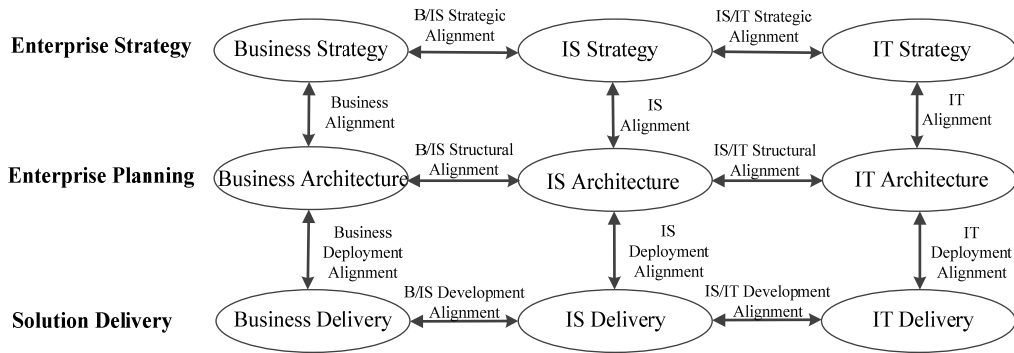
FIGURE 4. BITA domains relating to EA.

the most beneficial. Therefore, developing more research on BITA maintenance remains valuable.

D. "WHERE" ANALYSIS

This section aims to answer the RQ4: explores various research areas and their numbers.

Multiple BITA research areas exist in the literature. Take the strategic alignment model (SAM) for example, it includes the areas of strategy fit and functional integration [1]. Sabherwal *et al.* [43] considered the strategy alignment, business alignment, IS alignment, structure alignment, and cross-domain alignment in strategy information system. Magoulas *et al.* [3] introduced structural alignment, infological alignment, functional alignment, social-cultural alignment, and contextual alignment in his research.

Similarly, there are also multiple alignment areas with regard to EA. Pereira and Branco [44] argued alignments exist among business architecture, information architecture, and application architecture. Fritscher and Pigneur [45] discussed the alignment between business models and EA. IBM combined SOA and BPM when relating EA to solution delivery [38]. To synthesize the various alignment areas relating to EA, a three-layer framework is proposed to cover the alignment areas involving EA. The framework is shown in Figure 4, which includes 9 entities and 12 variations of alignment areas.

Figure 4 describes the BITA framework when applying EA to describe and design an enterprise, which contains an "enterprise strategy" layer, an "enterprise planning layer," and a "solution delivery" layer. The enterprise strategy refers to a balance between business opportunities and technological constraints [38]. It explains the requirements or goals an enterprise need to fulfill, and consists of the following three main entities: a "business strategy" that expresses the guidelines or goals to produce products and to compete in markets; an "IS strategy" that refers to the degree that IS influences the organizations, such as performance or cost; and an "IT strategy" that explains the tactics or innovations to deal with the IT changes.

Enterprise planning aims to use EA to create plans for an enterprise, to identify relevant change initiatives, and to guide the projects executing these changes [38]. Three entities exist in the "enterprise planning" layer: "business architecture" refers to the results of defining business strategies, processes, and functional requirements [44], including business processes, organizational structures, business functions, and the relationships among them; "IS architecture" describes the information systems which are required to fulfill the business requirements, including applications, application services, application functions, and so on; "IT architecture" explains the technologies to support the ISs, including software, hardware, network and so on.

Solution delivery aims to build solution models for the enterprise planning through carrying out projects. "Business delivery," "IS delivery," and "IT delivery" are the main deliveries of solutions, which include business solution models, IS solution models, and IT solution models.

The mappings among the above 9 entities form different patterns of BITA. Horizontally, the alignments among the "business strategy," "IS strategy," and "IT strategy" are strategic alignments, which refer the coherency of business goals, IS goals, and IT goals. Luftman and Kempaiah [2] and Luftman [4] explained what the strategic alignment is and how to conceptualize it. Bricknall *et al.* [46] adopted a balanced scorecard method to achieve strategic alignment of a pharmaceutical company. The alignments among "business architecture," "IS architecture," and "IT architecture" are structural alignments, which refer to the consistency of EA artifacts, data, behavior, and so on. Pereira and Branco [44] and Sousa *et al.* [47] discussed the structural alignment among contents in different EA layers . Strnadl [48] proposed a process driven architecture to achieve the structural alignment. Moreover, the alignments among "business delivery," "IS delivery," and "IT delivery" are development alignments; this term refers to the consistencies among different solution models. IBM argued that SOA could be applied to align solution models [38].

Vertically, the relationship between the "enterprise strategy" layer and the "enterprise planning" layer includes three separate alignments: the business, IS, and IT alignments. Each of these designations refers to the fitting between goals and their planning. Fritscher and Pigneur [45] adopted

TABLE 1. Motivations and challenges in combining BITA with EA.

Motivations	Challenges
EA is a good descriptive method for BITA.	It is difficult to address business and IT changes.
BITA is one of the goals of EA development.	Effects of combining BITA and EA are not apparent.
Adopting EA can achieve competitiveness and value.	Understanding environment or strategy is difficult.
EA is a management tool for BITA.	EA methodologies lack theoretical foundation.
EA enables planning of organization transformation.	Current EA modeling languages are inadequate.
Studying BITA using EA reduces organization complexity.	EA management is ineffective.
Studying BITA using EA improves enterprise agility.	Effective or universal EA frameworks are lacking.
Studying BITA using EA maximizes return of IT investment.	Misalignment has not been paid much attention.
Studying BITA using EA decreases organization uncertainty.	It is hard to evaluate BITA using EA.
Studying BITA using EA improves availability and fault tolerance.	Practical studies are lacking.
	EA tools representing BITA are lacking.
	The relationship between EA and SOA is not clear.
	Legacy systems haven't addressed effectively.

a business model ontology to align business strategy with EA. Hinkelmann and Pasquini [49] also proposed a business model motivation method to align enterprise strategies with Archimate language. Similarly, the relationship between the "enterprise planning" layer and the "solution delivery" layer includes three separate alignments: the business deployment, IS deployment, and IT deployment alignments. Project management is often used in the deployment alignment to determine if the enterprise planning suits with the solution delivery.
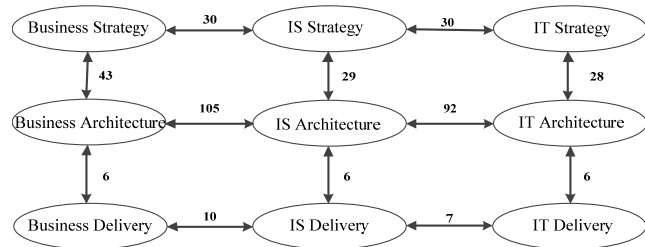

FIGURE 5. Statistical number of different alignment domains.

The research area of each literature can be located on the lines in Figure 4. After analyzing each paper's research areas, the numbers of different kinds of alignments are displayed in Figure 5. Quite a lot of literature has involved more than one kind of alignment. The numbers on the line represent the frequency at which each alignment occurred in the literature collected.

According to Figure 5, B/IS structural alignment and IS/IT structural alignment attracted the most attention, followed by the business alignment [30], [45], [49], [50], which received more emphasis than IS alignment and IT alignment. Strategic alignment acquired certain emphasis in included papers, while it was more discussed in the BITA domain. The two kinds of development alignments acquired less research, most are derived from the white papers of IBM or OMG which considered BPM or SOA technologies for designing solution models. In looking at Figure 5, the three kinds of deployment alignments received the least research

Overall, most of the BITA research exists in the "enterprise strategy" layer, the "enterprise planning" layer, or between the two. The alignments flocking around "business architecture" acquired the most emphasis. Further, alignments around the "Solution Delivery" layer acquired the least attention within the articles collected, which provide direction for further research.

E. "WHY" ANALYSIS

This section aims to answer the RQ5: extracts the reasons for studying BITA using EA. The literature is mainly driven by two aspects: (1) why is EA used to address BITA problems; (2) why did the collected papers introduce various EA approaches to realize BITA. The answers to the first question are the motivations appling EA to BITA, and the answers to the second question are the challenges in the combination of them. The two questions reflect the starting points of each publication. After analyzing the motivations and challenges in each paper and counting the numbers of frequency, similar categories are merged and displayed in Table 1. These categories are enumerated by frequencies from high to low.

Ten motivations are shown in Table 1. Some scholars deemed that EA is a good alignment descriptive method [44]. EA comprises a coherent whole of principles, methods, and models that are used in the design and realization of the enterprise's organizational structures, business processes, information systems and infrastructures. Several scholars argued that BITA is one of the goals of EA development [51], and combining BITA with EA helps achieve competitiveness and value [6], [16], reduce the organization complexity [48], improve agility [52], maximize IT investment [53], decrease organization uncertainty [48], and improve availability and fault tolerance of the enterprise [54]. Meanwhile, EA is deemed not only a method to achieve BITA, but also a tool to manage BITA [31]–[33]. Faced with the requirements of enterprise evolution, EA also helps transform the enterprise from as-is architecture to to-be architecture [47].

Thirteen challenges exist in Table 2. First, quite a lot of scholars recognized the difficulties in addressing the dynamic business environment, IT innovation, or platform migration [37]–[39]. SOA was often adopted to address this challenge, so as to BPM, or meta-model. Next, some scholars argued that although EA has benefits for BITA, the effects of combining

TABLE 2. Representative research models from four research mainstreams.

Models	Descriptions	Sources
Relationship		
Structural equation model	The relationships between BITA and EA were explained and calculated by structural equation models.	Mohammed Abdi(2010), Randy V. Bradley(2012), Morteza Alaeddini(2013)
FEM	A model describing BITA from a wider view of enterprise than just the business strategy.	Thanos Magoulas(2012), Padideh Parchami(2011)
System Dynamics Model	A system dynamics model to examine the effect of employing alternative SOA implementation strategies ob the BITA and IS cost.	Jae Choi(2013)
Achievement		
SEAM	A set of systemic methods addressing business, EA, software development through service view, value view and company view.	Alain Weggman(2002, 2005a, 2005b, 2007)
Situation-based model	A metamodel was developed to trace different BITA situations.	Jan Saat(2010)
SOAGM	Applying SOA in EA governance process from as-is architecture to to-be architecture step by step.	Mohammad Kazem HAKI(2010)
SAMM-TOGAF model	Applying SAMM in TOGAF and designing EA step by step.	Novianto Budi Kurniawan(2013)
Extended Business Model	Integrating EA modeling language with business models of strategies to make the BITA more comprehensive and continuous.	Boris Fritscher(2011, 2015), Knut Hinkelmann(2014), Maria Eugenia Iacob(2012, 2014)
Measurement		
BITA Assessment	A meta-model method to measure BITA with EA framework and artifacts.	Leonel Plazaola(2006, 2007, 2008)
BISMAM	A medical science model to visualize and measure BITA, which can identify, correct and prevent misalignment.	Gonçalo Carvalho(2008a, 2008b)
BEA	A framework for aligning business model, IT model and human resource with fact-based ontologies.	Dongwoo Kang(2010)
Maintenance		
BITAM/BITAM-SOA	A framework for correcting misalignment in dynamic environment.	Hongmei Chen(2005, 2008)
EAM	A federated maintenance process to keep the EA models up to date.	Ronny Fischer(2007)
IBM Model	A framework combining BPM, SOA and EA for addressing BITA in different practical patterns.	IBM(2008)
LEAP	A light-weight LEAP method for EA and analyzing the BITA level by simulation.	Tony Clark(2012, 2013)

them are not apparent [52]. Various techniques were proposed to explain the advantages of EA, such as questionnaire surveys or literature analyses. Besides, several articles claimed that the business strategy or external environment has not been understand totally, which demands the extension of business models [6]. Moreover, a few scholars pointed out that current EA research lacks theoretical foundation [6], [16]. To fulfill this, other scholars conducted their research from modeling languages [55], EA frameworks [44], tools [32] and case studies [53]. Enterprise architecture management (EAM) was proposed as a means to allow for timely reconfiguration and guide strategy-aligned change [56]. Several articles discussed the ineffectiveness of EAM in realizing BITA. From the counter aspect of BITA, a few articles argued that misalignment analysis should be taken seriously to identify the weak points in the BITA processes [34], [35]. Further, how to evaluate BITA with EA is also unclear in the literature, which is the same with the relationships between BITA and SOA [57], [58]. Pepin pointed out that legacy systems have not completely fit the current methods [59], [60]. As we can see, due to the above challenges, the vitality

of the combination of BITA and EA has not been totally excavated.

Overall, all of the motivations and challenges considered explained where the research of BITA stands and how it can be improved. While the visions of BITA are useful, the journey still faces a track of problems.

F. "HOW" ANALYSIS

This section aims to answer the RQ6: explores the research models and techniques in the included literature.

First, research models were explored through content analysis of all of the literature. From the four research streams in section 4.3, fifteen representative models are enumerated. Models, descriptions, and sources are listed in different columns of Table 2.

Three models are listed to explain the relationships between BITA and EA. First, a structural equation model was often adopted to calculate the influences of combining BITA and EA [26], [28], [61]. Second, Magoulas and his team introduced a new framework for understanding enterprise morphology (FEM) and compared it with three EA

frameworks [3]. Third, Choi proposed a system dynamics model to examine the effect of employing alternative SOA implementation strategies on the BITA and IS cost [52].

Five models are listed to achieve BITA with EA methods. To improve the theoretical foundation, Wegmann and his team proposed a systemic EA methodology (SEAM), which included a service view, value view, and company view [6], [16]. Saat et al. [7] argued that existing approaches did not distinguish between different BITA situations. Considering four BITA situations and multiple enterprise qualities, a total EA meta-model was introduced. Given the benefits of SOA in BITA, a SOA governance model (SOAGM) was introduced in EA design and transformation phase [62]. To better utilize EA in BITA, Kurniawan [63] provided a solution to integrate a strategic alignment maturity model (SAMM) with TOGAF 9.1. The guidelines and deliverable in each EA phase were explained. According to the insufficient description of the enterprise strategy, different business models were extended to correlate with EA modeling language [30], [45], [49], [50].

From the perspective of measurement, Plazaola and his colleagues introduced a BITA assessment meta-model based on Luftman's maturity model, and compared this meta-model with the artifacts of Zachman's framework [31]–[33]. An interesting research combining BITA with medical science was developed by Carvalho and Sousa [34], [35]. The authors believed that the misalignments in BITA are closer to human diseases. They applied concepts and techniques of medical science in misalignment classification and management. Kang et al. [64] deemed the enterprise should satisfy the alignment requirements of the business strategy, business process, and resources. A meta-model of business EA (BEA) was proposed, and fact-based ontology was used to represent the alignments in it. Meanwhile, a matrix method was introduced to visualize the alignments.

With regard to another side, Chen et al. [65] presented a BITA method (BITAM) to address the maintenance question using EA, which introduced a process that describes twelve steps for managing, detecting, and correcting misalignments. In another study performed by Chen [37], the process was combined with SOA to achieve a continuous alignment from business to IT and IT to business. Given the continuous changes in business and technology, Fischer et al. [39] deemed that EA management is a permanent process rather than a one-time effort. An EA maintenance process was introduced to keep EA models up to date. This process facilitated the mutual understanding and information sharing among EA stakeholders. Moreover, IBM believes that a long-term effective enterprise transformation is assisted by the application of SOA principles to BPM and EA in a synergistic fashion [38]. The whitepaper explained these concepts' relationships and proposed various patterns in practice. In order to combine the top-down analysis and bottom-up analysis of BITA, Clark et al. [66] and Clark and Barn [67] argued that the latter is more precise than the former. A LEAP language is proposed to examine the BITA through

describing and simulating logical architecture and physical architecture.

Through the above analysis, various research models were proposed to address different BITA questions. Integrating these models can lead to a better understanding of BITA using EA. From another angle, we can also extract the frequently-used techniques in the literature. Some of them are listed in the following:

- Questionnaire and literature survey. This technique was mainly used to explain the relationships between BITA and EA. For example, Dahalin et al. [68] analyzed the state of EA projects in Malaysia and found that BITA is the most important factor in addressing business issues. By studying US hospital cases, Bradley et al. [28] verified the ability of EA maturity to achieve strategic goals.
- BPM. This technique can be used to design business architecture or business solution models, and to keep them up to date. Maltaa and Sousab [8] highlighted the benefits of BPM and discussed how to use it to achieve and maintain BITA. IBM also argued BPM is the facilitation and acceleration of BITA [38].
- SOA. SOA owns advantages because of its openness and loose coupling. Haki et al. [62] pointed out SOA governance opens opportunities for BITA research. Abdi and Dominic [61] argued that in order to meet rapidly changing demands, and to achieve true agility, an enterprise needs BITA to integrate with SOA. Currently, SOA is still an important technique for achieving BITA.
- Meta-model. Meta-model refers to the abstract description of different enterprise parts. Hinkelmann and Pasquini [49] integrated the meta-models of business model and Archimate; Kurniawan [63] combined meta-models of BITA and TOGAF. The meta-model technique is intuitionistic to represent different layers of EA to coherent business and IT.
- Requirement engineering (RE). Several papers adopted RE to combine BITA and EA. Engelsman et al. [69] claimed that EA is an effective method to organize requirements in business and IT; Salgado et al. [70] argued RE plays a central role in the alignment between business and IT and explained the role of EA in achieving BITA.
- Ontology. An ontology includes definitions of concepts and an indication of how concepts are interrelated. Several articles provided variations of EA ontology to achieve BITA [71], [72]. The development of EA ontology helps us gain an understanding of concepts and models from different stakeholders.

In brief, the above techniques were often adopted to address BITA problems using EA, separately or in combination. Meanwhile, the "How" analysis can also be discussed from several other angles. The first is the direction of combining BITA and EA. Some scholars started their research from EA and explored the solutions on BITA, while others began with BITA and explained its requirements on EA. For example, Sousa compared three EA frameworks and extracted

alignment heuristics from them [47]; Saat et al. [7] analyzed four BITA situations and proposed a whole EA meta-model. Statistically analyzing the included publications, 90 studies started their reseach from EA and only 21 studies started from BITA. The second is the direction between business and IT. Some scholars studied the BITA with a top-down order (business to IT), while others studied it with a bottom-up order (IT to business). Meanwhile, some scholars considered them both. Statistically analyzing the included literature, there are 58 studies on the former and 36 studies on the latter. From another angle, some scholars adopted qualitative methods to study the combination of BITA and EA, such as historical analysis or theoretical framework; while some scholars proposed quantitative methods, such as cost-efficient analysis, structural equation modeling. Some others adopted them both. Based on the literature, just 28 studies adopted quantitative methods.

In this section, research models, techniques, and several other angles in addressing BITA with EA were explored. These approaches laid a substantial foundation for understanding and managing BITA with EA.

V. DISCUSSIONS

A comprehensive understanding of BITA research using EA has been acquired after answering the above six questions. Several conclusions are extracted from the results. For example, the numbers of the papers present a holistic and gradual rise over time; there is infrequent communication among different research communities; four research questions are always established in addressing BITA using EA, and the streams of "measurement" and "maintenance" are far smaller than the other two streams; seven categories of alignments relating to EA were discovered, in which the structural alignment and business alignment have received the most attention; multiple motivations and challenges appeared in the literature, and within these studies, "EA is a good descriptive method for BITA" and "Difficulties in facing business and IT changes" acquired the highest mentions.

Comparing the results of the six questions, several contradictory points have been found. First, though multiple motivations and challenges appeared in Table 1, the research trend in Figure 1 does not show a clear rise. Further, despite dealing with the dynamic changes is the most important issue, the literature on how to maintain BITA with EA is relatively slim. Besides, although the unapparent effect of combining BITA with EA is the second inhibiting factor, the literature explaining relationships between BITA and EA is quite large. Meanwhile, several limitations commonly exist in the literature. For example, a universal definition of BITA using EA has not been determined. Moreover, the set of complete governance mechanisms of BITA have not been explored. Further, a complete EA data collection method for measuring BITA has yet to be proposed. Given the conclusions, contradictions, and limitations, the research combining BITA with EA is still in its infancy. It would appear that a long journey is necessary to achieve the methodological consistency and integration.

The above analysis exposes directions for future research. On one hand, in order to address the dynamic business environment and IT innovation, sustainable BITA governance mechanisms should be introduced in the EA evolution process. Currently, knowledge sharing, training skills and several other factors were mentioned in the literature, while additional factors need also to be discovered. Moreover, given the stable research trend in recent years (Figure 1), more practical case studies should be developed to verify the vitality of combining BITA with EA. Then more practical problems could be found in this process. Furthermore, BITA should be extended to align enterprise planning with solution delivery, meaning BITA research could be associated with project portfolio management methods.

VI. METHOD CHECK

To evolve more rapidly toward a comprehensive and effective research genre's spectrum, Rowe [73] argued that we need literature reviews that offer the most solid foundation for theory building and research landscaping . In order to validate this review's efficiency and ensure this paper can offer solid foundations for BITA research, we will check whether or not this review meets the standards and guidelines for conducting literature reviews.

Schwarz suggested that a literature review should satisfy several purposes: to summarize prior research, to critically examine contributions of past research, to explain the results of prior research found within each research stream, and to clarify differences in alternative views of past research (not necessarily integrative) [75]. This article meets these guidelines by answering the aforementioned six questions and providing an extensive explanation of each. The prior research was summarized by timeframes and research communities. The contributions were explained through motivations and challenges. The relevant research streams were classified by various topics and alignment contents. Further, through the above discussion, the contradictions of the current research were explored.

Okoli [74] proposed a critical realist guide to develop a theory with systematic literature reviews. He distinguished reviews from theory landscaping, theory building, and theory testing. From our discussions in this article, we studied from the angle of theory building. Through comprehensively analyzing previous literature, we put emphasis on both integration and categorization, which facilitate theory building and provide directions for future research.

Fink [76] wrote a book on conducting research reviews. He paid more attention to searching and screening, and divided this area into several steps: selecting a research question, selecting data sources, choosing search terms, applying screening criteria, doing the review, and synthesizing the results. The contents of Fink's text are discussed in the second section of this paper. We first collected the relevant literature with the keywords and criteria, then screened them by personally reading.

Rowe [73] illustrated how to conduct a literature review and provided some recommendations in detail. He proposed

a four dimensions typology on reviews: goal with respect to theory, breadth, systematicity, and argumentative strategy. The first aspect focused on "describing," "understanding," or "explaining." Our research aims at synthesizing literature and identifying key findings, problems, and research thrusts, which belongs to the "understanding" type. The second aspect includes "problem," "stream," or "theme discipline." This paper has addressed six questions in synthesizing the current research which should be basically regarded as problem-centered. The third aspect illustrates "inclusion criteria," "coverage," "quality assessment," and "sources description." In many ways, this aspect is similar to the steps proposed by Fink, which has been explained in the second section. The fourth aspect refers to the logical structures in the argumentation enacted in a literature review. Four argumentative strategies were introduced in Rowe's research. Similarly, the logical structure in this paper is attributed to this type of "framework-based review for understanding". Our review contains several stages with developing structural dimensions and categories, material collection, descriptive analysis, evaluation, and synthesis. Additionally, this paper adheres to Rowe's belief that literature reviews should strive to identify thematic gaps and theoretical biases and propose some future research directions.

In brief, the standards for conducting literature reviews were checked, and this paper's location was determined by the above analysis. The review method of this paper reflects the majority of the proposed guidelines, and proves the ability to offer solid foundations for theory building and research landscaping on BITA.

VII. CONCLUSION

Given the dispersity of existing literature, we identified a need for a systematic review of BITA research using EA. We drew a holistic picture through the consideration of 111 papers. Six questions were proposed and analyzed using the 5W1H method. Several conclusions were drawn, and directions for future research were discussed. The paper was also checked by the standards and guidelines of common literature reviews.

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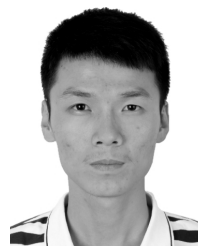
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