A coevolutionary framework of business-IT alignment via the lens of enterprise architecture

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Abstract: Due to the turbulent external business environment, the complexity of internal relations of the organization and the emergence of subversive IT roles, the business-IT alignment (BITA) has become increasingly difficult. The unsuccessful realization of BITA will lead to the waste of organizational resources, the reduction of return on investment and eventually the loss of competitive advantage. In recent years, coevolution has received widespread attention due to its ability to describe the dynamic relationship between IT and business. Multiple principles such as quickening learning action loops and adopt suitable organizing principles for achieving business and IT coevolution (BITC) are obtained. However, the continuous BITC is still hard to be achieved because of the lack of complete BITC management. This paper focuses on the management process of the BITC and how to perform it gradually. A coevolution framework combines the enterprise architecture (EA) approach with the coevolution analysis is proposed, which contains the design of EA, the sensing and governance of the misalignment and the procedure of the EA misalignment prevention. The steps for the governance and prevention of misalignment are discussed in particular. Through comparison with the principles, characteristics and methods of coevolution in the literature, the proposed framework is evaluated. The results show that the proposed framework is effective for BITC implementation.

Keywords: business-IT alignment (BITA), coevolution, misalignment governance, misalignment prevention, enterprise architecture.

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1. Introduction

Business-IT alignment (BITA) is defined as the degree of how the enterprise’s business strategy and information technology fit for each other. In recent years, BITA has always been one of the most concerned issues for the enterprises managers, which is a significant approach to increase the return on the IT investment and improve the enterprise’s competitive advantages [1 – 3]. A great number of researches have been studied from multiple perspectives, such as BITA achievement [4 – 6], BITA measurement [7 – 10], BITA maintenance [11,12], and the relationships between BITA with firm performances [13,14]. However, despite years of cumulative research, BITA is still considered as an unachieved objective [15 – 17].

The most challenging features of BITA are currently represented as dynamic [18] and complex [19,20]. A company can reposition itself by its varied corporate strategies and competitive strategies. For example, the business strategy of the Li-Ning company in China has moved from an imitation strategy to a focus strategy and finally to a differentiation strategy in the last 20 years [21]. Furthermore, the increasing connectedness, asymmetric relationships, and nonlinear dependencies between business elements (e.g., structures, processes, actors) and IT elements (e.g., services, applications, actors) have made the alignment more difficult. “Ecosystem” or “complex adaptive system” is sometimes used to describe this complexity [19,22].

Recently, the business and IT coevolution (BITC) has been advocated as a source of methods to address BITA [16,19,20,23,24]. This study employs Lewin’s definition of coevolution as “the joint outcome of managerial intentionality, institutional effects and environment” [25] that should face the dynamics and embrace the complexity of BITA. The literature analyzed BITC from multilevel, bidirectional, nonlinear, and positive feedback perspectives. Various definitions, features, and principles of BITC were previously discussed. These researches have provided significant implications for the exploration of BITC.

The extant literature proposed several recommendations to achieve BITC, such as modular design [23,24], sharing domain knowledge [26], and tension [16,23,24]. However, it is hard to manage BITC in an operative way, without a process to adopt these mechanisms.

The enterprise architecture (EA) method is useful to integrate the enterprise’s strategy with its processes and re-
sources more effectively through various viewpoints and models. EA has proven its capabilities to deal with the traditional BITA issues, but it is rarely used in the BITC field.

In summary, realizing the BITA is vital to improve the organization’s competitiveness. Due to the dynamic and complex features of BITA, BITC is becoming popular to address the BITA issue. Though there exist several BITC recommendations, they are not systematically categorized and managed. In addition, the EA is rarely used when considering the BITC. Meanwhile, a practical framework of BITC, which helps to describe the structure and process of BITC, is lacking in the literature. Therefore, a process-oriented BITC management framework should be proposed to describe and manage BITC, and flexibly reposition organizations.

To reach this objective, three basic arguments are considered in this study, each of which helps to face the dynamics and embrace the complexity of BITA. First, BITC should reconcile both “rational designs” and “emergent processes” [16,23,24,27]. Second, BITC should involve short-term and long-term alignments simultaneously [26,28–30]. And third, the firm is a complex adaptive system and its internal relationships are hard to perceive [20,31]. In this study, the EA method and coevolutionary analysis are combined to meet the above three arguments. Specifically, EA acts as a rational BITA design approach and coevolutionary analysis seeks to govern the deviations and misalignments in each period of EA evolution. A coevolutionary framework that is formed, contains four steps: EA design, sense of the misalignment, governance of the misalignment, and prevention of the misalignment. The main contributions of this study are as follows:

(i) The recommendation principles of BITC are summarized and are categorized as short-term governance principles and long-term prevention principles.

(ii) A coevolutionary framework combining EA design with coevolutionary sensing, misalignment governance and prevention principles is constructed, which could assist the senior manager to take related governance measures.

(iii) Demonstrate the proposed framework from several dimensions including the characteristics of BITC, the principles of BITC and the approaches of the BITC.

The remainder of this paper is organized as follows. Section 2 presents the relevant background of BITC, EA, and complex adaptive system. Section 3 introduces a coevolutionary framework combining EA design with coevolutionary sensing, misalignment governance and prevention principles. Section 4 evaluates the framework from different coevolutionary dimensions. Section 5 draws conclusions and presents directions for future research.

2. Theoretical foundation

2.1 BITC

BITC is a new quest in the BITA research, aiming to prove a company’s dynamism and agility in repositioning itself continuously [19]. For analyzing the BITC research deeply, we select 12 representative papers, which are coded and discussed in Table 1. They are discussed from main focuses, motivations, contents, and approaches.

Several conclusions can be deduced from Table 1. From the third column of Table 1, three motivations are driving the multiple focuses on BITC. First, the external competitive environment of a company is becoming “dancing rugged” [19,22,32]. Tanriverdi [19] pointed out that a firm represents a “dancing rugged” competing landscape if its choice variables become dependent with those of other firms. Thus, the BITA should understand how the IS strategy co-evolves with the competitive and corporate strategy. A firm needs to be able to show sufficiently complex behavior to survive in this environment [32].

Second, the internal relationships in a company are becoming polyphyletic and complex [16,20,23,33–35]. The relationships of the business and IT are multifaceted including the strategy level, operational level and the tactical level [35]. To address the complex relationships in a company, Fiss [31] proposed a qualitative comparative analysis method to discuss the company outcomes with discrete configurations. In brief, the relationships are multifaceted and multilevel, instead of representing simple deterministic logic. The organization is becoming a complex system on the edge of chaos.

Third, the IT roles have changed from one of the functional head to the strategic partner [36,37]. Since information systems (IS) have evolved from the management support tools to the components of business structures, Hiekkonen [38] pointed out that the IS planning and strategy discussion should go beyond the concept of alignment. Instead of a functional-level strategy, it is time to rethink the role of the IT strategy as a fusion between IT and the business strategy [39]. Therefore, the business and IT are fused and their boundaries have been blurred.

Facing the above challenges, dynamic BITC emerged beyond the traditional alignment. Multiple coevolutionary problems are discussed with various models and approaches as shown in column 4 and column 5 in Table 1. For example, Benbya and McKelvey [23] viewed alignment as a continuous process of coevolution, which coordinated the “rational designs” and “emergent processes”. They proposed a coevolutionary model from the strategy level, the operational level, and the individual level. Significant implications have been harvested with these research. However, the majority of them studied what the co-evolution is and how the business and IT coevolved, rather than provided ordered mechanisms for practical management [20]. In this paper, we aim to propose a management process on how to control and reposition the BITC within the evolution of a firm.
organizations proposed EA frameworks to describe EA in principles guiding its design and development [45]. Some its suppliers, customers and partners, and also contains the tion of an enterprise, maybe as a whole, or together with current and the future. EA represents the basic organiza-
tion of the enterprise’s states in the past, the 
lection of integrated representations of the business and
[44] argued that EA is a structured and aligned plan col-
ducts to abstract the details of the design tasks and pro-
theses. Multiple kinds of EA frameworks have emerged in the literature, such as that of Zachman [46], Ministry of Denfence Architecture Framework (MoDAF) [47], De-
artment of Denfence Architecture Framework (DoDAF) [47], Defense Architecture Framework (DoDAF) [47], De-

2.2 EA

EA is considered as a useful approach to achieve and sustain BITA. According to the ISO/IEC 42010 [43], EA is defined as “the basic organization of the enterprise embodied in its components, the relationships between them and the environment, and the principles guiding their design and development”. EA is a useful method to describe a complex organization from different viewpoints. Niemann [44] argued that EA is a structured and aligned plan collection of integrated representations of the business and IT landscape of the organization’s states in the past, the current and the future. EA represents the basic organization of an enterprise, maybe as a whole, or together with its suppliers, customers and partners, and also contains the principles guiding its design and development [45]. Some organizations proposed EA frameworks to describe EA in a unified and compatible way. EA frameworks contain various viewpoints and models which could help the architects to abstract the details of the design tasks and produce several models relating to the architectural descriptions. Multiple kinds of EA frameworks have emerged in the literature, such as that of Zachman [46], Ministry of Defense Architecture Framework (MoDAF) [47], Department of Defense Architecture Framework (DoDAF) [48], and Open Group Architecture Framework (TOGAF) [49].

EA is deemed as a discipline, and the target is to align the organization’s strategies together with their resources and processes more effectively [50]. Duffy [51] even argued that the design of the organization’s business and IT system alignment is the field of EA. Winter and Schelp [52] thought EA merges “pure” business related artifacts explicitly, hence providing an opportunity to align business and IT structures more effectively. Four main topics were

| Author | Focus | Why | What | How |
|--------|-------|-----|------|-----|
| Agarwaland Sambamurthy (2002) [40] | Organizing IT functions | Increasing IT roles | Partner model Platform model | Organize IT to foster coevolution between business and IT functions |
| Bendya and McKenzie (2006) [23] | A conceptual model of BITC | Dancing rugged environment Complex internal relationships | Strategic level Operational level Individual level | Top-down rational design and bottom-up emergent process |
| Tanriverdi, et al. (2010) [19] | A new quest of BITC | Dancing rugged environment | Strategic alignment quest | Improve the organization’s agility and dynamics in repositioning itself |
| El Sawy, et al. (2010) [22] | The ecosystem of environment, business, and IT systems | Dancing rugged environment Complex internal relationships Increasingly IT roles | Digital ecodynamics Environmental turbulence Business capabilities IT systems | Configuration theory |
| Nassim and Robert (2013) [24] | Verifying coevolutionary principles | Dancing rugged environment Complex internal relationships | Adaptive tension Change rate Modular design | Top-down rational design and bottom-up emergent process |
| Vessey and Ward (2013) [27] | A conceptual model of BITC | Dancing rugged environment Complex internal relationships | Adaptive IS management Enabling IS management Administrative IS management | Top-down rational design and bottom-up emergent process Short-term and long-term alignment |
| Sandberg (2014) [41] | A shift to digital business strategy | Dancing rugged environment Increasing IT roles | Digital business strategy Organizational performance | Improving organizational performance through coevolution |
| Peppard (2014, 2003) [16,42] | A conceptual model of BITC | Dancing rugged environment Complex internal relationships | “Never go ahead” loop “More of the same” loop | Glaserian form of grounded theory development |
| Weeger and Haase (2016) [33] | Transformation of BITA | Complex internal relationships | IT activity system Business activity system | Activity theory |
| Amarilli, et al. (2016) [20] | A conceptual model of BITC and different approaches | Dancing rugged environment Complex internal relationships | Macro scale Micro scale | Metaphors, functional comp lexity models, co-evolutionary models, and dynamic complexity models |
| Kahre, et al. (2017) [36] | A shift to digital business strategy | Dancing rugged environment Increasing IT roles | Organizational conditions changes Environmental conditions changes Changes in the content of strategy | Provide a structured clarification of the current digital business strategies knowledge base |
found in the literature to address BITA problems with EA methods, which are the relationship of BITA and EA, BITA achievement with EA, BITA measurement with EA, and BITA governance with EA. Their descriptions and research examples are displayed in Table 2. EA has proven its capabilities to deal with the traditional BITA problems.

| Topic                                  | Description                                      | Example  |
|----------------------------------------|--------------------------------------------------|----------|
| The relationship between BITA and EA   | What are the correlations of BITA and EA?         | [13, 14, 53] |
| BITA achievement with EA               | How can we achieve BITA with EA methods?          | [4, 5, 50] |
| BITA measurement with EA               | How can we measure BITA with EA methods?          | [7–10]   |
| BITA governance with EA                | How can we maintain BITA with EA methods?         | [11, 12, 54] |

However, the questions of BITC are more severe than the traditional BITA on the basis of the challenges explained in the last section. Rare papers considered EA in the region of BITC. We deem that EA still owns significant advantages in dealing with BITC problems.

In this paper, we consider EA as a rational top-down BITC design method. Various contents and relationships among them in a company are organized and classified within EA design, which helps to build the BITA. For the changes in the process of EA evolution, we consider a misalignment governance method.

### 2.3 Complex adaptive system

The commonality across the complex adaptive systems is that a large number of interacting components or agents are contained there [16]. According to the statement of several authors, a firm can be regarded as a complex adaptive system if exhibiting a number of the following characteristics:

1. **Dynamic**—Organization change over time, and different components with different rates.
2. **Governed by feedback**—Due to the tight coupling, actions will feed back on themselves. Every decision will have an impact on future decisions.
3. **Nonlinear**—The results are rarely proportional to the cause. Small changes in one place may cause disproportionate changes in other places.
4. **Adaptive**—Through learning experience, the actor’s decision rules and actions often change over time. However, learning may be detrimental to the overall performance of the organization.
5. **Policy resistant**—Solutions aimed at the obvious symptoms often get the opposite function.
6. **Trade-offs**—Solutions that address obvious symptoms rather than to find root causes will often lead to the initial improvement, followed by a long-term performance degradation.

Multiple researches have studied the aforementioned theory. Benbya found that if the added complexity is not properly managed, IS fails [23]. Based on the complexity theory, especially the self-organizing emergency behavior and structure, McKelvey put forward a view of IS alignment [23]. Based on the complexity characteristics of IS, Nassim constructed a process causal-loop model of the strategic alignment by using the empirical data [24]. Peppard [16] argued that symptom analysis methods are difficult to find out the root causes, and may lead to the initial improvement followed by a long-term performance degradation, which makes the BITA situation worse.

In this paper, we consider that the organizational IS is a complex adaptive system, and the simple symptoms correction action is not enough to cure the misalignments. Thus, the organizational manager should sense the deviations and misalignments at a timely manner, and apply governance principles to sustain the firm’s competitive advantages in a dynamic environment. At the same time, the misalignment prevention principles should be applied through the long-term EA management process.

### 3. A coevolutionary framework

In order to describe and manage BITC, a coevolutionary framework combining EA with coevolutionary analysis is proposed in this section. The extant literature always suggested that the coevolution should not only reconcile rational designs but also involve emergent processes of coherently and consciously interrelating all the relevant components of the organization [16,23,24,27]. In other words, the coevolution should combine both bottom-up adaptation and top-down control. Thus, BITC is always regarded as multilevel which needs to be aligned bidirectionally [23,35,36]. Meanwhile, the literature also argued the coevolution should consider both short-term alignment and long-term alignment with respective mechanisms [26,28–30]. As a summary, for the sake of coevolving business and IT more flexible and efficient, the coevolutionary framework should take into account the combination of bottom-up adaptation and top-down design, the combination of long-term alignment and short-term alignment, and the combination of exploitation and exploration.

We aim to express the coevolutionary issue more comprehensively and practically in this paper. A coevolutionary framework is displayed sketchily in Fig. 1. The DoDAF
is used to design and manage EA. Four parts exist in this figure: EA design, misalignment sensing, misalignment governance, and misalignment prevention. In the early stage of design, the organization achieved basic BITA through EA design. However, due to the complexity of the external environment and the deviations during the implementation phase, the misalignment may exist between the business and IT strategies. The enterprise could realize a short-term alignment by sensing the deviations and taking governance principles. In addition, it could also achieve a long-time alignment through taking prevention principles. The misalignment governance and prevention part will be mainly discussed in this paper. We will explain each part respectively.

![DoDAF meta-model](image)

**Fig. 1 Coevolutionary framework combining EA with coevolutionary analysis**

### 3.1 EA design

EA is an expression of organization’s design decision-making results. The information contained in the EA includes the organization’s strategic positioning, business process and IS capabilities [55]. The design content of the EA should include the strategic objects, business structure and processes, and IS components [56,57]. The different design concepts, and their relationships are often discussed in the literature [58,59]. In order to design EA, several EA frameworks such as Zachman, TOGAF, DoDAF have been published sequentially.

DoDAF is adopted in this paper. As other frameworks, it contains an EA meta-model, multiple viewpoints, and dozens of models. The meta-model of DoDAF (Fig. 1) is composed of 12 main tuples and the relationships among them, which normalizes the modeling standard and data criterion. The meta-model is used to represent, store, and collect EA contents in different organizations, or different life phases. Further, DoDAF includes eight viewpoints, i.e., capability, operational, services, systems, standard, data and information, all and project, which are responsible for describing EA from different perspectives. Quan-
Similar to the architecture development model (ADM) of TOGAF, DoDAF explains the design process of EA with six steps. Meanwhile, scholars also proposed design processes through different development sequences of architecture viewpoints and models. For example, Dam [60] studied how to design DoDAF with 16 specific steps; Zeigler and Mittal [61] discussed the DoDAF development process with a discrete event system specification; IBM rhapsody defined the development sequence of DoDAF models with an embedded DoDAF package [62].

Therefore, the BITA is suitably built in the EA design phase with a unified EA meta-model, the interdependent relationships among viewpoints and models, and a specific design process. Therefore, we deem the EA design as a rational top-down BITA design process.

3.2 Misalignment sensing

Organizations have made BITA achievements; they are
suffering from the misalignments at the same time [63]. Sensing the deviations from the intended strategies is the first step to tame the misalignments. When the complexity of the organizational structure and the external environment is at a lower level, we can sense the misalignment through detecting the misalignment symptoms. However, with increasing complexity of the organization, misalignment may occur without exhibiting any of these potential symptoms. When we realize that misalignments exit between the business strategy and the IT strategy, it is often too late to take governance process. Therefore, it is critical to sense the deviations in a timely manner.

As shown in Fig. 3, two kinds of deviations exist in the framework of the organizational architecture. The deviation between the business strategy intended and the business strategy realized is the first kind of deviation [64]. The intended business strategy comes from the business executives at the EA design phase, which reflects the perspective of the senior managers. Similarly, the intended IT strategy comes from the IT executives at the EA design phase. The business strategy and the IT strategy intended are basically aligned after the cogitative EA design phase. Due to various unexpected situations, i.e., environment dynamism, employee support for the business strategy, the realized business strategy could exhibit a deviation compared to the intended business strategy.

Similarly, the realized IT strategy could also exhibit a deviation compared to the intended IT strategy, which is the second kind of deviation [64]. Due to the aforementioned two kinds of deviations, there may be a misalignment between the realized business strategy and the realized IT strategy. We could sense misalignment through assessing the degree to which the business mission, objectives and plans are supported by the information technology mission, objectives, and plans.

### 3.3 Misalignment governance

The research on misalignment governance is scarce in the literature. Once the deviations or the misalignments are recognized by the organization, several governing principles should be taken to prevent the further drift of the organizational strategy and sustain the performance of the firm in the dynamic competitive environment.

The root causes of the misalignment are multitudinous and hard to trace. For example, due to the absence of the IT executives in the IT strategy design process, the business executives may not understand the emerging information technologies. Drastic changes in the external competitive environment could also make the realized IT strategy lag behind the organizational business development and further make the firm lose its competitive advantage.

There are several verified governance principles which could be taken to correct the aforementioned misalignments as shown in Table 3. Firstly, companies need to detect and sense deviations of the intended plans (P1), and then conduct root-cause analyses (P2) to investigate the reasons behind the scene. To adjust these deviations and to avoid further misalignment, companies need to add mechanisms and learn from environmental reactions (P3). These mechanisms are adjusting actions companies adopt, such as the dynamic resource allocation. Adapting with the reactions, these deviations need to be “tamed” instead of “solved”. Besides, P4 suggests that the coevolution needs to be ambidextrous and considers exploration and exploitation as part of IT strategies. We can achieve value creation through exploring and developing IT strategies.

With the importance of innovative technologies steadily increasing, enterprises should not regard the strategies of the IT/IS as subordinate or the business strategy anymore, but at equal status. According to Bharadwaj [39], it is time to rethink the role of the IT strategy, from a function-level strategy to the strategy reflecting the integration of the business strategy and the IT strategy. Being consistent with research of digital business strategy, P5 considers digital IT capabilities as intrinsic elements of business strategic planning. Additionally, organizations need to adopt suitable organizing principles (P6), either centralized, decentralized, or federal, to manage business processes. Multilevel communication is vital to develop a shared understanding, so P7 suggests that organizational members should communicate with each other and form a collaborating relationship.
to increase system units, and modular design is considered to be a mechanism to its employees. Simon [67] argued that complex systems concreted, precise, and detailed intentions (P8). Existence ented exactly as expected, the organization should have the literature. As Table 3 shows, for a strategy to be imple- alignment, various principles have been discussed in this part aims to consider appropriate principles, guidelines and common sense rules whose purpose is to prevent, rather than treat, the misalignment [9,10]. It belongs to the field of EA management.

In order to cultivate the coevolution and achieve sustain- able alignment, various principles have been discussed in the literature. As Table 3 shows, for a strategy to be imple- mented exactly as expected, the organization should have concrete, precise, and detailed intentions (P8). Existence of a clear and intentional IT strategy has a positive impact on the organization’s ability to communicate this strategy to its employees. Simon [67] argued that complex systems are hierarchical but consist of “almost decomposable” sub-units, and modular design is considered to be a mechanism to increase system flexibility and comprehensibility, while allowing to shorten the system development time. Therefore, modular design has been considered as a conducive principle to manage the IT/IS complexity (P9).

As Ashby’s “law of requisite variety” puts [68], in order to survive, a system needs to generate the same degree of internal complexity as the external complexity it faces in its environment. Only complexity can destroy complexity. In order to cope with the complex market conditions, the designed IS should possess sufficient upfront complexity (P10). Benbya and McKelvey [23] argued that in order to develop shared domain knowledge and the ability to coordinate alignment-related actions, a collaborative partnership should be established between business and IS managers at all levels (P11). In the absence of multi-departmental and all-level communication, leaders may find it difficult to reach a common understanding with their managers and other employees, and clearly commu-

| Principle | Name | Description | Supporting literature |
|-----------|------|-------------|-----------------------|
| P1        | Detect and sense deviations from intended plans. | Firms need to sense and respond to external or internal changes in a timely manner. | Sandberg, 2014 [41]; Weeger and Haase, 2016 [33]; Tanriverdi and Lim, 2017 [65]. |
| P2        | Conduct root-cause analyses. | Root causes should be identified on the basis of multiple symptoms. | Benbya and McKelvey, 2006 [66]; Weeger and Haase, 2016 [33]; Tanriverdi and Lim, 2017 [65]. |
| P3        | Add mechanisms and learn from environmental reaction. | Mechanisms should be added to analyze its reactions to dynamic actions. | Benbya and McKelvey, 2006 [23]; Tanriverdi et al., 2010 [19]; Tanriverdi and Lim, 2017 [65]. |
| P4        | Consider both exploration and exploitation as part of IT strategies. | Exploration concerns to discover new opportunities, and exploitation increases the productivity of existing capabilities. | Peppard and Karin, 2003 [42]; Zhang et al., 2011 [21]; Vessey and Ward, 2013 [27]. |
| P5        | Consider digital IT capabilities as inherent elements of planning business strategies. | IT strategies are no longer subordinate to business strategies but shape them. | Agarwal and Sambamurthy, 2002 [40]; Sandberg, 2014 [41]; Tanriverdi et al., 2010 [19]. |
| P6        | Adopt suitable organizing principles. | An organization should balance the internal coordination and external partnering. | Agarwal and Sambamurthy, 2002 [40]; Amarilli et al., 2016 [20]. |
| P7        | Communicate frequently among agents. | Agents should communicate with each other and form a collaborating relationship. | Plazaola et al., 2006 [7]; Peppard and Campbell, 2014 [16]; Baker, 2019 [64]. |
| P8        | Own concrete, precise, and detailed intentions. | The intended strategy must be specific and explicit. | Baker, 2019 [64]; Benbya and McKelvey, 2006 [23]; Benbya and McKelvey, 2006 [66]; Nassim and Robert, 2010 [24]. |
| P9        | Adopt modular design. | Modularity is the ability to easily reconfigure components by minimizing interdependencies among modules. | Benbya and McKelvey, 2006 [23]; Benbya and McKelvey, 2006 [66]; Nassim and Robert, 2010 [24]. |
| P10       | Design IS with sufficient up-front complexity. | A system needs to generate the same degree of internal complexity as the external complexity it faces in its environment. | Benbya and McKelvey, 2006 [23]; Tanriverdi and Lim, 2017 [65]. |
| P11       | Share domain knowledge. | Agents build consensus as to the shared reality of the organization. | Plazaola et al., 2006 [7]; Peppard and Campbell, 2014 [16]. |
| P12       | Quickened learning action loops. | Speeding up the learning action loops can increase an organization’s competitive advantage. | Benbya and McKelvey, 2006 [23]; Tanriverdi and Lim, 2017 [65]. |
| P13       | Foster coevolution to improve IS alignment. | The alignment is a dynamic process involving continuous adjustments between business and IS. | Benbya and McKelvey, 2006 [23]; Tanriverdi and Lim, 2017 [65]. |
| P14       | Predict possible emergent situations in advance. | Possible emergent situations should be examined to speed up future change rates. | Vessey and Ward, 2013 [27]; Amarilli et al., 2016 [20]. |
nicate their strategic plans.

Because of the emergence of new knowledge and the processes of learning and innovation, the rate of adaptation cannot exceed the rate of available changes, and El Sawy [32] called this process as “quickened action cycles” (P12). The faster the action loop is established, the easier it is to gain a competitive advantage. In order to obtain the sustained market condition, firms should foster coevolution to improve IS alignment (P13). Furthermore, with the intelligence capability, companies need to predict emergent situations in advance (P14), in order to increase companies’ internal complexity and to accelerate future change rate.

All of these principles should be used in the phase of long-term EA management and short-term coevolutionary analysis, which helps to cultivate a sustainable BITA environment.

With the above four parts, the BITC can be better described and managed. EA acts as a normative BITA achievement framework, and coevolutionary analysis treats each unbalanced EA state in the long run. The whole method aims to explore a practical coevolutionary framework. Though it is rather simple now, we argue that it is fascinating in the coevolutionary research. In the next section, the coevolutionary framework will be validated according to the features and methods from several significant studies.

4. Utility evaluation of the coevolution framework

To demonstrate the utility of our proposed framework, we follow Hevner et al. [69], who proposed five evaluation approaches, one of which is adopted in this paper. We use the descriptive approach of framework evaluation by employing the informed argument method using information from the knowledge base of our research domain to build convincing arguments for the framework’s utility. Our proposed framework provides a process-oriented approach to manage the BITC. This method cannot be directly compared with existing methods because of its different focus on coevolution. According to the existing knowledge base, we evaluate the proposed framework from three dimensions respectively: characteristics of BITC, principles of BITC, and approaches of BITC. We select one representative literature for each dimension and determine whether our framework is accordant with the results of the literature.

4.1 Utility evaluation from characteristics of BITC

The properties of the coevolution were always discussed by scholars, such as [16], [25] and [27]. Lewin et al. [25] identified properties of coevolutionary models of strategic management and organizational adaptation research, which are multi-levelness effects, multi-directional causalities, non-linearity, and positive feedback. These properties lay the foundation for the following research on coevolution. We aim to judge whether our proposed framework meets the above four properties.

(i) Multi-levelness effects

The multi-levelness effects refer to the coevolutionary effects occur at multiple levels within the enterprises. In our framework, the misalignments may occur in one EA viewpoint, or between two different EA viewpoints. Multi-levelness effects have been caused due to the emergence of misalignments.

(ii) Multi-directional causalities

In a system with complex relationships, the change of one variable is caused by the change of other variables. In our framework, complex relationships exist among the multiple entities in the EA. Changes for one entity or relationship may cause misalignments, and need other entities or relationships to be aligned with.

(iii) Non-linearity

The non-linearity means that we cannot deal with the effects of coevolutionary through simple linear logical relationships between independent and dependent variables. Like human bodies, we cannot say one disease is determinedly caused by the fixed symptoms. The symptoms for one disease may be volatile or can cause other diseases because of the complex relationships in human bodies. The organization is a complex system and a black box [20] as the human body [9,10]. It is hard to discover all of the misalignment symptoms and the absolutely right cause-effect relationships in one organization. In our framework, we aim to seek for the root causes of the misalignment, discover their cause-effect relationships, and provide governing mechanisms, which helps to control the company in the mist.

(iv) Positive feedback

The positive feedback refers to actions and interactions between enterprises and their environments are recursive and lead to interdependencies and circular causality. According to the framework we propose, the external environment could cause misalignments for EA, and the EA could also shape the external competitive environment after correcting the misalignments and executing management. The loop forms continuous positive feedbacks.

4.2 Utility evaluation from the principles of BITC

Part of the scholars conducted their studies on how we can cultivate and manage coevolution in an organization [23,24,27]. Multiple principles were introduced in these
studies. With the argument that the coevolution occurs in both bottom-up adaptation and top-down control, Vessey and Ward [27] proposed the adaptive IS management, administrative IS management and enabling IS management in his sustainable IS alignment framework, and introduced principles for each management. We tend to determine whether our proposed framework meets these principles.

(i) Adaptive IS management principle

Adaptive IS management focuses on emergence and self-organization, learning, and innovation [27]. Three principles are introduced for this management. The first is matching coevolutionary change rates. In our framework, suitable governance mechanisms are proposed according to the cause and effect relationships among symptoms. The realignment process can match the external changes.

The second is optimizing self-organization, which states that autonomous agents in a complex system organize themselves in such a way that they may best address the complexity in their environment [27]. The continuous misalignment sensing and governance help to achieve the self-organization in our framework. The third principle synchronizes exploitation and exploration. Exploration describes the activities that use or extend the enterprise’s existing resources. On the other hand, exploration describes the activities that lead to a new order [27]. In our framework, we realign the business and IT with exploiting existing resources and capabilities; also explore new capabilities and skills with the long-term learning, which helps to acquire new symptoms and governing mechanisms.

(ii) Administrative IS management principle

This principle represents management in the formal hierarchy that is responsible for planning and coordinating formally-sanctioned IS activities [27]. It is a rational design process. The EA design process satisfies this principle in this paper.

(iii) Enabling IS management principle

This principle governs the links between the bottom-up adaptive management process and the top-down management process. The EA evolution correlates the rational EA design and emergent coevolutionary analysis in this paper, which reflects the applicability of this principle.

4.3 Utility evaluation from the approaches of BITC

Several researches explored different approaches to achieve the coevolution, such as perspectives of questioning alignment and situated change [37], co-learning and collaboration [16], activity theory [33], conceptualization and degree of formalization [20]. Amarilli proposed two conceptual distinctions and four kinds of approaches in BITC [20]: (i) metaphors, which refer to use analogical reasoning to raise awareness or to influence the way of thinking; (ii) functional complexity models, which mean the relationships in a complex system can be expressed through mathematical models and formulated in the form of payoff functions; (iii) coevolutionary models, which study the evolution of a complex system based on the interaction of the constituting elements; (iv) complexity dynamics models, which capture the dynamics of a complex system through mathematical descriptions, usually in the form of non-linear equations.

Amarilli argued that the application of complexity dynamics models is rather difficult, which requires reductionism techniques to identify the limited number of relevant variables and rules that may explain the behaviour of the system. Based on this, he pointed out that the mixed strategies of alignment combining different methods can also help. For instance, a company may adopt a metaphor approach to improve social alignment and generate the conditions for implementing other alignment actions, apply coevolutionary models to pursue alignment on day-to-day basis, and monitor key properties through a functional complexity model [20]. This argument accords with our framework, which involves the first three kinds of approaches. With regard to the perspective of the metaphor, our framework looks the complex organization as human bodies, and the misalignments in organizations as the diseases in human bodies. This metaphor makes the complexity in organizations more easily to understand.

With regard to the perspective of the functional complexity model, our framework adopts a misalignment analysis method to seek for a short-term governance. With regard to the perspective of the coevolution model, our framework considers applying multiple rules in day-to-day organizational activities, which helps to seek a long-term management. With the advantages of the above three approaches, the BITC can be achieved in a process-oriented way.

5. Conclusions, limitations and future work

Following the research of BITC, this paper helps practitioners and researchers make sense of the coevolution achieve it, and manage it. Three basic arguments are mainly considered in this paper. First, the coevolution should reconcile both bottom-up “emergent processes” and top-down “rational designs”. Second, the coevolution should involve both short-term alignment and long-term alignment. Third, the organization is a complex adaptive system and its internal relationships are hard to perceive. On the basis of them, a coevolutionary framework combining EA with the coevolutionary analysis is proposed. The
framework is composed of four main parts: EA design, sensing of misalignment, governance of misalignment, and EA misalignment prevention.

This work contributes in several ways. We conclude the three main motivations for the research on BITC. With regard to the proposed framework, we primarily discuss the cause and effect relationships among symptoms in misalignment correction. In addition, we evaluate the applicability and utility of the framework through three ways: characteristics of coevolution, principles of coevolution, and approaches of coevolution.

The proposed framework and its evaluation methods have their limitations. On one hand, either EA or BITA is a discipline and owns extensive research. This paper mainly discusses their combination for addressing the co-evolutionary problem of business and IT, but not explains the research on EA in detail, neither the BITA research with EA methods. On the other hand, the cause and effect relationships among the multiple symptoms are used to re-align the business and IT. However, the internal relationships in a complex system are non-linear, which means, the outcome would not correspond to the constant input variables. Therefore, the cause and effect relationships among symptoms help to control the misalignment, while may not lead to an absolutely right correction scheme. Other complementary methods need to be considered here. Furthermore, this work only selects one utility evaluation method (informed argument) from Hevner et al. [69]. Other methods such as case study are also very useful. The adoption of multiple evaluation methods synchronously may help to verify the framework more thoroughly.

The above limitations provide a starting point for future work. EA is always acknowledged as a beneficial approach to deal with BITA problems. The complete EA components and relationships need to be further explained. Meanwhile, the extant research on EA management from as-is EA to to-be EA needs to be totally analyzed.

A suitable case study should be introduced for the proposed framework. The case study ought to include the EA design process and the EA evolution process. Due to the combination of long-term management and short-term governance, the case study should involve a long-term time frame and be punctuated by multiple short-term phases.

Finally, to control the coevolution directly, we plan to explore the complex dynamic models of BITC in an organization. The positive and negative influence relationships among different organizational contents will be explored. The complex dynamic models are more easily to satisfy the non-linearity and positive feedback features of coevolution.

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