Exploring the Role of Enterprise Architecture in IS-enabled OT:
An EA Principles Perspective

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***Abstract*—Although EA principles have received considerable attention in recent years, there is still little known about how EA principles can be used to govern the transformation of the Information Systems enabled organization. In this research-in-progress paper, we communicate our initial step towards answering the sub-question: how do enforcing EA principles contribute to IS-enabled OT? Based on a comprehensive literature review, we initially propose five testable hypotheses and a research model, which is a pre-requisite to developing a data-driven theory for this important area of research. It is anticipated that the ensuing theory will provide a basis for further research studying the impact of EA on IS-enabled OT. The tested research model will also provide guidance to practitioners on how to effectively design and use EA principles in managing transformative changes caused by IS within their organizations and overall industry sectors.**

Keywords—Enterprise Architecture; Enterprise Architecture Principles; IS-enabled Organizational Transformation; Organizational Inertia

I. INTRODUCTION

As explicated in the widely adopted definition of Enterprise Architecture (EA), EA principles govern the design and evolution of the enterprise over time [1], [2, p. 9]. Although the importance of EA principles, in the development of flexible architecture and coherent systems, has long been identified [3], EA principles have just began to receive considerable attention within the EA community in recent years [4]–[9]. Current literature is focused mainly on identifying the types of EA principles [7], the characteristics and development of EA principles [5], [10], and how they are grounded and managed in the organization [10]. This is partly because the research on EA principles is still in its fundamental stages.

The importance of EA principles is clear. However, the challenge is how can we use EA principles to govern the design and evolution of EA in the modern context of Service-Oriented Digitally enabled Architectures and Transformation [11]–[13]?. In particular, we seek to explore how can EA principles guide the evolution or transformation of the Information Systems (IS) enabled organization? In this "research in process" paper, we draw on Organizational Transformation (OT), Organizational Inertia (OI), and EA literature to draft our first step towards answering the sub-question: how do enforcing EA principles contribute to IS-enabled OT? Thus, based on a comprehensive literature review, we initially propose five testable hypotheses and a research model, which is a pre-requisite to developing a data-driven theory for this important area of research.

The rest of the paper is organized as follows. Section 3 presents a literature review on IS-enabled OT, OI, and EA principles. Hypotheses based on literature review are developed in section 4. Section 5 presents a brief discussion and conclusion, and description of future stages of the project.

II. LITERATURE REVIEW

A. IS-enabled Organizational Transformation (OT)

OT has been intensively discussed both in the management and IS literature [11]. OT can occur through punctuated equilibrium (revolutionary transformation), evolutionary transformation, or institutionalism: these are treated extensively in [11]. IS, including digital technologies [12], can enable three forms of OT, resulting in IS-enabled OT [11]. In the IS/EA literature, the concept of evolutionary transformation is more prevalent e.g. see , [11], [14]. However, punctuated equilibrium (revolution) and evolution do co-exist during the OT e.g. , [15]–[17]. For instance, consider the scenario in which an evolved centralized organization faces environmental turmoil leading to the need for decentralization [15]; or a scenario in which an organization decides to pursue ambidexterity by internal alignment of its current enterprise whilst simultaneously pursuing revolutionary change to establish a new enterprise to adapt to external environmental change [16], [17].

Venkatraman [18] explains how the two forms co-exists in IS-enabled OT. Evolutionary OT improves efficiency through local exploitation and internal integration whilst revolutionary

OT enhances capabilities through business process redesign, business network redesign, and business scope redefinition [18]. Furthermore, advancements in Service oriented Architecture (SOA) and Cloud Services, for example Business Process as a Service (BPaaS)[19], may increase the pursuance of institutionalism in IS-enabled organizations. In this paper, we consider IS-enabled OT as consisting of all three forms of OT which are intricately connected together as explained in prior research [11]. Definitely, particular architectural principles could have effects on particular types of IS-enabled OT, however, that is beyond the scope of this initial step.

B. Organizational Inertia (OI)

OI characterizes the level of stickiness of the organization being transformed [11], and has been identified as an inhibitor to OT and adoption of new systems and organizational practices [20]–[25]. OI occurs at different levels, including the individual, group, organizational, and industry sector. A number of different types of taxonomies have been proposed to classify and explain the OI e.g. , [20], [25], [11], [21]. For instance, Besson & Rowe [11]'s taxonomy presents five types of OIs namely, negative psychology inertia, socio-cognitive inertia, socio-technical inertia, economic inertia, and political inertia. Negative psychological inertia relates to denial, demands to learn new skills, loss of long standing relationships, and the emotions associated with them [11], [20]. Socio-cognitive inertia relates to the stickiness caused by adherence to norms, values and conscious behavior patterns at different levels [11], [25]. Socio-technical inertia involves the adherence to a technological and socio-technical path especially because of development time, and the quest for internal consistency[11]. Economic inertia relates to economic path dependency characterized by adherence to business models especially because of associated sunk costs, commitments, infrastructure activity costs, and switching cost [11]. Last but not the least, political inertia refers to the vested interests and the need to keep alliances and networks especially due to alliance rebuilding time [11].

C. EA Principles

EA principles are defined as an organization's fundamental philosophies or rule statements that guide the description, development/construction, and evaluation of the organization's architecture [3], [7]. For example, EA principles guide what is to be done [26], result in integrated and flexible architecture [3], and provide the basis for the evaluation [7] and governance [2, p. 78,265] of the architecture. These principles are generally described as a set of informal rules [2], [3] that are susceptible to different interpretations and therefore lack the ability to control or restrict the design space. This could also be seen as design agility or flexibility, which is important to handle and accommodate always changing business and technology environment [27].

A clearly defined actionable set of EA principles increases the understandability of, and reduces the ambiguity associated with informal rules or slogans [8]. EA principles should not result in a set of overly restrictive and bureaucratic rules. Thus, a set of unambiguous, actionable and measurable high-level EA principles set constraints with ample room for more details and adaptation at lower levels of design [8]. Further, EA principles can be classified in terms of EA representation and EA design principles e.g. [7]. EA representation principles are employed during the description and modeling of EA, and the evaluation of EA representation, whilst EA design principles guide the construction and evaluation of the EA. EA representation principles include understandability, consistency, and completeness; whilst EA design principles include separation of concerns, modularity, or loose coupling. These two types of principles guide the development and evaluation of the EA as a product or an artifact [28, p. 64]. For instance, whilst the EA design principles describe how modular a particular EA artifact (e.g. model) should be, the EA representation principles describe how understandably that EA artifact should be represented.

However, a careful review of the highly cited EA principles e.g. in [3] and TOGAF[2], reveals that some EA principles relate to EA process or practice [28, p. 64]. For instance, "Information systems planning needs to be an integral part of the strategic business planning process" [3, p. 390] and "All organizations in the enterprise participate in information management decisions needed to accomplish business objectives" [2, p. 270]. These principles are covered neither under EA representation principles nor under EA design principles. However, they foster the coordination of all the various architecture activities including the establishment of a coherent EA in response to enterprise level strategy [29, p. 3], and its use [2, p. 265]. Because of their close relation with the process nature of EA, some authors regard them as "non-principles" [30, p. 5] mainly from an EA as a product perspective. However, "architecture is a product as well as a process" [28, p. 64]. We therefore propose a third type of EA principles, EA management principles, to reflect the process nature of EA [28, p. 64]. EA management principles may include transparency, coherency, accessibility, inclusiveness, and compliance [2, pp. 269–280], [3]. The three types of EA principles are summarized below in **Table 1**.

Table 1: Types of EA principles

Type of EA Principle	Example	Sample of EA Principle
EA representation principles	Understandability, consistency, and completeness	"Data is defined consistently throughout the enterprise, and the definitions are understandable and available to all users." [2, p. 276]
EA design principles	Separation of concerns, modularity or loose coupling, adaptability	"Software and hardware should conform to defined standards that promote interoperability for data, applications, and Technology" [2, p. 280]
EA management principles	Transparency, coherency, accessibility, inclusiveness and compliance	"Information systems planning needs to be an integral part of the strategic business planning process" [3, p. 390]

III. HYPOTHESIS AND RESEARCH MODEL

In this section we briefly present the analysis leading to our hypotheses. These hypotheses are mapped in our research model in figure 1.

A. EA Design Principles and OI

EA design principles promote the separation of concerns, modularity, loose coupling and scalability of EA artifacts (e.g. business solutions, services, and models) [7], [31] and foster interoperability amongst these artifacts at different levels [2, p. 65]. Enforcing EA design principles promote open standards, adaptability and the use of the situational "building block" approach to EA [2, p. 500], [3, p. 400]. Modularity increases the chances of reuse and cognitive consistency, and thus reduces cognitive demands (e.g. anxiety related to learning new skills) associated with architectural artifacts created from reused modules, especially when the reused module is complex [32]. Appropriate degree of modularization [33], [34] has also been identified to enable scalability, loose coupling, high cohesion and enterprise reconfiguration [35], [36]; and to reduce complexity in large systems and development time [33], [37]. Thus, it seems that enforcing EA design principles could assist reducing socio-technical [11] and negative psychological inertia [11], [24], [25]. Switching cost, sunk cost, escalation of commitment, infrastructure activity cost are associated with economic inertia see , [11]. Switching cost consists of monetary costs and non-monetary costs [38]. Drawing on service modularization [39], enforcing EA design principles (e.g. standardizing interfaces) may result in less expensive fluxing of the enterprise through modular reconfiguration [40] of specific EA artifacts (e.g. information systems, processes, services, and solutions). Further, the relatively low sunk cost (e.g. low initial investment) associated with SOAs (e.g. IaaS, SaaS, PaaS, and BPaaS) [41] may lower the monetary switching cost, and thus may lower the economic inertia [11]. These various possibilities warrant further research and draw our attention to the following hypothesis:

H1: Enforcing EA design principles will lower economic inertia, socio-technical inertia, and negative psychological inertia associated with EA artifacts

B. EA Representation Principles and OI

EA stakeholders can be identified within and outside the enterprise [28], at different levels of the organization (e.g. strategic, tactical, operational levels), and from different EA domains [31], [42], [43]. They may have different interests and speak different languages [44]. Design complexity may arise because of the need to harmonize different perspectives of a problem in the design process [44] ; a process that demands the awareness of stakeholders with respect to their specific objectives and information needs [28]. Besides, all stakeholders must understand the EA [31], consisting of artifacts such as models and descriptions of services, business solutions, and capabilities. The use of reference aids become necessary to support reflection within a shared context defined by the task at hand, and subsequently may result in distributed cognition and shared understanding [44]. Enforcing EA representation principles may enable the provision of consistent information with the appropriate levels of details to stakeholders to aid their understanding, learning [28], [31], [45], [46], and perception of value and switching costs, and thus lowering negative psychological inertia[11], [24], [25], and socio-cognitive inertia [11], [21], [25], [24]. These open possibilities around EA principles draw our attention to the following hypothesis:

H2: Enforcing EA representation principles will lower negative psychological inertia and socio-cognitive inertia associated with EA artifacts

C. EA Management Principles and OI

The EA management principles bring the coordination and governance mechanisms of EAM to bear on the formation of coherent EA artifacts (e.g. services, business solutions) especially as we gravitate towards the fusion of business strategies and IT strategies in the formation of "digital business strategies" [12], and service orientation. EA management principles promote the transparency of the architecture process through the employment of a participatory design [47]–[50] and collaborative decision making processes [29], [51], [52] such that the ensuing architecture (EA artifacts) reflects a collaborative view of many contributors [29, p. 128]. Collaborative decision making, not merely consensus building, are useful particularly in context were there are social and political fragmentation, shared power, conflicting values, vested interests, and differences in knowledge [52]. Thus, enforcing EA management principles that promote collaborative decision making could lower political inertia [11], [20], [21] by promoting shared understanding, relationship building, agreements, ability to handle change, and experimentation [51], [52]. Participation may also promote extent of relevance ascribed to design artifacts [53]–[55] and could, perhaps, lower socio-cognitive inertia [11], [21], [25], [24]. Drawing on analysis in this sub-section, we propose the following hypothesis:

H3: Enforcing EA management principles will lower socio-cognitive inertia, and political inertia associated with EA artifacts

D. OI and Use of EA Artifacts; and Use of EA Artifacts and IS-Enabled OT

EA artifacts (e.g. processes, and business solutions) are "things" [2, p. 500], [50], [56] that may possess superior characteristics or potentials, however, these potentials will remain inert until they are unleashed through actual use [56]. In other words, the potentials (e.g. effectiveness and modularity) of an EA artifact will not result in organizational benefit (e.g. OT) unless the artifact is used. The use-benefit relationship is consistent with other models [55], [57]. Furthermore, though the presence of inertia may hamper the use of an EA artifact, lower or absence of inertia might not necessarily result in the use of the artifact especially when the EA artifact is not perceived to be more relevant than existing artifacts or ways of doing things [21], [25]. Meaning, there could be low inertia but no use. This is consistent with the "perceived relevance - use" relationship [54], [55], [57] and the "functional fit" construct in [58]. We therefore propose the following hypotheses:

H4: Provided the EA artifact is perceived to be of higher relevance, lower inertia will result in the use of EA artifacts

H5: Use of EA artifacts will result in IS-enabled OT

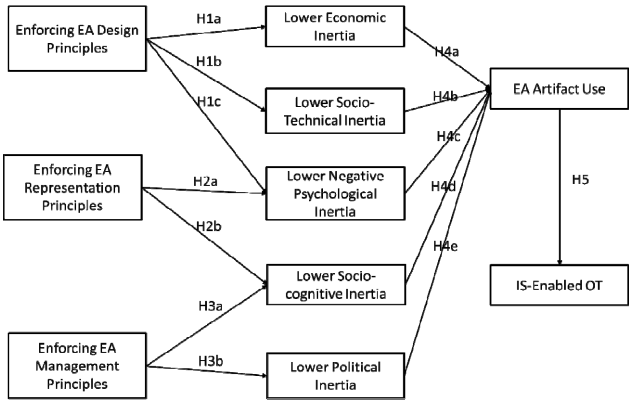

Figure 1: Research Model with Mapped Hypothesis

IV. Discussions and Conclusion

It is well known that EA principles are fundamental in governing the design and evolution of the enterprise. Though considerable attention has been given to EA principles lately, little empirical evidence or study is available on the role of EA principles in IS-enable OT. With the increasing interest in IS-enable OT within the IS community, especially because of service-oriented and digitally enabled architectures, and their potential impact on IS-enabled OT, we seek to investigate the role of EA principles in IS-enabled transformation.

Consequently, in this research-in-progress paper, as a first step, we drew on OT, OI and EA literature to establish the foundation for our research. The transformative effects of IS (including digital technologies) on organizations can manifest in three intertwined forms: evolutionary, revolutionary (punctuated equilibrium), and institutionalism. However, these transformations are neither so fluid, nor without resistance. The resistance to the OT process (i.e. OI) could be economical, political, socio-technical, negative psychological and socio-cognitive in nature. Lowering the different forms of OI therefore becomes paramount to the IS-enabled OT process. We therefore explored the role of EA principles (design, representation, and management principles) in enabling IS-enabled OT by lowering OI and increasing the use of EA artifacts. Along this path, we proposed five testable hypotheses and consolidate them into a research model. This is fundamental to studying and theorizing the impact of EA principles on IS-enabled OT.

Future efforts will concentrate on performing detailed empirical study involving data gathering, analysis and hypothesis testing. We do acknowledge that testing these five hypotheses will in no way be a trivial issue. To start with, we will draw on EA maturity models (e.g. as presented in [2, pp. 683–690]) to develop a measurement scale that will enable us to measure the three constructs; enforcing EA design principles, enforcing EA representation principles, and enforcing EA management principles. Haag [21] proposed a multidimensional scale that we can draw on to measure the five OI constructs. The EA artifact use construct will be measured using "IS Use" measurement scales in the IS literature e.g. in [55], [57]. We assume that EA artifacts (e.g. business models, business solutions, and architectural descriptions) are used in ways similar to how Information Systems are used. Lastly, we intend to extend the works of [59], [60] to measure the IT-enabled OT construct. In essence, the proposed research model provides an overarching model within which more detail research will be conducted to empirically discover the path along which EA can influence IS-enabled OT from an EA principles perspective.

We envisage our work to contribute to the IS/EA literature in diverse ways. For instance, theories that will ensue from testing the research model will contribute to understanding the role that EA could play in IS-enabled OT, and provide a basis for further research on the relationship between EA and IS-enabled OT. Also, the research will contribute a set of measurement instruments to enable IS researchers to measure the effects of IS interventions on IS-enabled OT.

To the practitioner, we envisage to provide guidance on how to effectively design and use EA principles in managing transformative changes caused by IS within their organizations and overall industry sectors. Specifically, the tested model will provide guidance on which EA principle to prioritize, or to enforce more, in order to lower a particular type of OI and to increase the use of EA artifacts. For instance, in situations where an organization experiences high economic inertia, enforcing EA design principles might reduce such inertia and increase the use of EA artifacts. Whereas in situations where an organization experiences high socio-cognitive inertia, enforcing EA representation principles and EA management principles might reduce the inertia and increase the use of EA artifacts.

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