Envisioning Information Systems Support for Business Ecosystem Architecture Management in Public Sector

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Abstract. Based on our research concerning Finnish national enterprise architecture (EA) adoption in long run, we discuss here how EA concept and tool are to be developed to support business ecosystem and organization design. Our research context indicates, beyond a federal government or a state one, that even a single municipality, like a city concern, can be perceived as an ecosystem of its sectoral domains, subsidiaries etc. We outline a vision of an overall ontology-based, shared EA repository for the-whole-of-government current state descriptions. We specify the central design principles and functional requirements for such a system and illustrate some potential use cases of it. The study suggests further abductive studies on the best design for such a system. Consequentially, we propose EA as a concept for organizational design of a government entirety.

Keywords: business ecosystem, enterprise architecture, ontology, public sector.

1 Introduction

The world has become interconnected so that the organizations are intertwined with business partners and integrate into networked business models. This enhances efficiency by focusing on company's core competencies while leveraging capabilities of their partners. The concept of a business ecosystem is suggested as an economic community of interacting organizations and individuals [28, p. 9] to create value through the increased information, services, and products for the customer [18, p. 28]. Ecosystems have attracted interest also in the public sector, and inspired new models of public services delivery, where the ecosystems-enabled co-creation is suggested as key innovation [5]. Recent examples include Nordic Smart Government project aiming at the data driven Nordic region, based on the interoperable digital ecosystem for data exchange between systems and authorized parties. Prevailing reform in Finnish Social and Health services aims at a shared business ecosystem that will include shared IT services as the common platform for currently siloed and fragmented data resources. The ecosystem model is believed to improve the quality of social and health services, and create new opportunities for business, research, and societal growth [39].

Enterprise architecture (EA) is commonly considered as a valuable approach to coherently manage and align the organizations' key assets, such as business processes and services, information systems, and data. EA has been applied in large and complex organizational change endeavors, business mergers (e.g. [9, [34]), electronic government (e.g., [6, 15]), and building business ecosystems platforms [39]. However, EA methodologies fall short in bridging internal and external environments, and in involving customers, supplier, business partners and other various stakeholders for building successful ecosystems [37]. Drews and Schirmer [12] propose a plausible idea of how intra-organizational EA should evolve to respond the organizations' interconnectedness.

For the interconnectedness of the *public administration (PA) as a business ecosystem*, (later *government ecosystem*), the paper proposes a vision of the real-time information system support. We ask, what kind of information system (IS) is needed in a complex socio-technical government ecosystem for real-time current state analysis. We outline basic functional requirements of an ontology-based, shared EA repository. The work is constructed as a design research, based on our observations in Finnish public administration EA adoption, e.g., [41, 24], as well as the literature anticipations of the future EA in business ecosystems, e.g., [12]. We recognize the far-reaching nature of the vision. However, the rapid development of the enterprise modeling and meta-modeling methodologies (e.g., [10, 38]), should anticipate that no long will take to the vision to be implementable. Artificial intelligence, neuro technologies etc., are the future options for creating and maintaining the as-is *business ecosystem EA* (BEA). We use Finnish National PA as an example to illustrate the given vision. The aim of the study is to encourage evolutionary studies, and pilots, especially constructive ones, to reach out to more specific specifications and design principles for the BEAM solution.

The remainder of this paper is structured as follows. In Chapter 2, the EA management is presented as a tool in collaborative networked environments. In Ch. 3, the research setting of the constructive study is described. In Ch. 4, the Finnish PA is illustrated as an example of the government ecosystem. We shortly outline the previous exploratory research of the EA adoption in Finland, that inspired the vision at the paper. In Ch. 5, the vision of the public sector EA management IS and its foreseen usage is described, with some core requirements and illustrations. In Discussion (Ch. 6) we answer the challenges presented for the execution of the business ecosystem EA management in [12]. Chapter 7 presents conclusions and suggests further studies of the subject.

2 EA Management in Networked Environments

Visnjic et al. [42] present cities as "ecosystems of ecosystems". Business ecosystems (later, *ecosystem*) have been much studied and defined in a variety of ways (e.g. [20, 31]). Similar ideas have been discussed in other fields under different terminology [1, 17]. Governments and the economy are perceived as complex social systems by several authors [3, 30]. As the world alters towards networked and complex structures, the changes within the organizations and in the environments are becoming more frequent, yet more difficult to perceive and foresee. This creates the demand for organizations to evolve constantly, to move out of the traditional, possibly stagnant structures and operating models. Public organizations have been struggling with the agile ideology [35], as means to the frequently changing environments.

The research of social architectures that are embodied in organizational design thinking, are concerned by social sciences [27], whereas technical architectures are discussed by engineering sciences, such as enterprise engineering and EA. The need to integrate technological and social perspectives in the design and engineering of organizations, is urgent [27]. Social nature of systems seems to be necessary to be taken into account in design of the ecosystem of organizations. Poli [33] distinguishes complex and complicated systems: a complicated one can be understood through structural decomposition, whereas complex ones can be understood via functional analysis. This suggests, that complicated systems can be modelled fully (in theory), while complex systems remain heuristic in nature, and cannot be fully captured. Therefore, disciplines (e.g. EA) which concern the analysis and design of an organization should possess a dualistic nature - concerning both complex and complicated problems.

The current EA methodology is lacking in the capabilities of business ecosystems analysis and design [13, 32]. Recently, a systemic stance on an organization in an ecosystemic environment has been supported, e.g., in [12, 19]. EA might need a reconceptualization on methods and tools, to provide requisite coherence and adaptability in reacting internal and external change demands [19, p. 278]. In the paper, we suggest the current state EA modeling to follow the engineerable path as the complicated problem, by semi-automated models of the as-is, whereas the target state design of BEA is left with situational, heuristic practices, however benefiting of the as-is repository.

3 Research Setting

The research follows the principles of the design research (DR) [16], where the theoretical knowledge base and the real-life environment are married for the researchers to create an artefact that is needed in the environment. In the study, we envision an IS solution for EA descriptions' accessibility, and automated update in government ecosystem. The IS vision stands for the design artifact in terms of [16]. The IS vision also proposes the hypothesis that is to be evaluated in future studies in government ecosystems, e.g., in a municipal corporate, or a national government. Beyond the EA research endeavors of the Finnish EA adoption, the authors hold EA development or EA education roles in Finnish PA. We build on the personal research and development endeavors, as well as the latest enterprise modeling and architecture knowledge base, where the most influential for the work have been the EA frameworks and methodologies [29, 14, 8, 10]; EA conceptual foundations [7, 21, 23]; EA studies from the business ecosystem perspective [4, 12]; and enterprise modeling and engineering [38, 22, 11, 36].

The proposed IS vision forms a continuum in abductive DR cycles concerning EA framework adaption in Finnish PA [39, 40, 41], that suggested two things. First, the current state EA descriptions of a government ecosystem were to be modeled as structural, re-arrangeable descriptions e.g., like in [29]. Secondly, the current state descriptions elements were to be represented in relation to the prevailing management structures in real-time. This requires a common meta level representation of PA management structures – i.e., a contextual ontology. Finally, as for the current state EA descriptions, the EA framework for public sector was proposed to be implemented as a dynamic data model of the current management structures [41]. In this paper, the described previous results are further enlarged by abductive logic reasoning to present the hypothesis for future iterative and constructive case studies. Abductive logic forms a ‘process of discovery’ where inferences are drawn to the next best explanation in each cycle, with wider set of data [25]. Consequentially, the paper presents the IS vision for government ecosystem EA based on the ontology of the government management context.

4 Challenges of the Finnish PA as Ecosystem

Finnish national PA, as a ‘whole-of-government’ forms a complex ecosystem of actors. The actors are organizations of high complexity, e.g., with variety of products, services, official responsibilities, and complex administration structures. The political organization comprises a parallel hierarchy with the administration. Further, various cross-organizational management forms, such as policy programs are typical. According to our observations, these management structures are not always documented transparently.

Re-organization of the administrative structures has become an established practice in Finnish PA. The trends to centralize and decentralize are simultaneous. New Public Management related reforms have taken place since 1987. Gradual outsourcing of prominent business areas can be perceived in both state and local sectors. Simultaneously, the mergers have been encouraged by the State government especially in the municipal sector. The municipalities have conglomerated in many ways, e.g., via forms of collaborative networks, joint ownerships or by strict mergers. A conglomerate form of management is typical to public sector organizations, creating a complex system per se with various corporate governance functions, deep administrative hierarchies, and multiple types of actors, like sectoral domains, in-house enterprises, subsidiaries etc.

Re-organization and re-structuring are not typically based on profound systematic analysis and design. The current state organizational structures form a hindrance to the recurring transformation efforts. In a network of organizations, the management structures and classifies should be transparent at high usability levels, to enable the comparative analysis of the as-is corporate structures of the ecosystem, before the design of the common goals implementations. Finnish Information Management Act 2011 necessitates PA actors to publicly model their EA. However, despite of the serious endeavors in launching the shared EA modeling tools among PA actors, the open sharing of the EA descriptions is not at adequate level. Innovations and best practice sharing has to be based on mutual agreement on personal level first. The search algorithms and comparisons are neither profoundly supported at model element level. Furthermore, as Finnish administrations are trending towards citizens-as-partners type practices in service development, the customers and citizens might form a remarkable resource in innovating public services and structures, based on an open source EA description.

5 Vision of The Ontology-based Real-time EA Repository

We outline the vision for the IS support of the government ecosystem EA at conceptual level, 1) to enable the comparative analysis across ‘whole-of-government’, and 2) to provide the real-time as-is information of the ecosystem for target state design. Sect. 5.1 describes the vision, and 5.2. outlines the tentative target state BEA design process.

5.1 IS support for the Ontology-based Real-time EA (OREA)

We suggest co-creating the public sector ontology of the different level government ecosystems (local, national, federal), and mapping the EA descriptions and metamodels to them. We would like to see the output as the contextual ontology of government ecosystem EA modeling and enterprise engineering, on which you could build the corresponding shared digital IS ecosystem for EA management and development. We yield below the design principles and some central functionals requirements for this IS vision, illustrated by exemplary use cases. The envisioned system provides kind of a semantic web, enabling many types of data mining and comparative analyses.

For the design principles of as-is BEA realization we suggest following: 1) *Dynamic as-is contents* - automated updates or suggestions for updates. 2) *Scalability*, from the local ecosystems to the national, and the federal ones. 3) *Open access EA information* for citizens, and partners. 4) *Plug-in architecture* options - external organizations outside of the ecosystem are facilitated to plug into the government ecosystem EA. The plug-in architecture enables co-creation, and co-evolution of the ecosystem also with the private actors. Plug-in option offers the option to the new actors to join the ecosystems, thus supporting spontaneous evolution of the BEA. Next, we present three functional requirements (R1, R2, R3) for the as-is BEA realization:

R1. Basic modeling and meta-modeling functionalities, that are readily available in many modeling tools, (e.g., [38, 36]**)**. Modeling techniques have still to be innovated more for the organizational coherency and co-evolution purposes. In our development work, e.g., the strategy architecture models of the city were iteratively designed for the best fit to the purpose. The model notations and templates are to be designed situationally, where the model elements and attributes may associate to each other. The real-time as-is descriptions can be automatically visualized via metamodel rules, based on the structural information yielded regularly in everyday-work of the civil servants.

R2. Agile analyses and comparisons tools, that necessitates interdependent, commonly agreed ontologies, e.g., for business catalogues, and organigrams. For example, the as-is management structures can be made transparent in real-time and used to categorize the EA descriptions and their elements. Each description model and element are associated to relevant management structures. Also, different types of organizations, different types of management structures, and different types of management classifications are represented in the shared ontology. They facilitate the management needs for re-structuring the model instances according to their needs. Leaders and enterprise analyst may search descriptions and their elements according to shared ontologies, into which the metamodels of different description types are associated. For example, the Minister of Commerce may browse for the different organizational options of the municipalities entrepreneurial services, to decide whether each municipality has organized them as a subsidiary, in-house-enterprise, via joint ownership, or other. Along the organigrams, he might get the visualized volumes of the actors. The citizen can compare, e.g., the service catalogues between the municipalities.

R3. Situational EA frameworks of the as–is description can be pulled out of the system according to given parameters. The system might offer different EA frameworks templates to different organization types, too. Each organization may instantiate their framework and choose the EA models they prefer in their EA. EA frameworks are sketched as printed outlines as functionally. For instance, the CEO of a water supply subsidiary may request the outline of the EA descriptions realized in his organization, and in those of the neighboring cities.

5.2 Target State Design in the Government Ecosystem.

Figure 1 suggests a tentative management model for the government ecosystem architecture. The stages 1 to 5 illustrate the tentative target state design process for co-creating new services in the ecosystem (Fig. 1): In the phase 1 (Idea), an initiative appears, e.g., from citizens, government actor, or private companies (cf. [24]). To support the innovation, the phase should be as open as possible. This creates a socio-technical dimension to the idea co-creation. In Phase 2 the idea evaluation is done by a variety of stakeholders. Agencies might have a special interest in the financial analysis, whereas local citizens might appreciate the geographical locations of the services. The balance between financial and functional performance must be achieved [24]. This is followed by Phases 3a Current state analysis, 3b Target state design, and 3c Gap analysis. In (3a), the participating actors are identified, resulting in the subset of necessary distinct EA's, covering concerns such as customers, partners and suppliers [12], i.e., *EEA* (see below). In Phase 4, Project implementation starts with suitable project organization, involving the configuration of internal and external ecosystem actors, and IT-service providers. The as-is BEA updates semi-automatically by increments in the project implementation, finally fully reflecting the previous target state. The deployment may be also ceased at any time based on the feasibility checks, too.

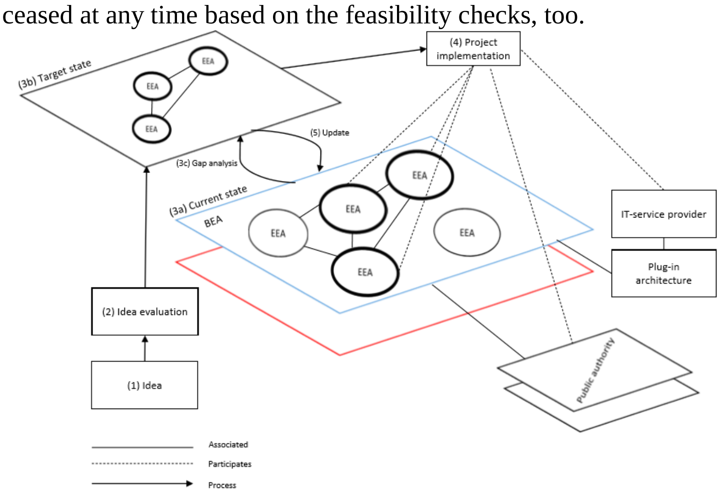

Fig. 1. BEA management: the blue and red layers illustrate as-is BEA repositories for a couple of government ecosystems. The phases 1-5 indicate the target state design of the ecosystem.

6 Discussion

The domain of EA methodologies has evolved towards the holistic organizational design and development [23]. Al-Kharusi et al. [2] note in their study of EA at dynamic environments that the human and organizational aspects is neglected in target state design. While [37] acknowledge the EA as a way to cope with organizations' ever-increasing complexity, they argue that the EA methodologies do not efficiently advocate the cross-organizational interactions between business entities. They call for business ecosystem architecture models to allow filling the gaps between internal and external operating environments, such as customers, suppliers, and business partners. Drews et al. [12] discuss the stages from the traditional EA to *Extended Enterprise Architecture* (EEA), and finally to the *Business Ecosystem Architecture* (BEA). While they suggest EEA to already extend to cover concerns such as customers, partners and suppliers, they argue that that for BEA, a central actor must have an overview of the whole ecosystem, i.e. the infrastructure and interfaces to all connected EEA's.

Drews and Schirmer [12] also present challenges of extending EA towards a value-producing instrument in complex and networked environments. Based on their four cases, 16 challenges for business ecosystem architecture management are displayed. and classified into four groups: (1) challenges regarding the (meta-)modelling of EEA and BEA; (2) challenges regarding the tool support; (3) challenges regarding the management of EEA and BEA; (4) challenges regarding the socio-technical dimension. We divide the challenges into the two categories: the complicated problems, i.e., those that can be dealt with by using engineering practices; and the complex problems, i.e., those that mandate the use of heuristic practices. Next, these problems, along with our proposed answers them are further discussed. The answers are derived from the afore-envisioned IS support of the OREA management of the government ecosystem. The answers can be seen as the anticipated benefits of the envisioned digital system.

6.1 As –Is BEAM as Complicated Problems

Our proposed solution to complicated problems is an ontology-based, shared EA repository for the-whole-of-government real-time updating descriptions.

Challenges concerning modelling include inter-organizational interfaces on all layers, finding the right level of abstraction and identifying shared business objects [12]. The shared ontology would support associating intra-organizational EA models inter-organizationally. The shared ontology might also help mapping the abstraction levels of the EA descriptions and their elements, whereby comparative cross-agency analysis were enabled. It would provide a common search index for comparative analyses and data mining, which would further enable the recognition of shared architecture objects, overlaps and bottlenecks.

The challenges [12] include those associated with ultra-large-scale architectures with a large number of actors in BEA. As a solution, the envisioned BEAM IS support semi-automatically would provide the ultra-scale current state descriptions. Updates would be based on the content changes in structural documents and automatically visualized as EA models in all EA layers. Therefore, the ultra-large-scale BEA descriptions would remain continuously updated. In future times, artificial intelligence might even make inferences based on less structured input or even graphic contents.

Challenges concerning tools include tool support for ontologies as well as those concerning open standards for data exchange (import/export). Here, we propose envisioned IS support per-se as described in the paper. Common modelling standards such as ArchiMate, UML, and BPMN could be mapped to the (core) concepts of the shared ontology to enable search and comparison regardless of the modelling language.

6.2 To – Be BEAM as Complex Problems

Concerning the complex problems, our proposed solution is the proposed target state analysis and design process.

Challenges concerning management**,** such as inter-organizational tasks and roles can be approached with more transparency both in inter- and intra-organizational levels via ontologies that apply to management structures [41]. Managing the aspects concerning BEA service provision can be solved with open network structure of actors and service providers. Also, our 'plug-in architecture' enables new (and temporary) actors to attach and contribute towards the development of ecosystems and services.

Challenges concerning socio-technical aspects, e.g. citizens and consumers as actors, and the lifeworld of customers and partners [12]. Our solution provides an open channel for citizens and consumers to suggest and peer-evaluate ideas for the development of the ecosystem.

The modelling and tool in Drews and Schirmer's challenges, is the part which our vision of ontology-based hits best, as the shared EA repository for the-whole-of-government, updating in real-time. It encounters with EEA and BEA modelling and tool challenges, since they can be seen as "complicated", engineerable ones. The management and socio-technical aspects are more related to the complex issues, where solutions can be considered mostly heuristic and situational in nature. Therefore, the tentative practice of the target state BEAM design given in Ch. 5, tentatively answers these complex challenges.

7 Conclusions

We presented the design principles and central functional requirements of the ontology-based as-is government ecosystem architecture repository, that is meant to be applicable to any chosen whole-of-government entirety. The proposed solution has several anticipated benefits. The system might maintain transparency and comparability across the entirety of the government, eliminate duplicate work, enhance the sharing of the best practices, and most importantly, support the co-evolution of PA structures towards higher coherency and synergies. Shared EA descriptions would support also co-creation and co-evolution of the ecosystem. However, the implementable solutions require further studies. Especially it requires the design of a future common, wider ontology of the public administration sector and concepts. This implies application of ontology engineering knowledgebase in further development and research of the subject (cf. [24]).

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