Challenges o EA Methodologies Facing Progressive Decentralization in Modern Organizations

Irina Rychkova[1], Jelena Zdravkovic[2], Thomas Speckert[2]

[1]Centre de Recherche en Informatique, Université Paris 1 Panthéon - Sorbonne,
90 rue Tolbiac, 75013 Paris, France
irina.rychkova@univ-paris1.fr
[2]Department of Computer and Systems Sciences, Stockholm University, Forum 100,
SE-16440, Kista, Sweden
jelenaz@dsv.su.se, tspeckert@gmail.com

Abstract. Enterprises with transparent boundaries, decentralized organizational structure, and constantly increasing requirements on IT flexibility, is a novel generation of organizations of 2020s. This paper elaborates on how the Enterprise Architecture (EA) can better support such organizations. We analyze three types of organizational structure: centralized, federated and decentralized. First, we identify the concepts that link organizational structure, IT Governance and EA. Then we use these concepts to identify conceptual problems related to IT decentralization, and to propose solutions. We illustrate our findings with a real case of a High Education organization in Sweden.

Key words: Enterprise Modeling, Enterprise Architecture, IT Governance

1 Introduction

According to [1], in the coming years enterprise software systems will not be able to continue to evolve along the beaten paths, because there is an urgent need for new directions in the ways enterprise software is conceived, built, deployed and evolved. This contention is becoming materialized even presently, when the boundaries of companies gradually fade away paving the road to *liquid enterprises* having fuzzy boundaries in terms of human resources, markets, products and processes which require adequate Internet-based Enterprise Systems.

Decentralization of organizations and subsequent changes of their management require major changes in organizations' processes and heavily involves the use of IT. Between traditional (highly centralized) and decentralized or "liquid" enterprise, many other organizational structures can be identified [2]. In these work, we analyze three forms of organizational structure: *centralized, federated and decentralized*.

This work studies the conceptual differences between these organizational forms with focusing *on how these differences affect creation, maintenance and evolution of the IT within the corresponding types of organizations*. Our objective is to make an explicit link between the structure of an organization and its EA, ensuring thus better support for federated and decentralized organizations. We envision an architecture-

driven corporate and IT governance involving adequately performed communication with a set of policies, multi-level decision making, knowledge management, automation of tasks by taking advantage of IT infrastructure, human management, etc.

The main research question addressed in this paper is: How to integrate the decentralization concepts into EA methodologies? The proposed solution follows Design Science research framework [18], which suggests that an innovative solution is proposed to solve a problem of general interest. Following the framework, in our study (i) we identify a problem from the real world - a need to support the modern types of enterprises characterized by increasing decentralization and demand in flexibility and agility of their IT; (ii) then we define a relevant knowledge base for our research that is grounded on organizational science, and the enterprise architecture discipline; (iii) we build design artifacts: the two constructs to be used for reasoning about organizational structure in general, and IT organizational structure in particular; (iv) to evaluate the created artifacts, we apply them in the environment of a Federated Organization in the Swedish Higher Education sector.

This paper reports on the research in progress and will be organized as follows: in Section 2, we outline the theoretical foundations for this work and discuss the related works. In Section 3, we define a relationship between a structure of organizational IT and an EA: first, we present the concepts of center and steering forces that link organizational structure, IT Governance and EA; than we use these concepts to identify conceptual problems related to IT decentralization and to propose solutions. These findings are illustrated with a real organization case in Section 4, which is followed by our conclusions and the direction of future work in Section 5.

2 Theoretical Foundations and Related Work

In this section brief overviews of the topics and the results related to the research of this paper are presented.

2.1 Centralized, Federated and Decentralized Organizations

The organizational structure defines the rules according to which allocation of responsibilities and resources, coordination and supervision, is made for an organization (and - in case of IT - for the IT). Many popular organizational types are defined in the literature [3]-[6] In this work, we focus on three types of organizational structure: centralized, federated and decentralized organizations [2].

Centralized organizations lean towards a vertical style of coordination [7], characterized by formal authority, standardization, and planning.

Decentralized organizations lean towards lateral coordination, characterized by meetings, task forces, coordinating roles, matrix structures, and networks [7]. An example of decentralized organization is a collaboration of partners working on a concrete set of problems (e.g. research collaborations, virtual labs) or forming in response to a particular customer need or market situation (e.g. virtual organizations, coopetitions [8]). Besides this collaboration, missions and objectives of each partner can be completely different and even concurrent.

Federated organizations combine characteristics of centralized organizations (e.g. centralized planning, standardization, etc.) and decentralized organizations (e.g. local leadership, competitive local objectives, etc.). One example of federal organizations is a research institution that is formed by multiple schools, centers, and labs.

2.2 Enterprise Architecture (EA)

The role of EA discipline is to provide the organizations with a roadmap for creation and evolution of their information systems. EA of an organization changes and grows together with the organization, its structure, vision and operating model [9].

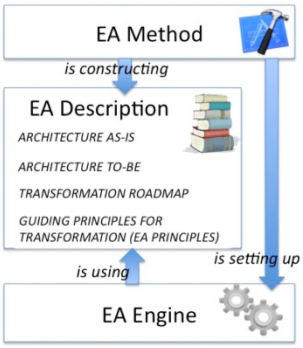

Fig. 1. Enterprise Architecture of an organization contains three interrelated parts: EA Method , EA Description and EA Engine .

EA "defines the underlying principles, standards, and best practices according to which current and future activities of the enterprise should be conducted" [10]. EA methodology and tools produce artifacts to specify the current state of a company's architecture ("as-is"), the target architecture ("to-be"), identify how to best cross the gap between them (architectural roadmap), and set up the standards and rules to follow during this transformation (EA principles). These elements are often addressed in literature as *EA description*; the process that an organization has to execute in order to obtain its EA description is called *EA method* (Fig.1). A traditional EA project consists in implementing an EA method and producing an EA description. To assure that the organization will continuously follow the EA principles and achieve the designated goals (architecture "to-be") a third element has to be defined: *EA engine*. The presence of this element in our model in Fig. 1 reflects the fact that EA is not static: it makes the organization change while changing itself over time. Dedicated structures and procedures have to be defined in an organization in order to continuously steer this organization towards its target architecture.

2.3 IT Governance

According to [17], IT Governance is a subset discipline of corporate governance focused on information systems and their performance and risk management. The discipline describes how people authorized over some domain of business should consider IT in the monitoring, control, and improvement of the business. Architecture

governance is a key aspect of IT Governance – it is responsible to create and manage policies for the structure and content of IT in an organization, and to enable their reuse in the form of best practices. Service Oriented Architecture (SOA) governance is a well-known example where the architecture, i.e. SOA and further up an EA that incorporates SOA, drives IT governance to ensure service orientation.

2.4 Peer-to-Peer

In [2], we claim that the structured and disciplined approach to IT evolution not necessarily has to rely upon IT centralization: novel EA concepts are needed to ensure the harmonization of development and evolution of IT with the properties of decentralized and federated organizations. We argue that peer-to-peer is a relevant concept to decentralization in EA for two reasons. First, units in decentralized organization are able to contribute to the enterprise in a manner that is completely up to them. This is similar to peers in a peer-to-peer system, where the peers participate in a voluntary manner. Second, the challenge that peer-to-peer systems overcome is similar to decentralized organizations: "to figure out a mechanism and architecture for organizing the peers in such a way so that they can cooperate to provide a useful service to the community of users" [11]. Therefore, we consider peer-to-peer principles [12], [13] applicable to EA for enhancing their support of decentralization.

3 Organizational Structure and EA

The objective of EA methodologies created in early 1990s was to align the IT capabilities with Biz needs via IT centralization. The main price to pay for IT centralization was the loss of flexibility and the inertia in decision making in IT. By that time, however, this was much less critical than to make the IT "disciplined" and to justify the investments in IT. Today, the flexibility in IT becomes more and more strategic. For modern organizations with transparent boundaries, it is simply impossible to centralize IT for literally independent partners. On the other hand, it is still crucial to maintain "disciplined" approach in IT evolution so that the partners not only remain independent but could also efficiently work together as a "virtual whole".

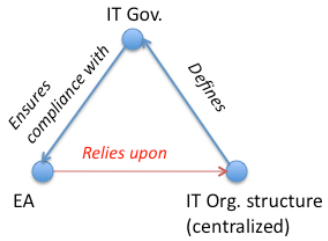

Fig. 2: IT Organizational structure, IT Governance and EA form a triangle where EA relies upon the IT Org structure.

The works presented in [4], [14], [15] and [16] focus on the relation between the structure of an organization and its IT. Following these works, we claim that the

notions of Organizational Structure (in IT), IT Governance, and EA are interrelated: IT governance is defined by the IT Org. Structure and has to comply with the vision of Architecture to-be and the EA principles; EA principles, in turn, should reflect the style of IT Organizational Structure. This relations form a triangle as shown in Fig. 2.

The question is: *how EA should reflect the change in the IT Org. Structure in order to support the "disciplined" IT evolution?* Upon what alternative mechanisms EA should rely when centralized strategic and resource planning is getting replaced by local planning; does central management replaced by the management on the operational level and centralized coordination and top-down decision making gives its way to self-organization and ad-hoc partnership?

To answer these questions, we define the concepts of *center* and *steering forces* (Section 3.1), and using these concepts, we represent the three types of organizational structures (Section 3.2). Than we formulate the problem related to mismatch between the organizational structure and the EA in use (Section 3.3).

3.1 Concepts for Reasoning about Decentralization

We consider three generic forms of organizational structures: centralized, federated and decentralized. We focus on the elements of these structures that impact the definition (EA method) and then implementation (EA engine) of the EA principles driving the organization to its target architecture: the *center* and the *steering forces*.

We define **Center** as a part of organization (a person, a group, or a unit), which plays the role of a leader, supervisor or coordinator, and possess some power to steer the other parts of the organization. Center can be implicit or explicit. Organizations with centralized IT (Fig. 3-a), have explicit center (e.g. EA department; EA steering committee etc). This center initiates, supervises and validates the changes in the organizational IT and in the EA itself. It steers all the organizational units by setting rules and checking for compliance. We can also say that there exist *steering forces* between the center and the non-central units.

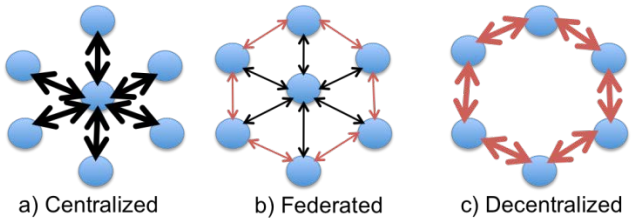

Fig. 3: Three types of organizational structure described with the notion of center and steering forces. Organizational units are depicted with filled circles. A circle in the centre stands for the "Center". The arrows relating the circles depict the steering forces.

Steering forces can be defined as explicit and implicit protocols, policies, rules and procedures regulating the flow of communication and control between organizational units. These forces can be characterized by their direction (top-down, bottom up, sideways) and their strength. In organizations with centralized IT, the strong steering forces connect the center with the other units forming a hierarchy (radial forces). In Fig. 3-a, a simple model with two levels of hierarchy is presented.

These forces can be both top-down (supervision, decision making, task/resource planning) and bottom-up (local initiatives leveraged to the center for approval).

In federated organizations (Fig. 3-b), the center remains explicit but the radial steering forces connecting the center with other units are weak since decision-making and prioritization in IT can be also done locally. On the other hand, sideways - steering forces appear in this model since more and more interactions are joint projects emerging locally, between units and without passing by the center.

In decentralized organizations (Fig. 3-c), the center disappears (or becomes implicit) and neither overall commitment to a given set of EA principles nor centralized control over IT evolution can be ensured. The only type of steering forces that makes the organizational IT evolve is strong sideways forces.

3.2 EA for Centralized, Decentralized and Federated Organizations

Based on the conceptual representation of the three organizational types from the previous section, we explore how these characteristics of centralized, federated and decentralized organizations can be reflected by the EA methodologies.

Centralized organization:

EA Method should set up a structure aligned with the structure in Fig. 3-a: to define a project leader or a sponsor (center) that will occupy a high hierarchical position in the organization and will automatically provide the top-down steering forces (decision making, resource allocation); to identify data/process owners in the local units that would provide the bottom-up steering forces and actively participate in the EA creation; to assign responsibilities and define protocols that would help to reach a consensus about the EA description to produce (radial steering forces).

EA Description has to focus on company-wide, long-term master plan for IT development that fits the global vision of the organization. EA principles have to define a single standard to be followed by all organizational units.

EA Engine, similarly to EA method, needs an explicit center (controlling authority) and strong radial steering forces (protocols, instrumentalized processes and resources to ensure compliance with EA) to be defined. The center will steer the organization by promoting initiatives, making decisions and validating results. The organizational units will leverage their initiatives to the organization level (bottom up) for further approval.

Federated Organization:

EA Method should set up a structure aligned with the structure in Fig. 3-b: define a project leader (center) who will ensure the alignment between the EA project and the objectives of the organization. Since the radial steering forces are weak and can only partially ensure communication and coordination of efforts between organizational units, no centralized control or validation of EA description can be achieved. Therefore, sideways steering forces have to be developed in to complement the lack of radial steering forces. Within an EA methodology, new protocols for negotiation, information sharing and cooperative decision making have to be elaborated.

EA Description has to focus on company-wide, short-term master plan for IT development that fits the global vision of the organization. EA principles should support variability in processes and resources instead of a single standard that “fits

all". For example: the central unit decides on generic process and resources, but the units implement their own variants.

EA Engine should rely upon both center and local leadership and define two types of steering forces complementing each other. EA methodology has to specify tools and activities based, for example, on the peer-production principles, and supporting both centralized and user-driven (collaborative) change management.

Decentralized Organization:

EA Method should set up a structure aligned with the structure in Fig. 3-c, where no center is explicitly defined and only cooperation-driven sideways steering forces are enabled. While possibly maintaining their own, local EA, the partners in a decentralized organization has to be able to "connect" their architectures and to achieve interoperability. EA methodology should provide metrics for assessing the interoperability and alignment between local EA and global EA.

EA description has to focus on local short-term master plans for IT development that are aligned with the objectives of an organization (a partnership). Organizational EA principles should support variability in processes and resources allowing the partners to implement their own variants of a given process with respect to their local architectures and local EA principles.

EA Engine should rely upon strong sideways forces, where EA methodology has to specify tools and activities supporting user-driven change management.

3.3 Mismatch Between the IT Organizational Structure and the EA on Place

Based on the theory above, many practical problems related to the EA implementation can be explained by a mismatch between the IT organizational structure and the EA in place. In particular, we identify two types of problems:

- *Problem A:* IT initiatives fail and decisions in IT become inefficient when federated/decentralized organization uses the EA that (still) relies on centralized coordination and control;
- *Problem B:* Poor or no strategic alignment can be guaranteed when centralized/federated organization relies uniquely on local leadership and implements solutions that require purely decentralized management.

We reformulate these problems in terms of misbalanced steering forces in the organization. This leads us to a solution that can be summarized as follows:

Problem A: A misbalance between the organization with *weak or non-existing* radial (top-down and bottom-up) steering forces and its EA that relies upon *strong* radial forces only; The solution is to revise EA Method and EA engine by involving sideways steering forces that would compensate the lack of radial forces. More concretely, the organization has to replace some (al for decentralized organizations) mechanisms of centralized control and coordination by their decentralized equivalents (e.g. cooperative decision making, peer-production etc)

Problem B: A misbalance between the organization with *weak or non-existing* sideways steering forces and its EA that relies upon *strong* sideways forces; The solution is to revise EA Method and EA engine by involving radial steering forces that would compensate the lack of sideways forces. More concretely, the organization has to reinforce the mechanisms of centralized control and coordination.

In the section below we illustrate our theory on the case of an organization for Higher Education reflecting a federated organizational structure.

4 Case Study

We have analyzed a prominent university for higher education in Sweden. As common, the university includes a number of units - faculties, and faculty departments. Nowadays, the units are becoming more independent than before due to several factors:

- Geographical dislocation. Some faculty departments have been moved out of the main university campus. An example is the Computer and Systems Sciences department located in Kista, the leading Swedish IT cluster. This proximity enables cooperation between IT companies and students through mentoring programs, internships, graduate work opportunities, guest lectures, etc.
- Decentralization of management. Coordination and decision-making are through delegation pushed down to the faculties and further to faculty departments. Concretely, the decisions are delegated by the principal to the faculty boards and deans, and to the faculty departments' heads and their administrations.
- Both formal and informal communication patterns. Formal hierarchical communication from the faculty to its departments and informal direct communication between the departments are present. For example, the administrative tasks (e.g. registration for graduate courses, or postgraduate research etc) is primarily formal, whereas the course curriculum can be established between departments cooperatively, using informal communication links.

According to the theory presented in Section 3, the organization above is a *federated organization* with explicit center and both radial and sideways steering forces defined. Below, we present some examples illustrating IT projects conducted by the university and the difficulties encountered. We will explain these difficulties using our theory and demonstrate that their origin is a mismatch between the organizational structure in place (federated) and the EA engine exploited for making decisions/developing solutions.

Example 1: Room reservation (over-centralization). The central (university) IT department has purchased a packaged IS to be used for room booking university wide. Some departments already had their local solutions for room booking, which were better adapted for their needs. As a result of this initiative, the departments ended up paying for the new system (due to centralized budgeting) but kept their own system and refused integration (due to decentralized decision making).

This example illustrates the Problem A from the previous section - A mismatch leading to inefficient and finally abandoned solution. The decision about purchasing the university-wide system relied uniquely on radial forces (centralized), whereas sideways forces (negotiation with departments, collaborative requirements gathering, etc) have not been exploited at all.

Example 2: Publication cataloguing (over-decentralization). In the past, some faculty departments developed local IT solutions for cataloguing research

publications. Over time, this multitude of local solutions became problematic due to numerous mappings and data inconsistencies. Recently, the university brought the decision to allow the faculties and their departments to continue to store and assess publications' data in the way that suits best to them, while requiring a workable mapping to a central catalogue structure that follows the required standard regulated on the state level. The coordination and decision-making here exploited the sideways forces only. Since the publications meant to reflect a common face of the university - their central management using radial forces was desirable.

In organizations with the federated structure, the problems above can be avoided if the EA methodology properly integrates the decision-making patterns that rely on both radial and sideways steering forces. In the first example, the centralized EA principles have been implemented (whereas the real organizational structure is federated). The correct solution would be to exploit both radial forces and sideways forces (to involve the departments into cooperative requirements gathering, solution evaluation etc). In the second example, in contrast, the decentralized EA principles have been implemented. The correct solution could be, for example, to centrally define a common standard for publications (radial forces) and to let the faculties implement this standard in the way that fits their local architectures.

5 Conclusion and Future Work

This paper outlined the challenges related to increasing demand in process flexibility and the emergence of novel generation of organizations with transparent boundaries. To meet these challenges, the IT structure of organizations has to change: the centralized organizations characterized by strong top-down coordination and control, now tend to move towards more agile (decentralized) structures, where new communication, coordination and decision making patterns are used. We claim that the structure of organizational IT not only defines the IT Governance style of the organization, but it also has to be explicitly reflected by the Enterprise Architecture of the organization and supported by an EA methodology.

In this work we defined the concepts of center and steering forces and modeled organizations with different degree of centralization in their IT: centralized, federated and decentralized. Using these concepts, we identified the problems that result from mismatch between the organizational structure and the EA in place. As we explained in Introduction, the work follows the Design Science IS research framework [18], in the problem definition, the use of relevant knowledge base, development of main research artifacts - the two constructs (center and steering forces) which allowed us to identify the problems related to a misfit between IT organizational structure and EA in use, and to evaluate in on an real case in the Swedish Higher Education sector.

For the future work, we plan to elaborate on the proposed concepts and to identify metrics that would allow us to assess the centralization/decentralization more precisely (to measure the strength of steering forces, etc.). We also envisage to study the concrete mechanisms and patterns for communication, coordination and decision making in centralized, decentralized and federated organizations, and to see how they can be transformed into concrete EA principles or explicitly integrated into EA

methodologies. For example, process variability as a mechanism to handle local differences while complying with global standards in federated organizations.

References

1. Missikoff, M.: The Future of Enterprise Systems in a Fully Networked Society. Proc. of CAiSE 2012, Lecture Notes in Computer Science, 2012, Volume 7328/2012, 1-18, DOI: 10.1007/978-3-642-31095-9_1, (2012)
2. Speckert T., Rychkova I., and Zdravkovic J.: On the Changing Role of Enterprise Architecture in Decentralized Environments: State of the Art. To appear in proceedings of 8th International Workshop on Trends in Enterprise Architecture Research (TEAR). 9-13 September, Vancouver, BC, Canada (2013)
3. Mintzberg, H. The structuring of organizations: A synthesis of the research. University of Illinois at Urbana-Champaign's Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship (1979)
4. Weill, P. Don't just lead, govern: How top-performing firms govern it. MIS Quarterly Executive, vol. 3, no. 1, pp. 1–17 (2004)
5. Thompson, J. D. Organizations in action: Social science bases of administrative theory. Transaction Pub (1967)
6. Robbins, S. P. Organizational behavior: Concepts, controversies and applications: Australia and New Zealand. Royal Victorian Institute for the Blind. Special Request Service (1997)
7. Bolman, L. G. and Deal, T. E. Reframing Organizations, 4th ed. San Francisco, California: John Wiley & Sons (2008)
8. Bengtsson, M. and Kock, S. Coopetition in business networks–to cooperate and compete simultaneously. Industrial marketing management, vol. 29, no. 5 (2000)
9. Weill, Peter, and David Robertson. Enterprise Architecture as Strategy. Harvard Business Press (2006)
10. Schekkerman, J. How to survive in the jungle of enterprise architecture frameworks: Creating or choosing an enterprise architecture framework, 2nd ed. Trafford Publishing (2004)
11. Saroiu, S., Gummadi, P. K. and Gribble, S. D. Measurement study of peer-to-peer file sharing systems, In Electronic Imaging, International Society for Optics and Photonics, pp. 156–170 (2002)
12. Benkler, Y. The wealth of networks: How social production transforms markets and freedom. Yale University Press (2006)
13. Aberer, K. and Despotovic, Z. Managing trust in a peer-2-peer information system. In Proceedings of the tenth international conference on Information and knowledge management. ACM, pp. 310–317 (2001)
14. Rockart, J., Earl, M., and Ross, J. Eight imperatives for the new IT organization," Sloan management review, pp. 43–56 (1996)
15. Fulk, J. and DeSanctis, G. Electronic communication and changing organizational forms. Organization science, vol. 6, no. 4, pp. 337–349 (1995)
16. Osterloh, M. and Frey, B. S. Motivation, knowledge transfer, and organizational forms. Organization science, vol. 11, no. 5, pp. 538–550 (2000)
17. Weill, P. and Ross, J. W. IT Governance: How Top Performers Manage IT Decision Rights for Superior Results. Harvard Business School Press, Boston (2004)
18. Hevner, A. R., March, S. T., Park, J., & Ram, S. Design Science in Information Systems Research. *MIS Quarterly , 28* (1), pp. 75-105 (2004)