Baltic J. Modern Computing, Vol. 4 (2016), No. 1, 59-67

Evaluation of Changes in Information Systems According to Enterprise Architecture Evolution Goals and Principles

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Abstract. Information systems (IS) are frequently modified according to changes in enterprise business and operating models and other internal and external factors that influence the enterprise. The changes are systematically managed following the engineering change management (ECM) process. The main issue in the ECM process is that the IS changes and their impact frequently are not evaluated with respect to the overall enterprise architecture (EA) and its evolution strategy. This paper proposes an approach for evaluation the changes with respect to EA. The proposed approach links aspects of operational change management and strategic EA management. The evaluation process is triggered by IS change requests, which are mapped to the current EA, multiple change request implementation scenarios are identified by analyzing relationships in the EA, and alignment of each scenario with EA evolution strategy is accessed using appropriate measures. An initial illustration of the approach is provided.

Keywords: Enterprise Architecture, Change Management, Evolution strategy

1. Introduction

Information systems (IS) are subject to frequent modification due to the continuous change of requirements. The software change management process often driven by change requests (Stojanov et al., 2009) is one of the ways for identification of the necessary modifications and keeping applications up-to-date. The change requests are usually submitted having in-mind a single application and focus on specific atomic aspects of this application. The engineering change management best practices and guidelines suggest using a more comprehensive approach to change management because of mutual interactions among changes and optimal allocation of resources to implementation of these changes (Cartlidge et al., 2009). Enterprise architecture (EA) provides a basis for more comprehensive evaluation of the changes of the software applications (Hanschke, 2009; Lautenbacher et al., 2013).

Several researchers have investigated the problem of EA evolution in the context of the change management (Diefenthaler and Bauer, 2013; Dam and Ghose, 2009; de Boer et al., 2005; Gringel and Postina, 2009; Postina et al., 2009). They mainly cover the gap analysis. The gap analysis deals with comparison among different states of EA. TOGAF uses the terms of baseline and target architecture for these two states (The Open Group,

2009). These research works deal with strategic level analysis and define what change is necessary to bridge the gap if the target architecture is known. However, they provide limited guidance on dealing with outstanding change requests, establishing the target state and the operational perspective of users might not be taken into account.

The objective of this paper is to provide a controlled environment for IS change implementation planning to meet envisioned EA development goals. This paper describes the overall approach to using EA for evaluation of individual change requests, defines, outlines the evaluation method and establishes foundations for the further elaboration of the evaluation method. The evaluation involves identification of change requests' implementation scenarios and identification of the most appropriate scenario. A set of the selected scenarios addressing different change requests defines actions to be performed for achieving the target architectural state if it is specified in advance.

The proposed method is envisioned as a middle-ground between isolated evaluation of the change requests and comprehensive strategic level planning of EA evolution. It provides a tactical level tool helping organization to understand implications of their change requests and facilitating stakeholder involvement because of addressing their operational concerns. At the same time, it supports planning of evolution of the EA. The paper relates to the work by Aier et al. (2011) suggesting that EA changes are due to both planned activities and evolutionary incremental improvements. The proposed method corresponds to their bottom driven approach. While their research focuses on synchronization of local and global partial plans, this paper deals with identification of change scenarios in compliance with EA goals and principles. The bottom-up approach is also explored by Farwick et al. (2012). They show that IS change events provide a valuable information for maintaining EA. It is also shown that not all IS change events results into architectural changes. Both papers relay on similar sources of information though they have different purpose, i.e., EA maintenance vs. modification of IS. Dam et al. (2015) emphasize that initial changes in enterprise architecture lead to further changes. They show that enterprise architecture model helps to identify these induced changes and repair plans can be generated for updating the enterprise architecture model

The rest of the paper is organized as follows. Section 2 states the problem. In the Section 3 the approach's outline is given. Section 3 describes an illustrative example. The paper closes in Section 5 with the conclusions and future research plans, tasks and objectives.

2. Problem Statement

An enterprise has defined its current EA. The EA is developed using one of architectural frameworks like TOGAF (The Open Group, 2009) and includes at least business architecture (BA), application architecture (AA) and data or information architecture (IA) layers that are usually considered in literature (Pulkkinen, 2006). BA depicts the business dimension (business processes, service structures, organization of activities). IA captures the information dimension of EA; high level structures of business information and, at a more detailed level, the data architecture. AA contains the applications dimension, including enterprise applications that are used to support business processes and that process enterprise data.

The EA layers include a limited set of EA core components. This EA is referred as to current enterprise architecture (CEA). The enterprise has elaborated its EA evolution strategy what is described in EA business architecture motivation dimension. The

strategy is formulated as a set of EA evolution goals and their indicators quantifying the desired qualities of the EA. The goals provide general strategic characteristics of "to-be" or target EA. They include business-oriented goals (e.g., reduce the administrative costs, increase business services) and IT-oriented goals (e.g., reduce the total amount of applications). The goals relate to all elements of EA in all layers (BA, AA and IA). Each goal can be measured by specific indicators. The IT-oriented goals are measured by EA architecture quality measurements similar to those defined in (Vasconcelos et al., 2007) as well as by ones defined in EA evaluation strategy The business-oriented goals are measured by the indicators that are set in the enterprise business strategy.

The enterprise has also defined its EA principles - general rules and guidelines for the construction of an architecture through to the physical implementation. The principles are established at least in the IT architecture level and according to (The Open Group, 2009) can be divided in the following groups:

- Principles that govern the architecture process, affecting the development, maintenance, and use of the enterprise architecture;
- Principles that govern the implementation of the architecture, establishing the first tenets and related guidance for designing and developing information systems.

The principles are used to justify the decisions an enterprise makes about the components in the architecture (Stelzer, 2009). They can be measured by their indicators and they can be associated to any EA element. The principles cover topics such buy vs. build, application development methodologies, end-user development, and application interfaces to external systems.

A reduced set of elements used to define EA and its development strategy are shown in Fig. 1.

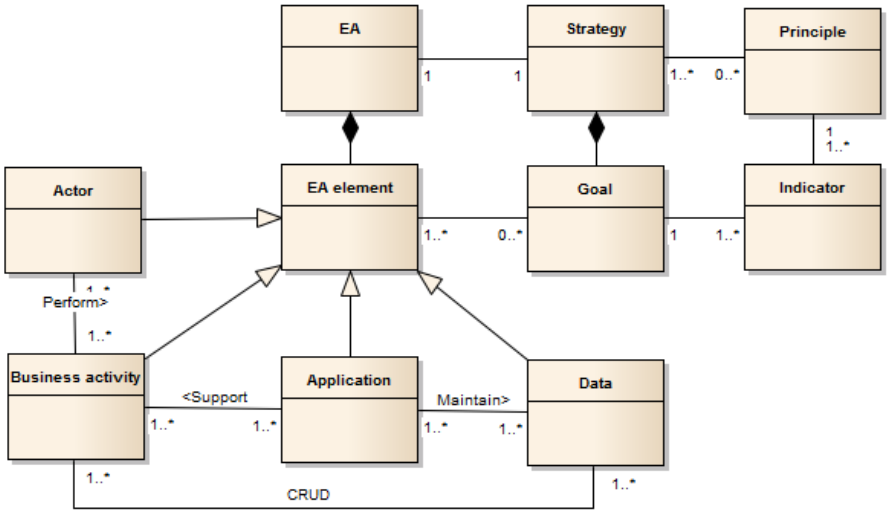


Fig. 1. Key elements of EA and strategy

The enterprise operates a centralized IT management service, where users submit their change requests if software applications do not provide necessary functionality or other difficulties are experienced. The change requests are usually submitted having in-mind a single application and focus on specific atomic aspects of this application.

Traditionally, the change requests are evaluated by an application change management board according to the IT governance best practice recommendations. They are evaluated according to their importance, utility, cost-efficiency and other similar factors. Their compliance with EA evaluation strategy is not assessed what can lead to sub-optimal architectural decisions.

In this case, an additional evaluation is performed with respect to EA and its evolution strategy. The additional evaluation objective is find the most appropriate change request development scenario with regards to the envisioned EA, its development goals, architecture principles and to implement suggestions for elaborating the target state of the EA.

3. Evaluation of Change Requests

The evaluation of change requests is performed in three phases including the change request pre-evaluation, change request analysis and generation of suggestions (Fig. 2.)

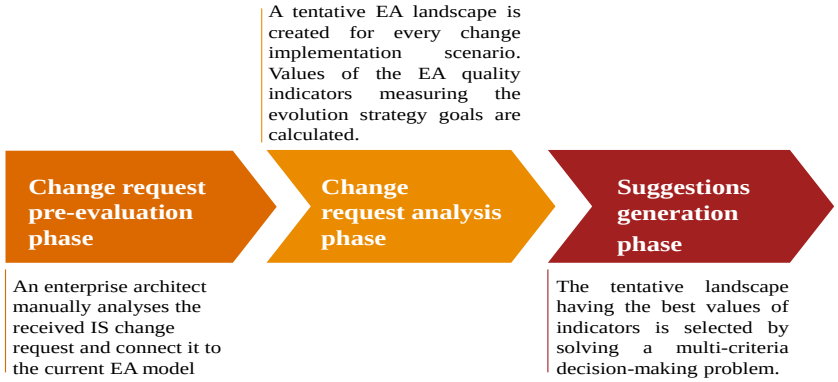


Fig. 2. Phases of the change evaluation process

Table 1. The change request attributes.

Nr.	Attribute	Properties	Example
1.	Application	Application name, product name	HR self-service system “MyData”
2.	User	Name, surname, job title, department	Ruta Pirta, IT Consultant, Advisory
3.	Approver	Name, surname, job title, department	John Brown, Senior Manager, Advisory
4.	Related Changes	Free text	Changes in the vacation requesting process, - the vacation requesting/approving workflow automation
5.	Related Applications	Application name, product name	N/A
6.	Description	Free text	The possibility from my employee profile to request the vacation electronically in the HR system “MyData”, send it to the approver (who can approve it) and see the request status (approved, not approved, pending).

The change request pre-evaluation phase is done manually by an enterprise architect or other authorised person in the enterprise. The evaluation process is initiated by receiving a change request containing pre-defined data items (Table 1).

From the functional perspective, the change request defines a desired business activity (denoted by B_R) of the application used by a user. This could be a new business activity or an existing activity inaccessible to the user. An enterprise architect determines the status of the business activity (a new activity or the existing one) and locates it in the current EA model (in BA layer). He also relates the activity to logical data components and data entities processed by this activity while relationships with applications are not defined.

In the change request analysis phase, the change request is analysed to identify B_R implementation scenarios. The analysis is done by automated successor relationship analysis in EA model. There are several types of possible modification in AA, including: 1) adding a new functionality; 2) integrating applications; 3) centralizing functionality; and 4) transferring functionality. As EA layers are interrelated the changes in AA also cause changes in other EA views (there are new relationships between the different EA elements etc.).

The applications to be modified are inferred by analysing the change request and EA. The inference rules are aimed at narrowing a set of potential modification scenarios. The proposed rules to be checked empirically are to select: 1) application mentioned in the change request; 2) applications maintaining data items processed by B_R; 3) applications supporting business activities linked to data items processed by B_R; and 4) applications maintain data linked to the actor requesting B_R. It is also possible to use textual analysis of the change request to identify other relevant functions, data items and applications.

The result of the analysis phase is several possible change request implementation scenarios. The scenarios define a planned EA landscape after change implementation, including changes in AA, BA and IA layers, for example, applications to be modified, a supported business activity and related application service. A tentative EA landscape is created for every scenario. It represents a state of the EA after eventual implementation of the scenario.

During the recommendation phase, the most appropriate implementation scenario is selected. Values of the EA quality indicators measuring the evolution strategy goals are calculated for every landscape. As well as every scenario is evaluated according to its compliance with defined architecture principles. The tentative landscape having the best values of indicators is selected by solving a multi-criteria decision-making problem. It is recommended as the most appropriate way of implementing the change request.

The result of recommendations phase is a ranked list of implementation scenarios. Applicable goals and principles are listed for every scenario as well as compliance evaluation results.

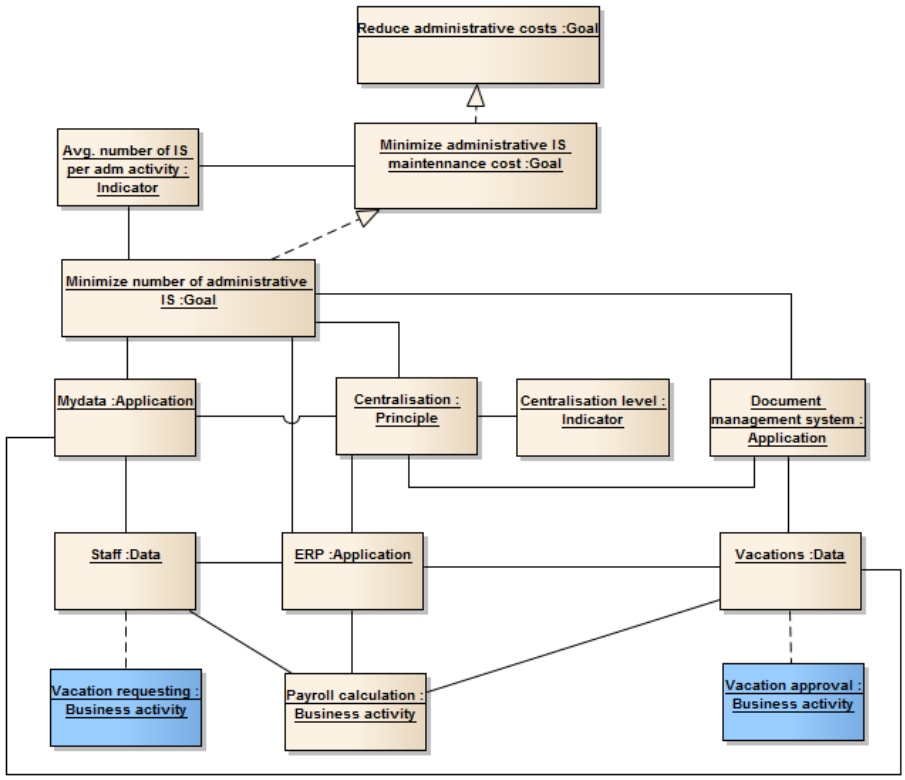
4. Illustrative Example

An example is based on the real-life case at a telecommunication company. The company has complex IT systems (a fragment of AA is shown on the Fig. 3). Administrative processes are supported by an ERP system as well by several weakly integrated legacy systems. Modules of the ERP system include Human resources (only Payroll), Projects, Finance, Budgeting, Assets, Debtors and Creditors. The legacy systems fragmentally support documents management, agreements control, employees'

evaluation and several HR management activities (Absence management, Self service). The company has defined its IT strategy what is aligned with the business strategy for the next 3 years.

The enterprise has done the business processes benchmarking as a part of the business strategy development and the results shows that they are quite effective in core business processes organization, but their administrative costs are 30% higher than the average in a benchmark group. So they focus their business strategy on improving effectiveness of administrative processes as well as on development of new products and services, mainly in the digital environment. Goals related to the administrative processes are:

- to reduce administrative costs by 20% and to increase controllable margin by 7% in the next three years (the business strategy goal);
- to minimise administrative IS maintenance costs by 10%, to minimise the number of administrative IS by termination of 2 systems, and to centralize administrative processes supporting functionality in the ERP system (aligned IT strategy goal).



* new business activities are highlighted

Fig. 3. A fragment of company's EA

On the basis of the aforementioned goals and industry best practices (Telemanagement Forum, 2015) the following key metrics derived from Vasconcelos et al. (2007) are defined:

- M1 – average number of applications per one administrative activity (measured on scale 0 to n with target value 1);
- M2 – average administrative business activates supported by ERP system (measured on scale 0 to n, target with target 30);
- M3 – centralisation level as ratio between centralised functionality and all applications functionality.

To support target EA implementation, the company has defined the following main architecture principles:

- Centralisation. The similar functionality is centralized in strategic information systems.
- Standardisation. The client processes are made to fit standardized technology solutions.

The company has measured their current and target centralisation and standardization level (current standardization level – 0.7, target – 3; current centralisation level – 1.5, target – 2.7). The measurement is done by evaluating properties of related EA elements (standardized processes vs all processes etc.).

The company receives the change request defined in Table 1. The enterprise architect pre-evaluates the change request and concludes that the change includes new business activities in the vacation requests management process – vacation requesting and vacation approving. These activities replace the previously existing manual vacations management activities. The enterprise architect adds new activities and establishes manual links in the current EA between new activities and related IA logical data components – staff data and vacation data.

The inference rules suggest that the change request relates to the following applications: (1) ERP system (from several links, including the link: vacation requesting and vacation approving-> staff data, vacation data -> ERP system); (2) MyData system (from several links, including the link: vacation requesting and vacation approving-> staff data, vacation data -> Mydata system); (3) Document management system (from several links, including the link: vacation requesting and vacation approving-> vacation data -> document management -> document management system).

On the basis of the analysis results, the following new vacation requesting/approving functionality implementation scenarios are generated: (1) Implement the requested functionality in the ERP system; (2) Implement the requested functionality in the MyData system; or (3) Implement the requested functionality in the Document management system. The measures characterizing scenarios' compliance with the goals and architecture principles are calculated (Table 2).

Table 2. The scenarios evaluation results.

IT strategy goal or architecture principle	Measure	Current score	Scenario 1	Scenario 2	Scenario 3
IT strategy goal: to centralize administrative processes supporting functionality in the ERP system	M1	3	2	3	3
	M2	12	15	12	12
Architecture principle: centralisation	M3	1.5	1.7	1.5	1.5

The evaluation results suggest that implementation of Scenario 1 would lead to the best fulfilment of the enterprise strategic goals and architecture principles. The recommended scenario has the best overall rating, what is based on ratings in several measurement positions, for example, average administrative business activates supported by ERP system (existing score before change – 12, after change – 15).

5. Conclusion and Future Work

This paper outlines using EA for evaluation and control of implementation of the change requests. The proposed approach locates change request in relation to EA, identifies implementation scenarios and evaluates these scenarios according to the goals and principles of EA evolution strategy. Its objective is to ensure that the IS changes are implemented according to the envisioned EA and its development goals. The main benefit of the approach is to provide a support for keeping the IS changes aligned with the envisioned EA, thus moving to EA strategic goals what is defined by the enterprise business and IT strategy. The rules for analyzing EA and types of modifications are used to define the implementation scenarios. Their formalization and empirical evaluation is necessary for further elaboration of the approach.

There are several limitations and risks what need to be mitigate in the future research: (1) change requests need to be filled completely and correctly (a tool, which is intertied with EA model, is planned to support proper creation of change requests) (2) EA and change requests have different levels of abstraction what needs to be addressed in the pre-evaluation phase; (3) change requests might be contradicting and change requests driven processing might lead to a myopic target architecture (therefore the approach should considered jointly with other EA management techniques).

The future research includes the change management methodology development what will be based on EA models and will integrate several enterprise resource management areas. The outline of the methodology is presented in (Pirta, Grabis, 2015). The methodology will provides an overall framework for elaboration of IS change management methods.

The methodology will consists of guidelines for IS change control by integrating the following significant resource management areas – IT governance, change management and EA change management. In addition, the methodology will includes lists of controls applicable at different change evaluation phases. The approach will be based on re-use and fusion of principles used by related methodologies as well as on empirical observations about typical IS change management mistakes in enterprises.

The planned research will combine both theoretical foundations as well as a practical tool that will be used IS change management support. The theoretical foundation will be designed for the IS change managers, enterprise architects and other for the IS change management responsible roles for IS change management processes optimization and integration with EA governance. In contrast, the tool will be focused on the end user (change requestor) needs. The tool will increase IS change management support systems usability by providing users EA model information for change request filling support. Planned tool implementation benefits are reduced change requests filling and processing time.

References

Aier, S., Buckl, S., Gleichauf, B., Matthes, F., Schweda, C.M. and Winter, R. (2011), Towards a more integrated EA planning: Linking transformation planning with evolutionary change, *In Proceedings of the 4th International Workshop on Enterprise Modelling and Information Systems Architectures, EMISA 2011*, 23-36.

Cartlidge, A., Lillycrop, M., Hanna, A., Rudd, C., Macfarlane, I., Windebank,, J., Rance, S. (2009), An Introductory Overview of ITIL V3, ser. The IT Infrastructure Library. ITSMF.

Dam, H.K.; Lê, L.; Ghose, A. (2015), Managing changes in the enterprise architecture modelling context, Enterprise Information Systems, In Press.

Dam, KH., Le, L., Ghose, A. (2010), Supporting Change Propagation in the Evolution of Enterprise Architectures. In: Enterprise Distributed Object Computing Conference (EDOC), 14th IEEE International , vol., no., pp.24,33, 25-29.

de Boer, F.S.; Bonsangue, M.M.; Groenewegen, L.P.J.; Stam, A.W.; Stevens, S.; van der Torre, L.(2005), Change impact analysis of enterprise architectures. In: Information Reuse and Integration, Conf, IRI -2005 IEEE International Conference on., vol., no., pp.177,181, 15-17.

Diefenthaler, P., Bauer, B.(2013), Gap Analysis in Enterprise Architecture Using Semantic Web. In: Technologies 15th International Conference on Enterprise Information Systems (ICEIS), Angers, France.

Farwick, M., Schweda, C.M., Breu, R., Voges, K. and Hanschke, I. (2012), On enterprise architecture change events, 7th Workshop on Trends in Enterprise Architecture Research, TEAR 2012, LNBIP 131, 129-145.

Gringel, P., Postina, M.(2010), I-pattern for gap analysis. In Engels, G., Luckey, M., Pretschner, A., and Reussner, R., (eds), Software engineering, Lecture Notes in Informatics. Bonn, p281–292.

Hanschke, I. (2009), Strategic IT Management. A Toolkit for Enterprise Architecture Management.. Original German edition published by Hanser Fachbuch, 342p. 130.

Lautenbacher, F., Diefenthaler, P., Langermeier, M., Mykhashchuk, M, Bauer, B.(2013), Planning Support for Enterprise Changes.

Pirta, R; Grabis, J. (2015), Integrated Methodology for Information System Change Control Based on Enterprise Architecture Models, Information Technology and Management Science, Volume 18, Issue 1.

Postina, M., Sechyn, I., Steffens, U. (2009), Gap analysis of application landscapes. Proceedings of 13th Enterprise Distributed Object Computing Conference Workshops, p274–281.

Pulkkinen, M. (2006), Systemic Management of Architectural Decisions in Enterprise Architecture Planning. Four Dimensions and Three Abstraction Levels', Proceedings of the 39th Hawaii International Conference on System Sciences.

Stelzer, D.(2009), Enterprise Architecture Principles: Literature Review and Research Directions, *Service-Oriented Computing, ICSOC/ServiceWave 2009 Workshops*, LNCS 6275, 12-21.

Stojanov, Z.; Dobrilovic, D.; Perisic, B. (2009), Modeling a submission phase of change request process in context of a running application, Intelligent Systems and Informatics. SISY '09. 7th International Symposium on , vol., no., pp.131,136, 25-26.

Telemanagement Forum, 2015, http://www.tmforum.org/browse.aspx [Accessed: 25th July 2014].

The Open Group. (2009). TOGAF Version 9 Personal PDF Edition [Online] Available from: http://www.kingdee.com/news/subject/10togaf/pdf/TOGAF_Manual_G091.pdf. [Accessed: 25th July 2014].

Vasconcelos, A., Sousa, P., Tribolet, J. (2007), Information System Architecture Metrics: an Enterprise Engineering Evaluation Approach, The Electronic Journal Information Systems Evaluation Volume 10 Issue 1, pp 91 – 122.

Received March 14, 2016, accepted March 15, 2016