Towards Strategic Information Systems Change Management

Rūta Pirta
Institute of Information Technology, Riga Technical University, Kalku Street 1, Riga, Latvia

1 INTRODUCTION

Enterprise architecture (EA) represents an enterprise's operating and business model, including several interrelated layers (domain/view specific architectures, for example, application architecture, information architecture, technology architecture). The layers consist of elements that are constantly changing, because of business environment dynamics, business processes improvement, new technologies, changes in the regulations and other internal and external factors that influence an enterprise. As these layers are interrelated, changes in elements of one layer affect elements in other layers. The changes in enterprise business processes cause modification of enterprise Information Systems (IS), for example, new functionality, updated existing functionality and new interfaces. These modifications can be systematically managed following an engineering change management (ECM) process. The ECM process guidelines in accordance with the best practices are defined and described in several international methodologies and frameworks. However, empirical observations made by the author in different enterprises and state institutions and several research works (Hanschke, 2009), (Erlikh, 2000), (Goknil et al., 2014) share an opinion that IS changes are not always handled properly and their impact is not fully understood.

Nowadays, the one of the major problem is that failure to comprehend the wider impact of the changes frequently results in sub-optimal architectural decisions having particularly adverse effect on EA (Tang and G.lau, 2014). The wrong architectural decisions cause inefficiencies such as poor IS performance, wrong interfaces, bad data quality, doubled data input and sub-optimal IS support to business processes. The importance of adequate change governance is highlighted in several research works (Pulkkinen, 2006), (Diefenthaler and Bauer, 2013), (Hanschke, 2009), (Lautenbacher et al., 2013) and also by an empirical evidence. Pulkkinen (2006) emphasizes that finding the right strategies for ICT investments and the implementation of any technologies takes careful planning at the managerial level. Both private business and public organizations face the challenges of rapidly evolving technologies and business environments.

In this paper the initial idea of strategic IS change management using EA landscapes and EA risks and goal domains is proposed. The envisioned approach will suggest comparing different EA landscapes (existing landscape, planned landscape and ideal landscape) to evaluate changes, their impact on related processes and data flows and to generate architectural recommendations about implementation of the changes in EA to meet the ideal EA landscape. The main focus of this paper is the problem domain analysis, what includes an overview of the related research and exploration of motivational examples drawn from empirical observations made at several companies and state institutions. Based on the problem domain analysis, a preliminary solution design is performed by defining the relevant concepts and future research questions to be explored.

The rest of the paper is structured as follows. Section 2 provides brief background information and reviews the related work. Section 3 states the research problem and reports the motivational examples observed in practice where suboptimal architectural decisions are taken. Section 4 includes outline of the research objectives and section 5 includes the planned research design. Section 6 identifies the current research stage. Section 7 defines the expected outcome. The paper closes in Section 8 with the conclusions.

2 STATE OF THE ART

Engineering change (EC) and its management (ECM) have several definitions, according to (Jarratt et al., 2004), an engineering change is an alteration made to parts, drawings or software that have already been released during the product design process. The change can be of any size or type; the change can involve any number of people and take any length of time. Wright (1997) also defines EC

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similarly: “An EC is a modification to a component of a product, after that product has entered production”. ECM refers to the organization, control, and execution of engineering changes (Jarratt et al., 2011) and covers the product life cycle from the selection of a concept to the wind-down of production and support (Hamraz et al., 2013). IS are subject to EC as a part of the overall EA.

EA and its management are topics receiving ongoing interest from academia, practitioners, standardization bodies, and tool vendors (Buckl and Schweda, 2011). The Open Group (2009) defines EA to be „A coherent whole of principles, methods, and models, that are used in the design and realization of an enterprise’s organizational structure, business processes, IS, and infrastructure”. According to (Pulkkinen, 2006), EA is a well suited tool for interconnected planning of business strategies, models and structures, and IT architectures. EA can be used for analysis in different ways and thus can support the decision making process that has to cope with an increasing number of changes, the clarification of the extent of changes and the complexity of these changes (Lautenbacher et al., 2013). Previous investigations (Pulkkinen, 2006), (Armour et al., 2006), (Armour et al., 1999), (Armour and Kaisler, 2001), (META Group Inc., 2002), (Spewak, 1993), (Wegmann, 2003) show that a better governance of IT architectures and the whole organizational ICT both in large private companies and in public organizations can be ensured with the EA approach. EA includes several dimensions/views/layers (further in this paper referred as layers). The four layers that are usually considered in literature are (Pulkkinen, 2006):

1. Business Architecture (BA). BA depicts the business dimension (Business processes, service structures, organization of activities).
2. Information Architecture (IA). IA captures the information dimension of EA; high level structures of business information and, at a more detailed level, the data architecture.
3. Systems or Applications Architecture (SA/AA). SA/AA contains the systems dimension, the information systems of the enterprise. Some conventions call it the Applications Architecture or Portfolio, the latter stressing the nature of the information systems as a business asset.
4. Technology Architecture (TA). TA or the technology dimension covers the technologies and technological structures used to build the information and communication systems in the enterprise.

Other frameworks such as the Zachman framework and TOGAF include additional dimensions/views/ layers, for example, people, time, motivation.

In the recent years, the interdisciplinary topic of EC and ECM has gained increasing popularity within systems engineering benefiting also from the rise of attention towards concepts such as concurrent engineering, simultaneous design, product platform development, mass customization, and configuration management (Hamraz et al., 2013). According to (Hamraz et al., 2013) the goals of ECM are to avoid or reduce the number of engineering change requests (ECRs) before they occur, to select their implementation effectively when they occur, to implement required ECs efficiently, and to learn from implemented ECs.

Hamraz et al., (2013) identify 348 journal articles and conference papers and 43 books, book sections and reports about ECM. The ECM research covers several research lines, including strategies and methods to cope with EC. According to (Hamraz et al., 2013) ECM researches can be categorized in different areas (strategic guidelines, ECM systems, impact analysis, ECM process etc.).

EA has been used as one of the methods for systematic ECM works to analyse the IS and/or AA changes and related architectural decisions (Lautenbacher et al., 2013), (Hanschke, 2009). These investigations mainly focus on gap analysis between planned changes, e.g. planned EA landscape and ideal implementation of IS changes in EA, e.g. ideal EA landscape.

The gap analysis between different EA states with the aim to support architectural decisions related to IS change management and implementation in EA is investigated by (Lautenbacher et al., 2013), (Gringel and Postina, 2010), (Postina et al., 2009), (Diefenthaler and Bauer, 2013). The term “gap analysis” is used in context of enterprise architecture as a name for the comparison between two architectures or strictly speaking two states of the same architecture. The Open Group (2009) Architecture Framework (TOGAF) uses the terms of baseline- and target architecture for these two states.

The approach described in (Lautenbacher et al., 2013) uses the graph theory for analysing differences between existing EA and target EA. Research focuses on how to achieve the target rather than on what the target should look like. It include the planning process with focus on the application architecture only, i.e. the IT applications and IT services used to exchange data.

Diefenthaler and Bauer (2013) propose a method that shows how the gap analysis can be performed on two high-level EA models representing the current and target state of an EA using semantic web technologies. The proposed gap analysis results with identified gaps and successor relationships what can help to lead migration from the current EA state to the target EA state. Ontologies are used to represent and to reason about the architectures. The EA states are compared in the ontology redactor Protégé.

Postina et al., (2009) and Gringel and Postina (2010) present a tool supported approach for performing a gap analysis on a current and ideal landscape. Tool can compare two landscapes, - current landscape and ideal landscape and provide a list of the actions that needs to be done to reach the ideal landscape. Gringel and Postina (2010) focuses on the problem of performing a gap analysis between two states of the application landscape, where the current state has a pre-SOA status and the envisioned state should be designed according to the principles of Quasar Enterprise. In the paper is compared the current (non-SOA landscape) with the ideal (Ideal – SOA) landscape. The main idea of paper is to find the answer of the question “How do I need to restructure the current application landscape to converge towards an ideal application landscape designed according to the principles of Quasar Enterprise?” In the paper the quantitative and qualitative metrics are created to measure the distance between the current EA landscape to ideal EA landscape. The research mainly focuses on how to restructure the current landscape to meet the ideal, not how to evaluate IS changes to take the right architectural decisions with the aim to meet the ideal landscape. Also, before the analysis, both, the current EA landscape and the ideal EA landscape, needs to be created manually by the analyst and imported into the tool.

To summarize, the proposed approaches for gap analysis mainly cover the analysis of different EA states (i.e., how to achieve that change will be aligned with the ideal future EA). However, creation of the ideal EA landscape is an open challenge.

3 RESEARCH PROBLEM

As already mentioned IS are changing continuously according to the changes in enterprise business and operating models and other internal and external factors that influence the enterprise. One of the major problems in the ECM process is that changes are not planned, evaluated, controlled and implemented (i.e. governed) appropriately resulting in sub-optimal architectural decisions. Besides that, the change management usually requires large investments. The size and complexity of IS makes the change management costly and time consuming.

3.1 Motivational Examples

The importance of adequate change governance is also evident in several motivational examples observed in practice. This empirical evidence is gathered by working with several Latvian enterprises and state institutions. It shows that suboptimal architectural decisions are taken in the ECM process. Mainly these suboptimal decisions are made because of an inappropriate change management, for example, lack of modelling, inappropriate system analysis, lack of change impact analysis or insufficient economical assessment.

The typical problems arising from inappropriate ECM and leading to suboptimal EA are summarized in Figure 1. The causes are grouped according to their affiliation to the EA layers. They are observed in different IT consulting projects during the last three years.

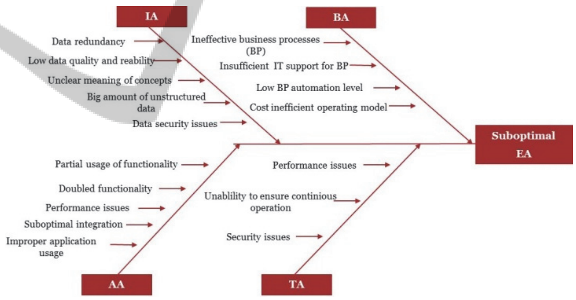

Figure 1: Typical EA problems.

In order to illustrate these typical problems and effect of wrong architectural decisions, empirical observations made in four enterprises are presented. The observations are made in the following cases/projects:

1) Cases PCD.01. and PCD.02. were observed during the IT strategy development project for a Latvian forestry company (referred as FORG). FORG is a relatively young company.. It manages commercially usable forests and, alongside with the forest management that includes timber selling, the company engages in other kinds of activities as well.
2) Case PCD.03. was observed during the ITC strategy development project for a Latvian utilities company (referred as UTL). UTL is a mature organization. It provides different utilities

services throughout Latvia.

3) Case PCD.04. was observed during the IS conception definition in a Latvian state institution (referred as FYD).
4) Case PCD.05., was observed during the future EA definition project in a Latvian state organization.

The brief description for each case is provided, inefficiencies in EA and the EA layers affected are identified and reasons of these inefficiencies are analysed. The cases are analysed from the change management perspective.

3.1.1 Geographic Information System Performance Problems (PDC.01.)

The Geographic information system (GIS) was used in the medium-size Latvian forestry company FORG. Although traditionally the main GIS objective is to visualize geospatial data, FORG took a decision to implement in the GIS a Felling management module what includes the following functionality: felling timber evaluation, felling timber data management, reporting, logging instructions maintenance, felling workflows management etc. The reporting functionality was implemented in GIS although at the same time FORG used a BI tool for centralised reporting. The GIS high-level conceptual architecture is presented in Figure 2. According to the expert evaluation, the gap between the existing EA and an ideal EA is highlighted. It shows that the Felling management module although satisfying the additional functionality requested by the users was implemented inefficiently from the architectural point of view.

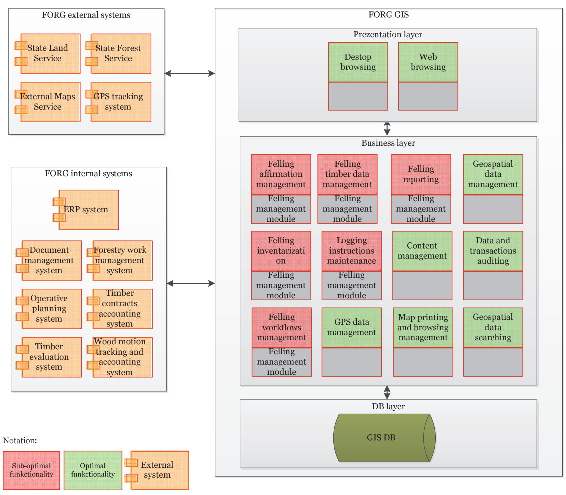

Figure 2: FORG GIS functionality gaps.

As the result of the described architectural decisions, the following problems were identified:

- FORG constantly had more than 100 outstanding change and problem requests regarding different corrections/additions in the GIS (estimated to reach 9 man years labor).
- The GIS performance problems were identified: system's response time in regional offices reached several minutes.
- The GIS functionality was partly doubled in others FORG IS and the overall FORG AA integration level was low, so the same data must be input in several IS, what resulted in poor data quality.
- Because of low data quality, the BI tool was also used just partially - only for operational purposes rather than for business analysis.
- Information security risks – the operational data was partly stored outside the system (temporary) due to the performance problems. The inappropriate data storage can lead to unauthorized access risks. As not all operational information was stored in the GIS database, the data backups were made only partly what can lead to the data loss.

The following EA layers were affected:

- BA – more than 15 FORG business processes did not have adequate IS support to perform them in a time-effective manner;
- AA – similar functionality was not concentrated in a strategic IS while some the centralized tools were not used in appropriate capacity.
- TA – GIS IT infrastructure was designed to provide traditional GIS functionality and, after the new functionality was added and the amount of transactions increased significantly, it was not able to ensure system's continuous operation.

3.1.2 Ineffective Human Resources (HR) Management Business Processes (PDC.02.)

FORG used an "of-the-shelf" enterprise resource planning (ERP) system, what originally provided also a HR management module. However, the module was not implemented and FORG used a separate HR system for HR management purposes. The HR system had a "self-service" functional block, where employees can see and update their own employment data and also plan vacations. Although, according to the best practice, it is recommended to centralize similar functionality in one IS, FORG took decision to implement the vacation management (requesting, approving etc.) functionality a Document management system (DMS) rather than in the HR system.

As the result of the described architectural decisions, the following problems were identified:

- FORG employees need to plan vacations in the HR system's "self-service" module, but requests and approvals are handled in DMS, what made the process less transparent and ineffective.
- Both systems were not integrated, so the users needed to set vacation statuses manually in the HR system, when the approval from their supervisor was received in DMS.

The following EA layers were affected:

- BA – the HR management business processes were not effective, FORG employees needed to perform several manual activities although FORG did have IS supporting the processes.
- AA – similar functionality were not concentrated in strategic IS. The IS development and maintenance costs also were higher (comparing with the case if the HR module had been implemented in the ERP system).
- IA – the FORG HR data structure and quality was suboptimal.

In both FORG's cases (PDC.01. and PDC.02.) the functionality, what was not aligned with the system's design and usage objective, were implemented. Besides that, AA development goals were not considered what resulted in suboptimal architectural decisions. Mainly, these decisions were made because of inappropriately evaluated change requests. At time of the project, FORG had more than 280 outstanding change requests. The company does not have such a position as Enterprise architect or Information systems architect. All change requests are divided in three groups (changes/IS that are related to manufacturing processes, changes/IS that are related to new products and changes/IS that are related to planning processes) and evaluated by a separate programme manager. The main problem is that each programme manager evaluates changes that are included in his programme but the common view on all FORG changes, their relations and impact to the current and future EA is missing. It is also observed that the economic assessment is not performed (for example, even for large IT investments business cases are not written), so there is a risk that IT investments are not cost-effective.

3.1.3 Cost-ineffective Solution Implementation for Workflow Management (PDC.03.)

To better manage industrial business processes and related workflows, the UTL decided to implement a workflow management system. Although UTL had already implemented a network information system what also included network related workflow management functionality and was widely used in several UTL's units, the company decided to implement a new system. Besides the network information system, UTL also had a local workflow management system in one of the units, what was used to manage unit specific workflows and related documentation. The new system was chosen by centralized IT function representatives. The solution was rated by Gartner as a one of the leading industrial workflow management systems for utilities companies, however, the system's standard functionality significantly exceeded UTL business needs.

As the result of the described architectural decisions, the following problems were identified:

- Users were not satisfied with the system, so the system usability was low. The end users were perplexed by myriad of features and un-needed data input fields;
- Improper system's usage because of unneeded functionality;
- The solution capital expenditure was high, as the solution was designed for complex asset and workflow management.

The following EA layers were affected:

- BA – industrial business processes management was cost-ineffective;
- AA – similar functionality were implemented in three different systems because the existing systems were not terminated. Besides that the unit specific workflow management system had performance problems, because it was not originally intended for industrial documentation management.

Although UTL had the centralized IT function and the ITIL compliant change management process was implemented, UTL did not develop the IT investments business cases and IT management did not asses if the IT investments value is optimal. Besides that UTL did not analyse possibilities and potential of the existing systems that provided the similar functionality. Thus, the overall AA analysis was not performed at an appropriate level. A unified

UTL IT strategy was also missing and the AA development goals were not set.

3.1.4 Ineffective Information Flow Management (PDC.04.)

FYD had several departments with different functions and locations. According to Latvian regulations, every department is responsible for providing citizens with different kind of information. The information concerns different data entities and is presented in various data formats. FYD had established a unified EA and its development vision including the IT strategy. The IT function was centralized and IT governance processes were implemented (following the ITIL guidelines). The unified AA included also a centralized customer portal and a content management system (CMS). Nevertheless every department had decided to implement at least one citizens facing web site with different design and navigation. These web sites were not linked with the portal and there are no integration among them. The unified CMS system was not used. Additionally, geospatial information was published in the web site in a static format (for example, the .jpg maps) although an interactive GIS system for serving end-users was implemented.

As the result of the described architectural decisions, the following problems were identified:

- Suboptimal information flow management due to the decentralized information maintenance and locally needed IT competence to publish information on the web sites;
- Partial usage of the GIS system's data publishing functionality;
- Data security risks due to the decentralized web sites management (lack of IT competence in departments).

The following EA layers were affected:

- BA – the FYD functions what required the information management processes were ineffective, because department-specific information mostly were kept locally and shared with other departments on request, what makes the process time-consuming. This was a major issue because the FYD functions are interrelated and data must be shared to perform them correctly. This influences citizens' wait time in the case of citizen facing functions.
- AA – the CMS functionality were not fully used and the locally published data were mainly kept in spreadsheet files.
- IA – the FYD data structure was suboptimal with redundant data input.

The FYD change management process had shortcoming looking from the organizational aspect. The FYD had strictly separated holders of information resources (IR) (business units) and holders of technical resources (TR) (IT unit). Each FYD department were responsible for their own data and its publishing, so the unified view of organization's IA was missing. The architectural decisions were taken without complex EA analysis, too.

3.1.5 Time Consuming Access to Electronic Services (PDC.05.)

Similar problems are also observed in nation-wide governmental IS when state's ICT infrastructure and services are viewed from the EA. An Eastern European country (referred as CTRY) is providing a wide range of e-services both at state and municipality level. Usage of e-services at the municipality level varies significantly. Major cities offer a wide range of different e-services and their usage increases constantly while the usage of e-services at small municipalities is low. Although the state provides a shared e-services platform, what constantly updates and where many state and also municipalities e-services are deployed, the municipalities also tend to other platforms. The major cities have established their own e-services platforms. Some of the smaller municipalities use the shared solution while others use a third private e-services environment. Besides that, some e-services are available also in municipalities' home pages.

As the result of the described architectural decisions, the following problems were identified:

- Because currently citizens are not able to access all state and municipalities e-services in one place, finding and accessing e-services is time consuming (especially in situations when citizen need to receive a number of differently located e-services). The related services do not have cross-platforms links, so the e-services must be searched in global search engines. To consume e-services in different platforms, separate authentication is required, too;
- Maintenance costs for several platforms usually exceed the costs of using a centralized platform, especially in this case because the shared platform maintenance costs are administered by the state.

The following EA layers were affected (here EA means the state's ICT architecture):

- AA – similar functionality were implemented in several unrelated platforms and local home pages;
- BA – the “one stop shop” concept is not used for providing state and municipalities services for the citizens.

The CTRY had not defined EA at the state level. Only some solution-specific development goals were set, but in most cases they were not aligned with state and municipalities EA development needs and goals. The organization what was responsible for maintenance and development of the shared solutions mainly performed tasks that were related to technical resources maintenance, but the IT governance processes were not fully performed. Besides that, the unified guidelines were not set on how and where the e-services must be deployed.

4 OUTLINE OF OBJECTIVES

The objective of the planned research is to ensure that the IS changes are implemented according to the envisioned EA and its development goals. The specific objectives are:

- to practical relevance of strategic IS change management with regards to EA;
- to conceptualize strategic IS change management in the EA framework;
- to develop a method for controlling change implementation with regards to the current and ideal IT landscapes;
- to elaborate a method for strategic change planning to attain the ideal IT landscape.
- to perform empirical validation of the elaborated methods.

5 RESEARCH METHODOLOGY

A research method to be taken to address aforementioned research and practical challenges follows the nested design science problem solving approach (Wieringa, 2009).

The research design in terms of regulative cycles is shown in the Figure 3.

The research will consists of three interrelated cycles – the engineering cycle EC1 and two research cycles RC1 and RC2. The engineering cycle consists of investigation and definition of practical problems including the analysis of empirical observations, after what the solution design and implementation will be done.

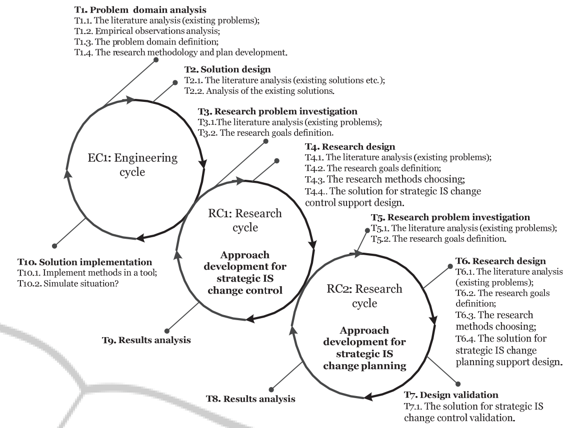

Figure 3: Research design in terms of regulative cycles.

After the engineering cycle, the two research cycles RC1 and RC2 will be completed. These cycles correspond to two key activities of strategic IT management (Hanschke, 2009), namely, strategic IT planning and strategic IT control. The planned research will cover both of these processes. The challenging part of IT management includes IT planning from the ideal IT landscape creation viewpoint. Therefore, initially in RC1 we will assume that the ideal IT landscape is defined in the enterprise’s IT strategy and a method for comparing the planned landscape (including IS change) with the ideal landscape will be elaborated. In RC2 we will propose a method for creating the ideal EA and aligning the IS changes with it.

6 STAGE OF THE RESEARCH

In this paper the initial stage of the research is presented – the problem domain analysis and outline of solution design. Following tasks were done to define the problem domain and planned solution design: (1) the literature analysis; (2) empirical evidence analysis; (3) the problem domain definition; and (4) the research methodology and plan development.

Main goals of this stage are to:

- identify and define the problem domain – the goal is set to gain theoretical and empirical evidence to planned research-related problems, to specify problems and evaluate their importance;
- identify and assess existing solutions and related researches – the goal is set to explore related

researches, proposed solutions and asses if they have limitations to solve identified problems completely;

- develop the future research methodology – the goal is set to perform adequate future research planning, set main stages, goals, activities and results.

Currently we are in the beginning of the research 2nd stage – development of the method for strategic IS change control. We have developed an outline of the planned solution, still many unresolved issues exists what needs to be solved to completed the outline.

7 EXPECTED OUTCOME

The main planned results will include two methods: (1) the method for strategic IS change control and (2) the method for strategic IS change planning and also guidelines for the IS change evaluation according to strategic EA development plans.

Achieving these results requires addressing several research challenges summarized in Figure 4. The figure defines the main concepts involved, their relationships and associated research questions. It is assumed that the change management process is driven by change requests concerning modification of some of the enterprise applications. The changes in applications are associated with changes in other layer of EA. EA has multiple states including the current EA, planned EA and ideal EA. Development of the ideal EA is guided by IT strategy, reference models and best practices though is not always attainable due to various constraints. The change requests need to be mapped to the current enterprise architecture to contextualize them, to evaluate their impact and to select an appropriate implementation approach. Transformation of the current EA into the planned EA is performed to accommodate the change according to the approach chosen. The gap between the planned EA and the ideal EA needs to be minimized.

The research questions name various research and technical challenges associated with strategic IS change management. Some of these challenges can be addressed by using and adopting existing methods. For example, the IT strategy definition, change impact analysis, IT and business alignment, IT investments evaluation, change management process implementation and controlling. The expected outcome is the newly developed methods on strategic IS change control and planning what will address the research questions:

1) How to control that change will be implemented according to defined ideal EA?
2) How to map the change request with current EA and transform it to planned EA?
3) How to compare the planned EA with the ideal EA?
4) How to generate the recommendations for change implementation?
5) How to define the ideal EA?
6) How to meet the ideal EA?
7) What are the best practices that can be used for suggestions?
8) How to differ and classify the best practices used for each EA type/class?
9) What are the reference models that can be used for suggestions?
10) How to differ and classify the reference models used for each EA type/class?

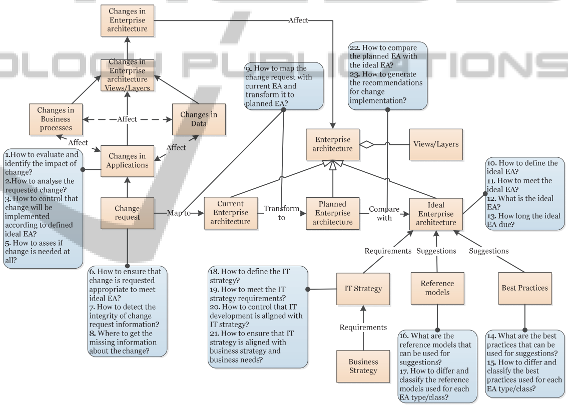

Figure 4: Research questions.

8 CONCLUSION

The paper sets stage for research on strategic change management for IS with respect to the overall EA. In this paper the initial steps of the research are presented: the problem domain analysis and the outline of the solution design. The complete solution design will be developed in the next research steps. In order to illustrate the effect of wrong architectural decisions, the typical practical problems arising in EA because of suboptimal architecture decisions in the ECM process are presented. The main conclusions arising from the initial research are:

1) The research problem domain is recognized in related research works as well as observed in practice.

2) The related research mainly focuses on the analysis of different EA states (i.e., how to achieve that change will be aligned with the ideal future EA). However, creation of the ideal EA landscape is an open challenge.
3) The suboptimal architectural decisions in the ECM process cause a number of problems in all EA layers.
4) The key typical problems arising from inappropriate ECM and leading to suboptimal EA are the following: data redundancy, low data quality and reability, ineffective business processes, cost inefficient operating model, partial usage of applications' functionality, performance and security issues.
5) To prevent the mentioned problems, the enterprises need to have complex vision on EA development, the EA development goals must be set and the introduced changes in any EA layer must to be aligned with this vision and goals. Enterprise architecting should be performed by comparing and analysing different EA layers, states, landscapes and their relations (including gap analysis between the current EA state and existing reference models).

REFERENCES

Pulkkinen, M. (2006). Systemic Management of Architectural Decisions in Enterprise Architecture Planning. Four Dimensions and Three Abstraction Levels. *Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS'06)*, p179-188.

Diefenthaler, P. & Bauer, B. (2013). Gap Analysis in Enterprise Architecture Using Semantic Web Technologies. *Proceedings of the 15th International Conference on Enterprise Information Systems (ICEIS)*, in print.

Hanschke, I (2009). Strategic IT Management. A Toolkit for Enterprise Architecture Management. München: *Hanser Fachburch*.

Lautenbacher, F. et al. (2013). Planning Support for Enterprise Changes. In: Grabis, J.et al. (eds.), The Practice of Enterprise Modeling, *6th IFIP WG 8.1 Working Conference, PoEM 2013*, Riga, Latvia, 2013, Lecture Notes in Business Information Processing. Riga: IFIP International Federation for Information Processing. p54-68.

Armour, F. J., Kaisler, S. H. and Liu, S. Y. (1999). A big-picture look at enterprise architectures. *IT professional. 1 (1)*, p35-42.

Armour, F. J., Kaisler, S. H. and Liu, S. Y. (1999). Building an Enterprise Architecture Step by Step. *IT professional.1(4)*, p31-39.

Armour, F. J., Kaisler, S. H. (2001). Enterprise Architecture: Agile Transition and Implementation. *IT professional. 3(6)*, p30-37.

Meta Group Inc. (2002) Enterprise Architecture Desk Reference. [Online] Available from: http://web.stanford.edu/~bvincent/Strategy/Enterprise_Architecture_Report. [Accessed: 27th June 2014].

Spewak, S. H. (1993). Enterprise Architecture Planning: Developing a Blueprint for Data, Applications, and Technology. *New York: John Wiley and Sons*.

Wegmann, A. (2003). On the Systemic Enterprise Architecture Methodology (SEAM). In: CAMP, O. et al. (eds.), *Proceedings of the International Conference on Enterprise Information Systems 2003 (ICEIS 2003)*. Angers.

Buckl, S. and Schweda, C. M. (2011). On the State-of the-Art in Enterprise Architecture Management Literature. Technical Report. [Online] Available from: https://wwwmatthes.in.tum.de/pages/qmobnr2wocn2/BS11-On-the-State-of-the-Art-in-Enterprise-Architecture-Management... [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].

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

Hamraz, B., Caldwell, N. H. M. and Clarkson, P. J. (2013) A Holistic Categorization Framework for Literature on Engineering Change Management. *Systems Engineering (16)*. p473-505.

Jarratt, T. A. W., Eckert, C. M. and Clarkson, P. J. (2004). Engineering change. In: Clarkson, P.J. and Eckert, C.M. (eds), *Design process improvement Springer*. New York: Springer, p262–285.

Wright, I. C. (1997). A review of research into engineering change management: Implications for product design, *Design Studies 18*, p33–39.

Jarratt, T. A. W. et al. (2011). Engineering change: An overview and perspective on the literature, Reseach in *Engineering Design 22(2),* p103–124.

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

Erlikh, E. (2000). Leveraging Legacy System Dollars for E-Business*. IT Professional, 2(3)*, p17-23.

Goknil, A. et al., (2014). Change Impact Analysis for Requirements: a Metamodeling Approach, *Information and Software Technology*, in press

Tang, A., Lau, M. G. (2014) Software architecture review by association. *Journal of Systems and Software 88*, February 2014, p87–101.

Wieringa, R. (2009). Design science as nested problem solving. *Proceedings of the 4th International Conference on Design Science Research in Information Systems and Technology*. Pennsylvania.