RIGA TECHNICAL UNIVERSITY

Rūta Pirta

INFORMATION SYSTEM CHANGE ASSESSMENT IN THE CONTEXT OF ENTERPRISE ARCHITECTURE

Summary of the Doctoral Thesis

RTU Press
Riga 2019

RIGA TECHNICAL UNIVERSITY
Faculty of Computer Science and Information Technology
Institute of Information Technology

Rūta Pirta
Doctoral Student of the Study Programme "Information Technology"

INFORMATION SYSTEM CHANGE ASSESSMENT IN THE CONTEXT OF ENTERPRISE ARCHITECTURE

Summary of the Doctoral Thesis

Scientific supervisor
Professor Dr. sc. ing.
JĀNIS GRABIS

RTU Press
Riga 2019

Pirta, R. Information System Change Assessment in the Context of Enterprise Architecture. Summary of the Doctoral Thesis. Riga: RTU Press, 2019. 44 p.

Published in accordance with the decision of the Promotion Council "RTU P-07" of 27 June 2019, Minutes No. 1.

ISBN 978-9934-22-352-5 (print)
978-9934-22-353-2 (pdf)

DOCTORAL THESIS PROPOSED TO RIGA TECHNICAL UNIVERSITY FOR THE PROMOTION TO THE SCIENTIFIC DEGREE OF DOCTOR OF ENGINEERING SCIENCES

To be granted the scientific degree of Doctor of Engineering Sciences, the present Doctoral Thesis has been submitted for the defence at the open meeting of RTU Promotion Council "RTU P-07" on 21 October 2019 at the Faculty of Computer Science and Information Technology of Riga Technical University, 1 Sētas Street, auditory 202.

OFFICIAL REVIEWERS

Professor Dr. sc. ing. Mārīte Kirikova
Riga Technical University

Professor Dr. sc. comp. Māris Vītiņš
University of Latvia

Ph.D. Nestori Syynimaa
University of Jyväskylä, Finland

DECLARATION OF ACADEMIC INTEGRITY

I hereby declare that the Doctoral Thesis submitted for the review to Riga Technical University for the promotion to the scientific degree of Doctor of Engineering Sciences is my own. I confirm that this Doctoral Thesis has not been submitted to any other university for the promotion to other scientific degree.

Rūta Pirta ……. (signature)
Date: ……

The Doctoral Thesis has been written in Latvian. It consists of Introduction; 7 chapters; conclusions; 34 figures; and 4 appendices. The total number of pages is 171 pages, including appendices. The bibliography contains 154 titles.

TABLE OF CONTENTS

1. GENERAL DESCRIPTION OF THE RESEARCH 5
2. MAIN CONCEPTS 10
3. CASE STUDY 13
4. EXISTING SOLUTIONS 15
5. SUMMARY OF THE ASSESSMENT OF THE CURRENT SITUATION 16
6. METHODOLOGY FOR CHANGE ASSESSMENT 17
    6.1. Lifecycle of IS Change Implementation and Controls 17
    6.2. Pattern of IS Change Assessment Methods 19
    6.3. Reusability Assessment Method 20
    6.4. Centralisation Assessment Method 23
7. ASSESSMENT OF THE METHODOLOGY 26
    7.1. Assessment of Change Positioning 26
    7.2. Assessment of the Reusability Method 27
        7.2.1. Case Study 27
        7.2.2. Experimental Evaluation 29
    7.3. Assessment of the Centralisation Method 30
    7.4. Expert Survey of Methodology Assessment 32
CONCLUSIONS 33
BIBLIOGRAPHY 35

1. GENERAL DESCRIPTION OF THE RESEARCH

Introduction

In the age of digital transformation, companies operate in a rapidly changing environment. Their operation is ensured by many interconnected information systems (IS). Changes in company processes also necessitate a change in IS. Systematic management of IS changes takes place according to information technology (IT) management methodology (e.g., ITIL, COBIT) and specialised methods such as [55], [65], [139]. One of the most important components of the change management process is the assessment of the IS change impact [30], [59], [83], [117]. The assessment of changes has been extensively studied at the operational level, but little research has been conducted on the assessment taking into account the company's strategic goals. The result of insufficient assessment of IS changes is change implementation decisions that have a negative impact on the overall performance of the company [103], [130]. To address this problem, IS change management should be performed in the context of enterprise architecture (EA). EA is defined as follows: *"Description of the organisation's current and future processes, information systems and structure that is aligned with the organisation's goals and development strategy"* [130]. The Doctoral Thesis investigates the opportunities of EA application to IS change management in order to ensure that IS changes are assessed according to the company's EA vision.

The author of the Doctoral Thesis has developed a methodology for assessing the planned IS changes before their implementation according to the EA vision. It is designed as a unifying control mechanism between the operational IS management and strategic EA vision planning, and provides recommendations for the selection of architecture solutions for IS implementation. Different methods are used to implement the measures provided in the methodology, and methods have been developed within the Doctoral Thesis that allow the changes to be introduced according to the principles of reusability and centralisation, which are often included in the EA vision [41], [42], [55], [56].

Topicality of the Research

The topicality of the research is related to shortcomings in the assessment process of IS changes. The main issues identified within the framework of the Doctoral Thesis are as follows [103]:

1. There are several methodologies used to manage IS changes in different areas that are not integrated.
2. IS changes are assessed in isolation, separated from the total EA of the company.
3. Assessment of IS changes is time-consuming and requires expertise in various fields.
4. Assessment of IS changes takes place within the assessor's primary areas of expertise of the IS.
5. Various tools are offered for managing IS changes, which basically provide opportunities for a descriptive analysis, but the generation of change implementation alternatives is not offered.

Goals and Objectives of the Doctoral Thesis

The goal of the Doctoral Thesis is to develop a methodology for the assessment of IS changes according to the EA vision, so that IS development would contribute to the achievement of the company's goals.

To achieve the goal, the following objectives have been set.

1. To analyse and evaluate the current situation in IS change management by conducting literature review and case studies.
2. To identify existing studies in IS change management that use EA models or EA-based IS change management.
3. To explore EA modelling tools and evaluate their capabilities in EA-based IS change management.
4. To develop a methodological framework for EA-based IS change management.
5. To identify controls to be integrated into EA-based IS change management.
6. In the framework of methodology, to elaborate specific methods for the assessment of IS changes used to introduce the change management controls.
7. To evaluate the methodology and the developed methods.

The Object and Subject of the Research

The object of the research is IS change management.

The subject of the research is a controlled environment for the assessment of IS changes according to the EA vision.

Thesis Statements and Hypothesis

Thesis statements to be defended are as follows.

1. The assessment results of IS changes depend on the EA principles and their relative importance in the company.
2. IS change assessment methodology ensures transparency of the decision-making process.

The hypothesis to be proven within the Doctoral Thesis: Assessment of IS changes, taking into account the EA principles of companies, helps companies make architectural decisions aimed at achieving their goals.

Research Methodology

The design science method is used in the research. The method has been chosen because it aims at using research-based knowledge to solve practical problems by strengthening the link between science and practice [63], [148], [149], [151]. Figure 1.1 demonstrates the research methodology in the form of regulatory cycles [136], [150].

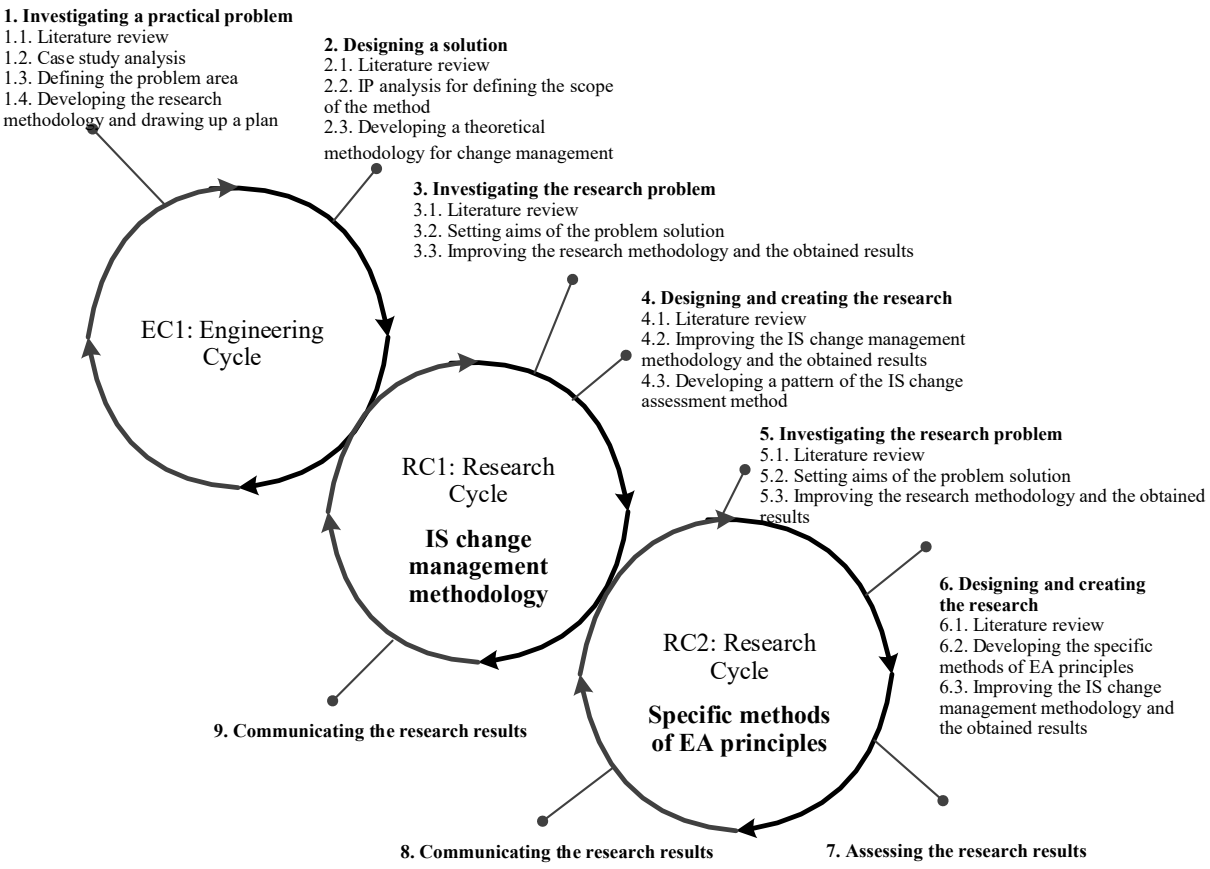


Fig. 1.1. Research methodology.

The research methodology comprises three interrelated cycles – engineering cycle EC1 and two research cycles RC1 and RC2. The results of each cycle complement the results obtained in the previous cycle.

Scientific Novelty of the Doctoral Thesis

Scientific novelty of the Doctoral Thesis:

1. Methodology for assessing IS changes in the context of the EA development vision.
2. Pattern for the development of methods for the implementation of controls included in the methodology.
3. Method for assessing the reusability of components of Application Architecture (AA).
4. Method for evaluation and optimisation of centralisation of AA components.

Practical Significance of the Research

Practical significance of the research:

1. Summary of shortcomings in the assessment of IS changes. The summary should be used as an auxiliary material that provides knowledge of the most typical shortcomings. Companies can use the summary to evaluate their existing IS change management processes and to design future processes.

2. List of IS change assessment controls.
3. Case study of change assessment and recommendations for change implementation to particular companies.

Approbation of the Research Results

The research results have been presented in seven publications.

1. Pirta, R., Grabis, J. Strategy Guided Enterprise Architecting: A Case Study// Dregvaite G., Damasevicius R. (eds) Information and Software Technologies. ICIST 2014. Communications in Computer and Information Science, vol 465. Springer, Cham, 2014, pp. 59–72.
2. Pirta, R. Towards Strategic Information Systems Change Management// Proceedings of Doctoral Consortium on Enterprise Information Systems (DCEIS 2015), Spain, Barcelona, 27–30 April 2015, pp. 3–11.
3. Pirta, R., Grabis, J. Integrated Methodology for Information System Change Control Based on Enterprise Architecture Models// Information Technology and Management Science. No. 18, 2015, pp. 103–108;
4. Pirta, R. Using enterprise architecture to guide application change management// 2015 IEEE 3rd Workshop on Advances in Information, Electronic and Electrical Engineering, Riga, 2015, pp. 1–4;
5. Pirta, R., Grabis, J. Evaluation of Changes in Information Systems according to Enterprise Architecture Evolution Goals and Principles// Baltic J. Modern Computing, Vol. 4, No. 1, 2016, pp. 59–67.
6. Pirta, R., Grabis, J. Evaluation of Application Architecture Change Cases: Building Blocks Reusability Assessment Method// Business Information Systems Workshops: BIS 2017 International Workshops: Revised Papers. Lecture Notes in Business Information Processing. Vol.303, Poland, Poznan, 28–30 June 2017. Cham: Springer Nature, 2017, pp. 150–162.
7. Grabis, J., Pirta, R. A Mathematical Model for Evaluation of Data Analytics Implementation Alternatives// 2017 IEEE 21st International Enterprise Distributed Object Computing Workshop (EDOCW), Canada, Quebec, 2017, pp. 79–84.

The research results have been presented at six conferences.

1. 9–10 October 2014. The 20th International Conference on Information and Software Technologies (ICIST 2014). Druskininkai, Lithuania.
2. 14–17 October 2014. The 55th International Scientific Conference of RTU. Riga, Latvia.
3. 27–30 April 2015. The 17th International Conference on Enterprise Information Systems (ICEIS 2015). Barcelona, Spain.
4. 14–17 October 2015. The 55th International Scientific Conference of RTU. Riga, Latvia.
5. 11–24 November 2015. The 1st IEEE Workshop on Advances in Information, Electronic and Electrical Engineering (AIEEE 2015). Latvia, Riga.

6. 28–30 June 2017. The 8th Workshop on Business and IT Alignment (BITA 2017) in conjunction with the 20h International Conference on Business Information Systems (BIS 2017). Poland, Poznan.

The Structure of the Doctoral Thesis

The Doctoral Thesis consists of 7 chapters, conclusions, bibliography and 4 appendices.

Chapter 1 provides the description of the research, i.e., states a problem to be solved, defines the goal, objectives and thesis statements to be defended, as well as presents the research methodology, the main results and structure of the Doctoral Thesis.

Chapter 2 defines the main concepts used in the Doctoral Thesis.

Chapter 3 includes case studies on the research issues.

Chapter 4 provides literature review, including existing studies and their results.

Chapter 5 summarises the findings of the case studies and literature review.

Chapter 6 presents the IS change assessment methodology for the assessment of IS changes in the context of EA vision and principles, which includes a pattern of controls and methods, as well as two methods – reusability assessment method and centralisation assessment method.

Chapter 7 evaluates methods using different assessment techniques (case studies, experiments, and expert assessment).

The Conclusions provide an outline of the research results, the obtained findings and directions for future research.

The Doctoral Thesis comprises 4 appendices. Appendix 1 contains a list of the most important terms and abbreviations used in the Doctoral Thesis. An example of the classification of IS changes is provided in Appendix 2. Appendix 3 contains a summary of the results of analysis of change cases. Appendix 4 includes the experiment task of evaluating the reusability assessment method.

2. MAIN CONCEPTS

The conceptual basis of EA and its management is formed by the concepts defined in the TOGAF standard [130]. The TOGAF standard includes EA modelling concepts – architecture views and component categories. The following EA views are considered in the Doctoral Thesis [130].

- Business architecture (BA) – representation of the company's business model.
- Information architecture (IA) – representation of the data structure and data entities of the company.
- Application architecture (AA) – representation of applications used by the company.

For EA design and governance, the TOGAF standard [130] offers the concept of Building Blocks. Building Blocks bring together functionality of logical clusters, which is defined to support company's business capabilities and needs. Depending on the level of detail of the Building Blocks, the following types are distinguished [130].

- Architecture Building Blocks (ABB) that include the architecture level solutions.
- Solution Building Blocks (SBB) that include solution level components.

An example of the EA is provided in Fig. 2.1. It includes the EA model of the financial institution developed by the author of the Doctoral Thesis. The EA is made up of several layers, which group together different components of the company. In the model, the business layer defines the financial institution's core business and support functions that are ensured by the use of applications identified at the application layer. Technical infrastructure is used for applications operation. The EA can display links between different components and analyse their interdependencies, for example, how the customer relationship management function will change if changes are made to the E-Service application.

The architecture principles are mainly used for EA development planning. Principles are general conditions and long term gudelines that are used by the company to achieve its mission [130]. Reusability and centralisation are two principles that are often used in practice [41], [42], [54], [57], the impact of which is analysed in detail in the Doctoral Thesis.

Adhering to the principle of reusability helps the company increase productivity, reduce the workload and costs of IS development, increase IS quality and improve interoperability of solutions [78], [125]. The principle of centralisation requires that specific functionality be logically integrated into central information systems that are closely integrated with each other [68].

The TOGAF 9.1 standard [130] does not use EA development scenarios, but changes to EA can be implemented in various ways [103]. Scenarios provide a high-level overview of the company's future business and operational model, incorporating key components without architecture details.

Reference models are used for EA development planning, they help companies reuse EA governance knowledge. Reference models are used to define sector- or domain specific components and their properties [108].

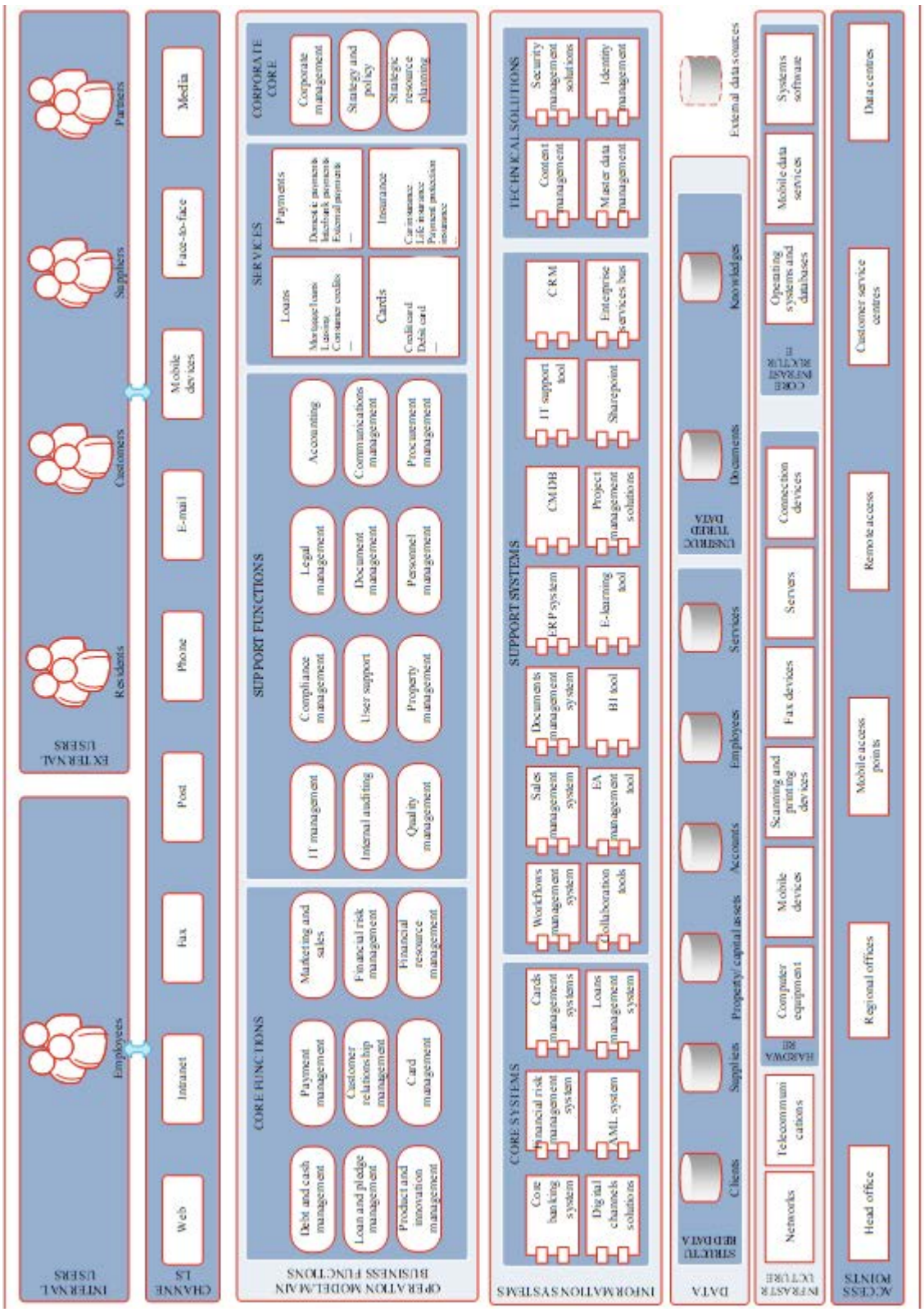


Fig. 2.1. An example of EA model.

IS Changes

The definition of IS changes is [152]: "*Modifications of a product or component after its commissioning*". Changes can be of any size, they can affect the number of different people and their implementation may require a different time period [79].

IS change management covers change planning, implementation and control [80]. The aim of the IS change management process is to manage the initiation, review, approval and implementation. The IS change management process ensures that the negative impact of changes in IT services and their components is minimised on IT integrity, security and service levels, as well as the productivity and quality of change processing and deployment are promoted [75].

Practical recommendations for the implementation of specific IS change management process are summarised in several international enterprise IT management and other enterprise resource management methodologies. Table 2.1 lists the methodologies used in enterprises and specifies the specific scope of their use.

Table 2.1

Commonly Used IS Change Management Methodologies

Name of methodology / Control area	Project management	IT governance	EA management	IT security management	Risk management	Change management
ITIL [136]		×				
COBIT [69], [70], [71]		×				
PRINCE2 [13]	×					
PMBok [115]	×					
TOGAF [130]			×			
CMMI [25]					×	
ISO 27001 [72]				×		
ISO 42010 [73]			×			
Transform [114]						×
ADKAR [116]						×

For IS change management, both private and public sector organisations use several methodologies, but there is a lack of coherence among them. A lack of integration of methodologies is a problem identified in practice [127], guidelines for their integration and implementation in enterprises have been developed [54], [76], [127]. However, studies do not consider EA-based assessment of planned IS changes (i.e., how to assess whether the changes are in line with the company's stated principles, goals, etc.).

3. CASE STUDY

The development of EA design and governance theory is largely driven by practioneers and their observations. The author uses the same approach for methodology development. Observations in practice have been obtained as a result of original multi-case study research (Pirta, Grabis, 2014).

Architectural decision-making processes and existing EA models of 20 Latvian and international enterprises and public administration institutions have been analysed within case studies. Cases are summarised within the implementation of more than 15 different IT and management consulting projects over the past 6 years. The research has been conducted according to a case study methodology [121].

In the case study, the following main shortcomings in the assessment of IS changes have been observed.

- The existing EA and its components are not sufficiently analysed.
- The EA vision and its principles are not taken into account.
- The initiated and planned EA changes are not taken into account.
- The reusability of existing EA components is not assessed.

Therefore, decisions that do not correspond to the EA vision are made and gaps between the existing and the target EA is formed. As a result, companies obtain a suboptimal EA with the unwanted features demonstrated in Fig. 3.1. Observation examples are summarised in Table 3.1.

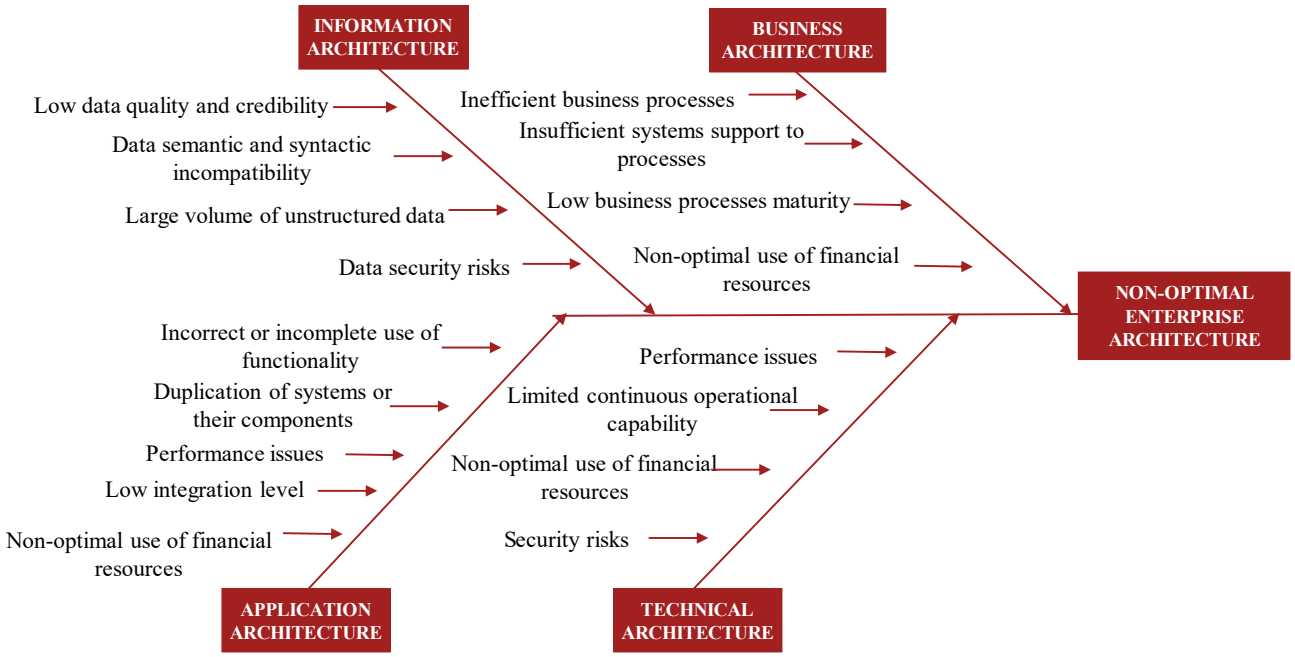


Fig. 3.1. Typical EA problems in different architecture views defined by TOGAF standard.

Table 3.1

Case Study Examples

Case	**Limited data analysis in a transport and logistics company**
Characteristics	Centralised ERP system and more than 40 other ISs
Architectonic decisions	Business analytics reports are implemented in the ERP system, rather than in specialised business intelligence systems
Identified problems	Conflicting data Large investment in infrastructure, but no improvement in performance
Classification of problems	TA – non-optimal use of financial resources AA – duplicated functionality, lack of centralised BI solutions BA – manual loading and restoring data among tables IA – lack of unified information architecture, limited data analysis options
Case	**Duplication of EA components in public administration**
Characteristics	European-level initiatives [40], [41], [42] recommend reusing EA components not only within one country but also among European public administrations; however, in Latvia there is limited reusability of EA components, they are duplicated. Many institutions develop their own customer service systems, integration platforms, and service portals, which co-exist with public sharing solutions.
Architectonic decisions	Institutional IS development projects have historically been planned and implemented outside a unified IS architecture framework that creates component duplication, such as: • The number of national websites exceeds 115; more than 50 different content management systems are used to manage them. • More than 10 institutional level integrators; inadequate application of public integrators of common use. • In addition to the public service portal, there are more than 10 service portals at the institutional level, separate portals for municipalities. • More than 30 data centres and server rooms.
Identified problems	Duplication of functions and resources Low level of process standardisation Difficult IS integration, insufficient data compatibility High IS development and maintenance costs
Classification of problems	As a result, all EA layers are affected, the most significant problems are related to the non-optimal use of financial resources in the acquisition, maintenance and operation of parallel solutions, as well as inefficient process organisation and other related aspects.

4. EXISTING SOLUTIONS

IS change management has been extensively studied in various areas of IS planning and IT management [58]. The most popular IS change management research topics are [58]: change process organisation, change strategy planning, change management tools and systems, as well as change impact analysis. The main goals of IS change management are to minimise the number of change requests before they occur, if they occur, to implement effective changes and learn from the implemented changes and their implementation process [58].

The use of EA for IS change management is identified both in international enterprise resource management methodologies [48], [130] and in scientific [62], [83], [117] and practical studies [29], [81]. EA is used as an information base for change planning and related decision making, its use helps companies move in a coordinated and planned way towards achieving the defined target architecture [62].

Although many studies consider EA-based change management options, existing studies use EA to define a change management context (a descriptive approach), while the development of change implementation recommendations (a prescriptive approach) has been little studied.

Studies on reusability focus on exploring the benefits [91], [100], [123], [154], IS reusability assessment [99], [153] and recommendations for practical use [41], [42].

Studies primarily address the benefits of reusability, as well as the technical characteristics of components (e.g., source code quality). Methods limitedly consider the assessment of reusability of IS components, taking into account their linkage to other EA components. The methods involve the attraction of qualified experts for assessment, with limited use of automated EA data analysis options.

Centralisation and assessment of IS services remain a little-studied area. Taking into account the specificity of IS services and IS types, centralisation and its evaluation have been studied according to the types of IS services and systems, for example, centralisation of IS company resource management services [94], centralisation of data analytics IS services [83].

5. SUMMARY OF THE ASSESSMENT OF THE CURRENT SITUATION

The problems identified in the assessment of the current situation have been used to develop a new methodology for the assessment of IS changes according to the research methodology (Chapter 1). Table 5.1 summarises the identified problems and the underlying methodology requirements.

Table 5.1

Problems Identified and Requirements Set in the Analysis of the Current Situation

No.	Problem	Requirement
1.	Several methodologies are used to manage IS changes in different areas, but their integration is insufficient. Each area is managed autonomously, usually within a variety of organisational structures, so there is a lack of a common framework for overview and control.	The methodology should cover the integration of different areas by offering a unified control framework for comprehensive IS change management. The methodology should combine different components and be designed as a constructor.
2.	IS changes are evaluated in isolation. Their architecture and impact are often not assessed in the context of existing and target EA, taking into account the vision of EA development and its performance indicators.	The methodology should include a mechanism for assessing IS changes in the context of both existing and targeted EA.
3.	Existing methodologies are not flexible, they are difficult to integrate and adapt to a particular company and its proposed EA vision (for example, the company's established principles and their weights).	The methodology should be flexible and easily adaptable to the company's EA vision. Principles should be addable and removable. Their weights (importance) should be changeable.
4.	Methods for integrating existing IS change management methodologies are partly addressed by predefined problems, but they limitedly assess IS changes in the context of EA development (how to assess, whether the changes are in compliance with the company's set principles, goals, etc.).	See Requirement 2
5.	The EA-based IS change management methods are primarily designed for EA component dependency / impact analysis with the aim of ensuring change implementation, covering changes in related components and ensuring their interoperability after change implementation. Approaches are based on the assumption that there is only one "correct" scenario for change implementation from an architectural point of view. The issue of identifying and recommending the scenarios for implementing various architectonic changes to decision-makers is not actually addressed.	The methodology should provide an opportunity to identify and analyse various alternatives (scenarios) of IS change implementation.
6.	EA tools offer functionality for change planning, assuming that a change implementation scenario is known.	See Requirement 5

6. METHODOLOGY FOR CHANGE ASSESSMENT

A methodology for EA-based change assessment has been developed within the framework of the Doctoral Thesis. The methodology is based on the traditional lifecycle of change management, which is supplemented with controls and specific methods for change assessment (Fig. 6.1). Controls at each methodological stage determine which aspects should be assessed to verify the compliance of IS changes with the EA development vision and the principles contained therein. Methods for assessing changes specify how to implement the necessary controls. Methods are developed according to a pattern of the method that defines the overall evaluation approach. In this way, the methodology is considered to be component oriented as it can be accompanied by new controls and methods for assessing changes.

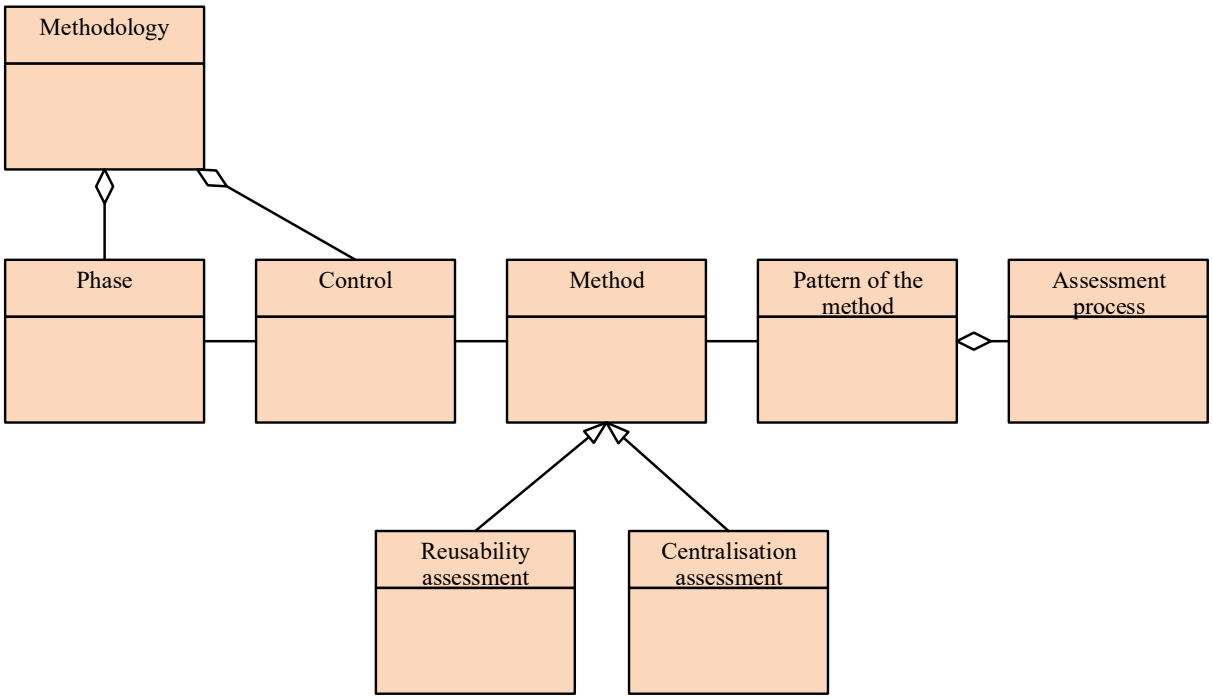


Fig. 6.1. Assessment of IS changes.

6.1. Lifecycle of IS Change Implementation and Controls

The methodology is developed taking into account the problems and shortcomings identified in the current situation (Chapter 5) and the requirements set for their elimination.

The phases included in the methodology form a lifecycle of the IS change implementation (Fig. 6.2). The lifecycle is based on the recommendations of the general company's change management methodology, with the addition of change assessment controls [105].

The lifecycle includes five successive phases – assessment, design, development, implementation, as well as operation and revision. The first two phases are assessment and design, as they are directly related to the planning, assessment and decision making of IS changes.

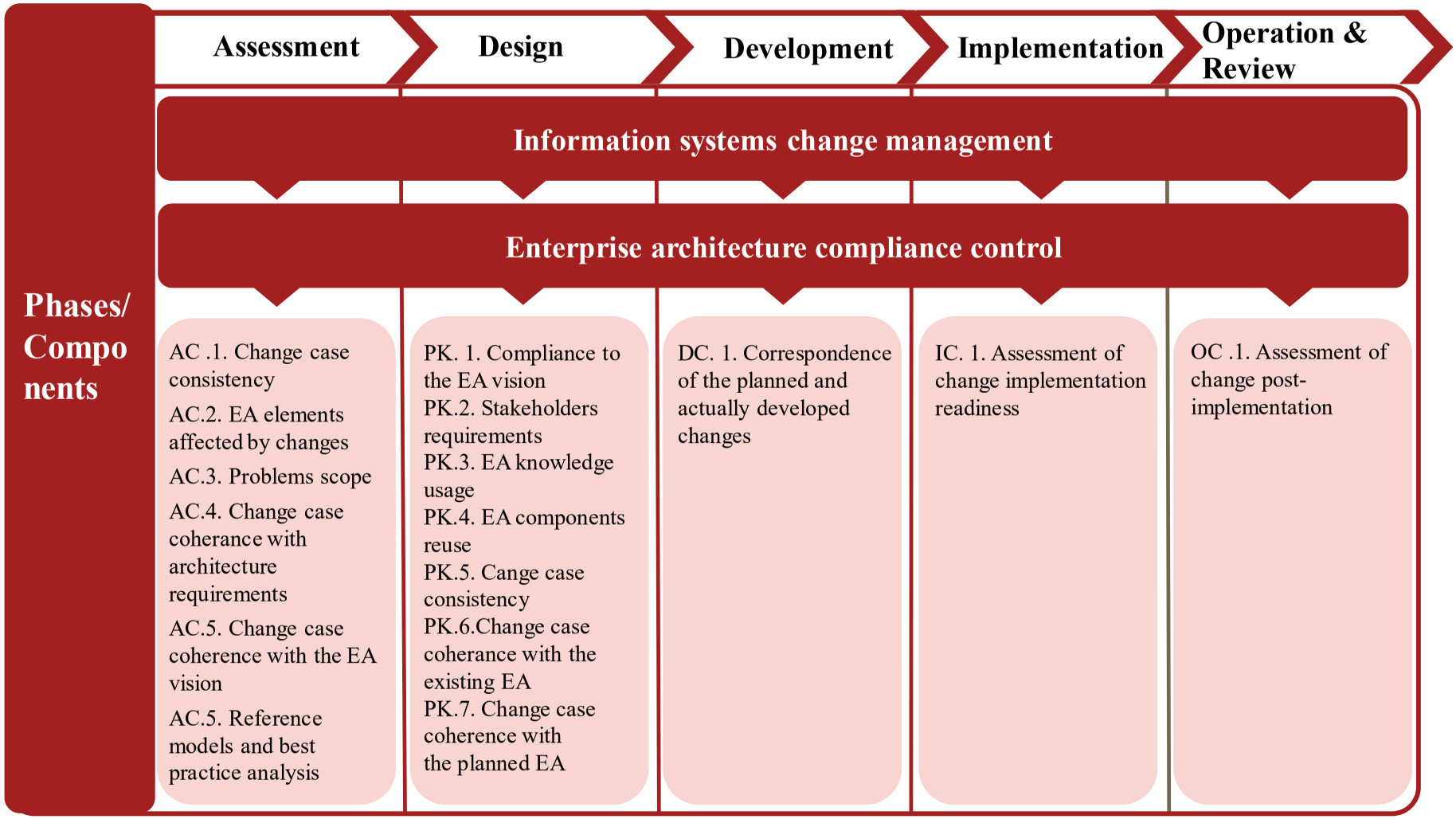


Fig. 6.2. Lifecycle of IS change implementation.

At the assessment phase, the scenarios for change implementation are analysed and the architecture of IS changes directed to achieving the EA vision is defined. At the design phase, changes are modelled in detail and the consistency of the actual IS change architecture design is ensured with the design made during the previous phase. At the development phase, the actual implementation of the planned change is controlled. At the implementation phase, the implementation of change benefits is managed and controlled. At the operation and revision phase, post-evaluation of change implementation is carried out and the acquired knowledge is retained.

6.2. Pattern of IS Change Assessment Methods

The section develops a pattern of IS change assessment methods, which will be used to develop specific methods for the assessment of IS changes in the principles included in the EA vision. The pattern defines the evaluation process (Fig. 6.3) and provides guidance for EA-based IS change assessment.

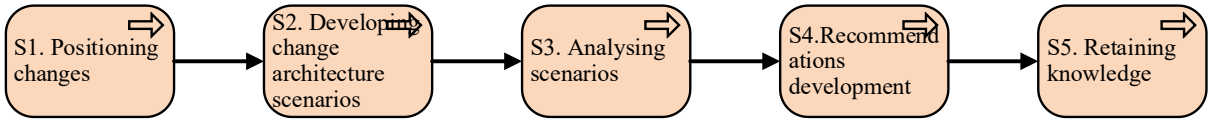


Fig. 6.3. IS change assessment process.

The assessment process begins with the positioning of changes by the Enterprise Architect or other responsible person at the company. Positioning involves analysing changes and defining links between the planned changes and the existing EA model. Initially, the affected AA components associated with BA and IA components are identified. The link is determined by the expert to obtain an accurate basis for the further analysis process.

Based on the change positioning results and predefined EA analysis rules, IS implementation scenarios or IS change architecture alternatives are prepared. Scenarios are created by analysing the company's existing EA model and the industry or domain reference model. As a result, multiple architecture scenarios for IS changes are offered to the company's architect for further evaluation.

Criteria for the analysis of scenarios are derived from the principles and goals set in the EA vision. The analysis is based on the information contained in the existing EA model about the properties of the EA components and their interrelationship. As a result of the analysis, quantitative indicators characterising the benefits of each scenario are obtained.

Based on the results of the analysis, recommendations are put forward for the implementation of the changes, which are directed towards achieving the company's EA vision.

The process ends with the renewal of defined rules and criteria. After several successful implementation cycles, the Enterprise Architect renews laws and criteria with empirically acquired knowledge of change implementation practice.

6.3. Reusability Assessment Method

The Reusability Assessment method is one of the specific methods for assessing changes. It allows evaluating the use of existing EA components to implement IS changes. The method uses the EA analysis and multi-criteria decision making. It includes five consecutive steps according to the sample of the method (Fig. 6.3). The assessment process starts with positioning the change case in the company's EA (Table 6.1).

Table 6.1

Linking Change Cases to the EA Components

No.	Attribute	Field properties	EA view and component
1.	Information system	IS name, product name	AA – AA essential element, logical AA component
2.	User	Name, surname, position, department	BA – actor
3.	Approver	Name, surname, position, department	BA – actor
4.	Related changes	Free text	N/A
5.	Related changes	IS name, product name	AA – AA essential element, logical AA component
6.	Description of changes	Free text	N/A

According to the TOGAF AA component classification, any change case includes one or more IS services related to BP and other EA components (Fig. 6.4).

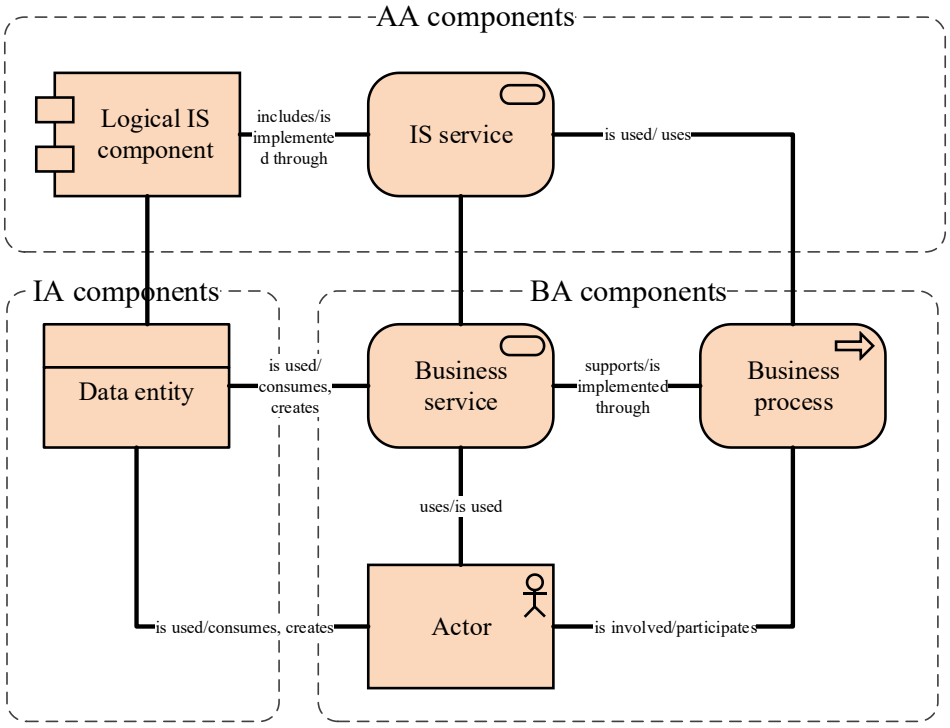


Fig. 6.4. Linking of EA components.

Next step is the development of IS change architecture scenarios. It identifies the essential elements of architecture and the alternatives to the essential elements of the solutions; they are grouped into scenarios, considering five alternatives to change implementation (Table 6.2).

Table 6.2

Alternatives to IS Change Implementation

Implementation type	**Degree of reusability**		
	New IS services	New and reused IS services	Reused IS services
Existing IS modification	×	×	×
New IS development	×	×	

The proposed scenarios are assessed against the criteria model and predefined assessment rules, which include criteria for assessing the reusability of ABB, SBB and criteria for assessing interoperability between ABB and SBB. Total scenario rating is calculated as follows:

$$TR = RK + RKp + RKi, \tag{6.1}$$

where TR is the overall scenario rating, RK is the total rating of the ABB reusability, RKp is the total rating of the SBB reusability, and RKi is the overall interoperability rating between ABB and SBB.

Table 6.3 and Fig. 6.5 show an assessment and rating example of alternatives to SBB for validating a method [104] (description of the case is provided in Chapter 7.2).

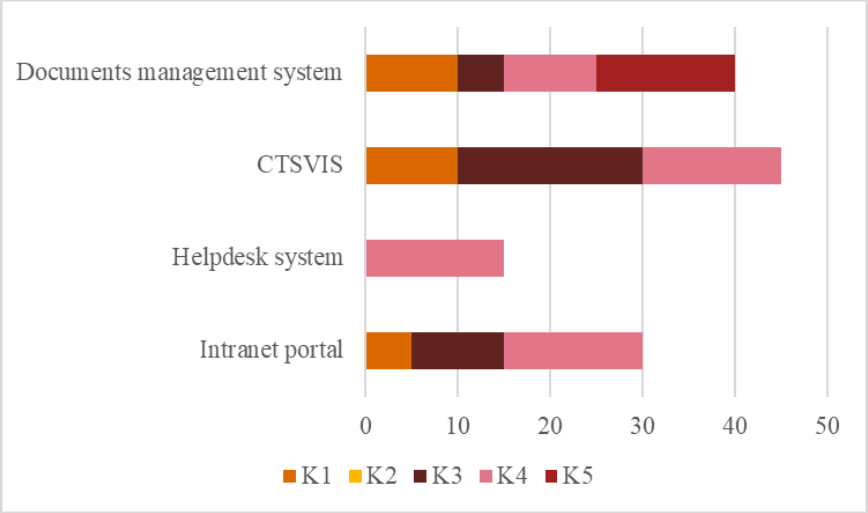


Fig. 6.5. An example of alternative ratings.

Table 6.3

An Example of IS Service Assessment

Alternative\Criterion	**K1 –** solution design	**K2 –** current reusability	**K3 –** contributing aspects of reusability	**K4 –** maturity level	**K5 –** expandability options
Intranet portal	The portal is integrated with document co-creation environment for searching normative and development planning documents using "iframe" technology. The portal uses API to ensure searching and visiting analytics service from external components (Google services).	The portal has not been reused.	The portal content management solution is modular (divided into modules or plug-ins) and service oriented (integrated with external Google services).	The portal has been put into operation and is used by 5 company BP. The portal is integrated with document co-creation environment for searching normative and development planning documents.	The portal has not historically been expanded with new modules.
Helpdesk system	IS is not integrated with other IS and does not use external APIs.	IS has not been reused.	IS is designed internally, it is not modular and service oriented.	IS has been put into operation and is used by 3 company BPs.	IS has not historically been expanded.
CTSVIS	IS is integrated with personnel management IS staff for receiving data and transferring data of hours worked using web services. The component consists of several logically separated ISs that mutually use API.	IS has not been reused.	The component consists of several logically separated ISs that are modular and mutually use API.	IS has partially been put into operation (separate modules have been introduced). It is used by 1 company BP, it has 1 active integration.	IS has not historically been expanded
Document management IS	IS is integrated with 3 company ISs – document co-creation environment, service provision IS and user management IS. IS is integrated with 2 external ISs – state document integration environment, and uses e-signer as an API. Various mechanisms have been used for integration, including web services.	IS has not been reused.	IS is not modular and does not offer other solutions integrable functionality in the form of API. But it uses an e-signer as an API.	IS has been put into operation and used by 10 company BPs.	IS has historically been expanded with new services.

Based on the assessment results, recommendations are put forward, which include proposals for the creation of IS change architecture (an example of case study analysis is provided in Table 6.4). The assessment results are discussed in Section 7.2.

Table 6.4

The Recommended Change Implementation Scenario

No.	IS service	Alternatives to architecture of essential elements		Alternatives to solutions of essential elements	
		Modified existing IS	**New IS**	**Reused IS service**	**New IS service**
1.	IP data processing and automatic retrieval from related ISs	CTSVIS		×	
2.	IP data input and processing	CTSVIS		×	
3.	IP workflow management	CTSVIS		×	
4.	IP status management	CTSVIS		×	
5.	IP classification management	CTSVIS			×
6.	Notification management	CTSVIS			×
7.	Change project documentation management	Document co-creation environment			×
8.	ICT item data recovery		ICT asset management IS		×

The process ends with the addition of criteria and conditions with empirically acquired knowledge from the actual implementation of the EA changes (addition is done after the introduction of several change cases).

6.4. Centralisation Assessment Method

The centralisation assessment method is one of the specific methods for assessment of changes. It allows assessing and comparing the use of different EA components to implement IS changes. Centralisation is considered in the context of reporting and business analysis, but the method can also be used to evaluate other centralised IS services.

The method includes a mathematical model designed to evaluate alternatives to the implementation of data analytics components for optimal implementation of AA changes. The alternatives are assessed with an aim of choosing the most optimal solution for a particular change case, taking into account the financial factors: implementation, maintenance and integration costs. Apart from the costs, the principles of EA development and user preferences regarding EA reporting are also taken into account.

The method involves five consecutive steps according to the pattern of the method.

1. Positioning changes – identifying the required reports, the data units they contain, and other information that characterises IS changes.

2. Developing change architecture scenarios – putting forward alternatives to introducing reports and calculating costs of implementing and maintaining IS changes.
3. Analysing scenarios – the proposed scenarios are assessed against the predefined mathematical model.
4. Putting forward recommendations – based on the assessment results, recommendations are made, which include proposals for the optimal development of the IS architecture.
5. Complementing criteria and conditions.

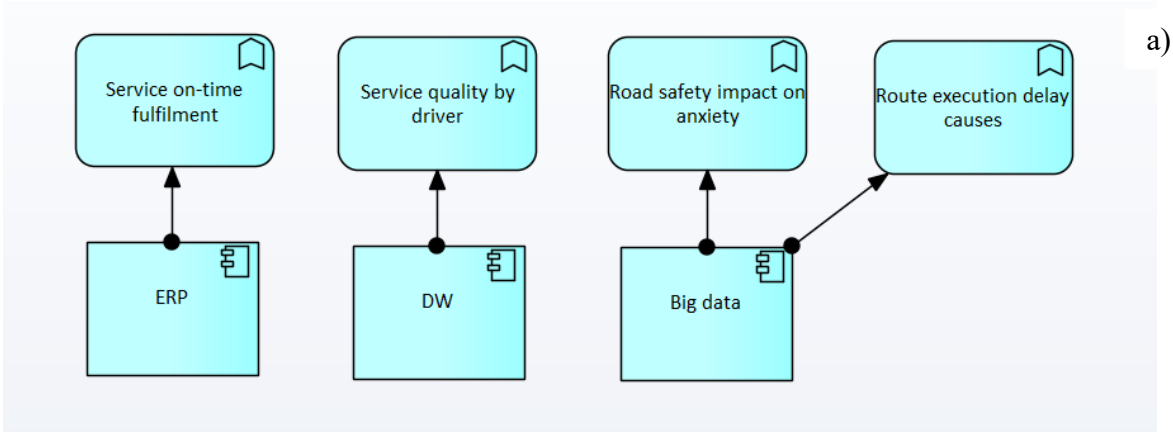
The most important step of the method is the scenario analysis, for which the optimisation model has been developed. The solution is considered optimal during the implementation of which the implementation and maintenance costs of the report are minimised, the EA principles and user preferences are ensured, as well as the restrictions are taken into account (Grabis, Pirta, 2017):

$$TC = DC + MC + IC + DP - UP \underset{X}{\rightarrow} \min, \tag{6.2}$$

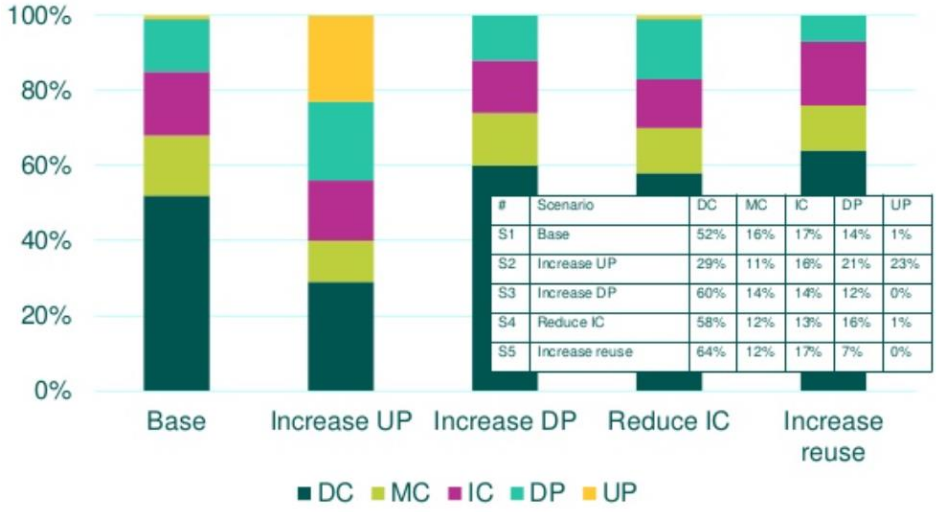
where $DC = \sum_{i=1}^{I} \sum_{j=1}^{J} c_{ij}^{D} \left(1 - \alpha_j R_1\right) X_{ij}$ is development costs of a new report, *MC* is maintenance costs, *IC* is the integration costs of data sources, *DP* is decentralisation penalty, and *UP* is a user satisfaction bonus (these indices are calculated similar to *DC*). X_{ij} is a binary variable that represents the scenario of the selected change architecture ($X_{ij} = 1$, if the *i*-th report is implemented in the *j*-th IS, and $X_{ij} = 0$ otherwise), c_{ij}^{D} is the development costs of the *i*-th report in the *j*-th IS, α_j is the number of existing reports in the *j*-th IS, and R_1 is a development reusability factor. The optimisation is based on the constraints that the report can only be implemented if the IS has access to the data unit required to run the entire report, and that each report can be implemented in one IS.

Alternative scenarios are obtained by changing the importance of user preferences and decentralisation penalty as well as other factors in the model. Figure 6.6. a) illustrates an example of optimisation results in which a link between the IS and a report indicates that the IS is used for report implementation (a description of the example is provided in Chapter 7.3). The optimisation model also allows evaluating the results depending on the importance of various factors (Fig. 6.6. b)). For example, if the principle of centralisation prevails, the user satisfaction bonus is significantly reduced, and if integration costs are low, the incentive to respect the principle of centralisation is reduced.

a)



b)



#	Scenario	DC	MC	IC	DP	UP
S1	Base	52%	16%	17%	14%	1%
S2	Increase UP	29%	11%	18%	21%	23%
S3	Increase DP	60%	14%	14%	12%	0%
S4	Reduce IC	58%	12%	13%	16%	1%
S5	Increase reuse	64%	12%	17%	7%	0%

Fig. 6.6. Results of the use of the centralisation method: a) the recommended reporting scenario in the form of the EA model fragment; b) distribution of *TC* costs depending on the scenario.

7. ASSESSMENT OF THE METHODOLOGY

The choice of assessment techniques has been made in accordance with the recommendations for the evaluation of artefacts in the case of design science research [137]. The methodology for evaluation is a combination of several approaches to obtain a comprehensive assessment (Fig. 7.1).

1. The empirical analysis of change positioning – evaluates the activity of methodology process S1 (Chapter 6.2) to show that it is possible to position the EA in the received change cases.
2. Evaluation of the centralisation method – evaluates the methodology as a whole and its activities S3 and S4 to assess the effectiveness of quantitative analysis for generating and assessing alternatives to change implementation.
3. Change case analysis – examines activity S5 of the change assessment process by simulating the knowledge accumulation process and testing its impact on the results of the method.
4. Case study of the reusability assessment method – verifies the operation of the methodology in natural conditions.
5. Expert survey of the methodology assessment – assesses the usefulness of the methodology.

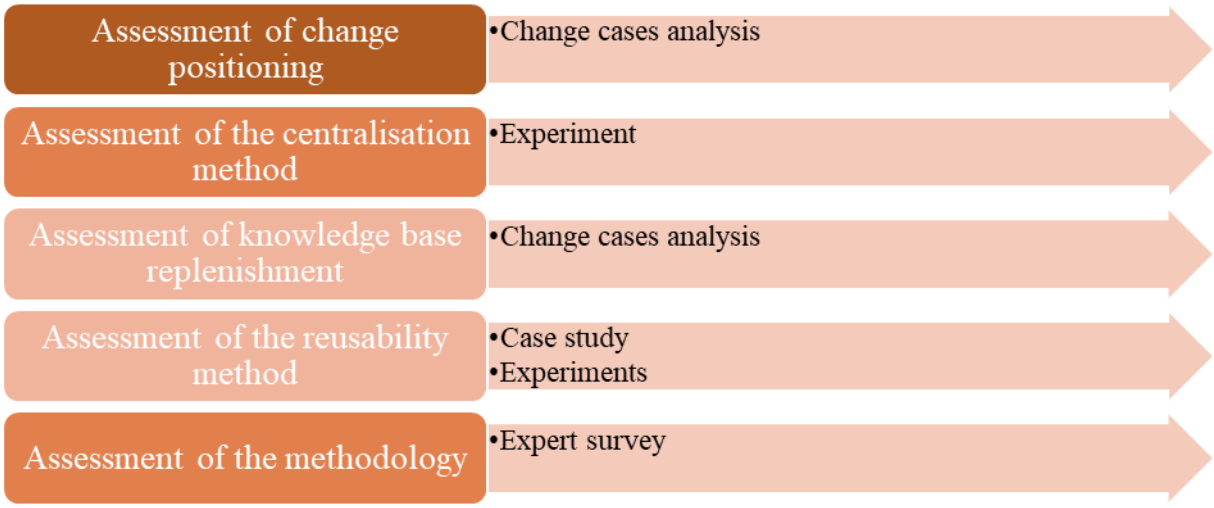


Fig. 7.1. Assessment methodology.

7.1. Assessment of Change Positioning

During the case studies described in Chapter 3, more than 300 change cases have been summarised by the author of the Doctoral Thesis in the EA context of the companies under consideration (i.e., the links between the change case and the EA elements have been determined). The goal of the assessment is to show that the change requests contain sufficient information to initiate the EA-based change assessment.

1. The existing EA can position 48 % of the change cases (all types of changes for all types of EA components are considered).

2. Most of the changes (66 %) cannot be attributed to the EA vision (Fig. 7.2); however, specific types of change can be identified where attribution is possible:
   a) the EA vision cannot be subject to non-functional requirements;
   b) the EA vision cannot be subject to simplified functional requirements (e.g., addition of forms with fields, etc.);
   c) the EA vision can be subject to high-level functional requirements (e.g., supplementing the system with analytical reports, system integration, etc.).
3. The existing EA can position 96 % incremental architecture changes and reiterative architecture development changes of change cases that include changes to IS services.

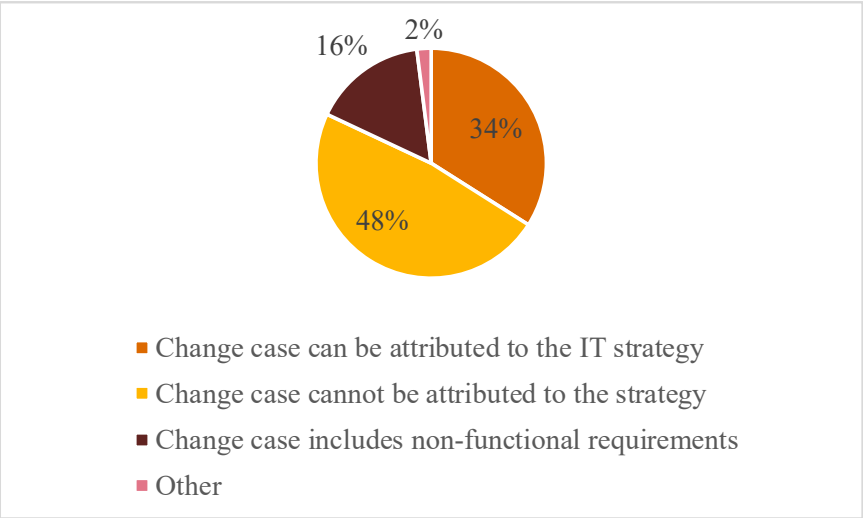


Fig. 7.2. Opportunities of attributing change cases to the EA vision (included in the IT strategy of the companies under consideration).

7.2. Assessment of the Reusability Method

The reusability method has been used for the assessment of changes in the public administration institutions by comparing the results of the method and the assessment of changes made by the outsourcing service provider. These evaluation results have been used as a reference point to carry out an experiment in which 30 independent experts made the assessment of changes.

7.2.1. Case Study

The reusability method has been used to assess IS changes in a public administration institution. The institution has a centralised IT management function in a separate organisational unit that provides IT services to more than 13 autonomous units of the institution with more than 10 000 users. The institution AA has been established and developed historically, with over 30 partially integrated ISs. The most important ISs are helpdesk IS, budgeting tool, user management IS, document management IS and CTSVIS (internal work management of IT organisational unit). The institution identified the need for changes to existing processes (Table 7.1).

Table 7.1

Change Case

No.	Description of the change case
1.	It is necessary to introduce a uniform IP traceability of all ICT services throughout its lifecycle in accordance with ITIL guidelines.
2.	Changes in the information on ICT services accumulated by the IT department of the institution are needed to enable the unit to measure the process of providing ICT services, as well as report to the institutions on the ICT services provided.
3.	It is necessary to accumulate information on ICT projects.
4.	It is necessary to accumulate information on ICT items. The data should be in a format that makes it possible to determine the accessibility time and calculate the accessibility.

As a result of the analysis, recommendations are made for the implementation of changes (Table 7.2). The recommended scenario includes a combination of the best TR values for the implementation of each identified IS service in an institution's existing AA.

The scenario implies the implementation of the following changes.

1. CTSVIS is expanded by reusing the services available (services in the existing EA are used to manage the internal work tasks of the IT department; in case of change, they will also be available to external users):
   - IP data processing and automatic retrieval from related IS;
   - IP data input and processing;
   - IP workflow management;
   - IP status management;
   - IP classification management;
   - Notification management.
2. CTSVIS introduces new IS services:
   - IP classification management;
   - Notification management.
3. The document co-creation environment introduces a new service – change project documentation management.
4. A new ICT asset management IS is introduced, which includes a new service – ICT item data recovery.

The outsourcing provider also made change assessment at the institution and the assessment was carried out over several weeks, taking into account that the analysis included extensive research into existing AA (documentation, interviews with users and representatives of IT departments, etc.). The use of the method without the involvement of an outsourcing provider significantly accelerated the analysis and produced an analogous result, which was also considered an appropriate solution for the institution.

Table 7.2

The Recommended Change Implementation Scenario

No.	IS service	ABB alternatives		SBB alternatives	
		Modified existing IS	New IS	Reused IS service	New IS service
1.	IP data processing and automatic retrieval from related ISs	CTSVIS		×	
2.	IP data input and processing	CTSVIS		×	
3.	IP workflow management	CTSVIS		×	
4.	IP status management	CTSVIS		×	
5.	IP classification management	CTSVIS			×
6.	Notification management	CTSVIS			×
7.	Change project documentation management	Document co-creation environment			×
8.	ICT item data recovery		ICT asset management IS		×

7.2.2. Experimental Evaluation

For an additional assessment of the method, an experiment was carried out in which 30 participants of the experiment used the method. The experiment was carried out in two stages. At the first stage, the experiment involved 9 experts with extensive experience and knowledge in the IT field (professionals), at the second stage – 21 participants with average knowledge and little experience in the field of IT (Master students).

At the first stage of the experiment, experts were divided into two groups.

- Expert Group 1 – carried out change case assessment based on their knowledge and experience, the second group used the guidelines of the developed method for the assessment of changes.
- Expert Group 2 – the method and its implementation steps were introduced to the group prior to the assessment process. As a result of the assessment, each group completed the assessment form, indicating for each IS service included in the change case the system (one of the existing systems of the company or a new system) in which the change should be made and the IS service implemented.

At the second stage, all participants of the experiment performed the task using the method.

A summary of the results of the first stage of the experiment is provided in Fig. 7.3 that shows the proportion of correct responses:

$$R = \frac{1}{N} \sum_{i=}^{N} x_i, \qquad (7.1.)$$

where N is the number of experts, and $x_i = 1$, if the expert assessment coincides with the correct variant obtained in the case study, and 0 otherwise.

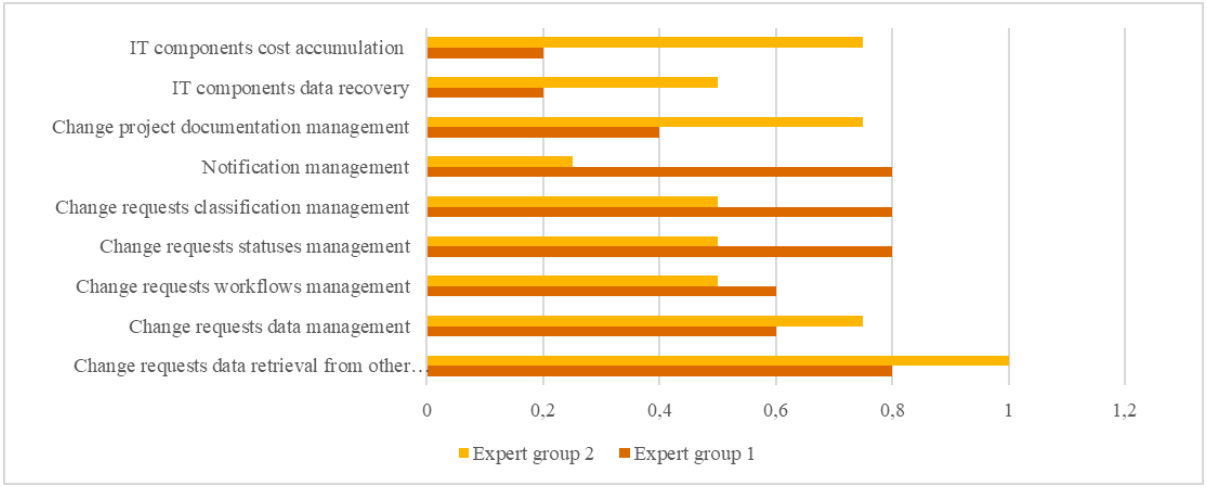


Fig. 7.3. Summary of the assessment results.

At the second stage of the experiment, about 85 % of the participants reached the recommended result using the method. This involved the implementation of common steps, explaining the activities to be performed by the participants in each step and providing examples.

7.3. Assessment of the Centralisation Method

Experiments with a scenario assessment model have been used to validate the centralisation assessment method. The aim of the experiment is to characterise the dependence of change implementation decisions on the importance of EA principles. The experimental evaluation of the method is based on the case of a research and development project that developed a multidisciplinary company's transport routing solution [53].

Within the company, analytical reports are implemented in different ISs, e.g., in the enterprise resource planning system or data warehouse. In the change requests, company employees require new reports. Assessing changes, it is necessary to decide in which IS to implement the requested reports, taking into account that the EA vision requires adhering to the principle of centralisation. The company architect identifies the data units required to run the reports, as well as defines the user preferences for the location of report implementation in the company's EA (Table 7.3).

Table 7.3

An Example of Change Positioning

No.	Report	Data units	User preferences
1.	Service quality by the driver	Customers, service requests, delivery routes, invoices, payments, drivers, customer feedback, delivery confirmation	Transport management IS
2.	Impact of road traffic safety on anxiety	Service requests, delivery routes, invoices, payments, drivers, customer feedback, delivery confirmation, insurance claims, accidents, absence, traffic, road traffic safety	Transport management IS
3.	Route execution delay reasons	Customers, service requests, delivery routes, invoices, payments, drivers, customer feedback, delivery confirmation, insurance claims, accidents, absence, traffic, road traffic safety	Transport management IS
4.	Timely provision of services	Customers, service requests, delivery routes, invoices, payments, drivers, customer feedback, delivery confirmation	Transport management IS

Changes are evaluated according to the method described in Chapter 6.4 and the scenarios are evaluated using an optimisation model. Figure 6.6. a) shows the optimised baseline change scenario. In addition to the baseline scenario, other scenarios that change the significance of EA principles and other model parameters have been experimentally analysed (Table 7.4):

- increased importance of user preferences;
- increased importance of the centralisation principle;
- reducing the integration costs;
- increasing economies of scale.

Scenario assessment results show that changing the importance of EA principles has a significant impact on the decisions of change implementation. For example, if the importance of the centralisation principle increases, the reports are concentrated in DWH and big data platforms.

Table 7.4

Optimal Report Implementation Scenarios depending on the Importance of EA Principles and Model Parameters

No.	Scenario	Service quality by the driver	Impact of road traffic safety on anxiety	Route execution delay reasons	Timely provision of services
1.	Increasing the importance of user preferences	CRM	Big data technologies	Big data technologies	CRM
2.	Increasing the importance of the centralisation principle	DWH/BI	Big data technologies	Big data technologies	DWH/BI
3.	Reducing the integration costs	DWH/BI	DWH/BI	Big data technologies	ERM
4.	Increasing economies of scale	DWH/BI	Big data technologies	Big data technologies	DWH/BI

DWH/BI – Data Warehouse; CRM – customer relationship management system; ERM – enterprise resource management system.

7.4. Expert Survey of Methodology Assessment

Expert interviews have been conducted to evaluate the methodology. Interviews have been conducted to evaluate the usefulness and feasibility of controls in practice. Interviews with 5 IT experts with over 20 years of industry experience have been conducted to evaluate the methodology. Experts are currently working in Latvian organisations in the field of IT management and IT consulting (experts interviewed from both public administration and private sector organisations). An individual face-to-face interview has been conducted with each expert.

The experts had a different assessment of the need for methodology and the usefulness of implementation. The assessment was directly related to the characteristics of the organisation represented by the expert (sector, size of the company).

The experts highly value particular methods for assessing changes rather than the methodology as a whole. Using the methodology would bring benefits to organisations, but it is necessary to re-evaluate its target group and make the methodology more detailed so that organisations have guidelines for the practical implementation of controls.

CONCLUSIONS

The goal of the Doctoral Thesis was to create a methodology for the assessment of IS changes according to the EA vision, so that IS development would contribute to the achievement of the company's goals.

To achieve the goal, the following results have been obtained.

1. The current situation of IS change management has been examined and assessed through literature review (Chapter 4) and case studies (Chapter 3).
2. The existing studies in EA-based IS change management have been examined (Chapter 4) and the potential of existing EA modelling tools has been explored in this area (Chapter 2).
3. The methodological framework has been developed for EA-based IS change management (Chapter 6).
4. Controls to be integrated into EA-based IS change management have been identified (Chapter 6).
5. Methods for the assessment of IS changes according to the principles of reusability and centralisation have been developed within the methodology (Chapter 6).
6. The developed methodology and methods, combining experiments, case studies, change cases analysis and expert interviews, have been comprehensively assessed (Chapter 7).

Within the framework of the Doctoral Thesis, the following conclusions have been made.

1. In practice, the EA development vision is not sufficiently taken into account in IS change management.
2. Problems caused by incomplete assessment of IS changes are non-compliance of IT provision with business requirements, low level of BP automation and low data integrity.
3. Existing EA-based IS change management methods are appropriate if the "right" change implementation scenario is known, but they do not provide generation and comparison of multiple change scenarios.
4. In the EA context, it is only possible to assess significant IS changes, since simple changes cannot be unambiguously linked to the EA development vision (Appendix 3).
5. It is possible to conceptualise significant cases of IS changes in the form of EA components and position in the EA model. This helps identify the EA components affected by the changes, as well as develop IS change architecture scenarios.
6. Implementation of EA controls in IS change management processes ensures the development of EA architecture in compliance with the company's strategic goals.
7. The EA development principles are used to assess the compliance of IS changes with the EA vision.
8. The EA reference models are used for IS change architecture planning by mapping the EA components affected by the planned changes to the reference model and analysing non-conformities.

9. The IS change assessment optimisation model allows adjusting the implementation costs of change implementation and ensuring compliance with the EA development principles. Experimental results demonstrate that changing the importance of the principles in the function of the goal leads to different results of changes, which prove thesis statement T. 1.
10. Empirical knowledge of the actual implementation of IS changes in EA has formalised the laws of EA analysis and can be used in the IS change planning process.
11. The benefits of the developed IS change assessment methods are as follows:
    - a more transparent decision-making process – stakeholders could get acquainted with the justification for a particular decision. For example, this would be a benefit for companies with high employee turnover;
    - reduced manual workload, the amount of time for assessment and the need to involve external experts.
12. The control environment of companies has been strengthened by facilitating progress towards the vision of EA development. The assessment results show that experts highly value specific change assessment methods rather than the methodology as a whole.
13. Experiments on the use of the reusability assessment method have demonstrated that even experts with limited information on the problem area and the EA of a particular company are able to identify the appropriate change implementation solution. This indirectly proves thesis statement T. 2, as during the evaluation the experts have considered a wider range of implementation alternatives rather than immediately choosing the most obvious solution in their opinion.

The results of the Doctoral Thesis provide an opportunity for conducting future research.

- Extension of the reusability assessment method, including the assessment of other components of architecture view, such as information items, infrastructure resources, etc., as well as expanding the scope of essential elements of architecture and essential elements of solution (i.e., elements can be viewed as a set of multi-EA view components).
- Development of methods for observing and evaluating other EA principles.
- Development of methods for change assessment in other EA views.
- Development of tools or plug-ins appropriate to the methodology.

BIBLIOGRAPHY

1. Abeloos, B.: EU Catalogue of ICT Standards / Internet. – https://joinup.ec.europa.eu/sites/default/files/ckeditor_files/files/2016Jan15%20EU%20Catalogue%20PwC%20webinar_Benoit_Abeloos.pdf.
2. Agrawal, D., Das, S., Abbadi, A. El. Big data and cloud computing: Current state and future opportunities// ACM International Conference Proceeding Series, 2011, pp. 530–533.
3. Aier, S., Buckl, S., Gleichauf, B., Matthes, F., Schweda, C.M., Winter, R. Towards a More Integrated EA Planning: Linking Transfomation Planning with Evolutionary Change / Internet. – https://pdfs.semanticscholar.org/5f25/7a41af52043d637904c2158a354532ffb1b3.pdf.
4. Aier, S., Gleichauf, B. Applying design research artifacts for building design research artifacts: A process model for enterprise architecture planning // Global Perspectives on Design Science Research, 5th International Conference, DESRIST 2010, Springer, 2010, pp. 333–348.
5. Akoum, M., Mahjoub, A. A unified framework for implementing business intelligence, real-time operational intelligence and big data analytics for upstream oil industry operators// SPE Intelligent Energy International 2013: Realising the Full Asset Value. – Manama: Society of Petroleum Engineers, 2013, pp. 230–244.
6. Ammenwerth E, Gräber S, Herrmann G, Bürkle T, König J. Evaluation of health information systems-problems and challenges. International journal of medical informatics 2003; 71(2-3):125–135.
7. Armour, F. J., Kaisler, S. H. and Liu, S. Y. Building an Enterprise Architecture Step by Step// IT professional, 1999, No. 1(4), pp. 31–39.
8. Armour, F. J., Kaisler, S. H. Enterprise Architecture: Agile Transition and Implementation// IT professional, 2001, Nr. 3(6), 30–37.
9. Armour, F. J., Kaisler, S. H., Liu, S. Y. A big-picture look at enterprise architectures// IT professional, 1999, No.1 (1), pp. 35–42.
10. ASPECT: Recommendations, Best Practices and known interoperability issues / Internet. – http://www.aspect-project.org/node/174.
11. Australian Government: Australian Government Enterprise Architecture Principles / Internet. – https://www.finance.gov.au/sites/default/files/AG-EA-Principles.pdf.
12. Avriel, M., Golany, B. Mathematical Programming for Industrial Engineers. - CRC Press, 1996. – 656 p.
13. AXELOS. Managing Successful Projects with PRINCE2® 2009 Edition. - TSO (The Stationery Office), 2009. 327 p.
14. Azevedo, C. L. B. , Almeida, J. P. A., van Sinderen, M., Pires, L. F. Towards Capturing Strategic Planning in EA// *2015 IEEE 19th International Enterprise Distributed Object Computing Conference*. – Adelaide: IEEE, 2015, pp. 159–168.

15. Bergeron, F., Buteau, C., Raymond, L. Identification of strategic information systems opportunities: applying and comparing two methodologies// MIS Quarterly, 1991, No. 15 (1), pp. 89–103.
16. Bernus, P., Noran, O., Molina, A. Enterprise architecture: Twenty years of the GERAM framework// Annual Reviews in Control, 2005, No. 39, pp. 83–93.
17. Bissyandé, T. F., Thung, F., Lo, D., Jiang, L., Réveillère, L. Popularity, Interoperability, and Impact of Programming Languages in 100,000 Open Source Projects// *2013 IEEE 37th Annual Computer Software and Applications Conference*. – Kyoto: IEEE, 2013. pp. 303–312.
18. Blom, R. Tools For Enterprise Architecture / Internet. – http://archive.opengroup.org/public/member/proceedings/q209/q209a/Presentations/blom_1.pdf.
19. Borgers, M., Harmsen, F. Case Report of Identifying and Measuring IT Architecture Principles in the Dutch Tax Agency// *2016 IEEE 18th Conference on Business Informatics (CBI)*, Parīze, 2016, pp. 100–110.
20. Buckl, S., Schweda, C. M.: On the State-of the- Art in Enterprise Architecture Management Literature. Technical Report / Internet. – https://wwwmatthes.in.tum.de/pages/qmobnr2wocn2/BS11-On-the-State-of-the-Art-in-Enterprise-Architecture-Management.
21. Buckl, S.; Ernst, A. M.; Matthes, F.; Schweda, C. M. An Information Model for Managed Application Landscape Evolution// Journal of Enterprise Architecture (JEA), 2009, pp. 12–26.
22. Cameron, B.H., McMillan, E.: Analyzing the Current Trends in Enterprise Architecture / Internet. – http://ea.ist.psu.edu/documents/journal_feb2013_cameron_2.pdf.
23. Chou, D.C., Bindu Tripuramallu, H., Chou, A. Y. BI and ERP integration// Inf. Manag. Comput. Secur. 2005, No. 13 (5), pp. 340–349.
24. Ćirić, Z., Raković, L. Change Management in Information System Development and Implementation Projects// Management Information Systems. 2010, No. 5(2), pp. 23–28.
25. CMMI Institute: Capability Maturity Model Integration. / Internet. – http://cmmiinstitute.com/.
26. Coghill, C., Zachman. J. A.: Historical Look at Enterprise Architecture with John Zachman. /Internet. http://www.irmuk.co.uk/articles/The_Open_Group_A_Historical_Look_at_EA_with_%20John_Zachman.pdf.
27. Dam, H., K., Le, L., Ghose, A. Supporting change propagation in the evolution of enterprise architectures / Internet. – http://ro.uow.edu.au/cgi/viewcontent.cgi?article=10808&context=infopapers.
28. Dam, H., K., Le, L., Ghose. Managing changes in the enterprise architecture modelling context// Enterprise Information Systems, 2005, No. 10 (6), pp. 666–696.
29. Dern, G. *Management von IT-Architekturen (Edition CIO)*. – Wiesbaden: Springer, 2009, 344 p.

30. Diefenthaler, P., Bauer, B. Gap Analysis in Enterprise Architecture Using Semantic Web Technologies// Proceedings of the 15th International Conference on Enterprise Information Systems (ICEIS), Angera, 2013, pp. 211–220.
31. Dokhanchi, A., Nazemi, E. BISC: A framework for aligning business intelligence with corporate strategies based on enterprise architecture framework// Int. J. Enterp. Inf. Syst., 2015, No. 11 (2), pp. 90–106.
32. Doucet, G., Gųtze, J., Saha, P., Bernard, S.: Coherency management: Using enterprise architecture for alignment, agility, and assurance / Internet. – http://siteresources.worldbank.org/EXTEDEVELOPMENT/Resources/JEA_May_2008_Coherency_Management.pdf?resourceurlname=JEA_May_2008_Coherency_Management.pdf.
33. Douglas C. Schmidt: Why Software Reuse has Failed and How to Make It Work for You / Internet. – http://www1.cse.wustl.edu/~schmidt/reuse-lessons.html.
34. Earl, M.H. Management Strategies for Information Technology. – NY: Prentice-Hall, Inc., 1989 – 218 p.
35. Edwards, R., Holland, J. What is Qualitative Interviewing?. – London: Bloomsbury Publishing Plc, 2013. – 134 p.
36. European Commission: ISA Decision / Internet. – https://ec.europa.eu/transparency/regdoc/rep/1/2016/LV/1-2016-550-LV-F1-1.PDF.
37. El Yamami, A., Mansouri, K., Qbadou, M., Illousamen, E. H. Toward a new multi-agents architecture for the adoption of ITIL framework by small and medium-sized enterprises// *2016 4th IEEE International Colloquium on Information Science and Technology (CiSt)*. – Tangiera: IEEE, 2016. pp. 40–45.
38. Encyclopedia of Research Design: Wilcoxon Rank Sum Test / Internet. http://methods.sagepub.com/reference/encyc-of-research-design/n500.xml.
39. Enterprise Architecture Council: Enterprise Architecture Business Intelligence (BI) Definition / Internet. – https://www.ftb.ca.gov/aboutFTB/Projects/ITSP/BI.pdf.
40. European Commission: European Interoperability Reference Architecture (EIRA) / Internet. – https://joinup.ec.europa.eu/asset/eia/description.
41. European Commission: Interopability solutions for public administrations, business and citizens (ISA) / Internet. – https://ec.europa.eu/isa2/home_en.
42. European Commission: Reusability Factsheet Template / Internet. – https://joinup.ec.europa.eu/sites/default/files/sc73_d02.03_reusability_factsheet_v4.00.pdf.
43. Farwick M., Schweda C.M., Breu R., Voges K., Hanschke I. On Enterprise Architecture Change Events// Trends in Enterprise Architecture Research and Practice-Driven Research on Enterprise Transformation. Lecture Notes in Business Information Processing, 2012, No. 131, pp. 129–145.
44. Flynn, D.J., Goleniewska, E. A survey of the use of strategic information systems planning approaches in UK organizations// Journal of Strategic Information Systems, 1993, No. 2 (4), pp. 292–319.

45. Forbes: Enterprise Architecture: Don't Be a Fool with a Tool / Internet. – https://www.forbes.com/sites/jasonbloomberg/2014/08/07/enterprise-architecture-dont-be-a-fool-with-a-tool/#5cca02057860.
46. Gall, H. ReUse: Challenges and Business Success / Internet. – https://www.ifi.uzh.ch/dam/jcr:ffffffff-fd5f-cdf8-ffff-ffff829017b4/09-reuse.pdf.
47. Garcia, V.C., Lisboa, L.B., de Almedia, E.S. Towards an Assessment Method for Software Reuse Capability// *2008 The Eighth International Conference on Quality Software*, Oxford, 2008, pp. 294–299.
48. Gartner, Enterprise Architecture Improves IT Planning Synergies / Internet. – https://www.gartner.com/doc/486421?ref=ddisp.
49. Gartner: Comparing the TCO of Centralized vs. Decentralized ERP / Internet. – https://www.gartner.com/doc/383962/comparing-tco-centralized-vs-decentralized.
50. Gartner, Magic Quadrant for Enterprise Architecture Tools / Internet. – https://www.gartner.com/doc/3723436/magic-quadrant-enterprise-architecture-tools.
51. Getter, J.R. Enterprise Architecture and IT Governance: A Risk-Based Approach// *System Sciences, 2007. HICSS 2007. 40th Annual Hawaii International Conference on,* Waikoloa, 2007, pp. 220–220.
52. Goknil, A., Kurtev, I., van den Berg, K., Spijkerman, W. Change Impact Analysis for Requirements: a Metamodeling Approach, Information and Software Technology, 2014, No. 56, pp. 950–972.
53. Grabis, J., Bondars, Ž, Kampars, J., Dobelis, Ē., Zaharčukovs, A. Context-aware Customizable Routing Solution for Fleet Management// Proceedings of the 19th International Conference on Enterprise Information Systems, 2017, No. 3, pp. 638–645.
54. Greefhorst, D. TOGAF & Major IT Frameworks, Architecting the Family / Internet. – https://www.itpreneurs.com/blog/architecting-family-togaf-major-frameworks.
55. Greefhorst, D., Proper, E. Architecture Principles The Cornerstones of Enterprise Architecture. – Berlin: Springer Berlin Heidelberg, 2011, 151 p.
56. Gringel, P., Postina, M. I-pattern for gap analysis// Software engineering 2010, Lecture Notes in Informatics, Bonn, 2010, pp. 281–292.
57. Guimarães, Th.S.M.: 21 principles of enterprise architecture for the financial sector / Internet. – http://www.ibm.com/developerworks/rational/library/enterprise-architecture-financial-sector/index.html?ca=drs.
58. Hamraz, B., Caldwell, N.H.M., Clarkson, P.J. A Holistic Categorization Framework for Literature on Engineering Change Management// Systems Engineering, 2013, No.16, pp. 473–505.
59. Hanschke, I. Strategic IT Management. A Toolkit for Enterprise Architecture Management. – Minhene: Hanser Fachburch, 2009. 342 p.
60. Henderson, J. C., Venkatraman, N. Strategic alignment: Leveraging information technology for transforming organizations// IBM Systems Journal, 1993, No. 32 (1), pp. 472–484.
61. Hentrich, C., Pachmajer, M.: The Path to Digital Business / Internet. – http://www.dquarks.com/wp-content/uploads/2016/10/d.quarks-leseprobe-engl.pdf.

62. Hess, C., Lautenbacher, F., Fehlner, K. Business Building Blocks as Coordination Mechanism for Enterprise Transformations// *2013 17th IEEE International Enterprise Distributed Object Computing Conference Workshops,* 2013, pp. 194–203.
63. Hevner, A., March, S., Park, J., Ram, S. Design science in information systems research// MIS quarterly, 2004, No. 520, pp. 75–105.
64. Hilt B.: What is ITIL / Internet. – http://www.ariscommunity.com/users/bhi/2009-10-29-what-itil.
65. Hofer, S. Modeling the Transformation of Application Landscapes// Lecture Notes in Business Information Processing, LNBIP-165, 2003, pp. 101–113.
66. Hoogervorst, J. Enterprise architecture: Enabling integration, agility and change// Int. J. Coop. Inf. Syst., 2004, No. 13 (3), pp. 213–233.
67. Howard, C. Experience sharing: How COBIT & ITIL fit into Change Management / Intenet. – http://www.itsmf.org.hk/eng/event35/Carl_COBIT_ITIL_for_Change_Mgmt.pdf.
68. Hugoson, MÅ. Centralized versus Decentralized Information Systems// IFIP Advances in Information and Communication Technology, 2009, No. 303, pp. 106–115.
69. ISACA: COBIT 5 Implementation, ISACA / Internet. – https://www.isaca.org/cobit/Documents/COBIT-5-Implementation-Introduction.pdf.
70. ISACA: COBIT 5: A Business Framework for the Governance and Management of Enterprise IT / Internet. – https://www.isaca.org/cobit/Documents/COBIT-5-Introduction.pdf.
71. ISACA: COBIT 5: Enabling Processes / Internet. – https://www.isaca.org/cobit/Documents/COBIT-5-Enabling-Processes-Introduction.pdf.
72. ISO/IEC 27000:2016**:** Information technology – Security techniques – Information security management systems / Internet. – https://www.iso.org/standard/66435.html.
73. ISO/IEC/ IEEE 42010: Systems and software engineering – Architecture description / Internet. – https://www.iso.org/standard/50508.html.
74. Isummation Technologies: Enterprise Application Architecture / Internet. – http://www.isummation.com/it-services/application-development/enterprise-application-development/enterprise-application-architecture/.
75. IT Governance Institute (ITGI): Enterprise Value: Governance of IT Investments, The Val IT Framework 2.0 / Internet. – https://www.isaca.org/Knowledge-Center/Val-IT-IT-Value-Delivery-/Documents/Val-IT-Framework-2.0-Extract-Jul-2008.pdf.
76. IT Governance Institute and The Office of Government Commerce: Aligning CobiT® 4.1, ITIL® V3 and ISO/IEC 27002 for Business Benefit / Internet. – http://www.isaca.org/Knowledge-Center/Research/ResearchDeliverables/Pages/Aligning-COBIT-4-1-ITIL-V3-and-ISO-IEC-27002-for-BusinessBenefit.aspx.
77. IT process Maps GbR: ITIL reference model for the ARIS Process Platform™ / Internet. – https://en.it-processmaps.com/products/itil-process-map-aris.html.
78. Jain, N.: Software Reuse / Internet. – https://www.scribd.com/presentation/13341998/Software-Reuse.

79. Jarrat, T., Clarkson, J., Eckert, C. Design process improvement. – Londona: Springer, 2004. pp. 262–285.
80. Jarratt, T.A.W., Eckert, C.M., Caldwell, N.H.M., Clarkson, P.J. Engineering change: An overview and perspective on the literature, Res Eng Des, 2011, Nr. 22 (2), pp. 103–124.
81. Keller, W. IT-Unternehmensarchitektur. – Berlīne: dpunkt.verlag, 2012.
82. Koehler, T., Alter, S. Using enterprise architecture to attain full benefits from corporate big data while refurbishing legacy work systems// CEUR Workshop Proceedings, 2016, No. 1753, pp. 1–11.
83. Lautenbacher, F., Diefenthaler, P., Langermeier, M., Mykhashchuk, M., Bauer, B. Planning Support for Enterprise Changes// Lecture Notes in Business Information Processing, 2013, pp. 54–68.
84. Lederer, A.L., Sethi, V.:The implementation of strategic information systems planning methodologies// MIS Quarterly, 1998, No. 12 (3), pp. 445–461.
85. Lederer, M., Knapp, J. Schott, P. The digital future has many names—How business process management drives the digital transformation// *2017 6th International Conference on Industrial Technology and Management (ICITM)*. – Cambridge: IEEE, 2017. pp. 22–26.
86. Li, Z., Liang, P., Avgeriou, P. Architectural Technical Debt Identification Based on Architecture Decisions and Change Scenarios// *2015 12th Working IEEE/IFIP Conference on Software Architecture*. Montreal: IEEE, 2015, pp. 65–74.
87. Luftman, J.N., Lewis, P.R., Oldach, S.H. Transforming the enterprise: The alignment of business and information technology strategies// IBM Systems Journal 1993, No. 32(1), pp. 198–221.
88. Malone, T., Interoperability in Programming Languages / Internet. – http://digitalcommons.morris.umn.edu/cgi/viewcontent.cgi?article=1014&context=horizons.
89. Matthes, F., Buckl, S., Leitel, J., Schweda, C.M. Enterprise Architecture Management Tool Survey 2008 / Internet. – https://wwwmatthes.in.tum.de/file/1ae7cg9fjm9bg/sebis-Public-Website/Publications/eamts2008_final.pdf.
90. Meta Group Inc.: Enterprise Architecture Desk Reference / Internets. – http://web.stanford.edu/~bvincent/Strategy/Enterprise_Architecture_Report.
91. Mili, A., Fowler Chmiel, S., Gottumkkala, R., Zhang, L. An integrated cost model for software reuse// Proceedings of the 22nd International Conference on Software Engineering (ICSE'00). Limerick: IEEE, 2000. pp. 157–166.
92. Mili, H., Mili, A., Yacoub, S., Addy E. Reuse Based Software Engineering: Techniques, Organizations, and Measurement – ASV: Wiley-Interscience, 2001, 650 p.
93. Mrdalj, U. A.: COMPARISON OF ENTERPRISE ARCHITECTURE FRAMEWORKS / Internet. – http://ggatz.com/images/SOA_COMPARE.pdf.
94. Nandi, M. L., Kumar J., A. Centralization and the success of ERP implementation// Journal of Enterprise Information Management, 2016, No. 29, pp. 728–750.
95. Newman, M. Networks: An Introduction. – Oxford: OUP Oxford, 2010. – 784 p.

96. Niu, N., Da Xu, L., Cheng, J. R. C., Niu, Z. Analysis of Architecturally Significant Requirements for Enterprise Systems// *IEEE Systems Journal*, 2014, No. 8 (3), pp. 850–857.
97. Nofal, M. I. M., Yusof, Z. M. Conceptual model of enterprise resource planning and business intelligence systems usage// Int. J. Bus. Inf. Syst., 2016, No. 21(2), pp. 178–194.
98. Noran. O.: Using Reference Models in Enterprise Architecture: An Example / Internet. – http://www.researchgate.net/profile/Ovidiu_Noran/publication/269575978_Using_Reference_Models_in_Enterprise_Architecture_An_Example/links/548f7b380cf214269f263c50.pdf.
99. Ohta, T., Murakami, H., Igaki, H., Higo, Y., Kusumoto, S. Source code reuse evaluation by using real/potential copy and paste// *2015 IEEE 9th International Workshop on Software Clones (IWSC)*. – Montreal: IEEE, 2015. pp. 33–39.
100. Mohagheghi, P., R. Conradi, An Empirical Investigation of Software Reuse Benefits in a Large Telecom Product, ACM Transactions on Software Engineering and Methodology, Vol. 17(3), June 2008.
101. Perks C., Beveridge, T. Guide To Enterprise IT Architecture – NY: Springer-Verlag New York, Inc., 2003. 473 p.
102. Philip Chen, C. L., Zhang, C.-Y. Data-intensive applications, challenges, techniques and technologies: A survey on Big Data// Inf. Sci. (Ny)., 2014, No. 275, pp. 314–347.
103. Pirta R. Towards Strategic Information Systems Change Management// *Proceedings of Doctoral Consortium on Enterprise Information Systems (DCEIS 2015)*.- Barcelona, 2015, pp. 3–11.
104. Pirta, R., Grabis, J. Evaluation of Changes in Information Systems According to Enterprise Architecture Evolution Goals and Principles// Baltic J. Modern Computing, 2016, 4 (1), pp. 59–67.
105. Pirta, R., Grabis, J. Integrated methodology for information systems (IS) change control based on enterprise architecture (EA) models// *Information Technology and Management Science*, 2015, No. 18(1), pp. 103–108.
106. Plataniotis, G., De Kinderen, S., Ma, Q., Proper, E. A Conceptual Model for Compliance Checking Support of Enterprise Architecture Decisions// Proceedings – 17th IEEE Conference on Business Informatics, CBI 2015, 2015, No. 1, pp. 191–198.
107. Plataniotis, G., De Kinderen, S., Proper, H.A. Relating decisions in enterprise architecture using decision design graphs// IEEE International Enterprise Distributed Object Computing Workshop, EDOC. – Vancouver: IEEE, 2013. pp. 139–146.
108. Armstrong Process Group Inc.: Understanding Reference Models and Reference Architectures / Internet. – https://resources.sei.cmu.edu/asset_files/Presentation/2014_017_101_90458.pdf.
109. POSC Data Store Solutions: POSC E&P Business Process Reference Model / Internet. – http://w3.energistics.org/epbprm/epbprm_v1.0_a4.pdf.

110. Postina, M., Sechyn, I., Steffens, U. Gap analysis of application landscapes// Proceedings of 13th Enterprise Distributed Object Computing Conference Workshops, 2009, pp. 274–281.
111. Premkumar, G., King, W. Assessing strategic information systems planning// Long Range Planning, 1991, No. 24 (5), pp. 41–58.
112. Premkumar, P., King, W. Organizational characteristics and information systems planning: an empirical study// Information Systems Research, 1994, No. 5 (2), pp. 75–109.
113. PricewaterhouseCoopers: Enterprise Architecture Training materials, 2009.
114. PricewaterhouseCoopers: Transform change management methodology, 2011.
115. Project Management Institute (PMI): PMBOK Guide and Standards / Internet. – https://www.pmi.org/pmbok-guide-standards.
116. Prosci: ADKAR change management model overview / Internet. – https://www.prosci.com/adkar/adkar-model.
117. Pulkkinen, M. 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), 2006, pp. 179–188.
118. Reese, R. Software reuse and simulation// Proceedings of the 19th conference on Winter simulation, Atlanta, Georgia, USA, ACM, 1987, pp. 185–192.
119. Ross, J.W., Weill, P., Robertson, D.C. Enterprise Architecture as Strategy. – Bostona: Harvard Business School Press, 2006 – 256 p.
120. Rostami, K., Heinrich, R., Busch, A., Reussner, R. Architecture-Based Change Impact Analysis in Information Systems and Business Processes// *2017 IEEE International Conference on Software Architecture (ICSA)*. – Goteburg: IEEE, 2017. pp.179–188.
121. Runeson, P., Höst, M. Guidelines for conducting and reporting case study research in software engineering / Internet. – http://portal.research.lu.se/portal/files/2838283/1276782.pdf.
122. Schekkerman, J. How to Survive in the Jungle of Enterprise Architecture Frameworks: Creating or Choosing an Enterprise Architecture Framework. – Manchester: Trafford Publishing; 2nd ed. Edition, 2003, 268 p.
123. Selby, W. Enabling reuse-based software development of large-scale systems// IEEE Trans. Software Engineering, 2005, No.31(6), pp. 495–510.
124. Sessions, R. A.: Comparison of the Top Four Enterprise-Architecture Methodologies / Internet. – https://msdn.microsoft.com/en-us/library/bb466232.aspx.
125. Sommerville, I. Software Engineering, 9th Edition – Pearson, 2011, pp. 429–452.
126. Stelzer, D. Enterprise architecture principles: literature review and research directions// Service-Oriented Computing. ICSOC/ServiceWave 2009 Workshops. Lecture Notes in Computer Science, 2009, No, 6275, pp. 12–21.
127. Sylvester, D. The Haze of Frameworks and Standarts: Where Does Cobit Fit? / Internet. – https://www.isaca.org/Knowledge-Center/cobit/Documents/COBIT-Focus-Vol-1-2007.pdf.

128. W. Jarratt, T. A., T. A. W., Eckert, C.M., Caldwell, N. H. M., Clarkson, P. J. Engineering change: An overview and perspective on the literature// Reseach in Engineering Design 2010, No. 22(2), pp. 103–124.
129. Tang, A., Lau, M.G. Software architecture review by association// Journal of Systems and Software 88, 2014, No. 88, pp. 87–101.
130. The Open Group: TOGAF, Version 9.1 / Internet. – http://pubs.opengroup.org/architecture/togaf9-doc/arch/.
131. TM Forum: The Business Process Framework (eTOM) / Internet. – https://www.tmforum.org/business-process-framework/.
132. TSO: An Introductory Overview of ITIL / Internet. – https://www.tsoshop.co.uk/gempdf/itSMF_An_Introductory_Overview_of_ITIL_V3.pdf.
133. Tuncer, O., van den Berg, J.: Implementing BI concepts with Pentaho, an evaluation / Internet. – http://www.enixe.nl/Upload/Productvergelijk/enixe-it-solutions-pentahoevaluation.pdf.
134. Turban, E., Sharda, R.E., Delen, D. Decision Support and Business Intelligence Systems, 8th ed. – Ņujorka: Pearson Prentice Hall, 2007. 720 p.
135. United Kingdom Government: UK Government Reference Architecture (UKRA) / Internet. – https://www.gov.uk/government/publications/uk-government-ict-strategy-resources.
136. van Strien, P.J. Towards a methodology of psychological practice: The regulative cycle// Theory & Psychology, 1997, No. 7(5), pp. 683–700.
137. Venable, J., Pries-Heje, J., Baskerville, R. A Comprehensive Framework for Evaluation in Design Science Research// Design Science Research in Information Systems. Advances in Theory and Practice, ser. Lecture Notes in Computer Science. – Berlin: Springer Berlin Heidelberg, 2012, pp. 423–438.
138. Vicente, M., Gama, N., Mira da Silva, M. Using Archi- Mate to Represent ITIL Metamodel// CBI '13 Proceedings of the 2013 IEEE 15th Conference on Business Informatics – Washington: IEEE Computer Society Washington, 2013. pp. 270–275.
139. Vicente, M., Gama, N., da Silva, M.M. The Value of ITIL in Enterprise Architecture// *2013 17th IEEE International Enterprise Distributed Object Computing Conference* – Vancouver, 2013, pp. 147–152.
140. Vicente, M., Gama, N., Mira da Silva, M. Using Archi-Mate and TOGAF to Understand the Enterprise Architecture and ITIL Relationship// Advanced Information Systems Engineering Workshops. CAiSE 2013. Lecture Notes in Business Information Processing, 2013, No. 148, pp. 134–145.
141. Vides aizsardzības un reģionālās attīstības ministrija: Eiropas Sociālā fonda projekts Nr. 1DP/1.5.1.2.0/08/IPIA/SIF/002 "Publisko pakalpojumu sistēmas pilnveidošana". Ar pakalpojumiem saistīto informācijas sistēmu arhitektūras rekomendējamā modeļa izstrāde. Mērķarhitektūra un tās ieviešanas ceļa karte / Internets. – http://www.google.lv/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwii-t_82NnUAhVDYJoKHWwzBm0QFggqMAE&url=http%3A%2F%2Fwww.varam.gov.lv%2Fin_site%2Ftools%2Fdownload.php%3Ffile%3Dfiles%2Ftext%2FFinansu_instru

menti%2Fes07_13%2F15120%2F%2FN3_Merka_arhitektura_v05.pdf&usg=AFQjCNG8IvUwxBhWv9cw4rf5WMKF27ZEZg.

142. Vinobha, A., Senthil Velan, S., Babu, C.:Evaluation of reusability in Aspect Oriented Software using inheritance metrics// *IEEE International Conference on Advanced Communications, Control and Computing Technologies* – Ramanathapuram: IEEE, 2014. pp. 1715–1722.
143. Wagter, R., van den Berg, M., Luijpers, J., van Steenbergen, M. Dynamic Enterprise Architecture: How to Make IT Work. – USA: Wiley, 2005. p. 256.
144. Waguespack, L.J., Schiano, W.T. A Reuse Reference Grid for Strategic Reuse Goals Assessment// *Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS'06)*. – Kauia: IEEE, 2006, pp. 228a–228a.
145. Wegmann, A. On the Systemic Enterprise Architecture Methodology (SEAM)// Proceedings of the International Conference on Enterprise Information Systems 2003 (ICEIS 2003), Angera, 2003, pp. 1–8.
146. Whelan, J., Meaden, G.: Business Architecture: A Practical Guide / Internet. – https://www.ashgate.com/pdf/SamplePages/Business-Architecture-Ch13.pdf.
147. Wieringa, R. Design science as nested problem solving// Proceedings of the 4th International Conference on Design Science Research in Information Systems and Technology. – Pennsylvania: ACM, 2009. pp. 1–12.
148. Wieringa, R. Relevance and problem choice in Design Science// Global Perspectives on Design Science Research. - Berlin: Springer Berlin / Heidelberg, 2010. pp. 61–76.
149. Wieringa, R., Morali, A. Technical action research as a validation method in information systems Design Science// Design Science Research in Information Systems. Advances in Theory and Practice. – Berlin: Springer. 2012. pp. 220–238.
150. Wieringa, R.J. Requirements Engineering: Frameworks for Understanding. – NY: Wiley, 1996. 470 p.
151. Winter, R., Aier, S. How are Enterprise Architecture Design Principles Used?// *2011 IEEE 15th International Enterprise Distributed Object Computing Conference Workshops*, Helsinki, 2011, pp. 314–321.
152. Wright, I.C. A review of research into engineering change management: Implications for product design// Design Studies No. 18, 1997, pp. 33–39.
153. Wu, J., Liu, Y.P., Jia, X.X., Liu, C. Mining Open Source Component Behavior and Performance for Reuse Evaluation// *2008 The 9th International Conference for Young Computer Scientists*. – Hunana: IEE, 2008. pp. 1241–1247.
154. Zhang, W., Jarzabek, S. Reuse without compromising performance: industrial experience from RPG software product line for mobile devices// Proceedings of the 9th int'l Software Product Line Conference (SPLC'05). – Berlin: Springer, 2005. pp. 57–69.