School of Technology

Department of Computer Science

Master Thesis Project 30p, Spring 2014

Challenges and success factors in the migration of legacy systems to Service Oriented Architecture (SOA)

By

Nataliya Vlizko

Supervisor: Annabella Loconsole

Examiner: Paul Davidsson

Abstract

Service-Oriented Architecture (SOA) provides a standards-based conceptual framework for flexible and adaptive systems and has become widely used in the recent years because of it. The number of legacy systems has already been migrated to this platform. As there are still many systems under consideration of such migration, we found it relevant to share the existing experience of SOA migration and highlight challenges that companies meet while adopting SOA. As not all of these migrations were successful, we also look into factors that have influence on the success of SOA projects.

The research is based on two methods: a literature review and a survey. The results of the thesis include identification and quantitative analysis of the challenges and success factors of SOA projects. We also compare the survey results for different samples (based on the company industry, work area, size, and respondents experience with SOA and respondents job positions).

In total, 13 SOA challenges and 18 SOA success factors were identified, analyzed and discussed in this thesis. Based on the survey results, there are three SOA challenges received the highest importance scores: “Communicating SOA Vision”, “Focus on business perspective, and not only IT perspective” and “SOA Governance”. The highest scored SOA success factor is “Business Process of Company”. While comparing different samples of the survey results, the most obvious differences are identified between the results received from people with development related job positions and people with business related job positions, and the results from companies of different sizes.

Keywords: SOA, Service Oriented Architecture, SOA challenges, SOA migration, Legacy Systems, SOA success factors.

Acknowledgement

This thesis would not have been possible without the valuable contribution and guidance of certain people.

First and foremost I offer my sincerest gratitude to my supervisor Professor Annabella Loconsole who has supported me throughout my thesis with patience and knowledge. I would also like to thank you my examiner Professor Paul Davidsson for valuable feedback and suggestions for improvement.

Besides that, I would also like to thank the people who responded to the survey used in the research for their input. They have shared valuable insights in this study.

Last but not least, I would like to show my deepest gratitude to my family for their support through my studies.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

BPM - Business Process Management/Modeling

CGI – Common Gateway Interface

COTS – commercial off-the-shelf

CRM - Customer Relationship Management

DDS - Data Distribution Service

EA - Enterprise Architecture

EAI - Enterprise Application Integration

ERP - Enterprise Resource Planning

GUI - Graphical User Interface

IT - Information Technology

LOB – Line of Business

ROI – Return on Investment

SCM - Supply Chain Management

SDLC - Software Development Life Cycle

SLA - Service Level agreements

SOA – Service Oriented Architecture

SOAF – Service Oriented Architecture Framework

SMART - Service-Oriented Migration and Reuse Technique

SMAT-AUS - Service Migration Assessment Technology - Australia

SRM - Supplier Relationship Management

TCO - Total Cost of Ownership

WSDL - Web Service Description Language

XML - Extensible Markup Language

XSD - XML Schema Definition

List of Terms

The term *'challenges'* refers to things that are imbued with a sense of difficulty.

The term *'legacy system'* refers to the old method, technology, computer system or application program, often implies that the system is out of date or in need of replacement.

The term *'factors'* refers to important components or steps when conducting migration of legacy system into SOA.

The term *'success'* refers to the accomplishment of organizational objectives as well as organizational goals specifically through migration of legacy systems into SOA.

The term *'success factors'* refers to those factors which can affect and play a role in the success of migrating the legacy systems into SOA.

Terms '*organization*' and '*company*' (used interchangeably) refers to an association or collection of individuals that share a common purpose and unite in order to focus their various talents and organize their collectively available skills or resources to achieve specific, declared goals.

1. Introduction

Nowadays the need for integration of information, business process, and knowledge becomes both relevant and necessary. In response to such need, service-oriented architecture (SOA) is becoming more and more relevant and major software corporations are venturing deeper into this area. Google, Microsoft and Amazon are currently amongst the largest contributors to SOA.

The area is driven by the need for organizations to quickly adapt to rapid changes, lower cost as well as insuring reusability of multiple entities across the enterprise. The benefits are many if the existing functionality could be reused instead of being re-developed for each part of the organization. At the same time, the use of SOA allows overcoming performance challenges, difficulties of integrating different technologies and programming languages among others. It improves the efficiency, flexibility and productivity of business by splitting business logic associated units and placing them as the primary form of access to underlying systems and functionality, among others.

SOA is often defined in two perspectives: business and technical. From a business perspective, SOA is a set of services that a business wants to expose to their customers and partners, or other portions of the organization [1]. From a technical perspective, SOA is an architectural principle followed by organizations in order to reduce total cost of ownership (TCO), ease of maintenance in software development, improve time to market IT responsiveness and/or establish a flexible platform for future expansion. The technical perspective is more focused on the technical issues of the implementation of SOA while business perspective studies the business internal and external factors which might affect the successes or failure of the project of migrating to SOA in an organization. In this research, we studied SOA from a business perspective, while considering technical perspective where it was relevant. We chose to consider the SOA term as provided by the Oasis Group [2], where SOA is defined as a paradigm that organizes business logics dispersed across different domains, creates new services from them, and compiles them to create further services again.

As the popularity of SOA has increased, organizations across many industries have moved or are in the process of moving towards SOA [3]. More and more organizations have chosen to use SOA as an architectural solution to provide a robust computing platform. A look at the TechTarget/Forrester Research State of SOA Survey for 2010 suggests that SOA is in fact broadly entrenched today. The results of the survey show that 47.4 % of respondents work in organizations where SOA projects are underway, and 30.9% have multiple SOA projects underway [4]. In many organizations, years of

changing business needs have resulted in complex, inflexible application architectures, often with high levels of redundancy of business functions and data [5]. The cost of maintaining such systems keeps accumulating with higher margins every year, causing organizations to spend more money just to keep their business running on a regular basis [6]. As a solution for the raised problem migration to SOA is often considered.

1.1 Problem

Increasing interest in SOA and increasing number of migrations towards SOA create a challenge. Many of the organizations using SOA are facing challenges in governance, testing, configuration, version control, metadata management, service-level monitoring, security and interoperability [7]. Varadan *et al.* [5], based on experience with more than a few hundred enterprises involved in SOA migration and transformation, identified four areas of challenges: technology, program management, organization and governance and briefly described them in their research. According to Galinium *et al.* [8], the challenge facing most companies is not whether to adopt SOA, but about when and how to adopt SOA.

Besides that, not in all cases the process of migrating of legacy systems into SOA was successful. Most companies have a long way to in order to implement SOA in a successful way [9]. Some companies have been disappointed by the low level of service-sharing ("reuse") that they have achieved, and some SOA projects have failed for a variety of reasons [7]. Many companies have common problems in SOA migration because they start the SOA migration process based on the IT perspective instead of a business one [10]. The implementation might appear successful at that time, but the impact after adopting the new architecture could not be aligned with the business goals of the company [8]. The level of success depends on some factors that vary from one infrastructure to another, from one business process to another. Succeeding with SOA is not always about transforming the entire organization. Frequently, focusing on a specific problem area or objective is an excellent starting point for increasing the service orientation of an organization [1].

1.2 Existing research

SOA is interesting to the researchers and a number of works about the migration of legacy systems into SOA have been already studied and published. Chatarij [11] provided a summary of the business advantages of migration to SOA. Varadan *et al.* [5] underlined importance of governance in SOA migration process and described a framework, the SOA governance model, and four approaches in achieving services flexibility and reuse. Several researchers [12] [13] [14] focused on the different

strategies and techniques that can be used in adopting SOA. Comella-Dorda *et al.* [12] underlined that organizations must consider modernizing the legacy systems and provided a general overview of modernization techniques including screen scraping, database gateway, XML integration, CGI integration, object-oriented wrapping and "componentization" of legacy systems. Canfora *et al.* [13] have discussed the wrapping methodology used in order to make functionalities of legacy systems accessible as web services. Almonaies *et al.* [14] have discussed the various approaches and methods used in the migration of legacy systems towards SOA and have provided a review of the existing literature in the area of legacy system modernization strategies to SOA.

Few researchers questioned the success of SOA projects. Franzen [15] in the year 2008 highlighted the essential factors to success with SOA in five case studies. According to her research findings, governance is a key factor to succeed with SOA. Similar research has been done a year later by Galinium and Shahbaz [8] as a master thesis and becomes a fundament for their published work in 2012 [10]. Galinium and Shahbaz [8] [10] identified factors affecting successful migration of legacy systems into SOA from business and technical perspectives in five different companies with different enterprises including bank, furniture, engineering and airline companies in Europe. While analyzing success factors in 2012 [10], they discovered that only three among ten mentioned success factors have been applied and mentioned as affecting by all of the five companies. These factors include: Potential of Legacy Systems to be migrated into SOA, Strategy of migration to SOA, and SOA Governance.

1.3 Goals and Research Questions

In this research, we identify challenges and success factors of SOA projects. In aiming to define challenges and success factors in the SOA migration process, we look at how they influence business goals.

This research has two main goals:

- Identify and analyze challenges in migration of legacy systems to SOA
- Identify and analyze success factors of SOA projects

The following two research questions have been identified:

RQ1: What are the major *challenges* in migration of legacy systems to SOA?

RQ2: What *factors* influence the success of migration of legacy systems to SOA?

1.4 Contributions

The previous researchers identify some of the SOA challenges, but do not make clear which SOA challenges are the most critical and which are less important. In our research, we aggregate the list of possible SOA challenges from the number of previous research works, and use a questionnaire to identify the importance of each of SOA challenges, based on the data received from the numbers of companies. Since SOA has the potential to offer significant benefits to an organization, there is a need to explore more about the challenges an organization meets while adopting SOA and make this experience to be available for reuse across the companies.

Besides the challenges the companies have to overcome in SOA projects, there are factors that have an impact on successful outcome of SOA projects. The existing research is based on the small numbers of the study cases. We think that there is a possibility to create more extensive knowledge by analyzing success factors in SOA projects from more companies. In our research, it is done by using questionnaires shared between the relevant audiences and analyzed afterwards. It is worth to do further research where we aggregate the success factors from the previous research works and clarify the importance of each success factor by performing quantitative analysis. It will help to identify percent weight of each success factor and to prioritize them more significantly.

This thesis can be used as a guideline for those approaching to migrate their legacy systems to SOA. It will help companies have better planning and strategy to manage the complexity of migration legacy systems into SOA. By sharing existing experience of companies that have already migrated to SOA, we help those companies that consider adopting SOA, have just started such process or are in the middle of the SOA migration process and meet some challenges.

1.5 Thesis outline

The remaining chapters of the thesis preamble are organized as follows:

- Chapter 2 gives an introduction to the research methods used in this thesis, such as a literature review and a survey.
- Chapter 3 describes the literature review of challenges and success factors in migration towards SOA.
- Chapter 4 describes the survey results of challenges and success factors in migration towards SOA.
- Chapter 5 provides conclusions and future directions of research.

2. Research methods

The main purpose of this chapter is to present a methodology which underlines this study and provides the theoretical basis for the chosen strategy and methods.

In this study in order to accomplish the main goals of research and to answer the two research questions, we have applied two research methods: a literature review and a quantitative survey.

The literature review is implemented with the aim of understanding the research topic and extracting information regarding the research questions. Furthermore, the literature review helps us to determine gaps in the current research and to choose additional methods to work with, the survey in our case.

The survey is constructed to extend the literature review results. Interviews and questionnaires are typically used to collect qualitative and quantitative data. The questionnaire is chosen in this thesis in order to perform the quantitative analysis of challenges and success factors in SOA projects. We choose a questionnaire because it allows to get a great number of inputs in the short period of time.

The overview of the research process is presented in Figure 1.

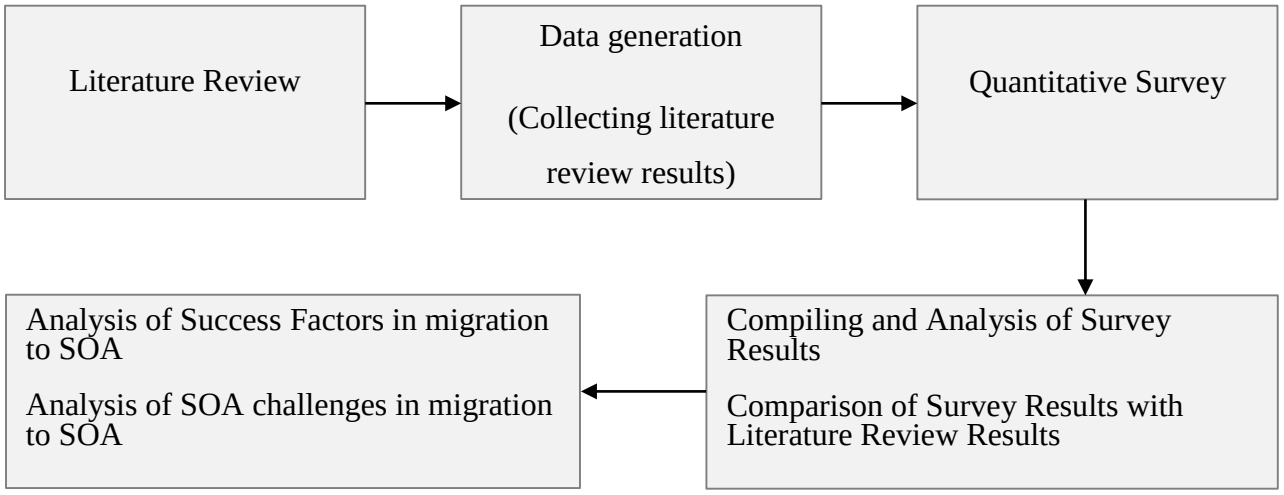


Figure 1 Research Methodology

2.1 Literature Review

This literature review provides the foundation for our research. The purpose of this literature review is to gain knowledge in the area of migration to SOA.

The literature review was conducted through the extensive search where we studied a number of research papers. We defined four key concepts we would like to find information about: SOA, Legacy systems migration to SOA, SOA challenges and SOA success factors. For each of these concepts we defined alternative keywords and synonyms, which are displayed in Table 1.

Table 1 Alternative terms for search concepts

SOA	Legacy systems migration to SOA	SOA challenges	SOA success factors
Service Oriented Architecture	SOA migration	SOA problems	SOA success
Service-oriented architecture	Legacy applications migration	SOA difficulties	SOA success rate
Services architecture	Legacy migration	Challenges in SOA	Succeed with SOA

While performing a search, we used both key concepts and synonyms. In the beginning we searched for the key concepts and did not include them in quotes. This resulted in too many results, a lot of them were irrelevant (not informative to answer our research questions). For instance, keyword "SOA challenges" had 1145 hits, keyword "SOA success factors" – 531 hits, and "SOA migration" – 341 hits. Then we continued our search for the key concepts, placing each of them in quotes. It created another problem – we did not get enough results for some of the key concepts, such as "Legacy migration to SOA" and "SOA success factor". In these cases, using synonyms was very useful. For instance, while searching for "Legacy systems migrations to SOA", we did not find any results if we searched for the whole phrase. Then we searched for a synonymic part of the phrase "SOA migration" and found 43 results. The same was for "SOA success factors". We did not find any results, when we searched for "SOA success factors" and got 49 results while searching for "SOA success".

In total, we chose 70 literature sources, based on the content of the abstract. Then we critically evaluated the content of each paper and its relevance to our research by quick reading every paper. Some of these papers were not useful for our research and we narrowed 70 literature sources to 36, where we found the content to be helpful and informative in order to give us the answers to the two research questions we have.

Most of the resources used in this literature review are published between 2006 and 2012 – see Figure 12 in Appendix 1 for an overview of the literature sources by published year. Out of 36 SOA literatures used in this literature review, 6 papers are relevant both for SOA challenges and SOA success factors, 22 papers highlight only SOA challenges and 8 papers highlight only SOA success factors. In total, 28 papers were used to review SOA challenges and 14 papers were used to review SOA success factors.

The outcome of this literature review is the list over SOA challenges and success factors of SOA projects (see Table 2 for SOA challenges and Table 4 for SOA success factors), the frequency analysis (see Table 3 for SOA challenges and Table 5 for SOA success factors) and a detailed description of each item.

Information, aggregated from the literature review, is compared with the results from the online survey, where we are also seeking the answers to our two research questions. The quantitative analysis of SOA challenges and success factors is performed in order to identify their importance.

2.2 Survey

The purpose of the survey is to find the answers to two research questions we have. This section describes how we did the survey, how we design the questions and how we select the population.

Oates [16] outlines six different activities in planning and designing a survey – data requirements, data generation method, sampling frame, sampling techniques, response rate and non-responses, and sample size. Below we describe how we perform these activities in our research work.

2.2.1 Data requirements

While planning survey, the first step was to decide what data we wanted to generate. Our target was to generate data that helps us to find the answers to our two research questions and is received from proper audience. For this purpose, we include two types of data in our survey: directly related and indirectly related.

Directly-related data in our survey include information about SOA challenges that organization has experienced during migration to SOA and information about the components and steps, which had an influence on success of SOA projects. We have four questions which generate directly related data: Q3, Q4, Q5, and Q6 (see Appendix 4 for all survey questions and section 2.2.2 for a brief overview of all questions).

Q4 and Q6 are based on the list of SOA challenges and the list of SOA success factors derived from the literature review. In these questions we ask to evaluate the importance of each criteria by using LIKERT scale, where each criteria is given a score from 1 to 5. 1 means "Not at all important" and 5 means "Extremely important". The respondents have possibility to choose "N/A", if they find a particular element not applicable to their organization.

We also expect to have some differences in the SOA challenges and in the SOA success factors derived from the literature review, compare to those, respondents of the survey might have experienced. Therefore, in Q3 and Q5 we ask about three most important SOA challenges and three most important SOA success factors the companies have been experiencing.

Besides that, we wanted to see relationships between the evaluation of SOA challenges and SOA success factors and other factors, such as respondents' job positions, work area, industry and so on. We achieve this by including the questions generated indirectly related data. There are six questions in the research that generate information about organization, industry, size, and IT role of the person responding to a survey - Q1, Q2, Q7, Q8, Q9, and Q10. Indirectly related data are also necessary in order to insure that we study the survey responses received from the proper audience.

2.2.2 Data generation method

Data generation in surveys can be done by means of questionnaires, interviews, observations and documents. We chose to use a questionnaire because it provides an efficient way to systemize data and allows covering a large geographical location.

The questionnaire is designed as a self-administrative form [17] and consists of four parts including the SOA state in the company, SOA challenges, SOA success factors and general questions about a respondent. We divided the survey into four sections because we had questions related to four different topics: the company itself, the respondents' experience with SOA, SOA challenges and SOA success factors. In 'Present state of SOA' part we ask about work area of SOA applications and company experience in using SOA. In 'SOA challenges' and 'SOA success factors' parts, participants are asked to evaluate the importance of listed elements and to name the most important three, SOA challenges and SOA factors accordingly. 'General questions' part highlights information about the company size and industry and particular information about the respondent, such as experience in SOA and a job title.

Below a brief overview of the survey questions:

Q1. How long it has been from your company started using SOA to now?

We created this question in order to be aware of the organization's experience with SOA and to ensure that analyzed data is received from the organizations where SOA projects have been implemented or are in progress. It is a closed choice question, where only one answer is allowed.

Q2. What is the work area to which the application of SOA was reviewed or implemented?

This question allows to highlight organizations' work areas where SOA projects are undertaken most often. We allowed to have multiple areas to be chosen for this question as SOA projects often cover more than one work area. Besides that, the question has a purpose to create fundament for further research - received data can be grouped by work area and analyzed for any differences, in connection to the work area. It is a semi-closed choice question, where multiple answers can be given and a work area not presented in the list can be specified.

Q3. What do you think is a challenge in SOA migration? Please write your thoughts about SOA challenges, including reasons.

This question was created in order to identify the challenges companies meet while adopting to SOA. We think that one single company can differ from another and might be different from those companies the previous researchers based their works on. We wanted to give the possibility for respondents to share their thoughts and experience in a free form. At the same time, we wanted to identify if the literature review findings are different or similar to the "real world" companies experience. It is an open question.

Q4. Below are the challenges in SOA migration derived through literature review. Please rate the importance of them in your organization below on a scale of 1 to 5, where 1 is "not at all important" and 5 is "extremely important".

This question was created in order to identify the importance of the challenges companies meet while adopting to SOA. This question includes rating of 13 SOA challenges derived from the literature review. It is a closed question designed in LIKERT scale format.

Q5. What do you think is a critical factor in SOA migration? Please write your thoughts about critical success factors, including reasons. (Write the contents of at least 3).

This question was created in order to identify the factors companies consider to be critical to the success of SOA projects. Even we have already identified the list of the success factors from the literature review, we consider the possibility that companies might have different opinion about success factors in SOA projects. It is an open question.

Q6. Below are the success factors in SOA migration derived through literature review. Please rate the importance of them in your organization below on a scale of 1 to 5, where 1 is "not at all important" and 5 is "extremely important". You can also indicate a success factor as not relevant in your organization by choosing 'N/A' option.

This question was created in order to identify the importance of the factors necessary for successful SOA projects. This question includes rating of 18 SOA success factors derived from the literature review. It is a closed question designed in LIKERT scale format.

Q7. What is your company industry? (Multiple responses are possible.)

This question was asked in order to have an overview of industries the respondents work within. The results of this question can be used in further analysis and research where the differences in SOA challenges and SOA success factors in the projects undertaken for different industries can be studied. It is a semi-closed choice question, where multiple answers can be given and the company not presented in the list can be specified.

Q8. What is your position? (Select one)

This is a general question with purpose to verify respondents' job background. It is a closed choice question, where only one answer is allowed.

Q9. How long have you worked with SOA? (Select one)

The purpose of this question is to insure that we receive data from people with SOA experience. It is a closed choice question, where only one answer is allowed.

Q10. How many employees does your company have? (Select one)

This question was asked in order to have an overview of companies' size the respondents work within. It is a closed choice question, where only one answer is allowed.

2.2.3 Sampling frame, sampling techniques, response rate and sample size

We used https://surveymonkey.net for creating and sharing the survey. We posted the survey on LinkedIn, in the SOA related groups, such as SOA Special Interest Group (included 31, 075 members at the time of posting the questionnaire), SOA and BPM – The Business Executive's Perspective (included 21,150 members at the time of posting the questionnaire) among others. We also shared the survey on SOA related forums such as IT Knowledge exchange and The Oracle FAQ.

The sampling frame is defined as IT audience, such as system architects, business analysts, system developers and people in similar positions, which have minimum one year of experience in the field of SOA. The population above were chosen because they are part of interest groups of legacy systems and SOA.

Sampling technique is systematic sampling. We chose to use the part of the questionnaire for selecting actual people, which identifies the persons' roles in the organization and their experience with SOA. We were not able to identify how many people we reached with the survey and monitor the response rate because the questionnaire was published on the internet. In total, 34 responses were received, 8 of which were incomplete. Incomplete responses are not included in the sample and the final sample is 26 responses.

3. Literature Review

This section of the research is based on the literature review of the challenges and success factors of SOA projects using a keyword index and an article title search. The section is divided into two subsections: section 3.1 describes literature review results about SOA challenges and section 3.2 - about SOA success factors.

3.1 Challenges in migration to SOA

Exposing existing software systems as services in SOA can be considered as a possible approach for managing a legacy system [13]. This approach has been successfully used for a while now, but there are a number of challenges the organizations meet while migrating towards SOA.

The results of this section are based on the literature review of 28 papers about SOA challenges, such as journal papers, articles and conference proceedings.

In Table 2 we provide the list over SOA challenges discussed in the literature sources we have studied. In Table 3 we provide a frequency analysis of studying SOA challenges in the literature sources. Below Table 3, we provide a detailed description of each challenge.

Table 2 Challenges in migration to SOA

SOA Challenge		**Source**
1	Choosing the right migration strategy	[12], [14], [18], [19]
2	Communicating SOA vision	[5], [15], [20]
3	Defining level of granularity	[21], [22], [23], [24], [25]
4	Facilitate Reusability	[5], [15], [20], [26], [27]
5	Focus on business perspective, and not only IT perspective	[5], [10], [20], [21], [28], [29], [30]
6	Implementation challenges	[7], [20]
7	Integration challenges	[27], [31], [32], [33], [34]
8	Managing cost	[35], [36], [37]
9	Organizational challenges	[5], [20]
10	Performance	[31], [38]
11	Program management challenges	[5]
12	SOA Governance	[22], [26], [31], [39]
13	Technology challenges	[5], [20], [31]

Table 3 shows the frequency analysis of SOA challenges and gives an idea of what SOA challenges have the most interest among researchers.

Frequency analysis draws a frequency table for categorized variables, SOA challenges in this case. This mode of analysis demonstrates the frequency together with the relative percentage (%) of variables [40]. For this analysis we consider the number of literatures reviewed and the number of literatures each challenge appears. Based on this, we derived a relative percentage frequency of each variable. For instance, if a variable was referred 5 times in 25 papers, this variable has significance of 20 %. SOA challenges were ranked accordingly based on their significance.

Table 3 Frequency analysis of SOA challenges based on literature review

Frequency analysis of SOA Challenge		**Literature (N = 28)**		
		Frequency	**Ratio**	**Ranking**
1	Choosing the right migration strategy	4	14%	3
2	Communicating SOA vision	3	11%	4
3	Defining level of granularity	5	18%	2
4	Facilitate Reusability	5	18%	2
5	Focus on business perspective, and not only IT perspective	7	25%	1
6	Implementation challenges	2	7%	5
7	Integration challenges	5	18%	2
8	Managing cost	3	11%	4
9	Organizational challenges	2	7%	5
10	Performance	2	7%	5
11	Program management challenges	1	4%	6
12	SOA Governance	4	14%	3
13	Technology challenges	3	11%	4

3.2 Description of SOA challenges based on literature review:

3.2.1 Choosing the right migration strategy

While moving to SOA, it is important to identify what can be migrated from the original legacy system and choosing the right strategy to migrate the existing application to SOA. There are several strategic approaches to transform or modernize the legacy environment. Almonaies *et al.* [14] provided a critical review of existing approaches of adopting SOA. They divided the approaches into four categories: *replacement* (rewriting the existing systems' application or buying new one), *redevelopment or reengineering* (using reverse engineering to add SOA functionality to legacy systems), *wrapping* (providing new interface(s) to the existing systems), and *migration* (moving the legacy system to SOA environment while preserving the original system's data and functionality). Umar *et al.* [18] proposed an application reengineering decision support model. This model includes the following components: strategic analysis of application reengineering, architecture analysis and solution development and detailed cost benefit analysis.

Below an overview for each of four approaches:

a. *Replacing or rewriting* the application from scratch is expensive, risky and time-consuming, but has the advantage that it delivers a customized solution that can be built exactly to meet the organization's need [14]. Replacing the application with COTS (commercial off-the-shelf) component, while less risky and time consuming than rewriting, can also be expensive since future modifications may be difficult and expensive to perform [14]. Commella-Dorda *et al.* [12] identified two significant risks of the replacement strategy: the maintenance of the new system, which will not be familiar as the old system; and the lack of a guarantee that the new system will be as functional as the original. Umar *et al.* [18] also mentioned the risk of the new system might not work as it is expected and can be time consuming and/or expensive. Besides that, investment in existing applications is lost and the staff may need to be retained in case of replacement with a COTS solution. Almonaies *et al.* [14] mentioned the cases were COTS solution may not be a good option: important business are embedded in the legacy system, modification of the COTS package is expensive, or the loss of control of the software code base by the organization.
b. There are three main issues in service-oriented *reengineering*: service identification, service packaging, and service deployment [14].

c. *Wrapping* is used when the legacy code is too expensive to rewrite, is not that big and a fast solution is needed. The main problem with this strategy is that it does not solve the existing issues, if there are any [14]. This strategy does not work if the target applications are too inflexible and expensive to maintain, it delays migration to very good COTS solutions that are increasingly becoming available and outdated and old functionality in existing systems is perpetuated [18]. However, this strategy does not introduce the new issues or challenges, and it is the least risky approach, and in some cases can also be the most appropriate.
d. *Migration* strategies incorporate both redevelopment and wrapping and aim to produce a system with an improved SOA-compatible design [14]. Grace Lewis [19] described the Service-Oriented Migration and Reuse Technique (SMART) that helps organizations analyze legacy systems to determine whether their functionality, or subsets of it, can be used as services. Converting legacy components to services allows systems to remain largely unchanged while exposing functionality to a larger number of clients through well-defined service interfaces [19].

3.2.2 Communicating SOA vision.

The business case for adopting SOA is often reflected in the SOA vision. In the interview, executed by Franzen [15], four out of five respondents admitted the difficulty of communicating what SOA is to the organization, and getting people to understand and embrace the concept of such architecture. Few of respondents proposed some suggestions how to deal with this problem. Thus, SAS (Scandinavian Airlines) stressed that collaboration between business units was needed, SEB and Skatteverket raised the need for a function responsible for communicating the SOA vision and Volvo IT called for increased governance, standards and guidelines [15]. Varadan *et al.* [5] mentioned that documented vision adds benefit as it allows consensus in the organization as to what SOA is, what is not, and how it is applicable to a specific project, transformation, initiative, or business goal. Natis *et al.* [20] suggested developing a long-term vision for SOA, but implementing it incrementally, learning during the process and managing the risks of transition. They also underlined that the political dimension of implementing SOA should not be underestimated and suggested to pay attention to the fact that different audience are motivated by correspondingly diverse objects and the business communication is required to handle these differences.

3.2.3 Defining level of granularity.

'Service granularity' refers to the functional complexity offered by a service [23]. According to Haesen *et al.* [23], defining a right level of granularity is important, because it has an impact on other system aspects such as reusability, maintainability, performance and flexibility. Alahmari *et al.* [21] said that in the absence of any usable theoretical foundation for service granularity, service granularity cannot currently be measured in absolute terms. This means that defining the optimal level of granularity is challenging task, because of inherent subjectivity.

A lot of research has been done in order to help define the right level of granularity. Alahmari *et al.* [21] provided a framework and guidelines for the identification of specific services from legacy code with the appropriate level of granularity and worked on making this process automated. Galster (cited in Alahmari [21]) proposed a graph-based framework that discovers service granularity. Xiaofeng *et al.* [24] utilized specific enterprise service hierarchy patterns for selected business processes to determine service granularity. Erradi *et al.* [25] extended the service design concepts of the SOAF framework with a business-driven approach based on a meta-model to define service granularity. Kulkani *et al.* [22] addressed the importance of the problem of determing the optimal service granularity as applications are built by assembling/composing internal and external services at a coarser-grain level for both Enterprise Application Integration and Business-To-Business Integration.

3.2.4 Facilitate Reusability.

In the research, provided by Franzen [15], five out of five case studies admit the difficulty of attaining a satisfying level of reusability of services. In the interview [15], respondents mentioned that governance, existing of central function, appropriate funding model, principles and policies, information modeling and repository are essential in achieving reusability. Brent Carlson *et al.* [26] underlined that in order for a service to be considered reusable, it must be maintainable, discoverable, and consumable. Channabasavaiah *et al.* [27] suggested that one of the SOA requirements must be "Build around a standard component framework" to promote better reuse of modules and systems. Varadan *et al.* [5] stated that when organizations choose to treat integration as just another technology implementation it shows zero to minimum reuse, minimal improvement in business responsiveness or flexibility, and higher IT cost over time. Opposite, when organizations implement an SOA Governance model, it makes it possible for them to realize and sustain reusable and shared services.

Achieving the level of reusability is difficult also due to migrated applications were often through numbers of merges and acquisitions, have duplicated functions with slight differences and have a very

complex structure. The challenge is to find the solution that instead of numbers of very similar functions provides a function that can be used by many. Natis *et al.* [20] named differences in security, integrity and performance characteristics of different applications and cultural differences of the teams working on such applications as the reasons that can block reuse.

3.2.5 Focus on business perspective, and not only on IT perspective

Galinium *et al.* [10] mentioned that many companies have common problems in SOA migration because they start the SOA migration process based on the IT perspective instead of a business one. Alahmari *et al.* [21] stated that in SOA, the context of a service is always driven from a business process or function. Varadan *et al.* [5] underlined that the focus shifts to overall business processes rather than on processes specific to business units due to services are shared across entities. Natis *et al.* [20] highlighted the risk of services being designed to optimize software performance and ease of use, and not to reflect the business functionality of the application, when the SOA process is left mostly to the IT side of the organization. Natis *et al.* [20] also underlined that although services are implemented in software, they must be defined to reflect the application's business functionality. Ang *et al*. [28] said that the most probable negative outcome of focusing on IT perspective and forgetting business perspective is the growing cost of IT without any return on investment (ROI) for the corporation.

Some researchers proposed the solutions for this problem. Rolland *et al.* [29] introduced an approach that depends on exploring the purposes of business process to identify a service by considering business goals and pre- and post-conditions. Zimmermann *et al.* [30] motivated the need for service modeling methodologies as means of handling the design of a business-focused SOA and look into a SOA service as a business feature available for customers, business partners etc.

3.2.6 Implementations challenges.

There are a number of implementation challenges that we cannot omit in this report. However, we do not describe these challenges in the details as it requires the deep focus on the implementation strategies and techniques that are behind the scope of this thesis. Among a number of implementation challenges, in the literature, the following have been mentioned:

- Complexity
- Security
- Flexibility
- Testing
- Configuration

- Version control
- Metadata management
- Service-level monitoring

Abrams *et al.* [7] identified managing application logic and data in SOA service components that are spread out over multiple business units as one of the greatest challenges. Natis *et al.* [20] mentioned that SOA can multiply the potential points of failure by breaking up a large monolith into multiple service implementations and underlined the importance of a well-developed discipline of design and management to deal with such complexity. They also recommended that the large project shall be subdivided into smaller components so that the SOA effort is applied initially in a relatively small scope to be expanded over time. Early SOA projects should not last longer than six months from the start of design to the delivery of results.

3.2.7 Integration challenges.

As an organization moves forward with its SOA strategy, there will be a need to integrate the migrated system with existing systems and/or potentially new systems. Channabasavaiah *et al.* [27] underlined that support of all required types of integration is a requirement for SOA. These include user interaction, application integration, process integration, information integration and build to integrate. Brien *et al.* [31] are developing a method SMAT-AUS which consists of several activities for determining the scope, size, effort and cost of the integration. Mulik *et al.* [32] mentioned that vendors such as webMethods, Tibco, and SeeBeyond (now part of Sun Microsystems) provide enterprise application integration (EAI) tools that can connect packaged applications and custom applications across the enterprise using either a single bus or hub for all kinds of integration needed. As integration brings risks, especially with large systems and big team, many integration problems can be avoided in the future by well-defined interfaces (service contracts). While the legacy systems are migrated to SOA, the goal should be achieving clear interface specifications. There are some researchers that propose the solutions to this problem. Channabasavaiah *et al.* [27] addressed the problem of multiple interfaces and explain how to deal with it. Scheider [33] outlined how to use Data Distribution Service (DDS) standard that allows “plug in” new modules without redesigning other interfaces. Behara *et al.* [34] provided an overview of two popular integration approaches: top-down and bottom-up. In the article they state that top-down approach can be further divided in two types such as business process driven (enterprise level) and use case driven (business unit level). Depending on the initiative level, enterprise or business unit, different types of business and process analysis shall

be undertaken. Bottom-up approach is usually taken into consideration if the target includes redundant business logic, multiple copies of data, and implementing the same logic in multiple products.

3.2.8 Managing cost.

In order to manage the cost of SOA migrations, there is a need to know the scope and the size of the work involved. Finding cost-effective and quality solutions for evolving them in order to meet new requirements was identified as a challenge by Bennett [35]. Pereira Games [36] described how to estimate and count SOA projects using SOA artifacts, like Service Candidate descriptions, WSDL and XSD artifacts. Linthicum [37] provides some guidelines to determine the cost and suggest using the following formula to estimate the SOA cost:

Cost of SOA = *Cost of Data Complexity + Cost of Service Complexity + Cost of Process Complexity + Enabling Technology Solution).*

He also provided additional formulas and detailed description on how to estimate Cost of Data Complexity, Cost of Service Complexity and so on.

3.2.9 Organizational challenges

Varadan *et al.* [5] identified organizational challenges as one of the most difficult challenges in the migration of SOA. They stated that the architecture and technology transformation that moves an organization to SOA will often move the IT organization towards a shared services model for requirements, development, service implementation, and operational support. Making the shift to SOA requires organizational changes that include the establishment of enterprise-scale integration competencies that focus on delivering skills associated with technology adoption, addressing competing concerns between business stakeholders concerning funding and sharing, and motivating SOA and technology communication to maintain and sustain a vision for improvement [5]. Because SOA is a long-term, complex initiative, enterprise should invest in developing the required understanding, best practices and organizational culture before committing to mission critical SOA projects, according to Natis *et al.* [20].

3.2.10 Performance.

It is vital to consider performance while migrating the legacy systems into SOA. Some of the known performance issues, mentioned by O'Brien *et al*. [31], are following: response time, scalability of the services that are exposed publicly and handling increased dependency between services among others. Brebner *et al.* [38] developed a method and tool support for early lifecycle performance modeling of

SOAs. The tool is designed around SOA models, a simulation engine and a Graphical User Interface (GUI). The GUI allows developing SOA models in terms of services, servers, workloads, metrics and parameters. SOA models are automatically transformed into run-time models for execution by Discrete Event Simulation engine. While the simulation is running, the metrics and parameters can be changed, giving immediate feedback on performance.

3.2.11 Program management challenges

Varadan *et al.* [5] outlined that due to the shared services concept within organization(s), program and project outcomes in SOA require additional negotiation and monitoring. Achieving a consensus-based culture can be costly and time-consuming, because organizations did not get used to cooperating with other entities on requirements, design and so on. The authors stated that achieving a good program management requires clarity of scope, priorities, project plans and deliverables. Besides that, experts in process and technology, stakeholder management and communication of a shared vision are also very important.

3.2.12 SOA Governance.

SOA Governance is an important activity to manage SOA decisions correctly on business and technical levels. Kulkarni *et al*. [22] addressed the problem of implementing thousands of fine grained web services without paying much heed to issues like governance, and usage within its business process. Marks (referenced in [31]) considered the following requirements to be addressed to the SOA Governance problem:

- Strategy and Goals
- Funding, Ownership and Approvals
- Organization
- Processes
- Policies
- Metrics
- Behavior

Carlson *et al.* [26] provided a detailed overview and guidelines about how to deal with SOA Governance. They underline that not only factors like service-level agreements and authorization policies must be important, but architectural governance, design-time (development) governance and operational governance/management should be in focus. Hassanzadeh *et al.* [39] developed a

framework for evaluating SOA Governance. This framework can be useful in determining SOA Governance requirements and ensures the alignment of SOA Governance with business.

3.2.13 Technology challenges.

In order to be able to run and manage SOA application, an organization needs to have SOA infrastructure. Garner (referenced in [31]) listed the following as major technical errors in SOA:

- Bad selection of application infrastructure components,
- Insufficient validation of SOA enabling infrastructure implementation,
- SOA infrastructure, service and consumer application are insufficiently instrumented for security, management and troubleshooting.

Varadan *et al.* [5] admitted that if expertise is lacking, projects may see schedule slippage, or worse, compromised implementations where the IT architecture is not implemented in a manner consistent with SOA principle. Natis *et al.* [20] underlined that the choice of middleware must never be an influence in the design of services. Instead, this choice should follow and support the established design of services. The choice of dedicated SOA middleware should be delayed until the service topologies are established and the requirements for the type and depth of the middleware can be established properly. Natis *et al.* [20] also mentioned that the technical challenges of SOA should not be underestimated and suggest that large-scale SOA implementation require a SOA backplane and an understanding of key SOA-enabled middleware.

3.3 Success factors of SOA projects

The legacy system has a significant business value to the organization as it runs its important business processes. However, not all of the migration of legacy systems to SOA were successful and there are several important factors have been identified which have an impact on successful outcome of SOA migration process.

The results of this section are based on the literature review of 14 papers on SOA success factors, such as journal papers, articles and conference proceedings.

Based on the literature review, Table 4 provides the list of success factors that have been identified. In Table 5 we provide a frequency analysis of studying SOA success factors in the literature sources. Below Table 5, the detailed description of each success factor is provided.

Table 4 Success factors of SOA projects

Success factors		**Source**
1	Agility	[20], [41]
2	Budgeting and Resources	[10], [15], [20], [42]
3	Business Process of Company	[8], [10], [41], [42]
4	Close Monitoring	[10], [42]
5	Communication and collaboration	[20], [42]
6	Dependence on Commercial Products	[10], [41],
7	Facilitate Reusability	[5], [15], [20], [41], [42]
8	Funding & Ownership	[15], [43]
9	Information Architecture	[10], [20], [42]
10	Leadership	[15], [41], [43]
11	Legacy Architecture	[9], [10], [41]
12	Management	[20], [41], [44]
13	Potential of Legacy Systems for being migrated	[10]
14	Principles, guidelines and standards	[15], [42]
15	SOA Governance	[1], [5], [8], [10], [15], [26], [39], [42] , [45],
16	Strategy of migration to SOA	[8], [10], [42], [44]
17	Technically skilled personnel	[10], [41], [42]
18	Testing	[10], [44]

In Table 5 we show the frequency analysis of SOA success factors and give an idea of what SOA success factors are the most interesting for the authors of the 14 papers we analyzed.

Frequency analysis draws a frequency table for categorized variables, SOA success factors in this case. The analysis and calculation are done by the same rules as analysis of SOA challenges earlier in this report: we consider the number of the literatures reviewed and the number of the literatures each success factor appears.

Table 5 Frequency analysis of SOA success factors based on literature review

Frequency analysis of SOA success factors		**Literature (N = 14)**		
		Frequency	**Ratio**	**Ranking**
1	Agility	2	14%	5
2	Budgeting and Resources	4	29%	3
3	Business Process of Company	4	29%	3
4	Close Monitoring	2	14%	5
5	Communication and collaboration	2	14%	5
6	Dependence on Commercial Products	3	21%	4
7	Facilitate Reusability	5	36%	2
8	Funding & Ownership	2	14%	5
9	Information Architecture	3	21%	4
10	Leadership	3	21%	4
11	Legacy Architecture	3	21%	4
12	Management	3	21%	4
13	Potential of Legacy Systems for being migrated	1	7%	6
14	Principles, guidelines and standards	2	14%	5
15	SOA Governance	9	64%	1
16	Strategy of migration to SOA	4	29%	3
17	Technically skilled personnel	3	21%	4
18	Testing	2	14%	5

3.4 Description of SOA success factors based on literature review:

3.4.1 Agility

The degree of agility achieved in enterprise IT is critical. According to Natis *et al*. [20], the agility is measured in time to market for the development of new services, as well as for the re-composition, change and removal of services inside and outside process sequences. Hoon Lee *et al.* [41] identified that the goal of SOA is to enable business agility by making available common services, thereby reducing IT cost through reuse.

3.4.2 Budgeting and Resources

The cost and budget of migration play an important role in the success of SOA projects in terms of business. If the cost is higher than its ROI in the coming years, the project will not be a success from a business perspective. Moreover, according to Shaief [42], migration for SOA shall be undertaken for the right reason: business should be the initiator of potential migration projects, instead of pushing state of the art technologies by the IT department. He identifies managing cost, budget and service quality as a critical success factor and underlines the risks of budget to have an influence on the migration process – some interviews mentioned that the duration of a migration project can take more time since the project continues when the budget is available again.

Franzen [15] identified 'Budgeting and Resources' as a success factor in two out of five study cases. Galinium *et al.* [10] identified 'Budgeting and Resources' as a success factor in three out of five study cases. Natis *et al.* [20] suggested designing long-term services systematically (at the added cost of planning and quality assurance), but at the same time recognizing that short-term services do not require investment in systematic qualities.

3.4.3 Business Process of Company

'Business Process of Company' defines the way the routine tasks are handled in the organization. There are some situations where the business processes stay unchanged, but in most situations business processes get changed with time. While moving to SOA, it is important to analyze the business process: whether it stays the same or requires slight or significant changes. Neglecting this can result in creating SOA architecture that cannot be used or can be used only partly.
In Galinium *et al.* [8] in 2009, 'Business Process of Company' has been identified as a success factor in four out of five study cases and the same result was published a few years later, in 2012 [10]. In Shaief [42], the interviewers believe that business process owners and executives should think more in terms of processes and services instead of functions. Hoon Lee *et al.* [41] paid attention to

standardization of business process. According to Hoon Lee *et al.* [41], without business process standardization, even a well-defined service can have limitations in being a reusable common service. Therefore, it is suggested that re-establishment and standardization of business process at the enterprise-level or SOA-applied business level must be preceded.

3.4.4 Close Monitoring

Close Monitoring is very important because it allows identifying mistakes in early stage and correcting them with much less cost compare to if such mistakes can be first found in late stages of the SOA migration process.

In Galinium *et al.* [10], 'Close Monitoring' has been identified as a success factor in four out of five study cases. Shaief [42] also identified Monitoring as an important success factor due to its contribution in ensuring that services live up to the service level agreements (SLA), and providing aid in noticing when services stop working or performing below expectations.

3.4.5 Communication and collaboration

According to Natis *et al.* [20], when the collaboration between business analysts and software architects is successful, the resulting SOA projects have increased level of reuse, the IT organization delivers new solutions to the business faster and the cost of change is lower. They also underlined that not only organizational aspects in communication are important, but also cultural as each organization in years' time have succeeded in creating their own specific culture. Cultural aspect is also mentioned by Shaief [42]. He indicated that there is a mind shift and culture change required in order to think together in terms of services instead of functions bounded to internal departments of an organization and says that the culture change management and awareness of business owners to the project are critical to the success of SOA migration projects. He named it as 'a shift in the culture from individualism to collectivism'. Moreover, Shaief [42] underlined that the success of SOA is not perceived at the end of the migration project and it mostly takes years to see the benefits of deploying SOA. Therefore, business might be very reluctant to invest and continue with the project if some achievement is not directly visible. Without the commitment of business process owners, it will be difficult to obtain the proper financial assets and interdepartmental support. Frequently communicating with different levels within the organization helps to over the bridge the fear of the unknown when thinking and using services other than they were acquainted with.

3.4.6 Dependence on Commercial Products

Galinium *et al.* [10] identified 'Dependence on Commercial Products' as a success factor in two out of five study cases. For instance, one of the study cases, a large European bank, even they did not have this dependency, considered that this factor can make integration more difficult. Hoon Lee *et al.* [41] suggested maintaining vendor independence and consider interoperability as one of the SOA implementation best practices.

We believe that dependency on commercial products should be carefully considered by companies as it might be time-consuming and cost-consuming to make any changes if the products will be upgraded, will become outdated and not supported any longer etc.

3.4.7 Facilitate Reusability

Varadan *et al.* [5] named asset creation and reuse as one of the key value drivers for SOA transformation for any enterprise. Hoon Lee *et al.* [41] specified that an important motive in adopting SOA is to obtain services with high reuse and this is mainly achieved in the design phase of development. Hoon Lee *et al.* [41] underlined, however, that reuse has limitations when it is applied within the boundary of an organization, but can be increased if an organization is offering software functionality as services to external parties or using external services. Natis *et al.* [20] stated that the success of a service in SOA can be measured partly by the degree to which it is reused by outside applications. Natis *et al.* [20] suggested that the IT environment must develop a culture where reuse of external solutions is considered a characteristic of excellence in software engineering and preferable to custom programming. They also admitted that service reuse does not happen by chance – it requires governance, incentives, discipline and tools. The same result can be seen from Frazen [15]. She outlined the importance of other factors, such as governance, leadership among others, in order to achieve reusability.

However, not in all research reusability is considered important. Shaief [42], based on four interviews, showed that "reusability of assets" was less important and was not seen as a driver to obtain success from a business perspective, which is in contrast with most of the scientific studies regarding the SOA concept.

3.4.8 Funding & Ownership

Carter [43] stated that funding and ownership of shared services is a critical task the SOA Governance function needs to deal with. In Franzen [15], two out of five respondents listed funding as a critical factor needed to be considered when adopting SOA, whereas three out of five respondents mentioned ownership. For instance, Volvo IT said that existing financial and ownership structure needed to be reviewed and adapted and SEB reported difficulties of attaining reusable services due to their present financial structure.

3.4.9 Information Architecture

In Galinium *et al.* [10], 'Information Architecture" has been identified as a success factor in one out of five study cases**.** According to their research, low maturity of the information architecture can lead to failure because SOA requires a global view of the information object. Shaief [42] also stated that the level of knowledge about the system is an important success factor for the developers and administrators of the system. It is significant in order to analyze the current architecture and legacy code before and during migration projects.

Natis *et al.* [20] suggested investing in systematically designed sets of fundamental core services and involving business analysts early and often.

3.4.10 Leadership

In Franzen [15], the presence of leadership was perceived as necessary to succeed with SOA by two out of five respondents. Hoon Lee *et al.* [41], based on literature review and interviews, gave an overview of the practices in SOA implementation. We think that some of these practices can improve leadership during SOA migration and will be a great help with succeeding with other aspects such as governance, resources, communication and collaboration and others. These practices include clarifying the goal of applying SOA through strategic workshop with business division, gathering and sharing success stories, motivating core human resources to actively participate, creating a culture of trust and collaboration for a partnership between business and IT among others. Carter [43] also stressed that it really takes an innovative IT leader with existing respect of business and a centralized IT organization to drive IT and SOA forward.

3.4.11 Legacy Architecture

If the applications have been well-structured and well-defined, these are expected to be easy to migrate. SOA causes changes in architecture and infrastructure and often requires rethinking and redesign of existing systems.

In the Galinium *et al.* [10], 'Legacy Architecture' has been identified as a success factor in four out of five study cases. This factor is important because it affects migration effort and the business processes of the organization have dependency on legacy architecture. Grønli *et al.* [9] described a successful case of migration towards SOA (Norwegian airlines) and particularly underline the importance of solution architecture. They suggested three main factors in SOA implementation: a comprehensive implementation of service bus with the encapsulation of components in levels, maintaining a clean ESB architecture and one team per layer.

SOA practices suggested by Hoon Lee *et al.* [41] will ease both system migration and system extensibility. These practices are: establishing SOA architecture bearing in mind enterprise-wide aspects of the project, selecting framework, infrastructure and technical standards prior to launching of the project, defining shared structure and using the service repository and simplifying architecture. Hoon Lee *et al.* [41] also suggested that a clear blueprint outlining corporate assets such as Business Architecture, Application Architecture, Technology Architecture, and Data Architecture and showing information flows across the assets should be prepared.

3.4.12 Management.

Natis *et al.* [20] underlined that management effort is essential to support reuse, service isolation, cohesive functional representation, impact control and change. Shaief [42] provided further classification of management as a success factor. He defines change management, configuration management, risk management, information management and project management.

Hoon Lee *et al.* [41] said that an organizational model for SOA management was also identified by both vendor and user as a success factor. Hoon Lee *et al.* [41] proposed a number of practices that can be applied in SOA projects in order to improve management in the organization. Such practices as achieving shared understanding of enterprise-wide SOA and conducting training for business division on value of SOA, encouraging view of it is a business tool, not just a technology help to deal with information management. Measuring time and cost, ensuring strong sponsorship on top-level board of directors and clarifying goals by selecting objectives of SOA based on business value help to deal with project management. Organizing a committee with decision-making authority to adjust overall business and IT work and exercise continued control is a good practice both to deal with change management and risk management. Such practices, as setting boundaries of utilizing an all-purpose business solution or internal development and verifying the stability of technical elements through

simple task process in the beginning stage of projects will help to succeed with configuration management.

3.4.13 Potential of Legacy System for being migrated

In the Galinium *et al.* [10], 'Potential of Legacy System for being migrated' has been identified as a success factor in all the cases performed. Good application structure of system, level of documentation and code quality plays a significant role in ability to migrate a system into SOA. In addition, size and complexity, support software required, reusability factors, scale of required changes in legacy system to SOA, service abstraction and service discoverability are also important characteristics of legacy system in SOA adoption [10].

3.4.14 Principles, guidelines and standards

Franzen [15] showed that four out of the five respondents emphasized the importance of having principles, standards, contracts, or guidelines as important factors to succeed with SOA. Shaief [42] named the use of supported middleware technology standards and protocols for the target operational environment as a success factor in his research. He also said that project management principles should be applied for each deliverable in the iterated and incremental migration process and proper change and configuration management principles should be in place and documented in order to ensure business continuity and controllable change at all stages of the migration project.

3.4.15 SOA Governance

Business should define clear and measurable objectives before starting a migration project and governance should be carefully considered. SOA Governance can define boundaries and regulations migration of system to SOA through SLAs (Service Level agreements).

Jayashetty *et al*. [45] defined SOA Governance as an integrated set of dimensions that provides the mechanism for defining, implementing, managing and measuring the effectiveness of SOA in the enterprise.

Several researchers highlighted the importance of SOA Governance in the process of migrating towards SOA. Srikanth *et al.* [1] noticed that often new service-oriented projects are undertaken without explicit SOA Governance in place. This works if the scope of the project is small, but as soon as the architecture grows to include new service providers and consumers, the results might be: overall reliability and predictability of the architecture begin to decline, duplicating some old IT service functionality in a new IT service, inability if the IT service to meet SLA among others.

Shaief [42] underlined that governance plays a crucial role when organizations start to steer in the direction of employing SOA and suggests having documentation of all non-technical issues concerning governance, such as processes, responsibilities, policies etc. to deal better with governance and SOA migration process in general. Varadan *et al.* [5] stated that a well-defined governance model is a key to success irrespective of the entry point chosen for SOA transformation and describes a framework, the SOA Governance model, which can be used to scope and identify what is required for effective SOA Governance. Hassanzadeh *et al.* [39] also named governance as the key factor of SOA project success. Carlson *et al.* [26] provided a detailed explanation why governance is so important in the migration process and highlighted numbers of the factors that can have an impact on successful applying governance while migrating towards SOA.
In Franzen [15] in 2008, five out of five respondents agreed that strong governance and control were the key factors to succeed with SOA. In Galinium *et al.* [8] in 2009, the result was the same: five out of five respondents agreed about the importance of governance for successful SOA migration. There was no change in the results in Galinium *et al.* in 2012 [10].

3.4.16 Strategy of migration to SOA

Strategy is important in the migration of legacy systems towards SOA. In Galinium *et al.* [8], [10], in five out of five case studies 'Strategy of migration to SOA' was admitted as an important factor on the way to successful migration of legacy systems to SOA. Depending on the companies' needs, different migration approaches have been used. They include: the refactoring approach, redeveloping, focusing on standardizing the information architecture, and extending the services.

Shaief [42] underlined several activities that are critical to the success of the migration strategy such as analysis of the reuse potential by understanding the business contribution of the legacy environment, assessment of business value against system quality, and creating a legacy portfolio. He admitted that a clear understanding and inventory of both the business processes and its supporting technical environment are required before deciding upon what migration strategy to be used. Moeini *et al.* [44] proposed a SOA adoption management roadmap consisted of eight steps and covering migration strategy on three levels: management, organization and process.

3.4.17 Technically skilled personnel

According to Shaief [42], successful migration and deployment of SOA also depends on the users of the target system and developers and administrators of the current systems. He admitted that exchanging and sharing the knowledge is evenly important, since the organization should have

engineers within the organization who can tackle problems in the future instead of strongly relying on external experts. He also suggested creating a center of competency in order to support the level of knowledge exchange and provide the proper education and training for users and administrators of the target system.

In Galinium *et al.* [10], 'Technically skilled personnel' has been identified as a success factor in one out of five study cases**.** According to their research, it has been due to the fact that the standardization is driven from IT.

Hoon Lee *et al*. [41] named such practices as establishing training planning on new technology and changes in development methodology and conducting training on the concept and technical elements of SOA for the organization and project staff. We believe that following these practices, among others available will have significant influence on improving this factor in SOA migration.

3.4.18 Testing

Galinium *et al.* [10] identified 'Testing' as a success factor in one out of five study cases. Testing was identified as an important factor, because it is necessary to validate and verify the quality of services in terms of performance, reliability and security. Moeini *et al.* [44] also underlined the importance of extensive testing due to the generic nature of services and its likeliness to reuse.

3.5 Discussion of the literature review

By analyzing the related work we admit that strong interest in SOA exists and there are many researchers who study different areas of SOA. Among them there are researchers that highlight some of SOA migration challenges and success factors. Below you can find detailed description of our finding.

3.5.1 SOA challenges findings

Our findings show that some of SOA challenges create more interest between researchers, while others are not so interesting. We base these findings on the frequency analysis of SOA challenges in the literature reviewed (see Table 3). For instance, "Focus on business perspective, and not only IT perspective" was admitted as a challenge in 25 % of reviewed papers and program management challenge - only in 4 % of reviewed papers. However, there is no a SOA challenge that has a considerably high level of interest among the researchers. 25 % was a maximum frequency, while most of other challenges have a frequency between 11 % and 18%.

Moreover, no one of the researchers has provided a critical analysis of SOA challenges in terms of importance, priority or difficulty to deal with. We cannot see if the organizations with different industries experienced different SOA challenges. We cannot identify if the conflicting areas exists, where solving one problem can possibly introduce another problem.

3.5.2 SOA success factors findings

The previous research of SOA success factors looks differently. Opposite to SOA challenges research works, where we did not come across an analysis of SOA challenges, there are some researchers that have provided an analysis of SOA success factors. However, these analyses are very different from each other, as the researchers use different classifications or do no use any. Some of the factors are too specific and related only for one organization. These factors are not analyzed in the current paper. Another interesting fact about the SOA success factors is the deviation in frequency how the factors appear in the research literature. For instance, "SOA Governance" appears in 64 % of the sources, while 'Potential of Legacy Systems for being migrated' only in 7% of the sources. This deviation is 57% and this is much greater than the deviation in the frequency analysis of SOA challenges (where deviation is 21%, maximum value is 25% and minimum value is 4 %).

3.5.3 Similarity between SOA challenges findings and SOA success factors findings

It is also found that there are some similarity between SOA challenges and SOA success factors in the literature. Some of the items were named both as a SOA challenge and as a SOA success factor. Among them are SOA Governance, Facilitate Reusability, and Migration Strategy. However, the frequency analysis shows different levels of interest among the researchers, depended on considering an item as a challenge or as a success factor. For instance, "SOA Governance" appears in 64 % of the literature sources of SOA success factors and only in 14 % of the literature sources of SOA challenges, "Facilitate reusability" – in 36% of the literature sources in SOA success factors and in 18% of the literature sources in SOA challenges, "Migration Strategy" – 29% and 14% accordingly.

Frequency analysis of the literature does not show the importance of each SOA challenge and SOA success factor for an organization, but only current interest among the researchers. We will use the results of the survey to study the importance of each variable, such as a SOA challenge and a SOA success factor.

4. Survey of SOA challenges and SOA success factors

This section describes the results of the survey about challenges and success factors in migration systems into SOA and is based on 26 responses. The section consists of four parts: background of the respondents, analysis of SOA challenges survey results, analysis of SOA success factors survey results and discussion of the survey results.

4.1 Background of Respondents

4.1.1 SOA experience

This section describes organizations' work experience with SOA, respondents' work experience with SOA and job positions of the respondents.

As shown below, in Figure 2, there are only 3,85% (1 response, later in the thesis we use numbers only) respondents working in the organizations that have just started using SOA and 7,69% (2) - in the organizations using SOA for the period between 6 and 12 months. There are 34.62% (9) respondents working in the organizations with 1 to 3 years of SOA experience, 23.08% (6) respondents – in the organizations with 3 to 5 years of SOA experience, and 30.77% (8) - in the organizations with more than 5 years of SOA experience. The breakdown of the results shows that the received data are related both to the organizations that are new to SOA and the organizations that are experienced with SOA.

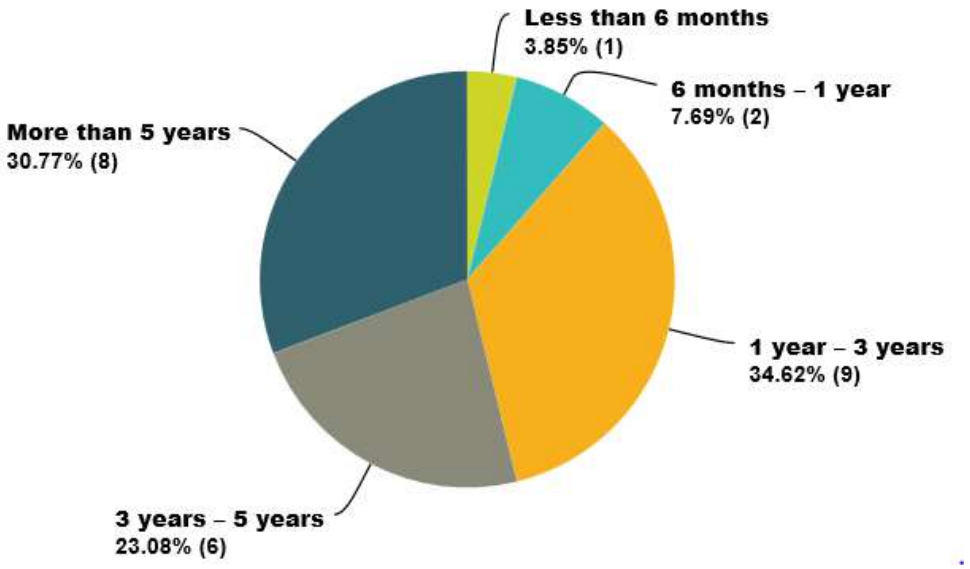


Figure 2 Results of survey Q1: How long it has been from your company started using SOA to now?

All respondents have minimum 2 years working experience with SOA – there are 50% (13) of respondents have worked with SOA for period between 2 and 5 years and another 50% (13) – for the period between 5 and 10 years.

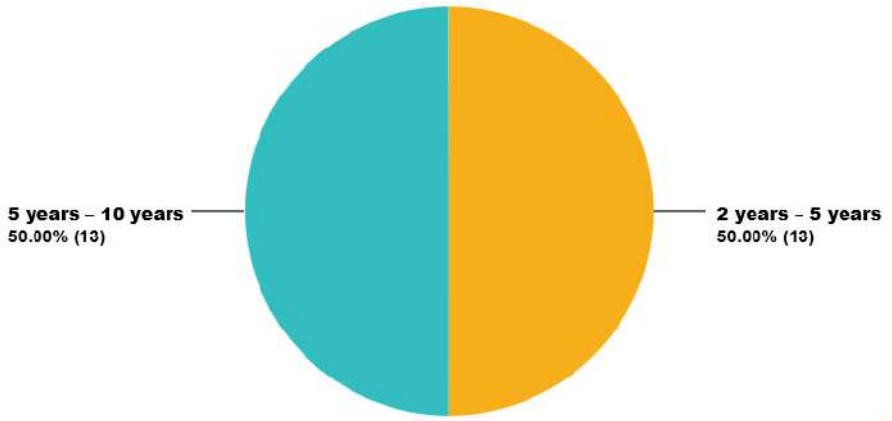


Figure 3 Results of survey Q9: How long have you worked with SOA?

Job positions of the respondents vary from Developer and Architect to Business Analyst and Project Manager. In total, 60% of all respondents have jobs related to development: Developer – 20% (5), Architect – 32% (8), and both Developer and Architect – 8% (2). 40 % of all respondents have jobs related to business analysis, project management and leadership – Business Analyst – 8% (2), Project Manager – 4% (1), Lead a team of architects – 8% (2), and Lead a team of developers – 20% (5). Later in this thesis, we compare the survey results about SOA challenges (see section 4.2.2) and SOA success factors (see section 4.3.2) between the respondents in the job positions related to the development and the respondents in the job positions related to business analysis and leadership.

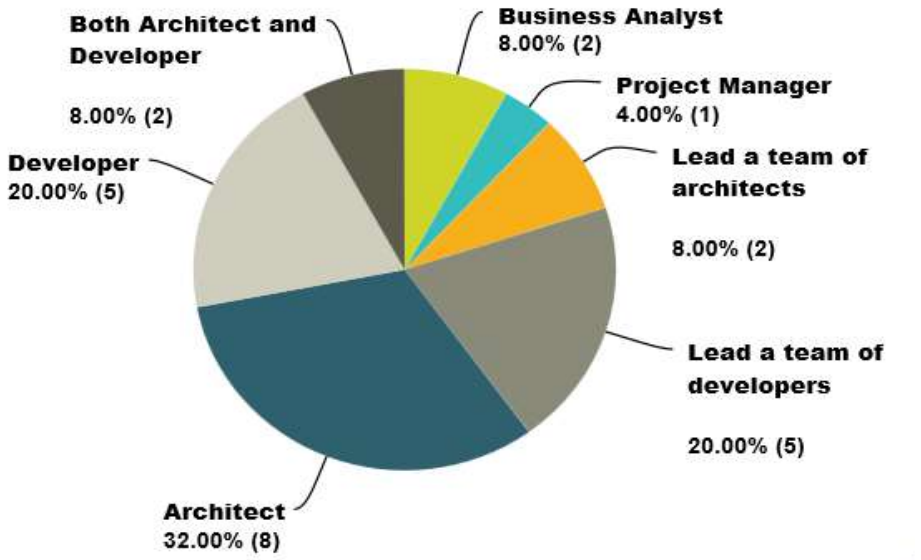


Figure 4 Results of survey Q8: What is your position?

4.1.2 Industry, company size and related work area

Below, in Figure 5, there is a chart of the industries the respondents work with. We used the chart of a stacked horizontal bar type as it is not possible to use a pie chart, as in the previous section. A pie chart takes total result of 100 % and this is not possible for data generated with multiple responses allowed. The same rule also applies to Figure 6 later in this section.

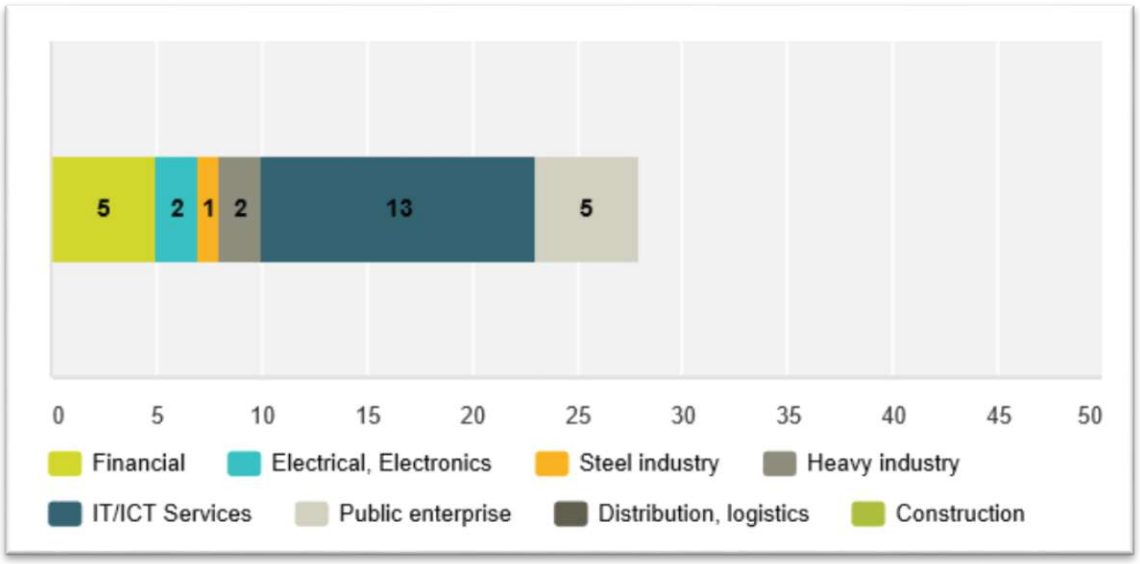


Figure 5 Results of survey Q7: What is your company industry?

It is interesting that relatively many responses are received from the organizations working with IT/ICT Services – 13 responses. It is about 50% of all responses (multiple answers were allowed to this question).

Later in this thesis, we compare the survey results about SOA challenges (see section 4.2.2) and about SOA success factors (see section 4.3.2) between all responses and the responses from IT/ICT Services industry only. We chose to compare with IT/ICT Services due to relatively many responses received from organizations working in this industry. By performing this comparative analysis, we would like to find out if there any major differences exist for IT/ICT Services industry compare to the average results for all industries.

The greatest number of responses were received from the organizations where the work area is related to Enterprise Resource Planning, or Customer Relationship Management – see Figure 5 for an overview. As we allowed to have multiple responses to the related questions, the number of results is greater than the number of responses. In total, there are about 30 % (17) of the respondents working in

the companies where the work area is related to ERP, about 30% (17) - in the companies where the work area is related to CRM and about 40% (26) – in the companies working with other areas.

As ERP related and CRM related work areas received the same number of responses, we think it is interesting to compare the survey results about SOA challenges and about SOA success factors between these two areas. We do comparative analysis later in this thesis – see section 4.2.3 for SOA challenges and section 4.3.3 for SOA success factors.

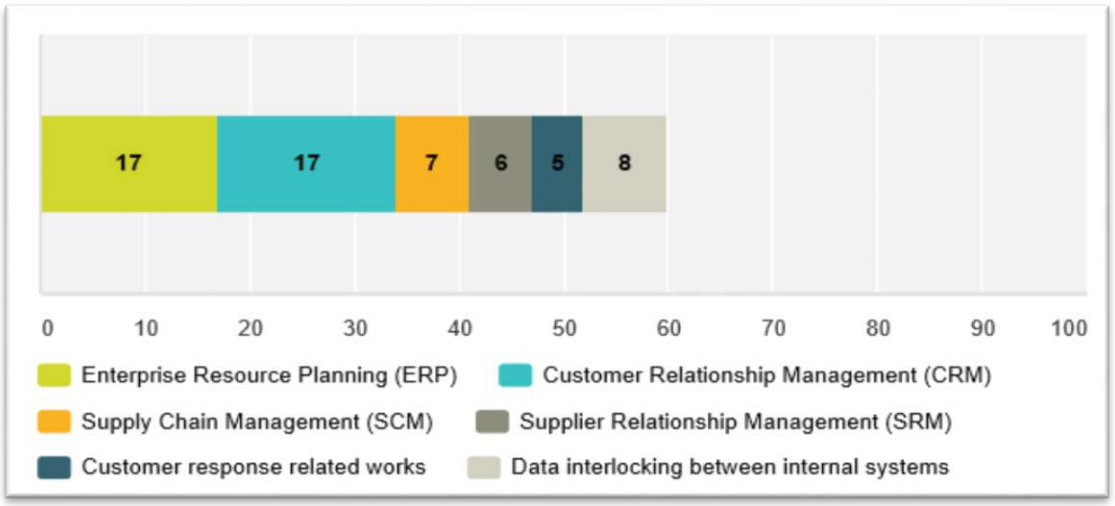


Figure 6 Results of survey Q2: What is the work area to which the application of SOA was reviewed or implemented?

The survey includes data about the company size. Survey results show that migration to SOA takes place most often in large organizations – 42.31% (11) of the total number of the responses.

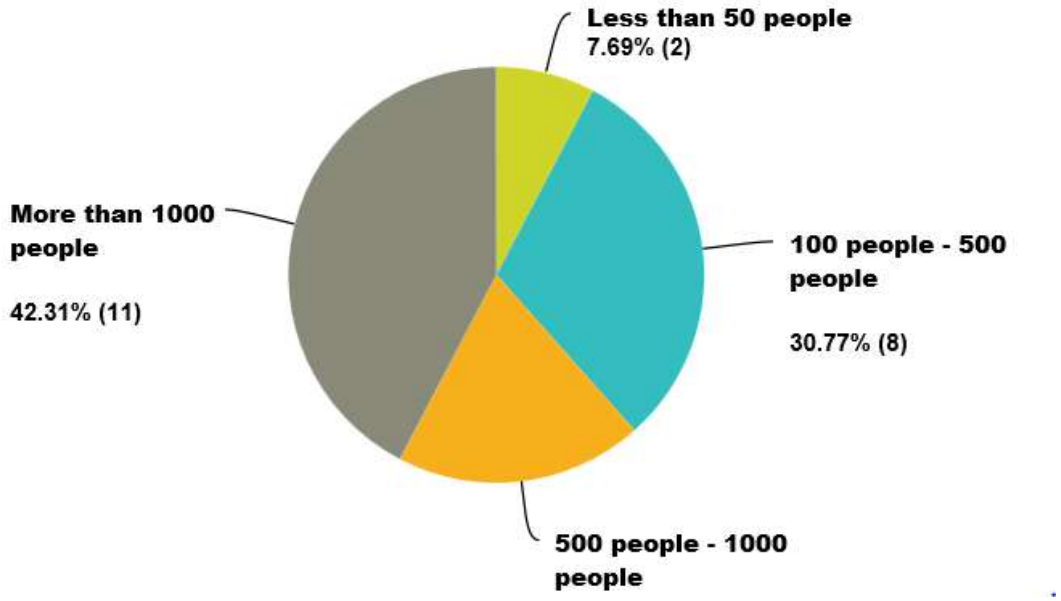


Figure 7 Results of survey Q10: How many employees does your company have?

4.2 Analysis of SOA challenges survey results.

4.2.1 Overview of SOA challenges survey results

In this section we describe the survey results about SOA challenges.

The survey results of SOA challenges are presented in Figure 8 and Figure 9. The Figure 8 presents SOA challenges average importance scores based on company background and includes the following samples: all results, IC/ICTS services industry, CRM work area, ERP work area, companies with a size of 100 to 500 people and companies with a size of more than 1000 people. The Figure 9 presents SOA challenges average importance scores based on the respondent background and includes the following samples: all results, the results from the respondents with 2 to 5 years of SOA experience, the results from the respondents with 5 to 10 years of SOA experience, the results from the respondents with development related job positions and the results from the respondents with business related job positions.

Based on the result presented in Figure 8 and Figure 9, we can conclude that every challenge in SOA projects is considered by respondents as important. In all results sample, the lowest importance score is 3.35 out of 5.0 what is also quite high. The lowest importance score belongs to 'Program Management challenges', which is followed by 'Defining Level of granularity', the next lowest scored challenge with the score 3.38. There are numbers of challenges rated below 4.0, such as "Technology challenges" (3.69), "Implementation Challenges" (3.73), "Managing Cost" (3.77) among others.

The greatest importance scores belong to "SOA Governance" and "Communicating SOA vision", both 4.23. This shows a strong alignment of the survey results with the literature review results, where both "SOA Governance" and "Communicating SOA vision" were most often discussed. "SOA Governance", "Communicating SOA vision" and "Choosing Right Migration Strategy" receive the score of 5 ("Extremely Important") from 50% or more than 50% of the total number of responses.

We display the ranking of SOA challenges based on the sample of all survey results in Table 6. We use average importance score values of all results sample to derive the ranking table. Later in this thesis, in the section 4.2.3 we compare SOA challenges importance ranking based on the survey results with the SOA challenges frequency ranking based on the literature review results. See Table 3 "Frequency analysis of SOA challenges based on literature review" earlier in this thesis for the literature review results.

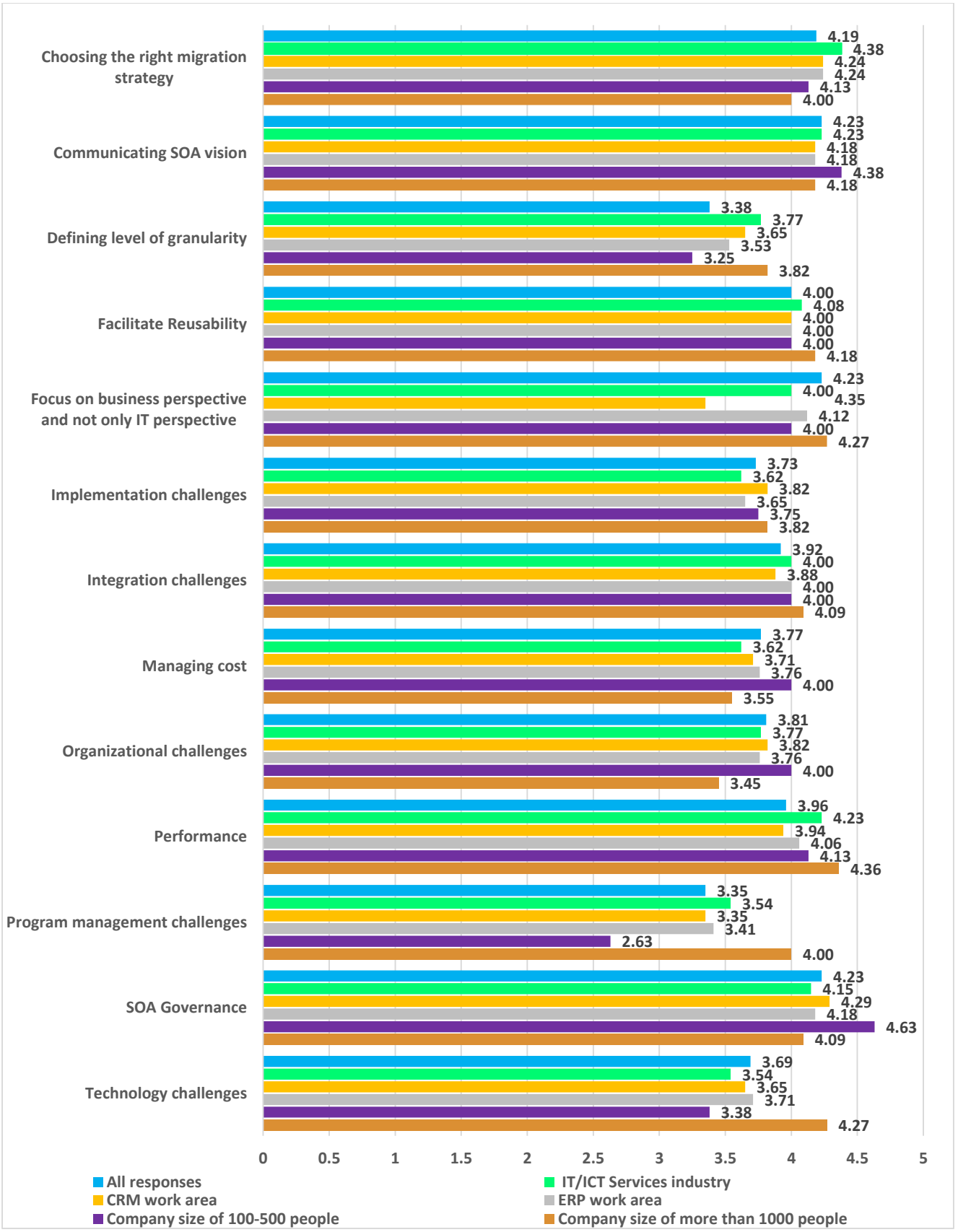


Figure 8 SOA challenges survey results in samples based on company background

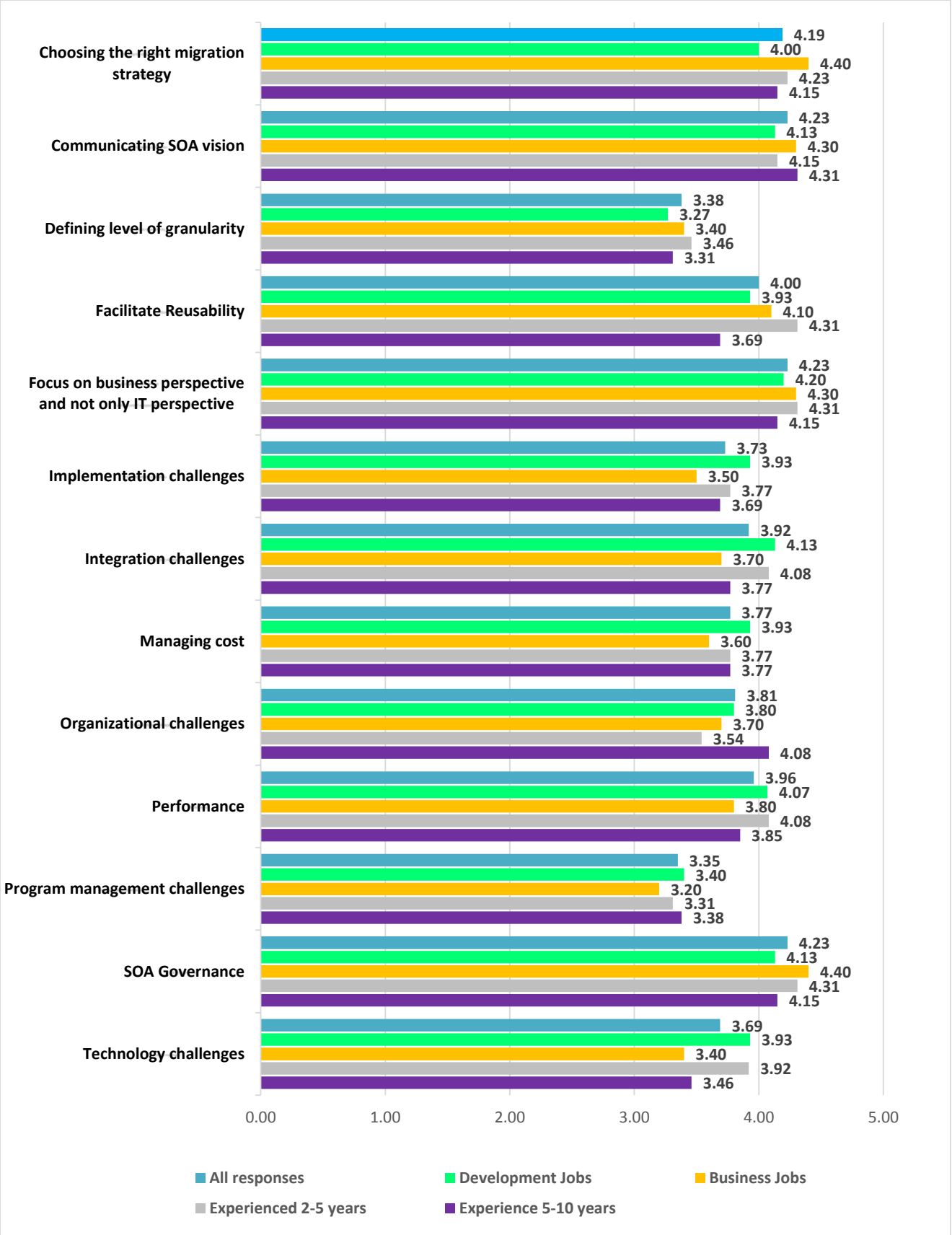


Figure 9 SOA challenges survey results in samples based on respondent background

Table 6 SOA challenges ranking based on the survey results

SOA challenge		Ranking number
1	Communicating SOA vision	1
2	Focus on business perspective, and not only IT perspective	1
3	SOA Governance	1
4	Choosing the right migration strategy	2
5	Facilitate Reusability	3
6	Performance	4
7	Integration challenges	5
8	Organizational challenges	6
9	Managing cost	7
10	Implementation challenges	8
11	Technology challenges	9
12	Defining level of granularity	10
13	Program management challenges	11

We also compare:

- The results of SOA challenges from all industries with results from IT/ICT Services industry.
- The results of SOA challenges between two work areas we received the greatest number of responses: CRM related work area and ERP related work area.
- The results about SOA challenges received from companies with a size of 100 to 500 people and results received from companies with a size of more than 1000 people.
- The results about SOA challenges received from people having business related jobs and the results received from people having development related jobs.
- The results about SOA challenges received from people having 2 to 5 years of experience with SOA and the results received from people having 5 to 10 years of experience with SOA.

We describe our finding in the section 4.2.2.

4.2.2 Comparison of SOA challenges survey results in different survey samples.

We compare the survey results of SOA challenges in five dimensions: industry, work area, company size, respondents' job position and respondents experience with SOA. For a complete overview of all average importance scores for SOA challenges in different samples see Table 16 in Appendix 2. In Table 7 we show the differences in average importance scores between: all results and IT/ICT Services results, CRM and ERP work area results, the results where the respondents work in companies with a size 100 to 500 people and with more than 1000 people, the results from the respondents with SOA experience 2 to 5 years and 5 to 10 years. We describe our finding afterwards.

Table 7 Differences of SOA challenges average importance scores between different samples of the survey

SOA Challenge		**Industry**	**Work Area**	**Company size**	**Job Position**	**Experience (years)**
		All vs. IT/ICT Services	**CRM vs. ERP**	**100-500 vs. more than 1000**	**Business vs. Development**	**2-5 vs. 5-10**
1	Choosing the right migration strategy	0.19	0.00	0.13	0.40	0.08
2	Communicating SOA vision	0.00	0.00	0.20	0.17	0.16
3	Defining level of granularity	0.39	0.12	0.57	0.13	0.15
4	Facilitate Reusability	0.08	0.00	0.18	0.17	0.62
5	Focus on business perspective, and not only IT perspective	0.23	0.21	0.27	0.10	0.16
6	Implementation challenges	0.11	0.17	0.07	0.43	0.08
7	Integration challenges	0.08	0.12	0.09	0.43	0.31
8	Managing cost	0.15	0.05	0.45	0.33	0.00
9	Organizational challenges	0.04	0.06	0.55	0.10	0.54
10	Performance	0.27	0.12	0.23	0.27	0.23
11	Program management challenges	0.19	0.06	1.37	0.20	0.07
12	SOA Governance	0.08	0.11	0.54	0.27	0.16
13	Technology challenges	0.15	0.06	0.89	0.53	0.46

Industry: 50 % of all responses were from companies working with IT/ICT Services. Due to relatively many responses within this industry, we decided to compare the results from all companies with the results from IT/ICT Services only. Table 7 shows that there is only a slight difference between the responses from IT/ICT Services industry and the responses from all industries. SOA challenge "Defining level of granularity' has the greatest difference – 0.39 and is considered to be more important in the responses from IT/ICT Services industry compared to the responses from all

industries. The importance scores of other SOA challenges are even less different. Based on this, we can conclude that SOA challenges are not industry-specific. However, more extensive research about SOA relationships with different industries should be performed before making the statement. This is not in the scope of this thesis.

Work area: In the results for CRM work area (see Figure 8) the greatest importance scores belong to the following SOA challenges: "Focus on business perspective, and not only IT perspective" – 4.35, "SOA Governance" – 4.29, "Choosing the right migration strategy" – 4.24, and "Communicating SOA vision" – 4.18. These results are similar to SOA challenges results in all results sample. The lowest score belongs to "Program Management challenges" – 3.35 and it is the same result as all SOA challenges results.

Figure 8 also shows the results for ERP related work area. Similar to the general SOA challenges and to CRM related results, the following SOA challenges are considered as the most important: "Choosing the right migration strategy" – 4.24, "SOA Governance" – 4.18, "Communicating SOA vision" – 4.18, and "Focus on business perspective, and not only IT perspective" – 4.12. "Program Management challenges" with a score of 3.41 is considered as least important.

Table 7 shows that average importance scores for SOA challenges in the results from CRM and ERP related work areas are very similar. There is no deviation in scores for "Choosing the right migration strategy, "Communicating SOA vision" and "Facilitate Reusability" SOA challenges. A little difference of maximum 0.21 exists for all other SOA challenges.

Company size: In the result samples of companies with a different size (100 to 500 people and more than 1000 people), there are some SOA challenges that have high deviations in average importance scores. The difference of 1.37 is identified for "Program management challenges". This challenge is considered more important in the results received from the respondents working in the companies with a size of more than 1000 people. We think, it is because successful management is more challenging if more people involved. Another interesting result is that "Technology challenges" are also considered more important in the companies of bigger size – the difference of 0.89 between an average score for companies with a size of 100 to 500 people – 3.38 and companies with a size of more than 1000 people – 4.27. There are a few more SOA challenges that have visible differences: "Defining level of granularity" – 0.57, "Organizational challenges" – 0.55, "SOA Governance" – 0.54 and "Managing cost" – 0.45. "Defining level of granularity" is considered more important by companies of more than 1000 people, while other three challenges – by companies of 100 to 500 people. A complete overview

of differences in the average importance scores between the results from companies of two different sizes is displayed in Table 7.

Job Position: In the results for SOA challenges, received from the respondents with business related job positions (see Figure 9), the highest importance scores were given to the following SOA challenges: "Choosing the right migration strategy" – 4.40, "SOA Governance" – 4.40, "Communicating SOA vision" – 4.30, and "Focus on business strategy" – 4.30. 4.40 is the highest average score given for a SOA challenge in all samples analyzed in this thesis. In the results for SOA challenges, received from the respondents with development job positions, the average importance scores are lower compare to the scores in a business related jobs sample. The highest score is 4.20 and belongs to "Focus on business perspective, not only IT perspective" SOA challenge.

Table 7 shows that there is a little difference in rating SOA challenges between the responses received from people with business related job positions and the responses received from people with development related job positions. The greatest difference is 0.53 and belongs to "Technology challenges". The next greatest difference is 0.43 and there are two challenges that have this difference: "Implementation challenges" and "Integration challenges". All three SOA challenges mentioned above are considered as more important by people with development related job positions. We think this is logical as it is most often that developers and architects struggle with these challenges, and not business analysts or project managers.

Experience (years): In the results for SOA challenges, received from the respondents with SOA experience of 2 to 5 years, the highest importance scores were given to the following SOA challenges: "SOA Governance" – 4.31, "Focus on business perspective and not only IT perspective' – 4.31, "Facilitate Reusability" – 4.31 and "Choosing the right migration strategy" – 4.23. In the results for SOA challenges, received from the respondents with SOA experience of 5 to 10 years, the highest score is 4.31 and belongs to "Communicating SOA vision" SOA challenge. Most of the SOA challenges, except a few, are considered as more important by the less experienced respondents. The greatest deviation belongs to "Facilitate Reusability" – 0.62. The reason for this could be that more experienced people find it easier to deal with challenges and therefore consider them less important. However, more experienced people pay more attention to another SOA challenges. For instance, they consider "Organizational challenges" to be more important (with a difference of 0.54) compare to less experienced people.

4.2.3 Aligning SOA challenges survey results with literature review results.

The comments from the survey respondents prove our literature review finding and survey analysis findings. For instance, one of the respondents says that the hardest part of SOA rollout is merging IT and business thinkers together. This statement aligns with "Communicating SOA vision" SOA challenge, which is ranked as one of the most important in the survey results and as one of the most frequently discussed in the literature review results. Few respondents commented on "SOA Governance" and "Focusing on business perspective", underlining the significance of these challenges. Both, "SOA Governance" and "Focus on business perspective, and not only IT perspective" are among the most important challenges based on the survey results and among the most discussed challenges based on the literature review results.

Below, in the Table 8 we highlight the challenges from the literature review, aligned with the survey answers. The table consists of two columns, where the left column includes SOA challenge name and the right column includes input from the results of the survey related to this challenge.

Table 8 SOA challenges comments from the survey results

SOA challenges from the literature review		**Comments from the survey respondents**
1	Communicating SOA Vision	"The hardest part of SOA rollout is merging IT and business thinkers together so each sees the benefits of the structured approach."
2	Defining level of granularity	"Identifying the right set of services. Right granularity and aligned with the organization profiles." "Defining service granularity effectively supports the governance process and allows people to understand what is being delivered."
3	Facilitate Reusability	"Writing services that can be reused for different process." (named as one of the most important challenges) "Scaling can be difficult when common business services are commonly reused."
4	Focus on business perspective and not only on IT perspective	"Not understanding the business context and treating SOA as a technical exercise is the single biggest driver of failure." "Understanding the meaning of SOA for business and other non-technical persons that all must be active in the migration."
5	SOA Governance	"People do not have the right SOA governance in place." (names as one of the most important challenges) "Sharing common vision across all participants: who should be responsible for what; when each step of migration occurs etc." "It is much harder to make changes to support SOA governance outside the SDLC (delivery model) as it involves changing business behavior."
6	Implementation challenges &	"Each time need to refresh service if any change is made in the end system package which acquire that service."

	Integration challenges	"Being confused between SOA and integration. Several companies are influenced by their choice of middleware in evolving the SOA blueprint. They simply build expose integration points as "Services" and then expect to see the benefits of SOA coming through."
7	Information Architecture	"After the initial architect leave the project, the original philosophies and design choices are often lost."
8	Managing Cost & Organization Challenges	"We are in a very aggressive project and business doesn't want to commit to spending time to flesh out requirements and really test the services. Which is caused things to be rushed and affects quality."
9	Managing Cost & Communicating SOA Vision	"Most business stakeholders struggle with moving from a project based financing model and SOA requires one to think about TCO across multiple program."
10	Program Management challenges	"There are needs to be a move from point delivery thinking to organizational delivery thinking to support SOA."
11	Technology challenges	"When it comes to technology the primary issues is that people don't govern interfaces tightly enough." "Chose right technology and practices to help the migration, but avoid too big gap with current culture and knowledge."

We ranked SOA challenges based on the results from the survey and the literature review. These results are displayed in Table 9 and explained afterwards.

Table 9 SOA challenges ranking – comparison of the survey results with the literature review results

SOA challenge		**Ranking (Survey results)**	**Frequency ranking (Literature review results)**
1	Focus on business perspective, and not only IT perspective	1	1
2	Communicating SOA vision	1	4
3	SOA Governance	1	3
4	Choosing the right migration strategy	2	3
5	Facilitate Reusability	3	2
6	Performance	4	5
7	Integration challenges	5	2
8	Organizational challenges	6	5
9	Managing cost	7	4
10	Implementation challenges	8	5
11	Technology challenges	9	4

12	Defining level of granularity	10	2
13	Program management challenges	11	6

A ranking of the SOA challenges based on the survey results includes values from 1 to 11, where 1 indicates the SOA challenge with the highest average importance score and 11 indicates the SOA challenge with the lowest importance score. Frequency ranking of SOA challenges based on the literature review results includes values from 1 to 6, where 1 indicates the SOA challenges that is most often discussed in the literature and 6 indicates the SOA challenge that is least often discussed in the literature.

The values of ranking are relative values, because the survey results have a greater number of different results than the literature review results. As we have 11 different ranking values based on the survey results and 6 different ranking values based on the literature review results, we consider 2 survey ranking values to be the same as 1 literature review ranking value: e.g., 1 and 2 from the survey results is the same as 1 from the literature review results, 3 and 4 – is the same as 2 and so on.

The results received from the survey and the results received from the literature review have both similar and different rankings – see Table 9 for an overview. The SOA challenges such as “Focus on business perspective, and not only IT perspective”, “SOA Governance” and “Choosing the right migration strategy” are ranked high in both cases; the SOA challenge “Program Management Challenge” is considered relatively low important in both cases too. There are some challenges that have different results from the survey and from the literature review. For instance, “Defining level of granularity” is one of the lowest scored SOA challenges based on the survey results (10 out of 11) and one of the highest scored SOA challenges (2 out of 6) based on the literature review results.

4.3 Analysis of SOA success factors survey results

4.3.1 Overview of SOA success factors survey results

In this section we describe the survey results about SOA success factors.

The survey results of SOA success factors are presented in Figure 10 and Figure 11. The Figure 10 presents SOA success factors average importance scores based on company background and includes the following samples: all results, IC/ICTS services industry, CRM work area, ERP work area, companies with a size of 100 to 500 people and companies with a size of more than 1000 people. The Figure 11 presents SOA success factors average importance scores based on the respondents' background and includes the following samples: all results, the results from the respondents with 2 to 5 years of SOA experience, the results from the respondents with 5 to 10 years of SOA experience, the results from the respondents with development related job positions and the results from the respondents with business related job positions.

Based on the results presented in Figure 10 and 11, we can identify that every single factor in SOA projects is considered by the companies as important in order to achieve the successful result. In all results sample, the highest average importance score is 4.28 and belongs to "Business Process of Company". It shows strong alignment with the literature review results, where "Business Process of Company" factor is also one of the most discussed factors. The lowest average importance score is 3.12 out of 5.0 and belongs to 'Dependence on Commercial products'. 16 out of 18 success factors received the scores between 3.71 and 4.08, only 4 of these 16 factors have the average importance score equal to 4.0 or higher. Among them are "SOA Governance", "Strategy of migration to SOA", "Communication and collaboration" and "Technically skilled personnel". The average importance score of "SOA Governance" is strongly aligned with the literature review results. For example, SOA Governance was named in Franzen [15] as a key factor to succeed with SOA and as an important success factor in five out of five case studies in Galinium [8].

We display the ranking of SOA success factors based on the survey results in Table 10. We use average importance score values to derive the ranking table. In section 4.3.3 we compare SOA success factors ranking based on the survey results with SOA success factors frequency ranking based on the literature review results. See Table 5 "Frequency analysis of SOA success factors based on literature review" for the literature review results.

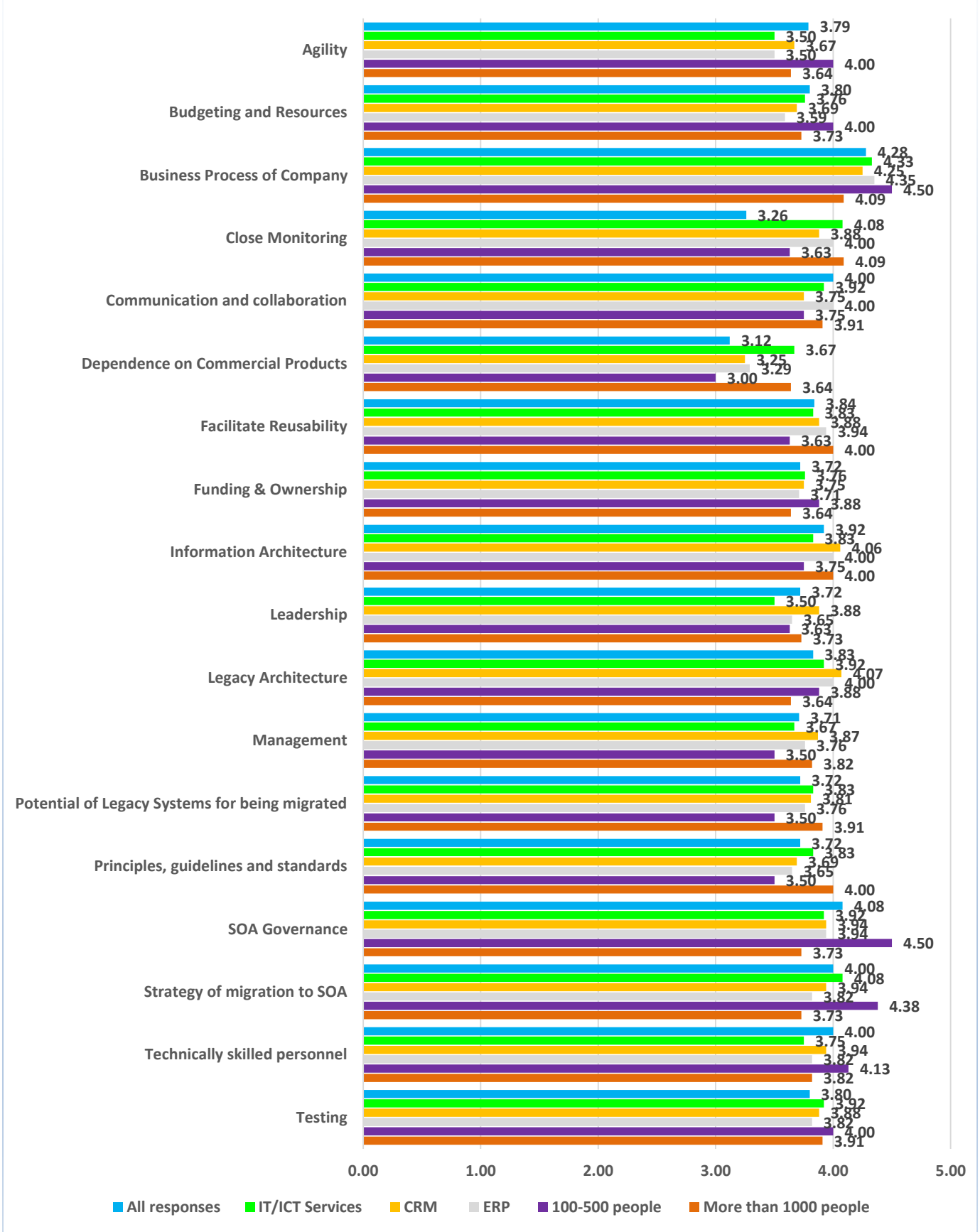


Figure 10 SOA success factors survey results in samples based on company background

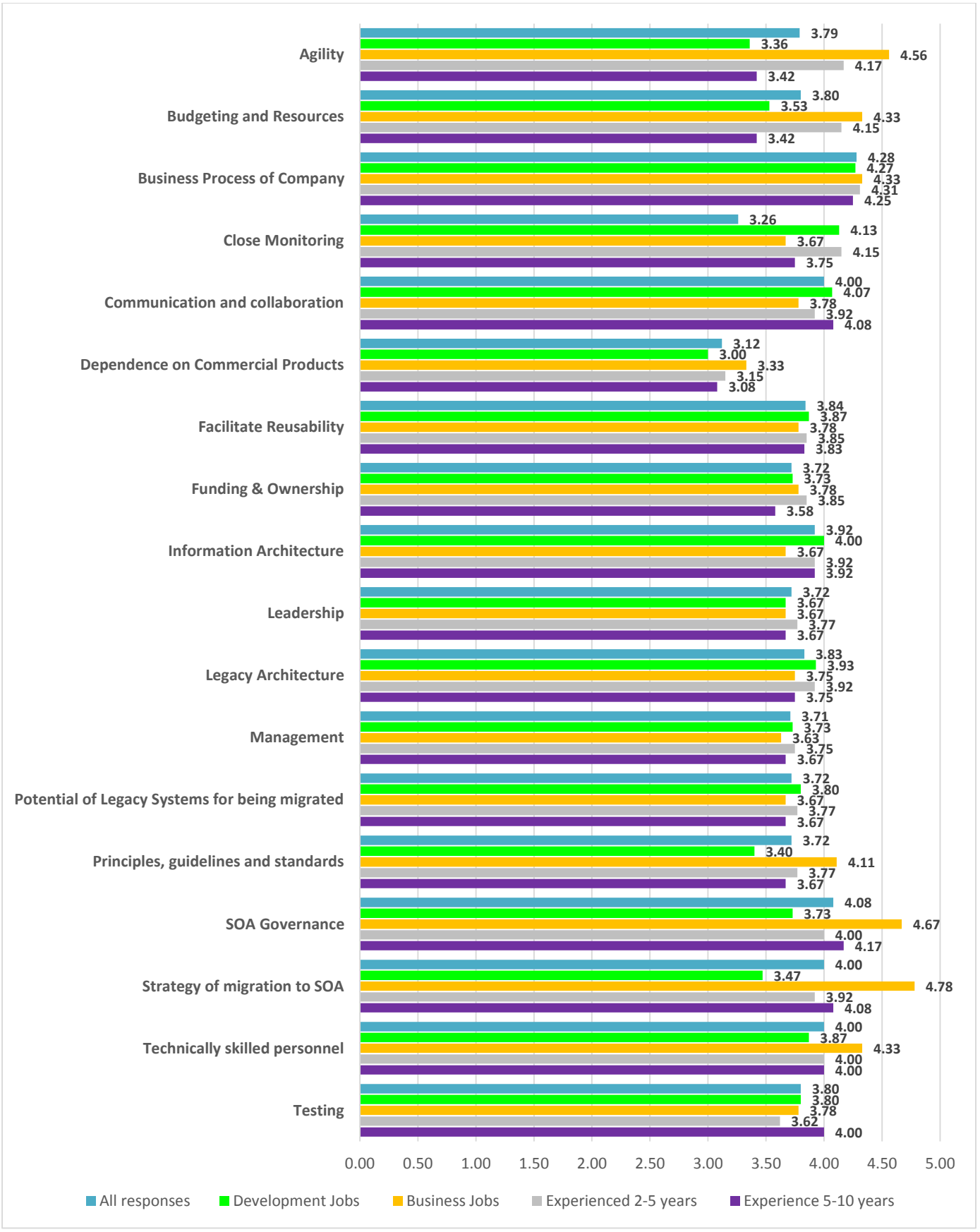


Figure 11 SOA success factors survey results in samples based on respondent background

Table 10 SOA success factors ranking based on the survey results

SOA success factor		Ranking number
1	Business Process of Company	1
2	SOA Governance	2
3	Strategy of migration to SOA	3
4	Technically skilled personnel	3
5	Communication and collaboration	3
6	Information Architecture	4
7	Facilitate Reusability	5
8	Legacy Architecture	6
9	Budgeting and Resources	7
10	Testing	7
11	Agility	8
12	Funding & Ownership	9
13	Leadership	9
14	Potential of Legacy Systems for being migrated	9
15	Principles, guidelines and standards	9
16	Management	10
17	Close Monitoring	11
18	Dependence on Commercial Products	12

We also compare:

- The results about SOA success factors from all industries with the results from IT/ICT Services industry.
- The results about SOA success factors between two work areas where we received the greatest number of the responses: CRM related work area and ERP related work area.
- The results about SOA success factors received from companies with a size of 100 to 500 people and results received from companies with a size of more than 1000 people.
- The results about SOA success factors received from people having business related jobs and the results received from people having development related jobs.
- The results about SOA success factors received from people having 2 to 5 years of experience with SOA and the results received from people having 5 to 10 years of experience with SOA.

We describe our finding in the section 4.3.2.

4.3.2 Comparison of SOA success factors survey results in different survey samples.

We compare the survey results of SOA success factors in five dimensions: industry, work area, company size, respondents' job position and respondents experience with SOA. For a complete overview of all average importance scores for SOA success factors in different samples see Table 17 in Appendix 3. In Table 11 we show the differences in average importance scores between: all results and IT/ICT Services results, CRM and ERP work area, the results where the respondents work in companies with a size 100 to 500 people and with more than 1000 people, the results from the respondents with SOA experience 2 to 5 years and 5 to 10 years. We describe our finding afterwards.

Table 11 Differences of SOA success factors average importance scores between different samples of the survey

Success factors		**Industry**	**Work Area**	**Company size**	**Job Position**	**Experience (years)**
		All vs. IT/ICT Services	**CRM vs. ERP**	**100-500 vs. more than 1000**	**Business vs. Development**	**2-5 vs. 5-10**
1	Agility	0.29	0.17	0.36	1.20	0.75
2	Budgeting and Resources	0.04	0.10	0.27	0.80	0.73
3	Business Process of Company	0.05	0.10	0.41	0.06	0.06
4	Close Monitoring	0.82	0.12	0.46	0.46	0.40
5	Communication and collaboration	0.08	0.25	0.16	0.29	0.16
6	Dependence on Commercial Products	0.55	0.04	0.64	0.33	0.07
7	Facilitate Reusability	0.01	0.06	0.37	0.09	0.02
8	Funding & Ownership	0.04	0.04	0.24	0.05	0.27
9	Information Architecture	0.09	0.06	0.25	0.33	0.00
10	Leadership	0.22	0.23	0.10	0.00	0.10
11	Legacy Architecture	0.09	0.07	0.24	0.18	0.17
12	Management	0.04	0.11	0.32	0.10	0.08
13	Potential of Legacy Systems for being migrated	0.11	0.05	0.41	0.13	0.10
14	Principles, guidelines and standards	0.11	0.04	0.50	0.71	0.10
15	SOA Governance	0.16	0.00	0.77	0.94	0.17
16	Strategy of migration to SOA	0.08	0.12	0.65	1.31	0.16
17	Technically skilled personnel	0.25	0.12	0.31	0.46	0.00
18	Testing	0.12	0.06	0.09	0.02	0.38

Industry: Figure 10 shows an average importance score of each SOA success factor received from the responses with IT/ICT Services industry. Average scores for all success factors have a range between 3.5 and 4.33, where the lowest scores belong to "Agility" and "Leadership", and the highest scores belong to "Business Process of Company". Table 11 shows that there is only a slight difference between the responses from IT/ICT Services industry and the responses from all industries. There are only two SOA success factors that have a relatively high difference in scores: "Close Monitoring" and "Dependence on Commercial products" with the difference of 0.82 and 0.55 accordingly. These two success factors are considered as more important in the responses received from the IT/ICT services industry compare to the responses from all industries. 16 out of 18 success factors have difference in average importance scores between two samples not greater than 0.29. Based on this, and also on the similar results about SOA challenges (described in the section 4.2.2) we can conclude that there is no reason to consider SOA as an industry–specific subject.

Work area: In the results from CRM related work area, the success factor "Dependence on Commercial products" got the lowest rating with an average score of 3.25, while the highest rating is 4.25 and belongs to "Business Process of Company". Such success factors as "Legacy Architecture" and "Information Architecture" received the next highest scores – 4.08 and 4.07 accordingly. It is an interesting result, because the survey results from CRM related work area is the only sample where these two factors are included in Top 3 of the highest rated factors. This result also underlines the importance of business processes in the company for achieving the successful results.

In the results from ERP related work area, the highest rated success factor is "Business Process of Company" with a score of 4.35 and the lowest rated success factor is "Dependence on Commercial Products" with the score of 3.29. There are also four success factors that receive the scores of 4.0: "Close Monitoring", "Communication and collaboration", "Information Architecture" and "Legacy Architecture". All other success factors are rated below 4.0. These results are very similar to the results from CRM related work area.

Table 11 shows the differences in the average importance scores between the results from CRM and ERP work areas. The greatest difference between scores in these two areas belongs to "Communication and collaboration" and is 0.25 what is also relatively low. Other success factors have even lower differences in the results from these two work areas. The result about SOA success factors is different from the result of SOA challenges analysis in different work areas, where more obvious differences were found.

Company size: In the results for companies with a size of 100 to 500 people, "Business Process of the Company" and "SOA Governance" success factors are considered as the most important ones, both with the average score of 4.50. In the results for companies with a size of more than 1000 people, "Business Process of the Company" and "Close Monitoring" are considered to be the most important ones, both with the average score of 4.09. Thus, "Business Process of the Company" receives the highest average importance scores in both survey samples.

In the results for companies with a different size, some SOA success factors have obvious differences in the average importance scores. The highest difference of 0.77 belongs to "SOA Governance". "SOA Governance" is considered as more important in the results received from the respondents working in the companies with a size of 100 to 500 people. After "SOA Governance" follows: "Dependence on Commercial Products" – 0.64, "Strategy of migration to SOA" – 0.65 and "Principles, guidelines and standards" – 0.50. "Strategy of migration to SOA" is considered more important in smaller companies, while "Dependence on Commercial Products" and "Principles, guidelines and standards" – in bigger companies. A complete overview of differences in the average importance scores between the results from companies of two different sizes is displayed in Table 11.

Job Position: In the results, received from the respondents with business related job positions, we can see that some factors received relatively very high scores – more than 4.5 out of 5.0. In Figure 11, there are three such factors are identified: "Strategy of migration to SOA" with the score of 4.78, "SOA Governance" with the score of 4.68, and "Agility" with the score of 4.56. The average score of 4.78 is the highest average score for a success factor in all samples we have analyzed. People with development related job positions indicate different success factors as the most important: "Business Process of Company" with the average score of 4.27, "Close Monitoring" – 4.13, "Communication and Collaboration" – 4.07 and "Information Architecture" – 4.00.

Table 11 shows that the results in rating SOA success factors are quite different between the responses received from people with business related job positions and the responses received from people with development related job positions. The following SOA success factors have the highest differences in importance scores and considered as more important by people with business related job position: "Strategy of migration to SOA" – 1.31, "Agility" – 1.20, "SOA Governance" – 0.94, "Budgeting and resources " – 0.80, and "Principles, guidelines and standards" – 0.71. It is interesting that the people with business related jobs indicate as the most important those success factors that are most related to the scope of their jobs.

This result indicates that people with business related job positions and people with development related job positions have different understanding and experience with SOA migrations. The samples based on respondents' jobs have the highest deviation among all samples we have analyzed in this thesis. We think that this deviation indicates the importance of considering the audience while analysing SOA migration or any other technical subject.

Experience (years): In the results for SOA success factors, received from the respondents with SOA experience of 2 to 5 years, the highest importance scores were given to the following SOA success factors: "Business Process of Company" – 4.31, "Agility" – 4.17, "Budgeting and Resources" – 4.15 and "Close Monitoring" – 4.15. In the results for SOA success factors, received from the respondents with SOA experience of 5 to 10 years, the highest score is 4.25 and belongs to "Business Process of the Company". The next highest score is 4.17 and belongs to "SOA Governance". Most of the SOA success factors received similar average importance scores in both samples. However, "Agility" (with a difference of 0.75), "Budgeting and Resources" (with a difference of 0.73), and "Close Monitoring" (with a difference of 0.40) are considered to be more important by less experienced people. A complete overview of differences in the average importance scores between the results from respondents with different experience is displayed in Table 11.

4.3.3 Aligning SOA success factors survey results with literature review results.

In the survey we received a few comments, underlining the importance of the following success factors: "Business Process of Company", "SOA Governance", "Funding & Ownership", "Principles, guidelines and standards", and "Technically skilled personnel". In Table 12 we highlight the success factors from the literature review, aligned with the survey answers. The table consists of two columns where the left one includes a name of a SOA success factor and the right one includes input from the results of the survey aligned with this success factor.

Table 12 SOA success factors comments from the survey results

SOA success factors from a literature review		**Comments from the survey respondents**
1	Business Process of Company	"Clear business objectives." "Enterprise commitment. SOA migration cannot be an IT decision only."
2	Funding & Ownership & Business Process of Company	"Building an understanding of the total cost of ownership of SOA, and aligning with business strategy so everyone is behind the vision."
3	Principles, guidelines and standards	This success factor is named as an important one in 1 out of 5 received comments.
4	SOA Governance	This success factor is named as an important one in 2 out of 5 received comments: "SOA Governance." "Define governance. SOA migration impact is enterprise wide. Benefits are expected to be also enterprise wide. For that to occur, governance is where all parties concerned can share their needs and constraints."
5	Technically skilled personnel	"Knowledge and expertise. SOA is not a piece of equipment that you can install and maintain. SOA is a different way of doing things. If knowledge and expertise are absent, people will simply carry on doing old things the old way but with a new technology. No benefits to be gained this way!" "The right people."

In Table 13, we compare ranking of the SOA success factors based on the survey results with frequency ranking of the SOA success factors based on the literature review results.

A ranking of the SOA success factors based on the survey results includes values from 1 to 12, where 1 indicates the SOA success factor with the highest average importance score and 12 indicates the SOA success factor with the lowest average importance score. Frequency ranking of SOA success factors based on the literature review results includes values from 1 to 6, where 1 indicates the SOA success factor that is most often discussed in the literature and 6 indicates the SOA success factor that is least often discussed in the literature.

The values of ranking are relative values, because the survey results have a greater number of different results than the literature review results. As we have 12 different ranking values based on the survey results and 6 different ranking values based on the literature review results, we consider two survey ranking values to be the same as one literature review ranking value. It is the same procedure as we did for the SOA challenges results earlier in this thesis.

The results received from the survey and the results received from the literature review have both similar and different rankings – see Table 13 for an overview. The SOA success factor "SOA Governance" is ranked high both in the survey results (2 out of 12) and in the literature review results (1 out of 6). Some success factors, such as "Leadership", "Funding & Ownership", "Principle, guidelines and standards" have similar rankings in the survey results and the literature review results. There are also some success factors such as "Communication and collaboration" and "Strategy of migration to SOA" among others that received different rankings. These factors should be studied more in order to get a better understanding of their role for successful SOA projects.

Table 13 SOA success factors ranking – comparison of the survey results with the literature review results

SOA success factor		**Ranking (survey results)**	**Frequency ranking (literature review results)**
1	Business Process of Company	1	3
2	SOA Governance	2	1
3	Communication and collaboration	3	5
4	Strategy of migration to SOA	3	3
5	Technically skilled personnel	3	4
6	Information Architecture	4	4
7	Facilitate Reusability	5	2
8	Legacy Architecture	6	4
9	Testing	7	5
10	Budgeting and Resources	7	3
11	Agility	8	5
12	Leadership	9	4
13	Funding & Ownership	9	5
14	Potential of Legacy Systems for being migrated	9	6
15	Principles, guidelines and standards	9	5
16	Management	10	4
17	Close Monitoring	11	5
18	Dependence on Commercial Products	12	4

4.4 Discussion of the survey results.

The survey results show that all mentioned SOA challenges and SOA success factors received an average importance score greater than 3.0 out of 5.0 possible. It means that in the SOA projects it is not possible to ignore any of these elements. Most of the challenges and success factors were considered as important by most all companies we received data from. There were only a few that listed some of SOA challenges and/or SOA success factors with importance score 1.0 or 2.0 (see Table 14 for an overview of importance scores for SOA challenges and Table 15 for an overview of importance scores for SOA success factors). Based on this, we think that the SOA projects can be treated individually and SOA challenges/SOA success factors can differ from one project to another.

Table 14 provides an overview of the survey importance scores over SOA challenges. The table's data consists of SOA challenges and their importance scores, including average scores, maximum scores, and minimum scores.

Table 14 SOA challenges importance scores

SOA Challenge		Average score	Maximum score	Minimum score
1	Choosing the right migration strategy	4.19	5.00	2.00
2	Communicating SOA vision	4.23	5.00	1.00
3	Defining level of granularity	3.38	5.00	1.00
4	Facilitate Reusability	4.00	5.00	2.00
5	Focus on business perspective, and not only IT perspective	4.23	5.00	1.00
6	Implementation challenges	3.73	5.00	2.00
7	Integration challenges	3.92	5.00	2.00
8	Managing cost	3.77	5.00	1.00
9	Organizational challenges	3.81	5.00	1.00
10	Performance	3.96	5.00	1.00
11	Program management challenges	3.35	5.00	1.00
12	SOA Governance	4.23	5.00	1.00
13	Technology challenges	3.69	5.00	2.00

Table 15 provides an overview of the survey importance scores over SOA success factors. The table's data consists of SOA success factors and their importance scores, including average scores, maximum scores, and minimum scores.

Table 15 SOA success factors importance scores

SOA success factor		Average Score	Maximum Score	Minimum Score
1	Agility	3.79	5.00	1.00
2	Budgeting and Resources	3.80	5.00	3.00
3	Business Process of Company	4.28	5.00	1.00
4	Close Monitoring	3.96	5.00	1.00
5	Communication and Collaboration	4.00	5.00	1.00
6	Dependence on Commercial Products	3.12	5.00	1.00
7	Facilitate Reusability	3.84	5.00	2.00
8	Funding & Ownership	3.72	5.00	1.00
9	Information Architecture	3.92	5.00	1.00
10	Leadership	3.72	5.00	1.00
11	Legacy Architecture	3.83	5.00	1.00
12	Management	3.71	5.00	3.00
13	Potential of Legacy Systems for being migrated	3.72	5.00	2.00
14	Principles, guidelines and standards	3.72	5.00	2.00
15	SOA Governance	4.08	5.00	1.00
16	Strategy migration to SOA	4.00	5.00	1.00
17	Technically skilled personnel	4.00	5.00	1.00
18	Testing	3.80	5.00	1.00

The survey results also show the most critical and the most important areas. Thus, in the SOA challenges part, 'Communicating SOA vision' and 'SOA Governance' received the greatest importance scores – both 4.23 out of 5.0. In the SOA success factors part, the greatest importance scores belong to 'Business Process of Company' (4.28 out of 5.0) and SOA Governance (4.08 out of 5.0). Based on this, we can state that in any SOA project, if the company fails to communicate, fails to create a proper governance or overlooks the business process in the company, the chance the project will receive successful outcome is quite low.

5 Conclusions

This chapter analyzes the results and the contributions of the thesis in the light of the goals listed in the "Goals and Research Questions" section. The purpose of the thesis was to identify and analyze the challenges and success factors in the migration of legacy systems to SOA. Open issues and future directions of this research are also discussed.

5.1 Summary

In this thesis a set of challenges and success factors in migrations of legacy systems to SOA were derived. Investigation of the challenges of migrations to SOA was done by means of the literature review method and the survey method. Challenges in migration to SOA were analyzed from different research papers, which allowed us to create the list of SOA challenges discussed in the literature. We also identified the frequency, SOA challenges are discussed in the literature. The average importance score of each SOA challenge was derived based on the responses we receive from the survey. The same procedure has been done for SOA success factors: we derived the list of SOA success factors from the literature review and identified the importance score of each success factor from the survey results.

Below the summary of the achieved results:

- The survey results are analyzed and the average score of each SOA challenge and the average score of each SOA success factor is presented. Table 14 shows importance scores for SOA challenges based on all survey results. Table 15 shows importance scores for SOA success factors based on all survey results. Table 16 shows importance scores for SOA challenges for all survey samples we analyzed. Table 17 shows importance scores for SOA success factors for all survey samples we analyzed.
- There are three highest scored challenges identified: "Communicating SOA Vision", "Focus on business perspective, and not only IT perspective" and "SOA Governance", and each one with the average score of 4.23. The highest scored SOA success factor is "Business Process of Company" with the average score of 4.28.
- The survey results are compared: between all industries and IT/ICT Services industry; between CRM related and ERP related work areas; between the companies with a size of 100 to 500 people and size of more than 1000 people; between business related and development related job positions; between the respondents with SOA experience of 2 to 5 years and 5 to 10 years.

- The results of SOA challenges between all industries and IT/ICT Services industry are similar, with the highest difference in scores of 0.39: "Defining level of granularity" has the average score of 3.38 in the results from all industries and the average score of 3.77 in the results from IT/ICT Services industry. The results of SOA success factors between all industries and IT/ICT Services industry are similar too. However, "Close Monitoring" success factor has the significant difference of 0.82 and is considered more important in the results from IT/ICT Services industry compare to the results from all industries: 4.08 and 3.26 accordingly.
- The results of SOA challenges between CRM related and ERP related work areas are similar for all SOA challenges, except "Focus on business perspective, and not only IT perspective". This challenge is considered as more important in the results from ERP related work area and has the average score of 4.12 compare to 3.35 in the results from CRM related work area. The results of SOA success factors between CRM related and ERP related work areas do not have significant differences. The highest difference in average importance scores is 0.25 and belongs to "Communication and collaboration". This success factor is considered as more important in the results from ERP related work area.
- The results of SOA challenges between companies of a different size (100 to 500 and more than 1000) have the highest difference in "Program management challenges" – 1.37 and "Technology challenges" – 0.89. "Program Management challenges" are considered more important in the results received from the respondents working in the companies with a size more than 1000 people. "Technology challenges" are also considered more important in the companies of bigger size. In the results for SOA success factors, the highest difference of 0.77 belongs to "SOA Governance". "SOA Governance" is considered as more important in the results received from the respondents working in the companies with a size of 100 to 500 people.
- The results of SOA challenges between the results from business related and development related job positions have the highest differences in "Technology challenges" – 0.53, "Integration challenges" – 0.43, and "Implementation challenges" – 0.43. All three challenges are considered more important in the results from the responses with development related job positions. The results of SOA success factors in this sample have even more obvious differences. The greatest differences in the results belongs to "Strategy of migration to SOA" – 1.31, "Agility" – 1.20, "SOA Governance" – 0.94, "Budgeting and Resources" – 0.80, and "Principles, guidelines and standards" – 0.71. All these success factors are considered as more important in the results from the responses with business related job positions.

- The results of SOA challenges between respondents with 2 to 5 years of experience and 5 to 10 years of experience have the highest differences in “Facilitate Reusability” – 0.62 and “Organizational challenges” – 0.54. “Facilitate Reusability” is considered as more important by less experienced people, while “Organizational challenges” – by more experienced people. The results of SOA success factors between these two samples are similar to each other, except the results for “Agility” success factor. “Agility” is considered as more important by less experienced people with deviation in scores of 0.75
- The survey results are compared with the literature review results and the differences have been identified. The main difference is that some of the highest scored SOA challenges and SOA success factors are not those that are most often discussed in the literature. For instance, one of the highest ranked SOA challenges “SOA Governance” was discussed only in 14% of the literature sources we analyzed. “SOA Governance” has also different frequency in the literature depending on if it is considered as a success factor or as a challenge: 65% and 14% accordingly. The highest ranked SOA success factor “Business process of the company” was discussed only in 29% of the literature sources. This factor is considered as one of the most important in Galinium [8], but is not mentioned at all in Franzen [15].

As shown below, the goals have been reached and the results described in the thesis can be summarized as follows:

- A total of 13 SOA challenges in migration towards SOA were defined from the literature review. “Focus on business perspective, and not only IT perspective” is the most discussed SOA challenge in the literature and appears in 25% of the literature sources we analyzed.
- A total of 18 SOA success factors in migration towards SOA were defined from the literature review. “SOA Governance” SOA is the most discussed SOA success factor in the literature and appears in 64 % of the literature sources we analyzed.
- The importance of each of 13 challenges was identified on the scale from 1 to 5 by 26 respondents in the survey. Top 3 of the highest scored SOA challenges belongs to: “Communicating SOA Vision”, “Focus on business perspective, and not only IT perspective” and “SOA Governance”. All three received the same average score of 4.23.
- The importance of each of 18 success factors were identified on the scale from 1 to 5 by 26 respondents in the survey. “Business Process of Company” is the highest scored success factor and has the average score of 4.28

- The research shows that all of underlined challenges are very important in migration towards SOA. Top 5 includes “SOA Governance”, “Communicating SOA vision”, “Focus on the business perspective”, “Choosing the right migration strategy” and “Performance”.
- The research shows that all of underlined success factors are very important in migration towards SOA. Top 5 includes “Business Process of Company”, “SOA Governance”, “Communication and collaboration”, “Strategy of migration to SOA”, and “Technically skilled personnel”.

As described above, this thesis makes a contribution by giving an overview and comparative analysis of SOA challenges and SOA success factors in different industries, different work areas and different respondent groups. We think that our results can be used for more specific research where the conflicting areas (those that have different results) described in section 4.2 and section 4.3 can be studied more deeply.

5.2 Validity of the results, limitations and threats to validity

To evaluate the quality of answers to the research questions we have to investigate validity of finding and reliability of selected methods. Validity means that we have found correct data, and reliability means that our research could be proved to be repeatability of other researchers’ works.

We consider the results of this thesis to be reliable as listed SOA challenges and SOA success factors were studied repeatedly in several papers. Frequency analysis of literature earlier in this thesis proves this. We consider that the results have some threats to validity which we discuss below:

Conclusion validity. One issue that could affect the conclusion validity is the relatively small number of the survey results. We have collected 34 survey results what is a relatively small size of the sample data. Concerning data quality, we included the questions in the survey about respondents. This makes the results more reliable as we know that the data is received from proper audience. We also analyze only completed responses, which were 26 responses and did not consider the other 8 responses.

Construct validity. One of possible issue could be the way we designed the survey questions. In Q2 and Q4 we asked the respondents to rate the number of SOA challenges/success factors by using LIKERT scale. We also had two open questions (Q3 and Q5) where we asked respondents to identify three most important SOA challenges and three most important SOA success factors. However, we did not receive much information for Q3 and Q5 and therefore had to rely on the results from Q2 and Q4 at most. We think that we should have used another way to identify the most important

challenges/success factors. We could, for instance, ask the respondents to rank SOA challenges/success factors, which could give more accurate results.

Internal validity. One threat to internal validity is that the survey is based on the assumption that the respondents have the same understanding of the definition of SOA, and all the challenges and all the success factors we listed. One of the way to avoid this threat in the future could be to provide the potential respondents with definitions of terms that might have different interpretations.

Another threat is that the respondents can answer based on their work opinion and experience and not base on how things are done in the company where they work.

External validity. The threats to external validity concern generalizations. We believe that our results can be generalized to any company as we received the results from professional audience with minimum two years of SOA experience, working in different roles, different industries, and work areas and in companies of different size. However, we consider a small size of data sample and a low-response rate as a threat to external validity. The questionnaire was posted in the groups with thousands of members, but only 26 complete and 8 incomplete responses were received.

Despite a small number of the survey responses and threats to validity, we consider the results of this thesis to be valid as the results were consistent based on both methods we used: the literature review and the survey. Besides that, all SOA challenges and all SOA success factors received the average importance score greater than 3.0 out of 5, and none of SOA challenges and SOA success factors derived from the literature results were eliminated in the survey results.

5.3 Future directions

This research uncovers factors that have an impact on the process of migration towards SOA. These factors include challenges in SOA migration and success factors, which, if are treated correctly, more likely lead SOA migration to be successful in the end.

There are interesting areas that were found in this thesis and need to be investigated more. Among them are the differences in challenges/success factors between the different industries in which SOA migration occurs, the differences in challenges/success factors between the different work areas, the differences in challenges/success factors between the responses from people in different job positions and similar.

Besides that, it would be worth to investigate the relationships between different SOA migration challenges or different SOA success factors with each other, which potentially could define some conflicting areas.

We think that it could be interesting to study more the SOA challenges/success factors received different results from the survey and from the literature review in order to get a deeper understanding of SOA migrations.

Bibliography

[1] V. Srikanth (IBM) and A. Laird (Oracle), "Adoption of Service Oriented Architecture (SOA) for Enterprise Systems in Education: Recommended Practices," IMS Global Learning Consortium, 2009.

[2] MacKenzie C., Laskey K., McCabe F., Brown P, Hamilton B., "Reference model for service oriented architecture. Technical Report Version 1.0.," Organization for the Advancement of Structured Information Standards (OASIS Standard), Beillerica, USA, 2006.

[3] P.Giganek, "Service-Oriented Architecture Adoption: Key Factors and Approaches.," *Journal of Information Technology Management,* 2008.

[4] M. DeBarros, "State of SOA Survey 2010 - Executive Summary: SOA is entrenched.," TechTarget/Forrester, June 2010.

[5] R.Varadan, K. Channabasavaiah, S.Simpson, K.Holley, A.Allam, "Increasing business flexibility and SOA adoption through effective SOA governance," *IBM Systems Journal,* vol. 47, no. 3, 2008.

[6] I. Somerville, Software Engineering 6th edition, CWS, 2000.

[7] R. W. S. Charles Abrams, "Service-Oriented Architecture Overview and Guide to SOA Research," *Gartner,* 2008.

[8] M. Galinium, N. Shahbaz, "Factors Affecting Success in Migration of Legacy Systems to Service-Oriented Architecture (SOA)," School of Economic and Management, Lund University, 2009.

[9] T.-M. Grønli, "A Successful Implementation of Service Oriented Architecture," in *26th International Conference on Advanced Information networking and Applications Workshops*, Norwegian School of IT, Oslo, Norway, 2012.

[10] M. Galinium, N. Shahbaz, "Success Factors Model: Case Studies in the Migration of Legacy Systems to Service Oriented Architecture," in *2012 Ninth International Joint Conference on Computer Science and Software Enginnering (JCSSE)*, 2012.

[11] J. Chatarij, "Introduction to service-oriented architecture (SOA)," 2004.

[12] S. Comella-Dorda, K. C. Wallnau, R.C. Seacord, J.C. Robert, "A survey of black-box modernization approaches for information systems," *ICSM*, pp. 173-183, 2000.

[13] G. Canfora, A. Fasolino, G. Frattolillo, P. Tramontana, "A wrapping approach for migrating legacy system interactive functionalities to Service Oriented Architectures," *The Journal of Suystem and Software 81*, pp. 463-380, 2008.

[14] A. Almonaies, J. Cordy, and T. Dean, "Legacy System Evolution towards Service-Oriented Architecture," School of Computing, Queens University, Kingston, Ontario, Canada, 2010.

[15] J. Franzen, "Factors to succeed with SOA," IT University, Goteborg, 2008.

[16] B. Oates, "Researching Information Systems and Computing," *SAGE Publications Ltd*, 2006.

[17] N. Vlizko. [Online]. Available: https://www.surveymonkey.com/s/SDV6BRX. [Accessed 05 10 2014].

[18] A. Umar, A. Zordan, "Reengineering for service oriented architectures: A strategic decision model for integration versus migration," *The Journal of Systems and Software*, vol. 82, pp. 448-462, 2009.

[19] G. Lewis, E. Morris, D. Smith, "Service-Oriented Migration and Reuse Technique (SMART)," in *Proceedings of the 13th IEEE International Workshop on Software Technology and Engineering Practice*, 2005.

[20] M. P. Y. Natis, "Twelve Common SOA Mistakes and How to Avoid Them," *Garther*, 2007.

[21] S. Alahmari, E. Zaluska, D. De Roure, "A Service Identification Framework for Legacy System Migration into SOA," in *IEEE International Conference on Services Computing*, 2010.

[22] V. D. N. Kulkarni, "The Role of Service Granularity in A Successful SOA Realization - A Case Study," in *2008 IEEE Congress on Services 2008 - Part 1*, 2008.

[23] R.Haesen, M.Snoeck, W.Lemahieu, S. Poelmanset, "On the definition of service granularity and its architectural impact.," in *Advanced Information Systems Engineering. 20th International Conference, CAiSE, pp. 375-389*, 2008.

[24] W.Xiaofeng, S. Hu, E.Haq, H.Garton, "Integrating legacy systems within the service-oriented architecture," in *IEEE Power Engineering Society General Meeting, pp.7. IEEE Computer Soc.*, 2007.

[25] A. Erradi, S.Anand, N.Kulkami, "SOAF: An architectural framework for service definition and realization," in *IEEE Service Computing Workshops, pp. 151-158. IEEE Computer Soc.*, 2006.

[26] B. Carlson, E. Mark, "SOA Governance Best Practices - Architectural, Organizational, and SDLC Implications," January 29, 2006.

[27] K. Channabasavaiah, K. Holley, E. Tuggle, "Migrating to a service-oriented architecture," IBM, 2004.

[28] J. Ang, L. Cherbakov, M. Ibrahim, SOA Antipatterns: the obstacles to the adoption and successful realization of Service-Oriented Architecture, http://www.ibm.com/dveloperworks/webservices/library/ws-antipatterns/, 2005.

[29] C.Rollannd, R.S. Kaabi, "An intentional perspective to service modeling and discovery," in *31st Annual International Computer Software and Application Conference, IEEE Computer Soc. Institute of Technology Linkoping University*, 2007.

[30] O. Zimmermann, N. Schlimm, G. Waller, M. Pestel, "Analysis and Design Techniques for Service-Oriented Development and Integration," IBM Deutschland, Stuttgart, Germany.

[31] L. O'Brien, P. Brebner, J. Gray, "Business Transformation to AOA: Aspects of the Migration and Performance and QoS Issues," *SDSOA '08, Leipzig, Germany*, 2008.

[32] S. Mulik, S. Ajgaonkar, and K. Sharma, "Where Do You Want to Go in Your SOA Adoption Journey?," *IT Pro*, May/June 2008.

[33] B. Schneider, "What Is Real-Time SOA?," Real-Time Innovations, Inc., Sunnyvale, CA 94089, 2010.

[34] G. K. S.I. Behara, "Service Identication: BPM and SOA Handshake," *BPTrends,* 2007.

[35] K.Bennett, "Legacy systems:coping with stress.," *IEEE Software 12(1),* pp. 19-23, 1995.

[36] Y. M. P. Games, "Functional Size, Effort and Cost of SOA Projects with Function Points," no. LXVIII, November 2012.

[37] D. Linthicum, "How Much Will Your SOA Cost? Here are Some Guidelines.," *Info World (last accessed 09/10/13 her: http://soa.sys-con.com/node/318452),* November 2006.

[38] P. Brebner, L. O'Brien, J. Gray, "Performance Modeling for Service Oriented Architecture," *ICSE,* 2008.

[39] A. Hassanzadeh, L. Namdarian, S. Elahi, "Developing a framework for evaluating service oriented architecture governance (SOAG)," *Knowledge-Based Systems,* no. 24, pp. 716-730, 2011.

[40] B. T., "Doing Quantitative Research in Social Sciences: An Integrated Approach to Research Design, Measurement and Statistics.," Sage Publications, London, U.K, 1999.

[41] J. Hoon Lee, H. Shim, and K. Kyu Kim, "Critical Success Factors in SOA Implementation: An Exploratory Study," Information System Management, Graduate School of Information, Yonsei University, Seoul, Korea, 2010.

[42] A. Shaief, "Critical Success Factors for the migration of Legacy Information Systems to SOA," Delft University of Technology, Delfft, The Netherlands, 2011.

[43] S. Carter, "The New Language of Business: SOA & Web 2.0," IBM Press, US, 2007.

[44] A. Moeini, N. Modiri, T. Azadi, "Service Oriented Architecture Adoption Management Roadmap," Iran.

[45] M. P. K. S. Jayashetty, "Adopting Service Oriented Architecture increases the flexibility of your enterprise.," *Infosys,* 2006.

[46] M. Easterby-Smith, Management Research, Second Edition. An Introduction., 2008.

Appendices

Appendix 1 Overview of Literature Review sources by year

Total: 36 literature sources are considered

Year	Number of sources
1995	1
2000	1
2004	1
2005	2
2006	5
2007	5
2008	8
2009	3
2010	4
2011	3
2012	3

Figure 12 Literature sources by year

Appendix 2 Overview of SOA challenges survey results for all survey samples

Table 16 Overview of SOA challenges survey results for all survey samples

SOA Challenges	All	IT/ICT Services	CRM	ERP	100 - 500 people	more than 1000 people	Business Jobs	Dev. Jobs	Experienced 2 - 5 years	Experienced 5 - 10 years
Choosing the right migration strategy	4.19	4.38	4.24	4.24	4.13	4.00	4.40	4.00	4.23	4.15
Communicating SOA vision	4.23	4.23	4.18	4.18	4.38	4.18	4.30	4.13	4.15	4.31
Defining level of granularity	3.38	3.77	3.65	3.53	3.25	3.82	3.40	3.27	3.46	3.31
Facilitate Reusability	4.00	4.08	4.00	4.00	4.00	4.18	4.10	3.93	4.31	3.69
Focus on business perspective and not only IT perspective	4.23	4.00	4.35	4.12	4.00	4.27	4.30	4.20	4.31	4.15
Implementation challenges	3.73	3.62	3.82	3.65	3.75	3.82	3.50	3.93	3.77	3.69
Integration challenges	3.92	4	3.88	4	4.00	4.09	3.70	4.13	4.08	3.77
Managing cost	3.77	3.62	3.71	3.76	4.00	3.55	3.60	3.93	3.77	3.77
Organizational challenges	3.81	3.77	3.82	3.76	4.00	3.45	3.70	3.80	3.54	4.08
Performance	3.96	4.23	3.94	4.06	4.13	4.36	3.80	4.07	4.08	3.85
Program management challenges	3.35	3.54	3.35	3.41	2.63	4.00	3.20	3.40	3.31	3.38
SOA Governance	4.23	4.15	4.29	4.18	4.63	4.09	4.40	4.13	4.31	4.15
Technology challenges	3.69	3.54	3.65	3.71	3.38	4.27	3.40	3.93	3.92	3.46

Appendix 3 Overview of SOA success factors survey results for all survey samples

Table 17 Overview of SOA success factors survey results for all survey samples

SOA success factors	All	IT/ICT Services	CRM	ERP	100 - 500 people	more than 1000 people	Business Jobs	Dev. Jobs	Experienced 2-5 years	Experienced 5-10 years
Agility	3.79	3.50	3.67	3.50	4.00	3.64	4.56	3.36	4.17	3.42
Budgeting and Resources	3.80	3.76	3.69	3.59	4.00	3.73	4.33	3.53	4.15	3.42
Business Process of Company	4.28	4.33	4.25	4.35	4.50	4.09	4.33	4.27	4.31	4.25
Close Monitoring	3.26	4.08	3.88	4.00	3.63	4.09	3.67	4.13	4.15	3.75
Communication and collaboration	4.00	3.92	3.75	4.00	3.75	3.91	3.78	4.07	3.92	4.08
Dependence on Commercial Products	3.12	3.67	3.25	3.29	3.00	3.64	3.33	3.00	3.15	3.08
Facilitate Reusability	3.84	3.83	3.88	3.94	3.63	4.00	3.78	3.87	3.85	3.83
Funding & Ownership	3.72	3.76	3.75	3.71	3.88	3.64	3.78	3.73	3.85	3.58
Information Architecture	3.92	3.83	4.06	4.00	3.75	4.00	3.67	4.00	3.92	3.92
Leadership	3.72	3.50	3.88	3.65	3.63	3.73	3.67	3.67	3.77	3.67
Legacy Architecture	3.83	3.92	4.07	4.00	3.88	3.64	3.75	3.93	3.92	3.75
Management	3.71	3.67	3.87	3.76	3.50	3.82	3.63	3.73	3.75	3.67
Potential of Legacy Systems for being migrated	3.72	3.83	3.81	3.76	3.50	3.91	3.67	3.80	3.77	3.67
Principles, guidelines and standards	3.72	3.83	3.69	3.65	3.50	4.00	4.11	3.40	3.77	3.67
SOA Governance	4.08	3.92	3.94	3.94	4.50	3.73	4.67	3.73	4.00	4.17
Strategy of migration to SOA	4.00	4.08	3.94	3.82	4.38	3.73	4.78	3.47	3.92	4.08
Technically skilled personnel	4.00	3.75	3.94	3.82	4.13	3.82	4.33	3.87	4.00	4.00
Testing	3.80	3.92	3.88	3.82	4.00	3.91	3.78	3.8	3.62	4.00

Appendix 4 Survey Questions

Part 1: Present state of SOA application

Directions: Part 1 consists of questions related to the present state of SOA in your business

1. **How long it has been from your company started using SOA to now? (Select one)**

☐ Less than 6 months
☐ 6 months – 1 year
☐ 1 year – 3 years
☐ 3 years – 5 years
☐ More than 5 years

2. **What is the work area to which the application of SOA was reviewed or implemented? (Multiple responses are possible)**

☐ Enterprise Resource Planning (ERP)
☐ Customer Relationship Management (CRM)
☐ Supply Chain Management (SCM)
☐ Supplier Relationship Management (SRM)
☐ Customer response related works
☐ Data interlocking between internal systems

☐ Other: _____

Part 2: Challenges in SOA migration

Directions: Part 2 consists of questions about major difficulties when you embody a SOA project.

3. What do you think is a challenge in SOA migration? Please write your thoughts about SOA challenges, including reasons. (Write the contents of at least 3).

4. Below are the challenges in SOA migration derived through literature review. Please rate the importance of them in your organization below on a scale of
1 to 5, where 1 is "not at all important" and5 is "extremely important". You can also indicate a challenge as not relevant in your organization by choosing 'N/A' option

- ☐ Choosing the right migration strategy
- ☐ Communicating SOA vision
- ☐ Defining level of granularity
- ☐ Facilitate Reusability
- ☐ Focus on business perspective and not only IT perspective
- ☐ Implementation challenges
- ☐ Integration challenges
- ☐ Managing cost
- ☐ Organizational challenges
- ☐ Performance
- ☐ Program management challenges
- ☐ SOA Governance
- ☐ Technology challenges

Part 3: Success factors in SOA migration.

Directions: Part 3 consists of questions about major reasons for success when you embody a SOA project.

5. What do you think is a critical success factor in SOA migration? Please write your thoughts about critical success factors, including reasons. (Write the contents of at least 3).

6. Below are the success factors in SOA migration derived through literature review. Please rate the importance of them in your organization below on a scale of 1 to 5, where 1 is "not at all important" and 5 is "extremely important". You can also indicate a success factor as not relevant in your organization by choosing 'N/A' option.

- ☐ Agility
- ☐ Budgeting and Resources
- ☐ Business Process of Company
- ☐ Close Monitoring
- ☐ Communication and collaboration
- ☐ Dependence on Commercial Products
- ☐ Facilitate Reusability
- ☐ Funding & Ownership
- ☐ Information Architecture
- ☐ Leadership
- ☐ Legacy Architecture
- ☐ Management
- ☐ Potential of Legacy Systems for being migrated
- ☐ Principles, guidelines and standards
- ☐ SOA Governance
- ☐ Strategy of migration to SOA
- ☐ Technically skilled personnel
- ☐ Testing

Part 4: General Questions

Directions: Part 4 consists of questions about general states of questionnaire respondents.

7. What is your company's industry? (Multiple responses are possible)

- ☐ Financial
- ☐ Electrical, Electronics
- ☐ Steel industry
- ☐ Heavy industry
- ☐ IT/ICT Services
- ☐ Public enterprise
- ☐ Distribution,
- ☐ logistics
- ☐ Construction
- IT/ICT Services

☐ Other: _____

8. What is your position? (Select one)

- ☐ IT Executive
- ☐ Business Analyst
- ☐ Project Manager
- ☐ Lead a team of
- ☐ architects Lead a team
- ☐ of developers Architect
- ☐ Developer
- ☐ Both Architect and Developer
- ☐ Infrastructure Specialist

☐ Other: _____

9. How long have you worked with SOA? (Select one)

- ☐ Less than 2 years
- ☐ 2 years – 5 years
- ☐ 5 years – 10 years
- ☐ 10 years – 15 years
- ☐ More than 15 years

10. How many employees does your company have? (Select one)

- ☐ Less than 50 people
- ☐ 50 people - 100 people

- ☐ 100 people - 500 people
- ☐ 500 people – 1000 people
- ☐ More than 1000 people

Appendix 5 Survey Responses

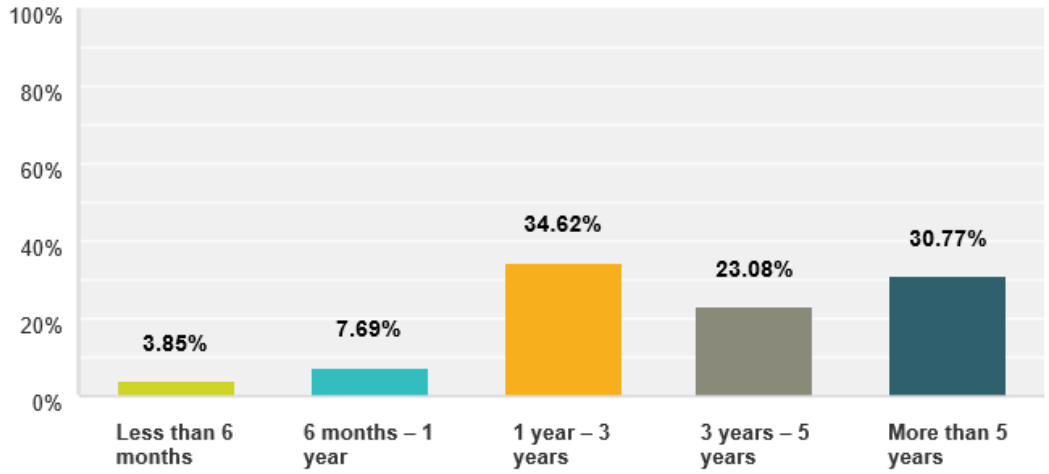
Part 1: Present state of SOA application

PAGE 1: Part 1: Present state of SOA application

Q1 Customize Export

How long it has been from your company started using SOA to now? (Select one)

Answered: 26 Skipped: 0



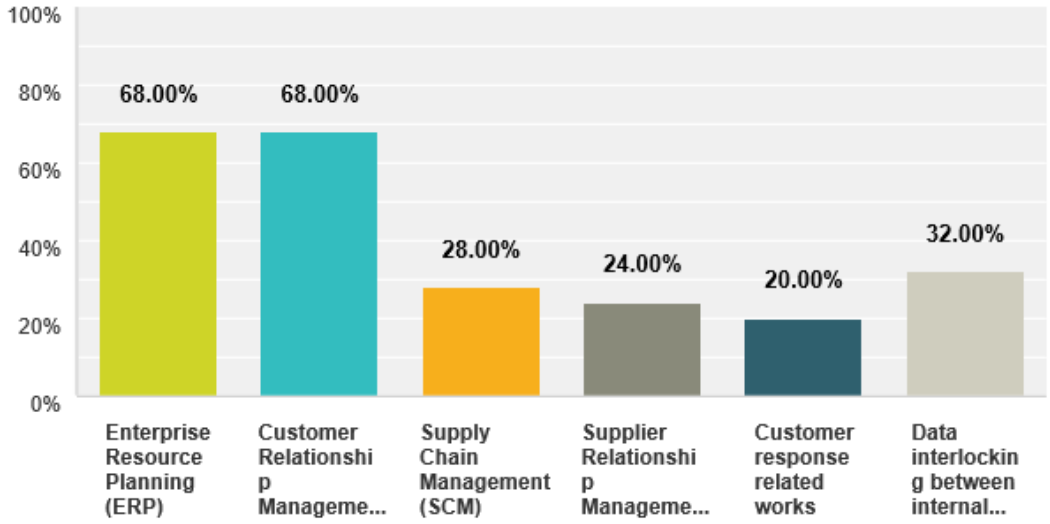
Answer Choices	Responses	
Less than 6 months	3.85%	1
6 months – 1 year	7.69%	2
1 year – 3 years	34.62%	9
3 years – 5 years	23.08%	6
More than 5 years	30.77%	8
Total		26

Q2

Customize | Export

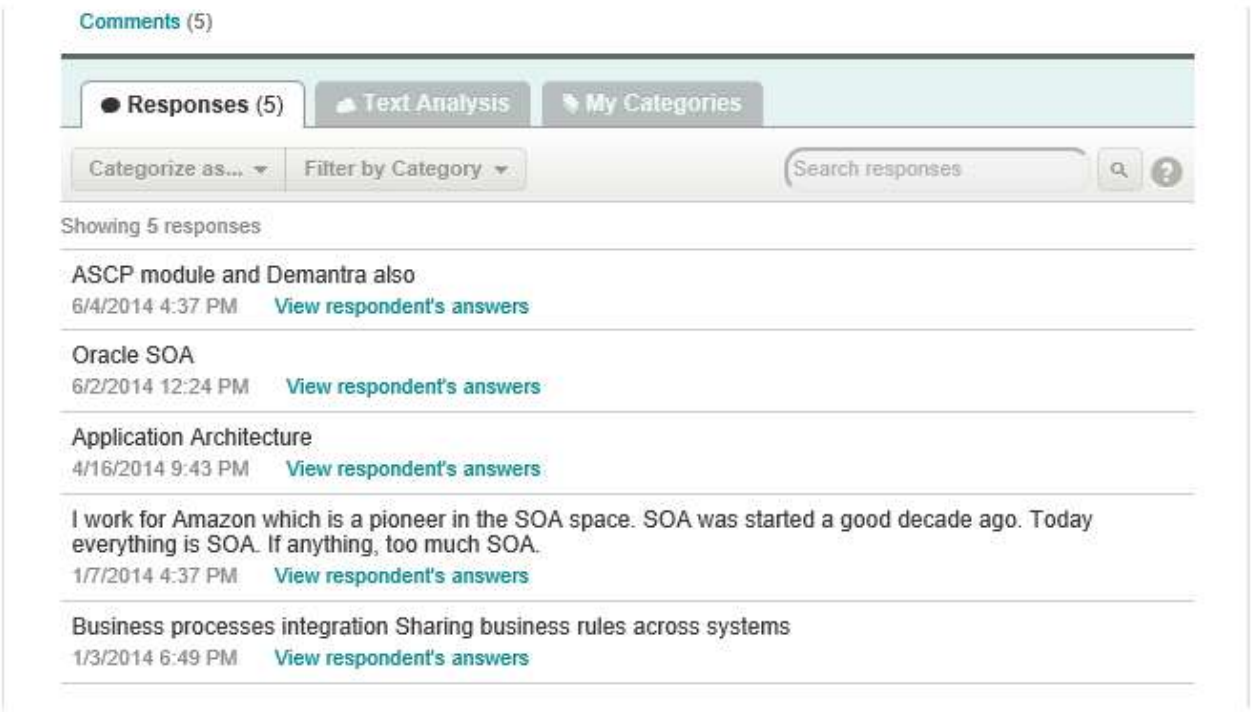
What is the work area to which the application of SOA was reviewed or implemented? (Multiple responses are possible)

Answered: 25 Skipped: 1



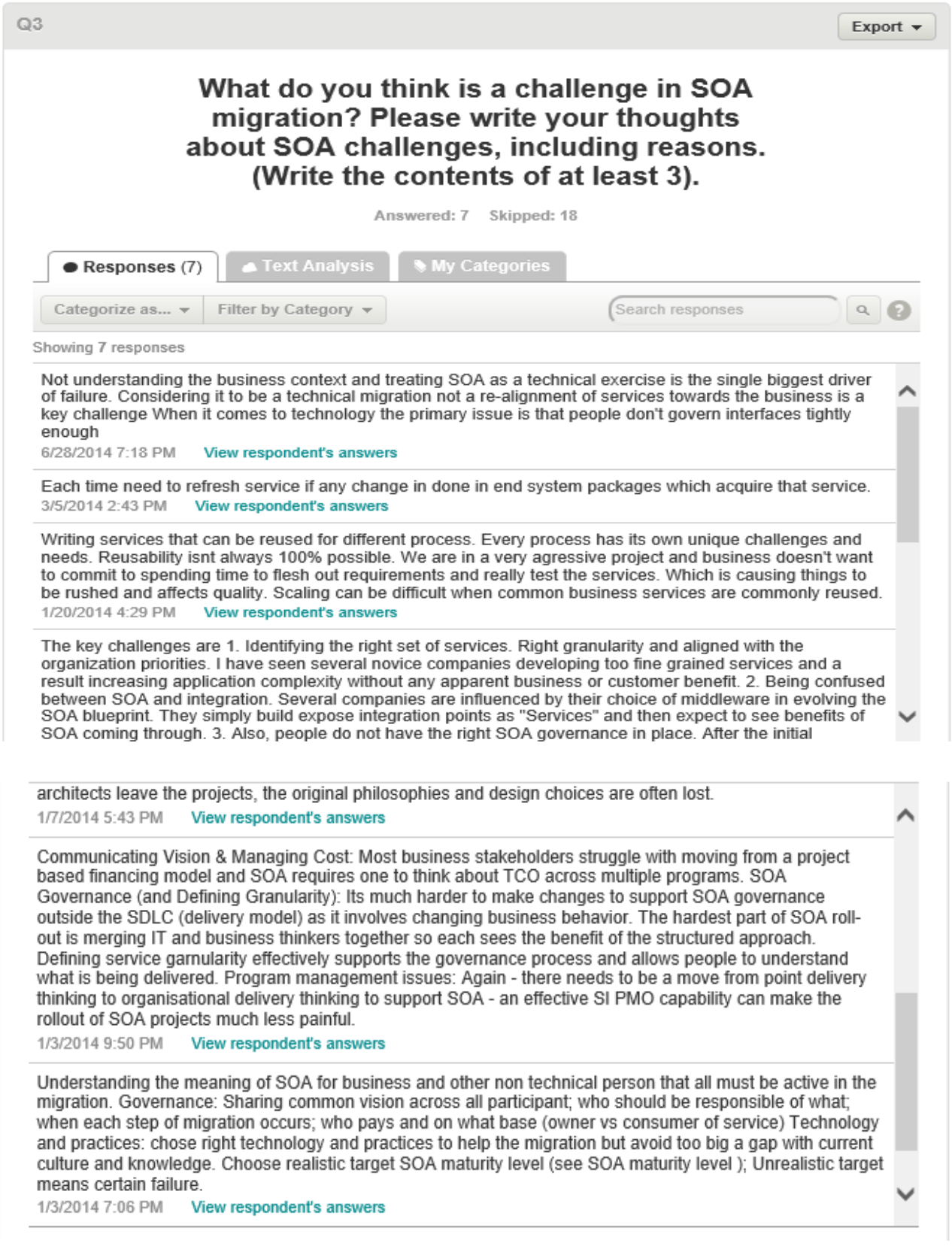
Answer Choices	Responses	
Enterprise Resource Planning (ERP)	68.00%	17
Customer Relationship Management (CRM)	68.00%	17
Supply Chain Management (SCM)	28.00%	7
Supplier Relationship Management (SRM)	24.00%	6
Customer response related works	20.00%	5
Data interlocking between internal systems	32.00%	8
Total Respondents: 25		

Comments (5)


Comments (5)
Responses (5)
Text Analysis
My Categories
Categorize as...
Filter by Category
Search responses
Showing 5 responses
ASCP module and Demantra also
6/4/2014 4:37 PM
View respondent's answers
Oracle SOA
6/2/2014 12:24 PM
View respondent's answers
Application Architecture
4/16/2014 9:43 PM
View respondent's answers
I work for Amazon which is a pioneer in the SOA space. SOA was started a good decade ago. Today everything is SOA. If anything, too much SOA.
1/7/2014 4:37 PM
View respondent's answers
Business processes integration Sharing business rules across systems
1/3/2014 6:49 PM
View respondent's answers

Part 2: Challenges in SOA migration

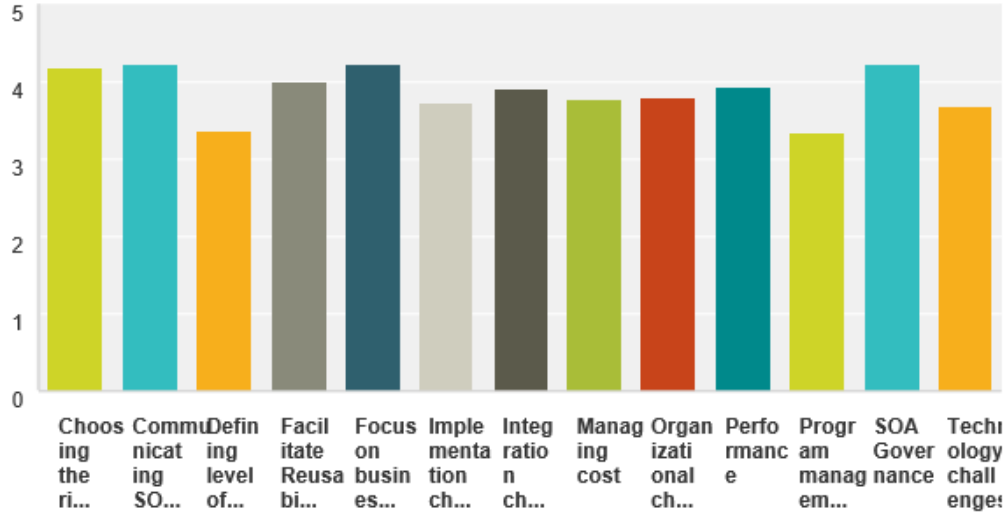
PAGE 2: Part 2: Challenges in SOA adoption



Q4 Customize Export

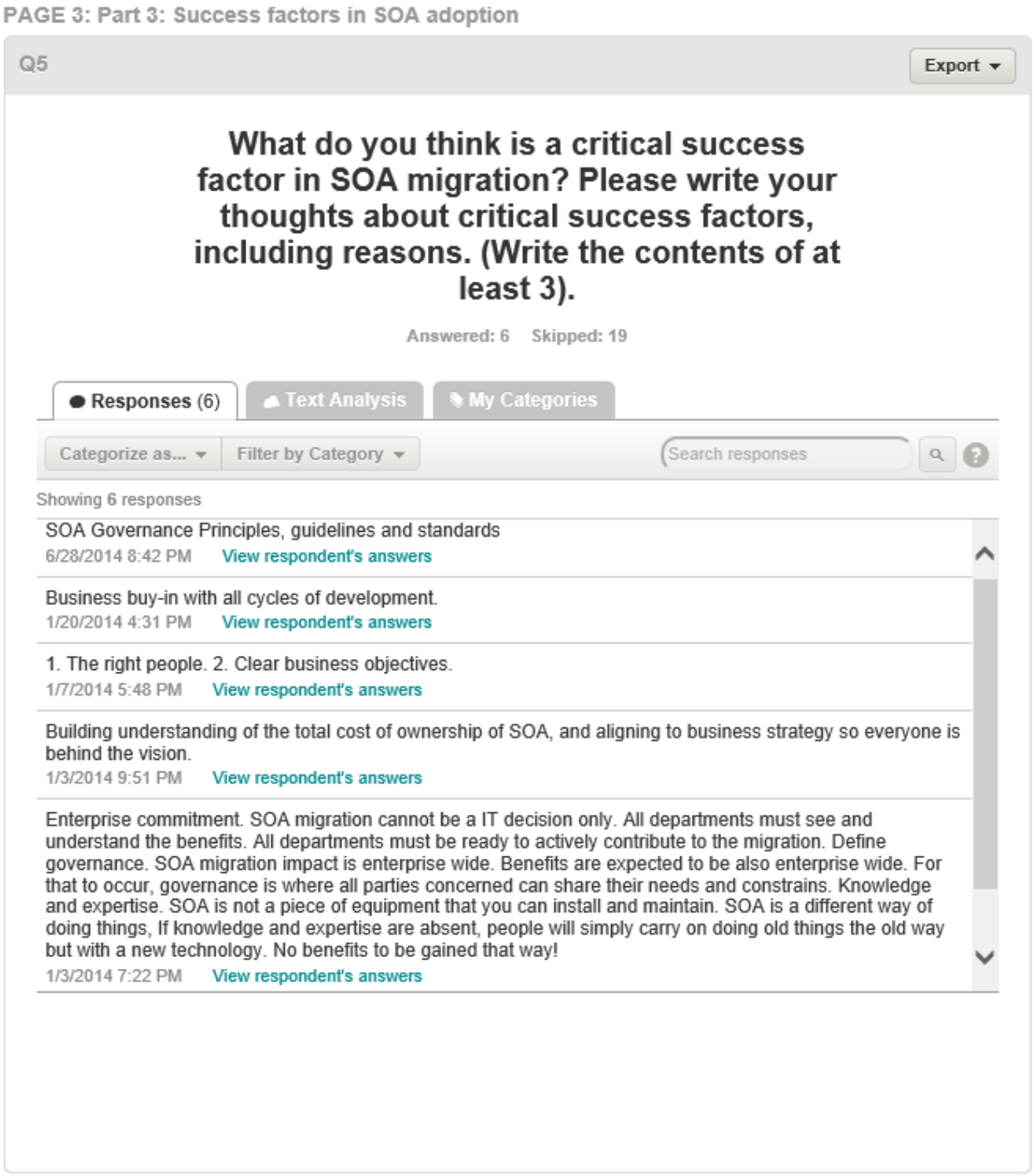
Below are the challenges in SOA migration derived through literature review. Please rate the importance of them in your organization below on a scale of 1 to 5, where 1 is “not at all important” and 5 is “extremely important” . You can also indicate a challenge as not relevant in your organization by choosing 'N/A' option.

Answered: 26 Skipped: 0



	1	2	3	4	5	N/A	Total	Average Rating
Choosing the right migration strategy	0.00% 0	3.85% 1	23.08% 6	23.08% 6	50.00% 13	0.00% 0	26	4.19
Communicating SOA vision	3.85% 1	3.85% 1	15.38% 4	19.23% 5	57.69% 15	0.00% 0	26	4.23
Defining level of granularity	15.38% 4	7.69% 2	26.92% 7	23.08% 6	26.92% 7	0.00% 0	26	3.38
Facilitate Reusability	0.00% 0	3.85% 1	23.08% 6	42.31% 11	30.77% 8	0.00% 0	26	4.00
Focus on business perspective and not only IT perspective	3.85% 1	0.00% 0	19.23% 5	23.08% 6	53.85% 14	0.00% 0	26	4.23
Implementation challenges	0.00% 0	7.69% 2	38.46% 10	26.92% 7	26.92% 7	0.00% 0	26	3.73
Integration challenges	0.00% 0	3.85% 1	26.92% 7	42.31% 11	26.92% 7	0.00% 0	26	3.92
Managing cost	3.85% 1	3.85% 1	19.23% 5	57.69% 15	15.38% 4	0.00% 0	26	3.77
Organizational challenges	3.85% 1	11.54% 3	19.23% 5	30.77% 8	34.62% 9	0.00% 0	26	3.81
Performance	3.85% 1	3.85% 1	19.23% 5	38.46% 10	34.62% 9	0.00% 0	26	3.96
Program management challenges	3.85% 1	19.23% 5	34.62% 9	23.08% 6	19.23% 5	0.00% 0	26	3.35
SOA Governance	3.85% 1	7.69% 2	3.85% 1	30.77% 8	53.85% 14	0.00% 0	26	4.23
Technology challenges	0.00% 0	15.38% 4	30.77% 8	23.08% 6	30.77% 8	0.00% 0	26	3.69

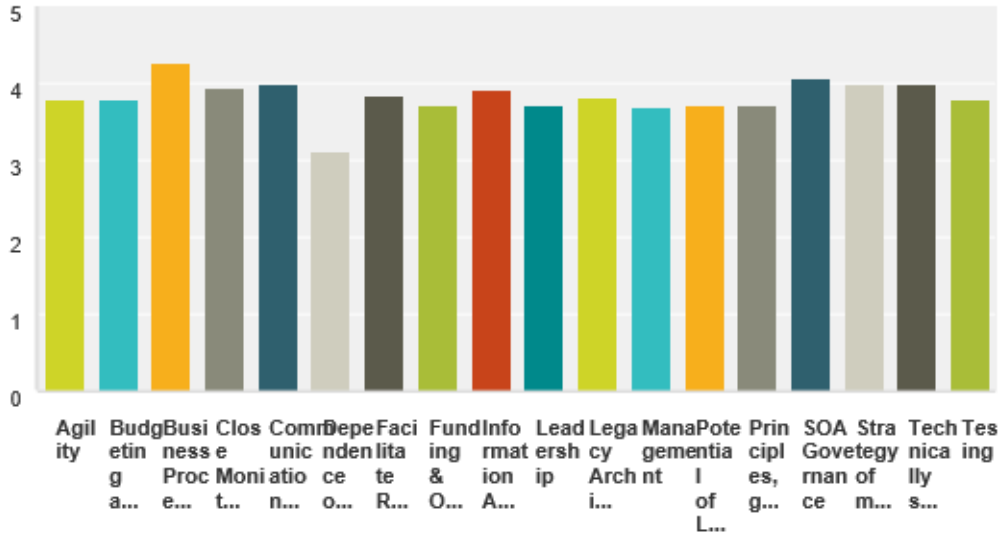
Part 3: Success factors in SOA migration.



Q6 Customize Export

Below are the success factors in SOA migration derived through literature review. Please rate the importance of them in your organization below on a scale of 1 to 5, where 1 is “not at all important” and 5 is “extremely important” . You can also indicate a success factor as not relevant in your organization by choosing 'N/A' option.

Answered: 25 Skipped: 1



	1	2	3	4	5	Not relevant	Total	Average Rating
Agility	4.00% 1	4.00% 1	36.00% 9	16.00% 4	36.00% 9	4.00% 1	25	3.79
Budgeting and Resources	0.00% 0	0.00% 0	36.00% 9	48.00% 12	16.00% 4	0.00% 0	25	3.80
Business Process of Company	4.00% 1	0.00% 0	12.00% 3	32.00% 8	52.00% 13	0.00% 0	25	4.28
Close Monitoring	4.00% 1	4.00% 1	28.00% 7	20.00% 5	44.00% 11	0.00% 0	25	3.96
Communication and collaboration	4.00% 1	4.00% 1	20.00% 5	32.00% 8	40.00% 10	0.00% 0	25	4.00
Dependence on Commercial Products	4.00% 1	24.00% 6	40.00% 10	20.00% 5	12.00% 3	0.00% 0	25	3.12
Facilitate Reusability	0.00% 0	4.00% 1	32.00% 8	40.00% 10	24.00% 6	0.00% 0	25	3.84
Funding & Ownership	4.00% 1	4.00% 1	24.00% 6	52.00% 13	16.00% 4	0.00% 0	25	3.72
Information Architecture	4.00% 1	4.00% 1	24.00% 6	32.00% 8	36.00% 9	0.00% 0	25	3.92
Leadership	4.00% 1	0.00% 0	40.00% 10	32.00% 8	24.00% 6	0.00% 0	25	3.72
Legacy Architecture	4.00% 1	4.00% 1	24.00% 6	36.00% 9	28.00% 7	4.00% 1	25	3.83
Management	0.00% 0	0.00% 0	44.00% 11	36.00% 9	16.00% 4	4.00% 1	25	3.71
Potential of Legacy Systems for being migrated	0.00% 0	4.00% 1	32.00% 8	52.00% 13	12.00% 3	0.00% 0	25	3.72
Principles, guidelines and standards	0.00% 0	8.00% 2	32.00% 8	40.00% 10	20.00% 5	0.00% 0	25	3.72
SOA Governance	4.00% 1	4.00% 1	8.00% 2	48.00% 12	36.00% 9	0.00% 0	25	4.08
Strategy of migration to SOA	4.00% 1	8.00% 2	12.00% 3	36.00% 9	40.00% 10	0.00% 0	25	4.00
Technically skilled personal	4.00% 1	4.00% 1	8.00% 2	56.00% 14	28.00% 7	0.00% 0	25	4.00
Testing	4.00% 1	4.00% 1	24.00% 6	44.00% 11	24.00% 6	0.00% 0	25	3.80

Part 4: General Questions about respondents

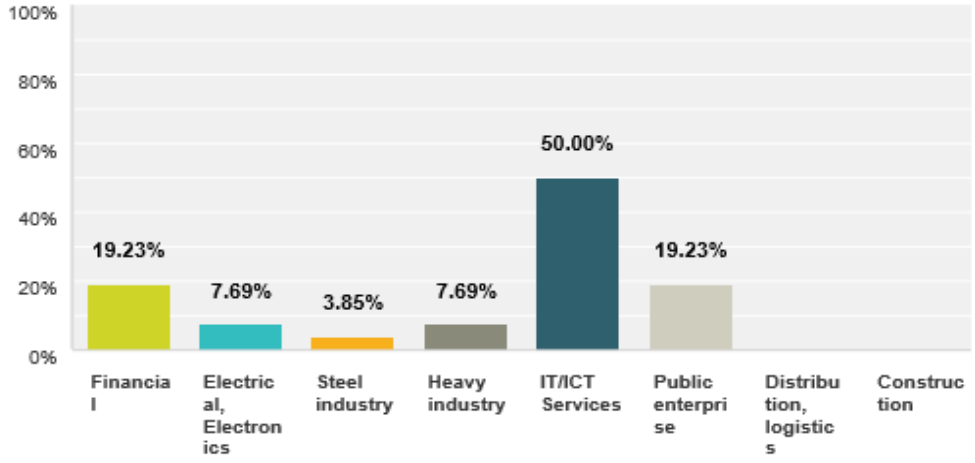
PAGE 4: Part 4: General Questions

Q7

Customize Export

What is your company's industry? (Multiple responses are possible)

Answered: 26 Skipped: 0



Answer Choices	Responses	
Financial	19.23%	5
Electrical, Electronics	7.69%	2
Steel industry	3.85%	1
Heavy industry	7.69%	2
IT/ICT Services	50.00%	13
Public enterprise	19.23%	5
Distribution, logistics	0.00%	0
Construction	0.00%	0
Total Respondents: 26		

Comments (3)

Responses (3) Text Analysis My Categories

Categorize as... Filter by Category Search responses

Showing 3 responses

Health Care
6/28/2014 8:42 PM View respondent's answers

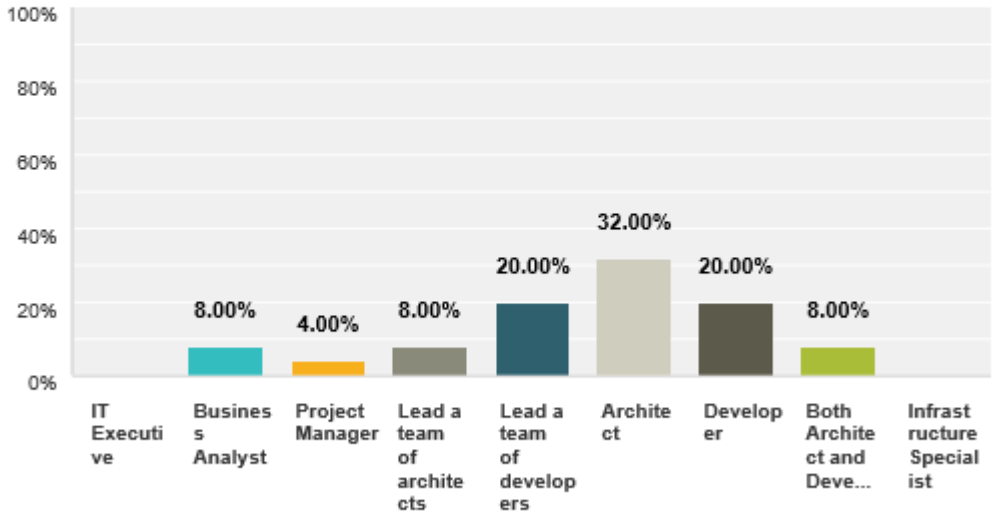
Health Care
1/20/2014 4:31 PM View respondent's answers

Government services
1/3/2014 7:23 PM View respondent's answers

Q8 Customize Export

What is your position? (Select one)

Answered: 25 Skipped: 1



Answer Choices	Responses	
IT Executive	0.00%	0
Business Analyst	8.00%	2
Project Manager	4.00%	1
Lead a team of architects	8.00%	2
Lead a team of developers	20.00%	5
Architect	32.00%	8
Developer	20.00%	5
Both Architect and Developer	8.00%	2
Infrastructure Specialist	0.00%	0
Total		25

Comments (1)

Responses (1) Text Analysis My Categories

Categorize as... Filter by Category Search responses

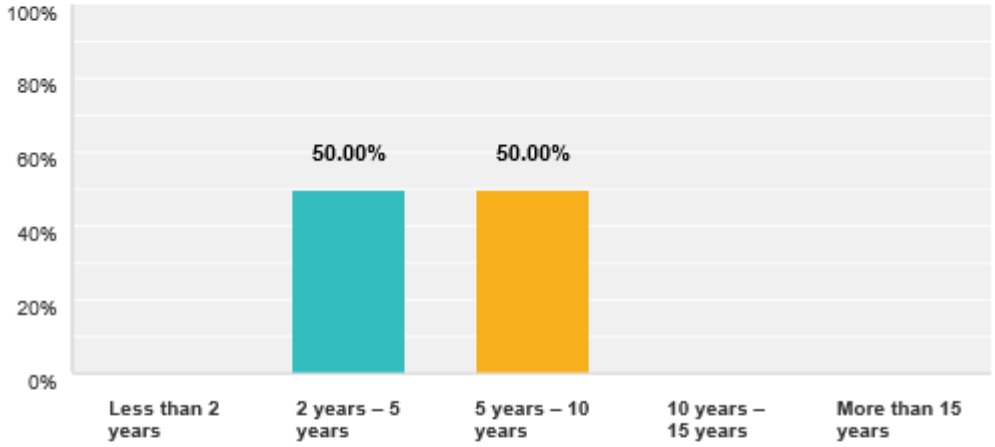
Showing 1 response

Leader of both developers and architects, with project management for SOA as well.
1/3/2014 9:52 PM View respondent's answers

Q9 Customize Export

How long have you worked with SOA? (Select one)

Answered: 26 Skipped: 0



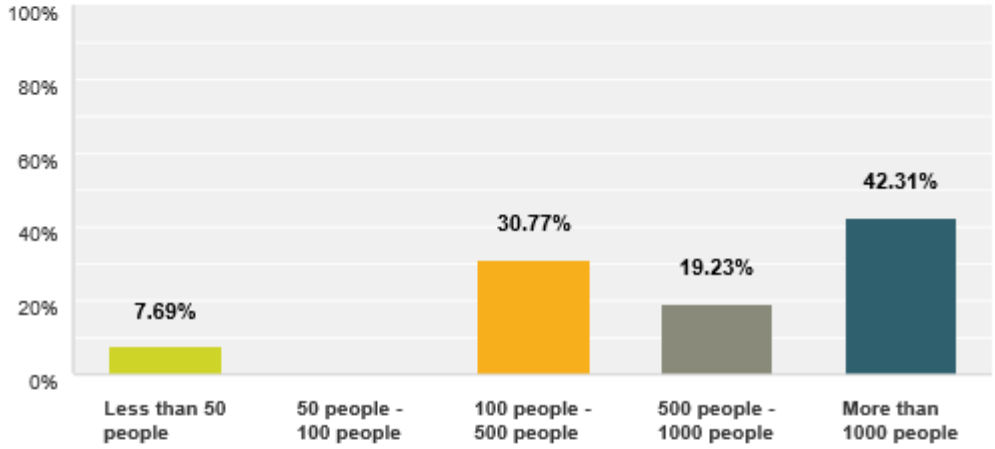
Answer Choices	Responses	
Less than 2 years	0.00%	0
2 years – 5 years	50.00%	13
5 years – 10 years	50.00%	13
10 years – 15 years	0.00%	0
More than 15 years	0.00%	0
Total		26

Q10

Customize | Export

How many employees does your company have? (Select one)

Answered: 26 Skipped: 0



Answer Choices	Responses	
Less than 50 people	7.69%	2
50 people - 100 people	0.00%	0
100 people - 500 people	30.77%	8
500 people - 1000 people	19.23%	5
More than 1000 people	42.31%	11
Total		26