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A Systematic Literature Review Towards Service Oriented Architecture Adoption from 2009 to 2015

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Abstract

Service Oriented Architecture (SOA) has appeared as an absorbing architectural approach that empowers the available systems to reveal their performance in the act of services, without creating important changes to the systems. This approach, due to its flexibility of adoption, has been widely recognized as an appropriate approach for implementing in organizations by many scholars and practitioners. Though, there are many studies that depict success factors of SOA; at the same time a few minor cases of failure has also been reported in the literature. In spite of the availability of rich material on SOA (in general), there is no systematic literature review on the potential aspect of SOA adoption factors. Hence, this article presents a systematic review of existing studies related to the SOA adoption and its success and failure factors from 2009 to 2015. The principle purpose of the study is to bring forward the existing issues and share our findings with researchers. Moreover, the findings of this paper would help IT experts in organizations to concentrate on the key factors highlighted in this study, so that they could decide whether it is advisable to adopt SOA or not in their context.

Keywords: *Service Oriented Architecture, SOA Adoption, Influential Factors, CSFs, and Systematic Literature Review.*

1. Introduction

In the last few years, leading technologies such as Cloud Computing (CC) and SOA have received an increasing attention to move towards challenges associated with improvement and maintenance of diverse IT environments [1]–[4]. For the reason that SOA offers flexible integration and service reusability due to its service-based modular architecture [5]. In fact, the emphasis on services makes SOA inimitable as it also offers transparency through several applications and data sources that encapsulated as a black box. In this way, an integrated pool of IT resources becomes accessible in spite of diverse IT systems, language codes,

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functionalities, and platforms.

So far, SOA has demonstrated itself to be a key paradigm in numerous industries such as banking, healthcare, transport and etc. As mentioned above that in spite its benefits, some of the primary studies reveal that organizations have trouble in receiving full benefits of SOA adoption for several reasons. For instance, lack of knowledge and information about critical success factors in SOA adoption and implementation are key causes of failure [6][7]. Yet, no detailed systematic study exist that could share critical influencing criteria for successful SOA adoption. In order to fill this gap, the authors believed that the investigation of significant factors pertinent to adoption of SOA in organizations is crucial as the understanding of these factors would help organizations to increase the benefits they get from SOA. This would help raise SOA acceptance rate, too. Accordingly, this paper concentrates on seeking the answer to the following questions of the research:

- What studies have been conducted on SOA adoption in organizations?
- What are the significant factors that impact SOA adoption in organizations?

Aiming at answering the mentioned questions, we studied a large amount of research material to extract influential factors for SOA adoption. All these findings are discussed in the following sections. The rest of the present paper is laid out in the following design. The second section focuses on the works which are interdependent works and the third one focuses on the research process that how actually this research was carried out. Section 4 shares our findings and presents discussion. Section 5 presents the result and further work on this topic.

2. Related Works

Before we discuss our findings in detail, it is appropriate to briefly discuss a few similar studies about SOA. One of such study was conducted by Khadka and his colleagues [8]. They reviewed about 121 early studies conducted from 2000 to 2011, systematically. They also catered a historical summary, concentrating on techniques and methods applied in a “legacy to SOA” evolution. In another study, an SOA research agenda has been developed by the Software Engineering Institute (SEI) [9]. Lewis and his teammates discussed the relocation of legacy applications to SOA [9]. The primary goal of their study was to create a taxonomy for categorizing subjects into the engineering, operations, and business features of SOA systems. According to their research, the taxonomy delivered more details on precise challenges in research associated with the maintenance and evolution of SOA systems.

Based on our analysis of these previous studies, there is no detailed systematic literature review that extracted all influential factors through SOA related papers. Therefore, we initiated the endeavor to work on a SLR to find out all SOA influential factors during 2009-2015. The findings of this study would help IT managers and practitioners to realize which factors are more important in the way of implementing SOA in their organizations. It is worth mentioning that it would also assist academic researchers to understand which factors are considered critical in SOA adoption studies.

3. Search Process

This systematic literature review has been conducted by following the guidelines according to Kitchenham [10]. The current SOA adoption studies and their influential factors have been extracted from literature reviewed as described in the following subsections and shown in Figure 1 with three phases.

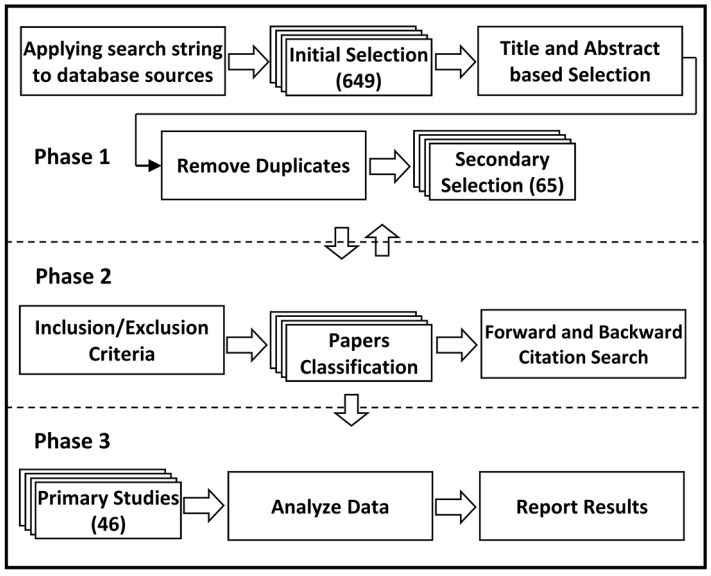


Figure 1. Systematic Literature Review Phases

3.1 Phase 1: Search Strategy

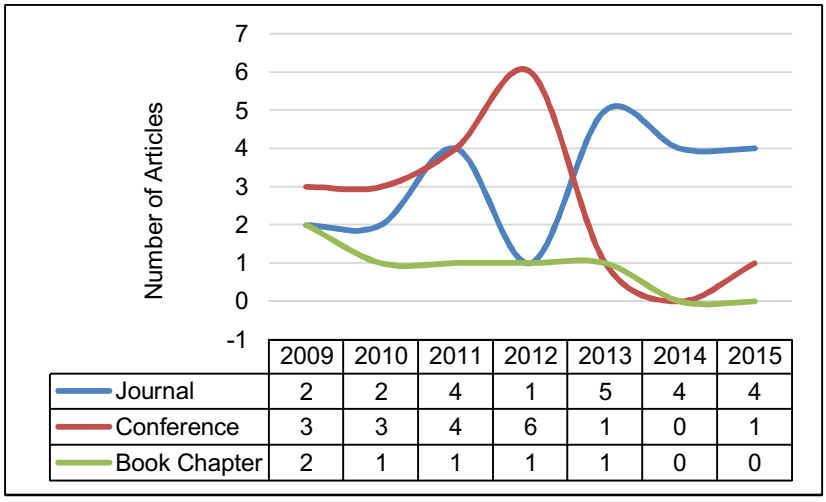
In this phase, the search strategy for reviewing was defined based on keywords used in this field. According to the first research question of this study, the main search keywords used are "SOA", "Adoption", "influential factors". The operators "OR" and "AND" are used to connect the primary keywords, synonyms, and some related key terms. In order to execute these keywords, we used the database engines that published journals, conference proceedings and book chapters such as IEEE, ACM, Springer, Taylor & Francis, Science Direct, AISeL, Scopus, and Google Scholar. In the first search step, 649 articles were resulted. In the next step, titles and abstracts of the collected papers were reviewed and related papers were chosen as preliminary studies. After removing duplicated papers 65 papers were selected as secondary selection.

3.2 Phase 2: Inclusion and Exclusion Criteria

In order to select appropriate and related studies, all related papers were selected for reviewing SOA adoption issues including surveys, case studies and review papers. However, for identifying the significant factors, review papers were excluded from primary studies. The most important reason is that these types of papers did not verify the factors through experimental researches such as survey and case studies. Of the 46 papers, 8 articles were identified as review papers. Moreover, we found 3 papers that did not mention any influential factors in their contents. So, 35 papers were selected for extracting influential factors among the total number of 46 primary studies.

3.3 Phase 3: Primary Studies

As a result, 46 peer-reviewed papers from 2009 to 2015 were comprised in this survey. The publication of the primary studies was focused in order to match with the objectives of this study. According to Figure 2, most of the selected papers were published in 2011. In this Figure 3, the numbers of published articles are demonstrated based on their type and publication year. This result shows that researchers' inclination to study about SOA were increased between 2009 and 2013.



	2009	2010	2011	2012	2013	2014	2015
Journal	2	2	4	1	5	4	4
Conference	3	3	4	6	1	0	1
Book Chapter	2	1	1	1	1	0	0

Figure 2. Analysis on the Primary Studies' Type based on Year (N=46)

The selected primary articles are briefly summarized in continue. Lawler et al. clarified the critical success factors which boost SOA influential management and planning from procedural, technical, and business prospects [11]. The authors figured out that the highly crucial criteria in managing SOA strategy are business factors. In another study, Ciganek et al. tried to find out crucial factors that are challengeable in the adoption of SOA (using Web Services technology) by investigating eight firms in four various industries based on TOE framework [12]. Moreover, the research team has been developed a model to get a right direction towards SOA adoption. They also discovered many factors that are standard for all organizations, whereas some factors are varying between industries. Hence, based on their research the steps and process of adoption can be different between various industries.

Antikainen & Pekkola discovered factors influencing successful SOA implementation in an exploratory study by interviewing IT and business people from nine organizations which are pioneer in implementing SOA in Finland [13]. This study identified four groups, containing eleven factors that are relevant to business and IT alignment for developing SOA. The groups are: a) Organization culture and human resources b) Processes and methodologies c) Communication and artifact d) Technology [13].

Chang and Lue (2009) in an exploratory study itemized the risky factors influencing the adoption of SOA systems based on the order of strength of effect as follow: "Insufficient technology planning, lack of expertise, in effective project governance, organizational misalignment, technology newness, and resource insufficiency" [14]. In an empirical study, Kokko et al. studied the adoption of SOA in nine companies in Finland through conducting interviews [15]. The findings of their research displayed that the most common obstacles during adopting SOA in the interviewed case studies were resistance to change, lack of skilled professionals, SOA governance, and the complexity of SOA based systems [15].

Vegter examined and validated CSFs for implementing SOA in a study through an insurance company as their case study [16]. The researcher selected Complexity of SOA and governing the adoption of SOA process as CSFs. In a later article, Luthria & Rabhi explained the different aspect of SOA adoption from two different vision, namely: Technical and business [17]. Boh & Yellin conducted a survey among 108 organizations to analyze the important managerial factors which are influenced on the implementation of SOA [18]. The authors concentrated on two significant factors for being success in implementing SOA, namely: "Top management support and centralization of IT decision-making" [18]. A survey provided by Antlova in 2010 exposed that five critical success factors affect ICT adoption from a service-oriented

viewpoint, namely: "Business strategy, information strategy, information technology, and processes in organizations" [19]. A survey was carried out in Croatia to pinpoint the benefits and drawbacks of developing and implementing of SOA in ICT firms that were impending to implement SOA successfully [20]. Nasr et al. introduced two case studies covering the reengineering and extra evolution of SOA adoption in the industry [21]. It is worth mentioning that authors published a same paper with a descriptive case study in transport sector in 2010 [22]. However, they revised their findings in their next publication with two case studies. The first case study conducted an application portfolio of more than 700 systems for a firm in the transport industry. The second one carried out for a firm in public sector. The main aim of their researches was to show the feasible advantages and impediment of recognizing Service Oriented Architecture in large-sized companies to gain a better viewpoint on the real advantages of SOA in practice.

Julian Eckert and his partners investigated SOA readiness and maturity in banking industry in Germany through a single case study with multiple participants [23]. The results of their interviews showed that German banks have reached to an acceptable level of readiness and maturity. According to their study, the key inhibitor for preferable SOA maturity is the absence of alignment among IT and management parts in banks. An exploratory research was conducted by Lee et al. in 2010 [24]. The research team reviewed 34 SOA papers and carried out 22 interviews. As the result of their study 20 CSFs were recognized for adopting SOA successfully. This study classified CSFs within six groups: strategy, awareness, organizational management, governance, technology infrastructure, and project management.

A survey was carried out by Aier et al. to focus on service orientation systems for IS engineering as a design approach [25]. The survey conducted through distributing questionnaires among 4500 firms in Switzerland, Germany, and Austria in multiple industries. Migration legacy systems to SOA is one of the challenges posed in SOA adopted process. Moeini et al. determined success factors based on Balanced Scorecard (BSC) form and presented a roadmap for SOA adoption by combining the existed roadmaps based on challenges and these success factors [26]. Caimei Hu in a study presented the Web Service technology standard system, according to the framework of TOE and examined the primary factors influencing the technology of Web Service adoption [27].

According to Bhallamudi and Tilley, adopting SOA would give a new existence to the legacy system while performing a wrong adoption would lead to fiasco [28]. Researchers conducted a study to analyze the existing projects which are on the way to adopt SOA to find out effective factors for migrating to SOA. Well-defined policies and procedures are the most significant result of the study to express, publish and maintain services. Peter Trkman and his colleagues presented SOA influential factors through examining a single case study in a large company in Slovenian [29]. Researchers emphasized that lack of skills, lack of expertise, and feasible business models are the most important problems during implementing SOA. Moreover, the authors offered a Hype Cycle for SOA to provide a better way to solve technological problems. Marco Torchiano and his teammates conducted a survey among 59 IT companies in Italy to investigate the challenges and issues during migrating information systems to SOA in practice [30].

Nils Joachim in a literature review paper synthesized 40 sources and integrated their results in order to offer a research plan to unify and extend earlier studies [31]. Abdul Manan and Hyland provided an SOA framework established based on critical success factors [32]. In addition, the authors published another article to examine the implantation of SOA readiness in an organization through a case study and a critical success factors scorecard [33]. In another review paper, the SOA implementation factors identified from articles and research work from 2001-2011 [34]. Researchers also identified to what extent factors are critical for implementing SOA. Sulong et al. conducted a review study to compare exclusive approach with previous information systems to demonstrate the success factors in implementing SOA [35]. Maurizio Leotta

and his research team carried out two series of surveys among IT professionals to examine the existing stage of SOA adoption in Italian companies in 2008 and 2011 [36][37]. They investigated that the level of SOA knowledge is at a suitable level and SOA is well-known among Italian firms. In addition, the researchers emphasized that the existing SOA adoption trends among Italian companies is stable but certainly it is not negative. In an article Gronli and Bygstad offered and explained a real successful SOA implemented airline company [38]. They emphasized three success elements through examining the relation among SOA and business services in their case study. The first factor is implementing enterprise service bus (ESB) comprehensively and encapsulating all components in different architecture levels. The second factor is protecting a clear enterprise service bus architecture. Last but not least, allocating a developer team in each layer is another crucial factor.

Galinium and Shahbaz applied strategy of the theoretical propositions in their papers [39][40]. The factors which they mentioned in their study as influential factors, leading the legacy systems migration into SOA. All factors were extracted from literature review and empirical data findings from multiple case studies. Ian Owens and John Cunningham determined SOA specific critical success factors on a research project through empirical study [41]. To externally validate the critical success factors extracted from their literature review, researchers explored project managers and executers in a large international defense-related organization which was executing service oriented systems.

Koumaditis et al. identified a various number of CSFs influencing SOA implementation by critically reviewing the literature and identify individual factors that may form CSFs for SOA implementation in healthcare sector [6][42]. Moreover, researchers proposed a model of SOA CSFs in their study. In a research Basias et al. developed an initial conceptual framework to categorize and examine procedural, business, technical and human potential factors of adopting SOA in banking sector [43]. Researchers identified 16 significant factors which may affect SOA adoption in electronic banking sector.

In a study, Emadi and Hanza identified significant success factors for implementing SOA project successfully [7]. A meta-study was performed on a number of related publications. Moreover, a researcher team identified factors that affect service oriented architecture design and implementation in a research and categorized them with a help of proposing a model [44]. The authors claimed that based on the organizations' size their offered model can be applied as a guideline for implementing SOA projects. In another study, Hustad and Staverløkk addressed various crucial issues for adopting SOA [45]. The results of their research showed that implementing SOA in heterogeneous environments may cause considerable benefits. A systematic literature review was conducted by Abu Bakar and his research team to review the existing researches related to the adoption of Service Oriented Enterprise Architecture (SOEA) [46]. The researchers proposed a model for the success factors in adopting SOA according to their review. Besides, the study created helpful information about SOEA adoption issues and relevant maturity models.

In 2014, a survey was conducted to emphasized the significant factors influencing SOA adoption in South Africa by MacLennan and Van Belle [47]. The authors proposed an SOA adoption model based on TOE framework and diffusion of innovations (DOI) theory. In the same year, Basias [48] analyzed the importance of adopting SOA benefits in banking sector. The research team tried to show and analyze e-banking and service oriented advantages. They suggested a conceptual framework and examine their framework in a European Bank and revise the framework by organizing new results.

We provided a review paper in 2014 to investigate the essential factors affect the adoption of SOA during 2008- 2013 [49]. We specified 32 factors as the most significant factors based on the reviewed papers. A framework has been proposed regards to decision making issues by Basias and his partners to adopt SOA successfully in e-banking through a Large American Bank case study [50]. The case approves the significant

of the effective factors in the research model to adopt SOA successfully in banking industry.

In another article, Themistocleous and his fellow teammates investigated the necessity of electronic banking integration through adopting SOA [51]. The research team believed that banks failure is mostly referred to the scarcity of a technological framework and to test the effective factors in adopting SOA. To fill this gap, they proposed a technological framework and examine it via two case studies in a transition and a developed economy. Yong Cen provides a methodology to evaluate SOA implementation critical success factors to help managers for making proper SOA investment strategies [52]. Through an extensive review of SOA articles fifteen CSFs related to SOA implementation are identified. The researcher used DEMATEL approach to formulate the structure of difficult causal relationships among the identified critical success factors and gain the effective level of these factors [52].

A precise literature review was carried out by Koumaditis and Themistocleous to examine SOA organizational studies in a public healthcare case study in Greek [53]. The researchers emphasized the CSFs for implementing SOA to assist academic researchers to focus on the essential benefits of SOA organizational studies through implementing SOA. The last reviewed article carried out a survey to investigate CSFs for implementing SOA in Big Data structure systems in India. The authors believed that the following factors are critical for implementing SOA in Big Data systems: "SOA migration strategy, potential of legacy systems, SOA governance, business process of an organization, and business plan for SOA migration" [54].

4. Findings and Discussions

In this section, we are analyzing the findings of this systematic literature review. It is worth mentioning that "N" refers to a number of articles related to each analyzing parts. We classified the primary studies into 5 groups, namely: survey, single case study, multiple case studies, field study, and review papers. According to Figure 3, the number of articles we have found are divided among survey (29 percent), single case study (27 percent), and multiple case studies (24 percent). Based on our analysis, the research design of 18 percent of articles rely on literature review and only one paper used field study strategy in its study. It should be noted that one of the articles neither explained the research design nor the methods used in the study [26]. So, the number of classified articles based on our research design are 45 (N=45).

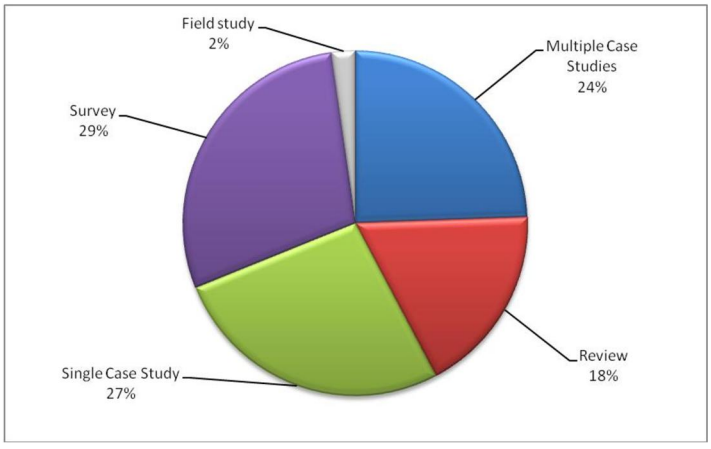


Figure 3. Research Design Percentage (N=45)

According to Figure 4, of the total number of primary studies, 36 articles explained about their research

approach. The rest of articles (8 papers) were review papers and 2 papers have not been mentioned their research approach. Based on this analysis, it could be concluded that most of the articles used qualitative approach for collecting data (55%) while 28 percent of papers used quantitative method and 17 percent of them used mixed method. It should be noted that mixed method is the combination of both qualitative and quantitative approaches.

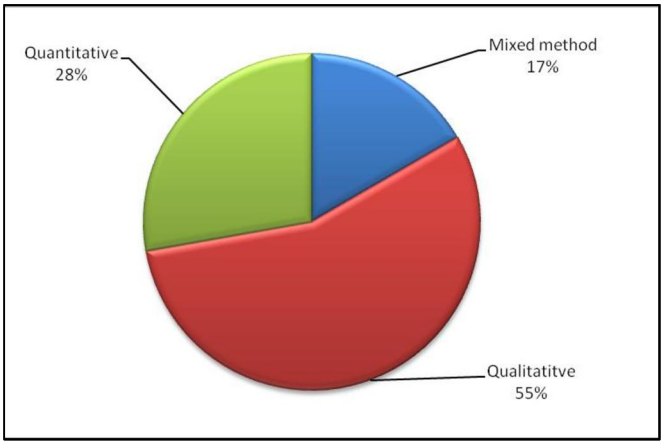


Figure 4. The Research Approach of Primary Studies (N=36)

Table 1 presents theories and approaches that the primary studies of this systematic review are used. Diffusion of Innovations (DOI) [55] and Technology-Organization-Environment framework (TOE) [56] are two theories that are frequently used to investigate the acceptance of IT adoption in organizations [57]. In line with [57] as is shown in Table 2, 2 papers [47][27] used both TOE and Innovation of diffusion theories together. Moreover, we identified that most studies used TOE framework for classifying SOA significant factors [12][31][49][47][27].

Table 1. Primary Studies' Theories and Approaches

Theory/Approach	Reference of Papers
TOE	[12][31][49][47][27]
Innovation Diffusion Theory	[27][47]
SIMM- IBM	[14]
The Gartner Hype Cycle	[29]
Grounded Theory Methodology	[13][15]
Evolution Process Framework- EPF4SOA	[28]
Punctuated Equilibrium Theory (PET)	[25]
Theory Building	[25]
BEA Domain Model	[45]
CSF Scorecard	[33]
DEMATEL	[52]

We classified our primary studies into 5 groups, namely: SOA implementation, migrating to SOA, SOA adoption trends, SOA readiness and factors. We divided papers related to factors into 3 sub-groups, namely: CSFs, influential factors, and obstacle factors. Figure 5 shows the classifications and the percentages of papers related to each groups. Based on this analysis, 61% of primary studies are related to "Factors" while

19% of papers are related to "SOA implementation", 10% related to "Migrating to SOA", 6% related to "SOA Adoption Trends", and 4% related to "SOA Readiness".

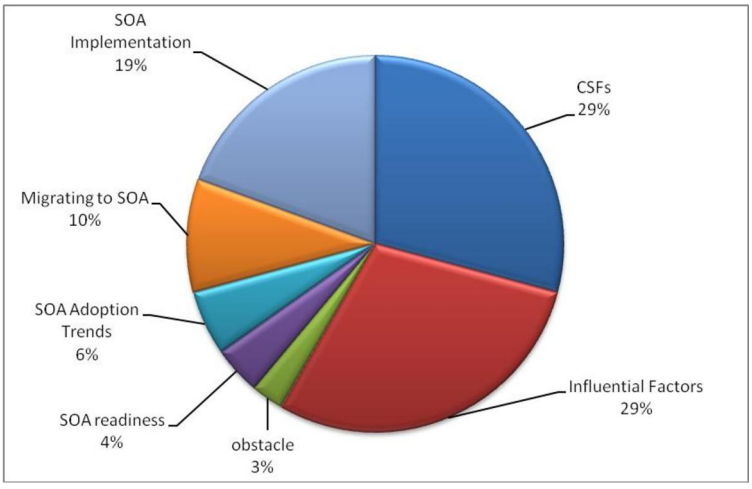


Figure 5. Analysis of Primary Studies based on Research Classification

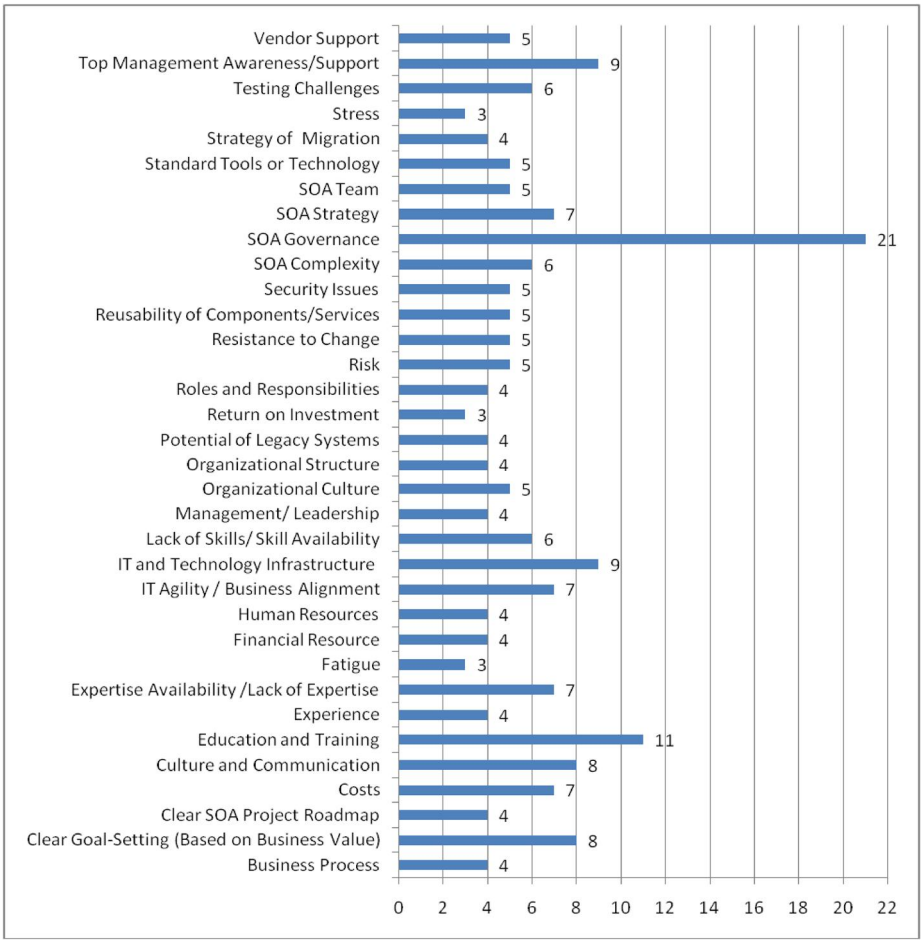


Figure 6. Extracted Factors

To answer the second research question of this systematic literature review, we extracted all factors from primary studies. Since in literature review papers, the factors were not evaluated through case studies or surveys we excluded them from primary studies for extracting SOA influential factors. Figure 6 represents extracted factors which are mentioned more than 3 times in primary studies. It shows that SOA governance is the most controversial factors among researchers, since 21 papers mentioned it as influential factors in adopting/implementing SOA. The next most influential factor based on primary studies is education and training (11 papers).

5. Conclusion and Future Work

As far as we have aimed at doing our best in reviewing the related literature, we could conduct the first systematic background for the study which extracted all factors influencing SOA adoption/implementation during 2009-2015. It should be noticed, since this study is done during 2015 the authors cannot claim that this systematic review covers all publications in 2015. Through an extensive search, 46 papers were selected as primary studies in this survey. We classified papers into 5 groups, namely: SOA implementation, SOA adoption trends, migrating to SOA, SOA readiness, and SOA factors. It is worth mentioning that almost all papers are related to SOA factors group. Due to lack of space, of the total number of factors (around 180), we analyzed 33 factors as the most important factors as these were repeatedly perused at least 3 times in previous studies. Among these factors, according to our analysis, SOA governance appeared to be the most important factor in a way that it is cited 21 times as CSF or influential factor in adopting/implementing SOA. Moreover, based on our findings, researchers and experts in the banking sector are the most interested groups in conducting SOA survey.

We also found out many researchers believed that using mixed method (both quantitative and qualitative) can explain research problem more comprehensible than using quantitative or qualitative methods singly [58]. Based on the findings of this study, most researchers used quantitative or qualitative methods in their study. So, there is a need to mix both methods for collecting and analyzing data as future work. Moreover, based on the analysis of industry based studies, there is not any research that focus on education sector for investigating influential factors in SOA adoption/ implementation. It could be an area for researchers as a future work. We are also planning to conduct a survey among SOA experts to highlight the most significant factors for adopting SOA through a multi-criteria decision analysis method. The result of that upcoming survey will be published later this year.

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