



Alignment of Requirements and Services with User Feedback

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CERTIFICATE OF AUTHORSHIP/ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of Candidate

Muneera Bano

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“Glory be to you, we have no knowledge except what you have taught us. Verily, it is You, the All-Knower, the All-Wise” (Quran 2:32)

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It's supposed to be hard! If it wasn't hard, everyone would do it. The hard is what makes it great !!!

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It is good to have an end to a journey; but it is the journey that matters, in the end

PUBLICATIONS

This thesis includes some parts of the following papers I published during my candidature:

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ACRONYMS AND ABBREVIATIONS

ARISE	<i>Alignment of Requirements and Services</i>
CBSD	<i>Component Based Software Development</i>
KG	<i>Knowledge Graphs</i>
KM	<i>Knowledge Management</i>
MCDA	<i>Multi Criteria Decision Analysis</i>
NFR	<i>Non Functional Requirements</i>
NLP	<i>Natural Language Processing</i>
OOAD	<i>Object Oriented Analysis and Design</i>
RE	<i>Requirements Engineering</i>
SaaS	<i>Software as a Service</i>
SDLC	<i>Software Development Lifecycle</i>
SE	<i>Software Engineering</i>
SLR	<i>Systematic Literature Review</i>
SME	<i>Situational Method Engineering</i>
SOA	<i>Service Oriented Architecture</i>
SOC	<i>Service Oriented Computing</i>
SORE	<i>Service Oriented Requirements Engineering</i>
SOSD	<i>Service Oriented Software Development</i>
SOSE	<i>Service Oriented Software Engineering</i>

ABSTRACT

It is widely acknowledged that software reuse reduces the cost and effort of software development. Over the years many solutions have emerged that propose methodologies to support software reusability. Service oriented software engineering (SOSE) advocates software reuse while aiming to achieve better alignment of software solutions to business requirements. Service orientation has evolved from Object Oriented Analysis and Design (OOAD) and Component Based Software Development (CBSD), the major difference being that reusable artefacts are in the form of services rather than objects or packaged components.

Although SOSE is considered a new architectural style of software development that addresses some of the shortcomings of previous approaches, it has also inherited some of the challenges of CBSD, and OOAD, in particular in the requirements engineering process. In Service Oriented Requirements Engineering (SORE) an analyst has an additional challenging task of aligning requirements and services to select the optimally matched service from an increasingly large set of available online services. Much of the existing empirical research in SORE has focused mainly on the technical aspects while the human related issues are yet to be fully explored and addressed. The lack of empirical evidence to investigate the human related issues in SORE provides the overall motivation for the research covered in this thesis.

User involvement in software development has been the focus of significant research and has been intuitively and axiomatically accepted to play a positive role in users' satisfaction thus leading to system success. More recently, past users' feedback, reviews and comments from online sources are considered a form of user involvement. These offer valuable information to assist analysts in increasing their knowledge for making more informed decision for service selection. In service

oriented paradigm the full extent of the benefits of this form of user involvement has not been empirically investigated.

This thesis addresses three important high level research goals: (1) to investigate and identify the most important challenges of SORE, (2) to design an innovative and flexible method to address the top challenge of SORE, focusing specifically on the important relationship between user involvement and system success, and (3) to evaluate the applicability and effectiveness of the proposed method in an empirical study.

This thesis presents research conducted in three parts for achieving each of the stated goals respectively: *problem analysis*, *solution analysis* and *implementation analysis*. For problem analysis a mixed method approach is used, i.e. literature review, quantitative online survey, and qualitative industrial interview study. For solution analysis a Systematic Literature Review (SLR) is conducted to analyse the existing empirical studies about the relationship between user involvement and system success. Inspired by the results of this SLR, I designed the ARISE (Alignment of Requirement and Services) method, following Situational Method Engineering to make it flexible for adoption in various project contexts. The ARISE method aims to exploit the benefits of experiences of past users for service selection. For implementation analysis, the ARISE method was instantiated in a case study with real life data with two objectives in mind: (1) validation of the effectiveness of ARISE in overcoming the challenges of alignment, and (2) improvement and refinement of the ARISE method. Analysis of the results of this validation revealed the need for automated tool support for the ARISE method. This automation is achieved through the design and implementation of software tools created for supporting the analysts in service selection.

The systematic and mixed method research approach of the problem analysis phase identified that alignment of requirements and services was the top challenge for practitioners in SORE. It also increased our understanding of why this alignment is considered the most challenging task. The findings of the SLR confirmed that the effective user involvement in software development in general,

and in requirements engineering in particular could lead to system success. In SORE, the past users of services can be involved through their feedback and sentiments about the services from online sources. These concepts were the basis for the design of the ARISE method. The results of the case study complemented by the experimentation with the automated tools revealed that past users' feedback and sentiments are indeed valuable sources of information that can assist analysts in overcoming the challenges of alignment between requirements and services thus making a more informed decision in service selection.

CHAPTER 1: INTRODUCTION

1.1 Context and Background

Software Engineering (SE) research aims to improve software development by focusing on increasing reusability and quality of the end product while reducing time and cost of the development efforts required. With these objectives, over the period of time, there has been an evolution from structured plan based style of development to object oriented, component based, and finally towards service oriented. The internet and advent of Web 2.0 has played vital role in the fields of global communication by providing the appropriate infrastructure and technologies that has revolutionised the distributed computing and software application development. It provides developers and programmers with the transparency to the underlying working protocols, platforms and technologies so that they can focus only on designing application by locating and reusing the required components in distributed environment. This view takes us to the Service Oriented Software Engineering (SOSE) paradigm (Stojanović & Dahanayake 2005). Software applications in this paradigm are offered as services, which are software components available on the internet with web interfaces (Gold et al. 2004; Papazoglou 2003; Turner, Budgen & Brereton 2003). These services can be developed within organisations or can be provided by independent service provider. Service providers have to publish the specifications (or description of the service functionality) of their services in online repositories in order to describe the required input, output and functionalities offered by the services. The service consumer can search for these specifications in order to find a service that meets their business needs. Once a service is

selected, the service consumers create a binding with service providers known as service level agreement (SLA) for the usage of that service (Figure 1). SLA provides a mechanism for specifying the performance and quality attributes associated with the service application. It outlines the agreed upon desired performance targets and actions taken when these targets are not met. Once the service provider and consumer agree on the terms of SLA, the service can be accessed remotely by the standard interface in a distributed environment.

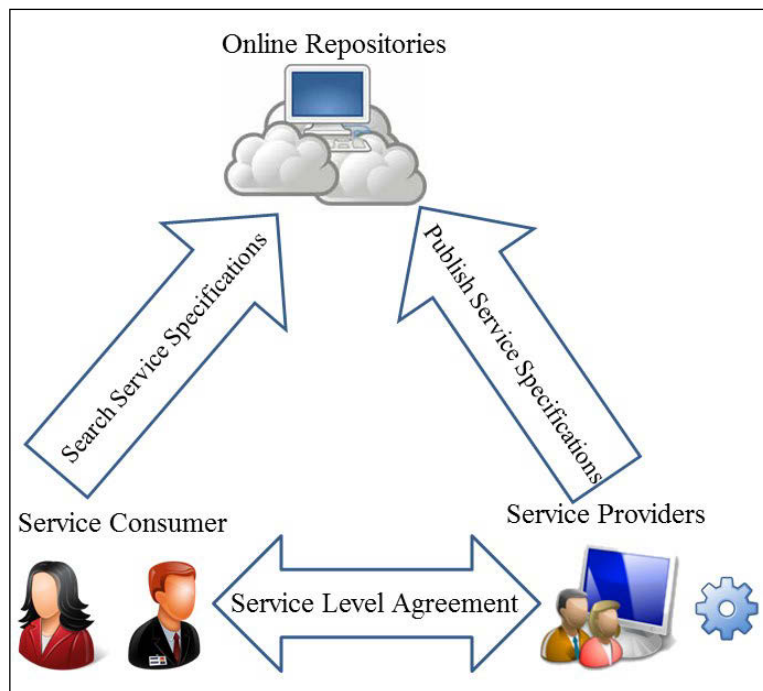


Figure 1 High Level overview of Service Oriented Architecture

The concepts of service orientation have been used by various terms such as Service Oriented Architecture (SOA), Software as a Service (SaaS), Service Oriented Computing (SOC), and Service Oriented Software Engineering (SOSE). The aim of introducing Service Oriented software development was to achieve the true form of reusability along with agility, platform independence and dynamic discovery, reconfiguration and change management (Papazoglou et al. 2008; Papazoglou & van den Heuvel 2003, 2007). The main focus of service orientation

is on the reusability of the software and better alignment of software solutions to business needs. Software reusability is acknowledged to reduce cost and efforts and time required for development. Various solutions have emerged as a result of research to propose development methodologies that would support reusability. Component based Software Development (CBSD) and Objected Oriented (OO) development were the results of such efforts. Service oriented software development is the evolutionary form of CBSD and OO, with the main difference that the software to be reused is in form of service rather than object or packaged component (Garofalakis et al. 2004; Iribarne 2004). Component based software development (CBSD) though proved promising for software reuse and maintainability but it still faces issues like heterogeneity of platforms and protocols and difficulty of locating required components and selecting them against system requirements (Breivold & Larsson 2007).

SOSE can be seen as an evolved form of CBSD that seems to provide solution to the problems faced in CBSD so as to make application development easier, low cost even in heterogeneous distributed environment based on web services which can easily be located over the internet. This style of development provides opportunities for saving time and cost of development but introduces new challenges at the same time (Kohlborn et al. 2009a, 2009b; Kontogogos & Avgeriou 2009; Ramollari, Dranidis & Simons 2007).

A great deal of research efforts has been put into achieving the true spirit of service orientation in academia and industry alike (Gu & Lago 2010; Huergo et al. 2014; Kontogogos & Avgeriou 2009; Papazoglou 2003; Papazoglou & Van Den Heuvel 2006; Papzoglou & van den Heuvel 2007; Ramollari, Dranidis & Simons 2007). The current dynamic market conditions pressurise the development teams to meet stringent deadlines along with fulfilling the quality and budget requirements and satisfying the customers (Karlsson et. al. 2007).

The most challenging part in SOSE is to find a service that fulfils the business needs accurately while at the same time satisfies the customers' needs (Gu & Lago 2010; Huergo et al. 2014). Reusing existing components in form of services in collaborative and distributed environment presented a very interesting perspective for saving time and cost of development. In spite of being advocated as a new architectural style of software development, SOSE has inherited the challenges of CBSD and traditional development especially in requirements engineering (RE) (Gu & Lago 2009, 2010; Huergo et al. 2014).

Traditionally, a requirement is considered as a need, want or desire for a condition, capability, or characteristic of a system or service by stakeholders (Davis 2013; Sommerville & Sawyer 1997). RE process aims to define and document the requirements by following activities comprising of elicitation, analysis, specification, negotiation, and change management (Cheng & Atlee 2007; Nuseibeh & Easterbrook 2000). RE is considered the most crucial part of software development that establishes the goals and objectives of the system in consultation with all the relevant stakeholders. If these goal and objectives are not articulated correctly at the outset, the end product cannot fully satisfy the intended customers, no matter how much time and resources are spent for the development. According to (Wiegiers 1995) *"If you don't get the requirements right, it doesn't matter how well you do anything else."*

The Service Oriented Requirements Engineering (SORE) is different from traditional RE, as a result of separation of service development (a concern of service provider) and Service-Oriented software development (a concern of service consumer) (Eck & Wieringa 2003). Service-Oriented solutions have to consider both service provider and service consumer. The service provider needs to understand the functional and non-functional aspects of the service being offered, which has to compete in marketplace with other available services but at the

same time satisfy the basic requirements of the service consumers. This requires understanding of the market trends and the needs of the potential consumers of such service. For service consumers, the challenge is to find the service that aligns accurately to the business needs of their organization.

For more than a decade improvements have been made as a result of research in technologies and standard protocols for network infrastructure to support distributed development and deployment of services (Gu & Lago 2010; Huergo et al. 2014; Papazoglou et al. 2008). The technology is important, but how to make best use of that technology by understanding the real objective of the system to build and satisfaction of those who will ultimately use it, is far more crucial. This makes the role of RE in SOSE very important. It emphasizes the need for an understanding of the objectives of the system to build, business needs of organizations, full functionality of a service, the environment where it will be used and most importantly the group of users who will actually be using that service.

1.2 Problem Statement

In the Service Oriented RE there is an additional task of alignment of services to requirements (Gehlert, Bramsiepe & Pohl 2008). By aligning a service to the requirements I refer to finding the best matched service for the requirements while making a trade-off among cost, functional and non-functional requirements (Rong & Liu 2010). Identification of the correct service has long been recognized to be the most crucial step in SOSE over the past decade (Birkmeier, Klöckner & Overhage 2009; Boerner & Goeken 2009; Caetano, Silva & Tribolet 2010; Cai, Liu & Wang 2011; Gu & Lago 2010; Huergo et al. 2014; Inaganti & Behara 2007; Zhang, Liu & Yang 2005).

The developers have software components available to them in the form of services. After gathering requirements, the ideal situation is to find a service that can be correctly aligned to the business requirements. The organizations require quick solutions and the developers are usually under pressure of tight deadlines. Instead they may attempt to provide solution where requirements are compromised based on available services. This would result in unsatisfied customers and perhaps even failure of the project even though the technology is highly promising (Rong & Liu 2010). It was perceived almost a decade ago that there will be an exponential growth in the number of online services (Garofalakis et al. 2004). With companies like Amazon, Google, IBM and Microsoft offering large number of services in a highly competitive environment (Tasi et. al 2010), the increase in the number of available services has caused an overload of choice. Finding the most suitable service (that satisfies the customers' requirements) among available options is becoming highly challenging for the analysts.

Gu and Lago (2010) and Huergo et. al. (2014) have provided comprehensive and systematic reviews of the studies using service identification methods. They have acknowledged that identifying the correct service is the most crucial step in building service based systems. According to their reviews, the existing methods employ various techniques and strategies for identifying the correct service for implementation e.g. model driven approaches, value analysis, pattern matching, ontology etc. In relation to the evaluation of services, much of the previous work provides mostly the technical solution (discussed in full detail in Chapter 2).

The real benefits of research efforts that offer practical solutions to the real problems can only be verified when it is applied in a real setting. Most of the previously proposed solutions for alignment problem to date are not adapted and verified by the industry (Kontogogos & Avgeriou 2009; Ramollari, Dranidis & Simons 2007). The software engineering research

community has a tendency of building their solutions solely based on the problems reported in the earlier literature (Davis & Hickey 2002). It is not particularly useful to conduct research in providing technological solutions to the problems and challenges that may not be considered accurate or even real by the practitioners. The results of the academic research are produced in a meticulous and methodical way, but often lack the considerations for real industrial settings and hence may not be applicable there (Verner et. al 2007). According to Davis and Hickey (2002), the RE researchers have to practice what they preach and analyse the reality behind the problems for which they propose the solutions. They state that many RE researchers fail to understand the current industrial practices; therefore their proposed solutions are not applicable to industry (Davis & Hickey 2002; Wieringa 2005). There is a lack of empirical evidence that investigates the challenges of SORE (Gu & Lago 2009), which necessitates further work in this area with real life projects. This would provide feedback for improvement in current methods and practices, to enrich the knowledge in service oriented domain, and open up further research directions. This motivates the need to validate the identified challenges of SORE before any solution can be proposed which can be applicable in industrial settings.

Based on the findings from my systematic analysis of the literature (Bano & Ikram 2010), a quantitative study (online survey) (Bano & Ikram 2011), and a qualitative study (interviews with practitioners) (Bano & Zowghi 2012; Bano et al. 2014), alignment of requirements to services was found to be the most challenging and problematic task in SORE due to the following reasons:

1. Lack of Context: The services are designed and developed free of context to target the needs of larger group of customers. It is sometimes challenging to align the context

free services, to the requirements of a project, which has a specific contextual details attach to it.

2. **Missing Information:** The specifications published by the service providers may not provide all the information that is required by the analysts to make the decision for its selection.
3. **Mismatch in the Level of Abstraction:** Service specifications may not be providing the information and the details about its functionalities at the same level of abstraction as the requirements.
4. **Mismatch in the Level of Granularity:** Service granularity refers to the range of functionalities offered by the service. Services can either be fine-grained (focused, limited functionality) or coarse-grained (broader functionality). Fine granularity offers more flexibility and reusability in customizing the system but also results in increasing the effort and cost of integration. A coarse-grained service is typically expected to carry out more functions but would also exchange more messages and data. This reduces the reusability as the functionality might be too overloaded for the actual need of most consumers.
5. **Paradox of choice:** Over the past few years the number of online services has increased exponentially. The analysts now face the problem of ‘over choice’ while selecting a service form a huge number of available options that offer more or less similar functionalities. With situations where hundreds of alternative choices are available, the decision making for service selection becomes very difficult.

1.3 Proposed Solution

The current solutions for the alignment (e.g. (Adam, Riegel & Doerr 2008; Galster & Bucherer 2008a; Gehlert, Bramsiepe & Pohl 2008; Gu & Lago 2010; Huerger et al. 2014; Papazoglou & Van Den Heuvel 2006; Steghuis 2006; Zachos, Maiden & Howells-Morris 2008)) are focused primarily on the technological aspect of the problem. Technological aspects of SOSE are concerned with computer programming, design and developmental sides of service orientation. They do not consider the human factors i.e. who will use the system ultimately? Technology is an important aspect but equally important are the people affected by this technology. Involving the people who have the past experience of using a service can provide valuable information that can be helpful in decision making process (Johnson 1998; Kokash, Birukou & D'Andrea 2007). The online social media presents a new opportunity for monitoring trends and sentiments of previous users towards a particular service among a large pool of options. In this thesis I propose a method ARISE (Alignment of Requirements and Services) to explore the benefits of past user feedback to assist the analysts in making a more informed selection decisions to overcome the challenges of alignment during service selection. The construction of the proposed method is grounded in the findings and systematic analysis of the literature study, a quantitative study i.e. online survey, qualitative study i.e. interviews with practitioners.

Users' involvement in software development has been the focus of research over three decades and has been studied in various disciplines from different perspectives and has been intuitively and axiomatically accepted to play a positive key role in users' satisfaction ultimately leading to the system success (Abelein & Paech 2014; He & King 2008; Kujala et al. 2005). In service oriented paradigm, active user involvement is needed in order to provide systems that can be

customized for individual user needs (Seyff, Graf & Maiden 2010b). There are various levels, degrees and roles proposed in literature for user involvement e.g. consultative, informative, participative etc. (Damodaran 1996). In consultative and informative roles, users are required to provide the necessary information that can impact the design related decision processes of the system development.

The user comments and feedback have been major sources of evolution of Android market and Apple store applications (Chen & Liu 2011; Fu et al. 2013; Galvis Carreño & Winbladh 2013). Recently online user feedback and sentiment analysis has gained a great interest in various areas of software engineering research e.g. Requirements Elicitation (Galvis Carreño & Winbladh 2013; Seyff, Graf & Maiden 2010a, 2010b), Software Evolution (Pagano & Bruegge 2013; Pagano & Maalej 2013), Software Quality (Chen & Liu 2011). Sentiment analysis (also known as opinion mining) is used for calculating and monitoring the attitude and behaviour of the past users from their feedback, comments and reviews available on the online social media. Various Sentiment Analysis tools, techniques and methods (Pang & Lee 2008), are proposed that make use of Natural Language Processing, Computational Linguistics, Text mining and analytics capabilities for calculating quantitative values of various users' attitude and behaviour towards a particular phenomenon or a product. The benefits of the user feedback and sentiment analysis have not been fully utilized in the alignment process of service oriented development (for detailed discussion see section 5.3).

In my proposed method ARISE, I have explored the benefits of past user feedback analysis on the process of alignment and to evaluate whether it helps analysts in overcoming the challenges of alignment. The best aligned service here is defined as the one that satisfies a maximum set of customer requirements (both functional and non-functional) within the approved budget. Evaluating a service only with the information advertised by the service

providers in their specification may not always lead to an optimal decision for service selection. User feedback can help in increasing the knowledge of analysts about actual working of the service besides the functionality published in the service specification.

1.4 Research Methodology

1.4.1 Philosophical Stance

For the conduct of research in this thesis, I have adopted a positivist stance from both ontological and epistemological perspective (Orlikowski & Baroudi 1991). The philosophy of positivism is based on the opinion that there is only one true objective reality that can be observed, studied and analysed through empirical scientific methods irrespective of the observers. The data resulted from such process is considered as empirical evidence. Within this stance, I have used a mixed method approach (Easterbrook et al. 2008) throughout the thesis by using qualitative data i.e. understanding the phenomenon within a context (Myers 2007), as well as quantitative data i.e. use of numbers and values to represent concepts (Straub, Gefen & Boudreau 2005).

In positivist philosophical stance, various research methods are available for studying different types of phenomenon. All of them have their advantages as well as weaknesses and no one method is perfect for all circumstances. The mixed method approach advocates combining different research methods in a strategy to overcome the weakness of one method by the use of another method. It has been debated that the qualitative studies often lack reliability, while the quantitative studies mostly lack validity. In order to take both the reliability and validity of a study into account, a mixed method approach is most appropriate for enhancing the quality of research (Easterbrook et. al 2008).

1.4.2 Research Strategy

There are three analytical steps involved in any engineering research i.e. *Problem Analysis*, *Solution Analysis* and *Implementation Analysis* (Wieringa 2005). A researcher is required to gather relevant knowledge regarding each step and for the solution analysis employ the scientific research methods as suitable for the problem under investigation. Following these guidelines, the research presented in this thesis is conducted in three parts. The first part was focused on evaluating the true nature of the challenges of SORE and to pinpoint the reasons that makes SORE challenging for the practitioners. The second part of my research was to propose the solution and investigate if the benefits of past user feedback in alignment process of requirements and services would assist in overcoming the challenges of alignment and would lead to better service selection. The ‘better service selection’ is measured based on the coverage of the functional and non-functional requirements by the proposed method. Third step was the implementation and the validation of the proposed solution. Figure 2 presents an overall view of the research strategy that I have followed in these three main stages i.e. Problem definition, developing a proposed method as a solution and validation by instantiation of proposed method.

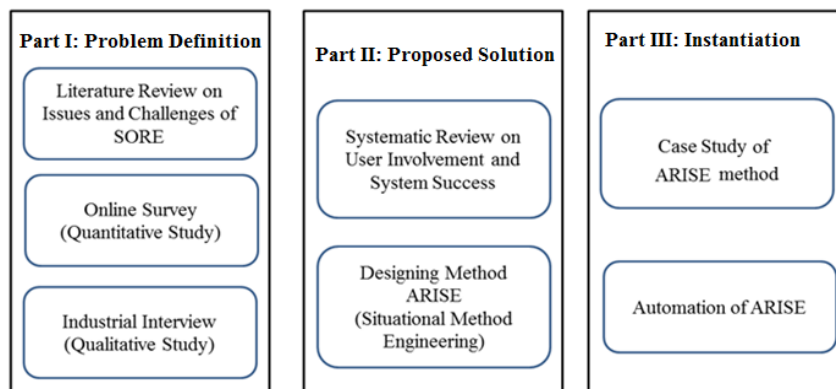


Figure 2 Research Strategy

1.4.2.1 Problem Definition

Research Goal 1: Explore and define the problem and scope of the research by investigating both theory and practice in service oriented requirements engineering.

To achieve Research Goal 1, this phase was guided by the following main research question:

RQ1. What are the challenges of Service Oriented Requirements Engineering?

This question was further divided into four parts:

RQ1.1: What are the challenges of Service Oriented Requirements Engineering reported in published literature?

RQ1.2: What are the challenges of Service Oriented Requirements Engineering considered important by the practitioners working on Service Oriented projects?

RQ1.3: What is the most important challenge of Service Oriented Requirements Engineering?

RQ1.4: What are the reasons for the top challenges of Service Oriented Requirements Engineering?

In this phase I employed a mix method strategy i.e. Sequential explanatory strategy (Easterbrook et al. 2008) to answer the sub questions i.e. Literature Review (for RQ1.1), Quantitative online survey (RQ1.2), Qualitative industrial interviews (RQ1.3, RQ1.4). The strategy is “characterized by the collection and analysis of quantitative data followed by the collection and analysis of qualitative data. The purpose of this strategy is typically to use qualitative results to assist in explaining and interpreting the findings of a quantitative study” (Easterbrook et al. 2008).

In order to define the problem and scope of the research, I have conducted a comprehensive literature review to find the challenges of SORE reported in the published literature (Bano &

Ikram 2010). Based on the results of literature review I conducted an online survey for confirmation of those challenges from 117 practitioners across the globe having experience of working on service oriented projects (Bano & Ikram 2011; Bano, Ikram & Niazi 2013). Utilizing the results from the literature review and survey I conducted open ended interviews with 14 experts from industry in Australia to gain a detailed insight into the challenges of service oriented requirements engineering as to why the practitioners find them challenging (Bano et al. 2014; Bano & Zowghi 2012). The alignment between business requirements and services was identified as the top challenge that business analysts have to face in service oriented projects.

1.4.2.2 Proposed Solution

Research Goal 2: Propose a method based on existing theory of “user involvement and system success” by investigating the existing literature

To achieve Research Goal 2, this phase was guided by the following main research question:

RQ2: Does involving user feedback help in overcoming the top challenges of alignment in Service Oriented Requirements Engineering?

The main question was further divided into following parts:

RQ2.1: Is there any relationship between user involvement and successful software systems?

RQ2.2: What are the benefits of user involvement in Software Development Lifecycle?

RQ2.3: Is user involvement beneficial in Requirements Engineering?

RQ2.4: How can we apply the existing theories of “user involvement” in Service Oriented Requirements Engineering?

As I was interested in exploring the concepts of user involvement in alignment process, I conducted a systematic literature review of the existing empirical research on the topic to answer RQ 2.1, RQ 2.2, and RQ 2.3. The review resulted in the selection of 87 studies from the literature for the period of 1980-2012 (Bano & Zowghi 2013a, 2013b, 2015). The results showed a positive impact of user involvement in terms of system success from empirical literature.

The next step was to design a method that utilises the concepts of user involvement in service oriented software development domain (RQ 2.4). I designed the method ARISE following Situational Method Engineering (SME) guidelines to make it flexible for adoption in various project situations. SME provides a systematic and flexible approach to tailor methods for software development activities according to project requirements at run time (Henderson-Sellers & Ralyté 2010). It requires availability of the method base (MB) for the project team which is a kind of a lookup table where different methods (method chunks) are listed along with their associated situational factors (when to use them), and required tools/techniques to carry them out. The MB is dynamic and can grow with the new projects and methods being introduced. According to the project context and situations the suitable method chunks are selected by following the process guidelines and combined to tailor a method for the project at hand (Brinkkemper, Saeki & Harmsen 1998). SOSE is dynamic in nature and SME is an appropriate choice for building a method of alignment for a specific project context based on the available services. SME has been applied to modify the existing method of alignment by incorporating past user feedback.

1.4.2.3 Instantiation

Research Goal 3: To evaluate the applicability and effectiveness of the proposed method in an empirical study

The third phase was guided by following research question:

RQ3: Does the proposed method helps analysts in overcoming challenges of alignment in Service Oriented Requirements Engineering?

The mix method approach adopted in part III is “Concurrent triangulation strategy” that uses both qualitative and quantitative methods simultaneously for understanding of a phenomenon (Easterbrook et al. 2008). To answer RQ3, I carried out an empirical study to instantiate the execution of ARISE method in practice and validate it’s working. The objectives for this study were twofold: (1) *validation of the idea of involving past user feedback in the service selection process*, and (2) *refinement and improvement of the method*. The last step in implementation of the solution was to develop automated tool support for the ARISE method. This was conducted by combining an NLP tool based on Knowledge Graphs and a web based tool (EVALUATOR) created for providing ease of use for analysts.

1.5 Thesis Contributions

This thesis contributes to the existing body of knowledge in the following five major ways:

1. A mixed method analysis of the problem space

Understanding of the real nature of a problem is crucial in justifying the solution that is offered in any research. A solution is of no value unless it deals with a real world problem. This thesis provides a detailed and in-depth analysis of the research problem

by following a structured mixed method approach. The problem analysis was carried out in three major steps; comprehensive review of the existing literature, collecting the opinions of 117 practitioners across the globe in a quantitative online survey, and 14 face to face interviews with the practitioners in a qualitative study. This mixed method analysis enabled me to define precisely the nature of the problems faced by practitioners in the real world setting and also the reasons that give rise to it. There has not been an existing study that has investigated the problems faced by requirements analysts in service oriented software development in such a comprehensive level of details.

2. Systematic Review of user involvement literature of the past three decades

While proposing a solution it is necessary to gain full and thorough background knowledge about its validity and working in other domains. For understanding the full potentials of the idea of user involvement, I performed a systematic literature review following the well established guidelines of Evidence Based Software Engineering (EBSE). This review is the first of its nature to combine the empirical results of three decades (1980-2012) and to provide a comprehensive state-of-the-art analysis of the various multi-faceted concepts of user involvement encompassing all the dimensions in full details. The review showed positive results in existing empirical studies about the benefits of user involvement and thus increased my confidence in justifying the proposed idea for my solution. The review also resulted in identifying some of the research gaps in existing empirical work on this topic for future researchers.

3. Development of a method using Situational Method Engineering (SME)

Innovation can be as a result of exploring the application of existing ideas and solutions in a scenario that has not been done before. In my thesis, I decided to

explore the idea of the benefits of user involvement in service oriented domain by utilising sentiment analysis. User involvement has been shown to have positive impacts on successful outcomes of system development. However, focused empirical research that investigates the full potential of user involvement in SORE is not available. The design of a solution has to follow standard guidelines. In my thesis, I have developed a method for service selection “Alignment of Requirements and services” (ARISE), using Situational Method Engineering (SME) and ISO/IEC 24744 standard that guides the design and development of methods in software engineering. SME focuses on formalizing the design and use of methods for software or system development. Henderson-Sellers and Ralyte (2010) define SME as *“encompassing all aspects of creating a development method for a specific situation (and excludes topics such as comparing methods and method knowledge infrastructures)”*. ARISE provides the mechanism of involving previous users of the service through their feedback that is analysed with sentiment analysis tools and guides the service selection process through MCDA approach. ARISE at process level provides guidelines for practitioners and is flexible for various project context due to being designed using SME.

4. ARISE Method instantiation

A solution lacks confidence unless it has been observed to work in the real world setting and to show that it can deal with the problems for which it was proposed. The proposed method ARISE is instantiated in a real world case to provide an empirical validity to the working of the solution. Also it has enabled me to justify the solution for the problems that I have identified.

5. Automated tool support

To reduce the time and effort required for analysis using the ARISE method, I designed and developed a web based tool EVALUATOR. The tool is considered as a research contribution due to the fact that it was developed based on research observations made during case study by following the inductive research methodology. The needs and objectives for the tool were motivated by the empirical research. I have also utilised an existing NLP tool that is based on Knowledge Graphs to support granularity analysis in ARISE. Both tools have been applied to the case study data as a proof of concept to demonstrate the applicability of the ARISE method in service selection.

1.6 Thesis Structure

The thesis has been organized to create a flow according to the research methodology as described in 1.4.2 and is divided into three parts. Following is the overview of the contents of the chapters in each part:

- Part I: Problem Definition

Part I describes in details the investigation of the problem space in three chapters i.e. Chapter 2 for literature review on challenges of service oriented requirements engineering. This chapter establishes the background for the readers to understand the nature of the current state of the art about the various concepts used in this thesis. It also shows the gaps in the current research and will improve the understanding of the readers about how my work fits in the research body of knowledge. Chapter 3 describes quantitative online survey and Chapter 4 discusses the qualitative interview study. It gives the details of the methods followed, the results, and defines the scope the research.

- **Part II: Proposed Solution**

Part II is about the solution space. Chapter 5 gives details of the Systematic Literature Review on user involvement. Chapter 6 describes the designing of the ARISE method using Situational Method Engineering Approach.

- **Part III: Instantiation**

Part III is comprised of the Instantiation phase. Chapter 7 describes instantiation of ARISE method in an empirical study and discusses the results. Chapter 8 explains the automated tool support for ARISE method.

- **Conclusion and Future Work**

Chapter 9 concludes the finding of the thesis and how they overcome the challenges of alignment. It also discusses its implication of the thesis on research and practice while referring to the current state of the art. Finally it paves the way for future directions from current state of the research.

PART I

PROBLEM DEFINITION

PART I: PROBLEM DEFINITION

Service Oriented Requirements Engineering (SORE) is considered different from traditional RE (Eck & Wieringa 2003; Tsai et al. 2007) due to the difference in the basics for software development methodology by designing a software with reusable services. For an analyst the biggest challenge is to find the correct service that satisfies customer and system requirements, quality and budget constraints (Cai, Liu & Wang 2011; Gu & Lago 2010; Huergo et al. 2014; Vale et al. 2012).

A responsible researcher is advised to address an existing problem thoroughly from two aspects (Davis & Hickey 2002; Wieringa 2005): the previous research (to ensure the validity of problem and avoid reinventing the wheel), and the practice (value to the practitioners in the industry). In this thesis the problem definition phase was carried out in three stages of exploratory research. The objective was not only to explore the field of SORE but also to scope the research problem. The three-stage exploratory research plan to investigate and understand the challenges of SORE guided by the following main research question:

“What are the challenges of Requirements Engineering in Service Oriented Software Development?”

Part I consists of three chapters that investigates the problem space by giving the details of the three studies carried out for exploring and understanding the problems of service oriented requirements engineering (SORE). In order to define the problem and determine the scope of my research, I have conducted a comprehensive review to find the challenges of SORE that are reported in the published literature. Based on the results of literature review I conducted an online survey for confirmation of those challenges from 117 practitioners across the globe having experiences of working in service oriented projects. Utilizing the results from the

literature review and the online survey I conducted an interview study with 14 experts from industry in Sydney, Australia to gain a deeper insight into the specific challenges of service oriented requirements engineering and the reasons for them. The alignment between business requirements and services was identified as the top challenge that business analysts face in service oriented projects. These interviews also gave details of why the task of alignment of requirements and services is considered the most challenging.

CHAPTER 2: LITERATURE REVIEW

A literature review is considered an essential component of a thesis that establishes the importance of a problem by demonstrating familiarity of the current and significant research related to that problem (Leedy & Ormrod 2005). It describes, compares, and contrasts existing research on the problem to highlight significant gaps and opportunities relating to the problem. A good review should provide comprehensive coverage and focus on the concepts related to the research problem by following a structured approach of locating all the relevant sources for review (Webster & Watson 2002).

In this chapter I present an overview of the relevant literature to the various concepts that are used for problem definition and scoping of the research to answer RQ1.1. The objective of my literature review was to conduct an extensive search for available publications to identify the challenges faced during service oriented requirements engineering (SORE). The findings were analysed to find the gaps and future research potentials. I conducted the first stage of the literature review in 2010, systematically analysing the issues and challenges of SORE. The procedure for the search and the results of the analysis of the literature were published in (Bano & Ikram 2010). My literature review was a continuing effort as I progressed in the research and discovered new concepts. The final version of the literature review presented in this chapter is extended to include review of literature conducted in parallel to my work up to August 2014.

2.1 SERVICE ORIENTED SOFTWARE ENGINEERING

2.1.1 Background

Service Orientation emerged as a new paradigm for designing software by providing the essential conceptual foundations for practitioners to deal with the increasing complexity of software development in distributed environment (Papazoglou 2003; Papazoglou et al. 2008; Papazoglou & van den Heuvel 2003, 2007).

2.1.1.1 What is a ‘Service’?

There is little uniformity in terminology used to describe the concept of a “service” in the literature (Azevedo et al. 2014). Before proceeding further it is necessary to clarify the meaning of the term ‘service’. The founding concept is a loosely coupled ‘service’ that has well defined interface, is reusable, platform and technology independent and can be integrated with other services to compose a system. Papazoglou *et al.* (2007) has defined ‘services’ as:

“Autonomous, platform-independent entities that can be described, published, discovered, and loosely coupled in novel ways. A service may perform functions that range from simple requests to sophisticated business process. Any piece of code and any application component deployed on a system can be reused and transformed into a network-available service.”

A service can be a ‘Business Service’ that is offered by an organization to its consumers or to be used within the organization. They are derived from business processes of the organization and consist of certain set of business activities. These can further be mapped to one or more “Application Services” which are software services that are implementation of one or more business functions and can be reused in various contexts of the project. Another form of software service is “Process Service” where a complete workflow support is provided for a

business process. “Web Services” are those services that are published, located and used through internet by using interoperable protocols and they can be used remotely on different platforms (Papazoglou et. al. 2003, 2007).

There are two main actors in Service Oriented Architecture i.e. service providers and service consumers. A service provider (e.g. organization or company) that has the implementation of service available is required to publish the service descriptions and provide technical and business support for customers to use the service. The service consumers are the analysts or developers who integrate these services into the applications (developed for their clients) that typically operate in distributed environment. To be seamlessly integrated to service based system, a service must be (Papazoglou et al. 2008; Papazoglou & van den Heuvel 2003, 2007):

- Platform independent *“they must be invocable through standardized lowest common denominator technologies that are available to almost all IT environments. This implies that the invocation mechanisms (protocols, descriptions and discovery mechanisms) should comply with widely accepted standards.”*
- Loosely coupled: *“they must not require knowledge or any internal structures or conventions (context) at the client or service side”*
- Support distributed computing: *“services should have their definitions and location information stored in a repository such as UDDI and be accessible by a variety of clients that can locate and invoke the services irrespective of their location”*

2.1.1.2 Traditional Software Development and SOSE

Traditional software development processes includes the activities like requirements elicitation and analysis, design, implementation, testing, deployment and maintenance. Various models are available for traditional software development process e.g. cascade, iterative, incremental

component-based, spiral, and Rapid Application Development (Pressman 2001). Although SOSE also includes all these activities of traditional software development, however these models are not directly applicable for service oriented software development life cycles due to the main differences in the style of development (Gu & Lago 2010, 2011; Huergo et al. 2014). In service oriented paradigm, the services are developed separately from the service based systems that will ultimately use them. In SOSE additional considerations are required from the point of view of both service providers and consumers for dealing with requirements, alignment of requirements and business process and eventually to services. For developing service based systems, where the services are not owned by the service consumers, additional issues are introduced regarding the service (e.g. trust, security, reliability and availability) that would make it different from traditional software development (Gu & Lago 2011). Service oriented SDLC is more like CBSD (discussed in detail in the next section) where the software or the system is to be built from existing software components. However, the software components in SOSE are in the form of “*services*” which is different from CBSD. Standard and universally accepted processes for SOSE do not exist. There is a need for a specific service oriented SDLC model (Pulier & Taylor 2006).

2.1.1.3 Service Oriented standards and protocols

To realize service orientation there are various standards and protocols that provide the required technological and networking interfaces for distributed application development. An overview is given in Figure 1 to show how the basic architecture of SOA works. Within SOA, a service uses standard protocols that define the ways in which the service would interact through its interface.

Web Services Description Language (WSDL) is an XML based language used for providing details about service's functional capabilities. It is used for providing a coded way of describing a service, how to call, what parameters to send and what results to expect in return. WSDL is used in combination with *Simple Object Access Protocol (SOAP)* which provides the basic framework for messaging in web services. It is also an XML based protocol that relies on other application layer protocols for message negotiation and transmission e.g. *Hypertext Transfer Protocol (HTTP)* and *Simple Mail Transfer Protocol (SMTP)*. An example of operation of SOAP can be of an application sending request to a server that is hosting a hotel booking service to search for price, room feature, location etc., and the response would be given in XML format to make it possible to integrate with the application and easy to parse. The objective of these networking standards and protocols is to make the service oriented SDLC independent of the platform where services are hosted, and easier to discover services with XML based queries. The service provider advertises their service online along with service description that would inform about the functional range that the service offers. The service consumers (analysts and developers) can easily discover the services and compose them into service based system without worrying about all these underlying technologies. Once the service is selected to be used in service based system, a *Service Level Agreement (SLA)* is created between service provider and consumer regarding the quality and usage of the service. Discovering the services on internet can be done manually or automatically (with the help of XML queries, if the service provider has published the service in web service registry with WSDL description).

With large number of services on internet that offer almost similar functionalities, the discovery (either manual or automatic) would produce large number of results. The challenge arises when the analyst has to identify a correct service that would best match to the customer

requirements. For effective and accurate matching of customers' requirements to a service and its reusability in various project contexts it is essential to have a good '*Service Description*' for advertising service capabilities (Huergo et al. 2014). Service description refers to the information that is needed for searching and assessment of a service against requirements (Galster & Bucherer 2008). There is no single way of describing service functionality (OASIS 2006). However it is necessary that a service description (in whatever format it is) should provide both technical and non-technical descriptions regarding the service behaviour. The technical descriptions should specify how the service can be invoked remotely, what parameters are used for input and output etc. WSDL is used for formal description of technical aspects of a service. Non-technical description of service are the quality attributes that can affect the functional capability of a service and hence its usability in a system e.g. availability, accessibility, performance, response time, reliability etc. These are described by a Service Level Agreement (SLA) and Quality of Service (QoS) artefacts. These service descriptions can be semantic (with the help of ontologies (Huang, Lee & Crespi 2012) and contextual (Lee, Muthig & Naab 2010) methods) or syntax-based (by exposing only the input/output interface details and hiding the internal implementation of the service (Teka, Condori-Fernandez & Sapkota 2012).). Service descriptions are important for dynamic and automatic service discovery (Berners-Lee, Hendler & Lassila 2001). All of these approaches require certain degree of formalism and are not applicable to natural language requirements and service descriptions.

2.1.1.4 Actors involved in SOSE

There are three types of actors involved in SOSE:

- **Service Providers:** a person, company or organization that owns the service, they advertise the service specifications in online service registries, independently or within relevant organization
- **Service Consumers:** The analysts or developers, who search the services from online or in house service registries, match them to customer requirements and identify the correct service for the software or the system.
- **Customers:** the project sponsors of the service based systems being developed by the service consumers; they supply the requirements and will actually use the resulting service based system in the future.

In this thesis, the term '**user**' covers either past service consumer or customer, who has previous experience of interacting with the service and can offer insights on the capabilities and functionalities of the service under consideration.

2.1.2 SOSE and CBSD

SOSE evolved from component based software development (CBSD) to provide solutions to the challenges that were faced by practitioners in CBSD i.e. heterogeneity of platforms and protocols, difficulty of locating required components and selecting them against system requirements (Breivold & Larsson 2007). In spite of being advocated as a new architectural style of software development, SOSE to some extent has inherited the challenges of CBSD and traditional plan based software development due to the similarity in the basic philosophy of reusability of existing software components.

Components and services hold many similarities such as: search and selection of appropriate component that meets system requirements (Garofalakis et al. 2004; Iribarne 2004), components or services in ready to use state have to be leased or purchased from third party,

need for an iterative process to satisfy system requirements, evaluation of available components or services for selection against quality criteria, reuse in multiple applications, and separation of the development of system from component or service development (Breivold & Larsson 2007).

Various solutions have been proposed for requirements analysts to tackle the task of component selection in CBSD (Land et al. 2008). The most notable are as follows:

- **Off The Shelf Option method (OTSO)** (Kontio 1995): It defines hierarchical evaluation criteria for component selection. It highlights importance of requirements acquisition for COTS selection but gives no solution to it.
- **Procurement Oriented Requirement Engineering (PORE)** (Ncube & Maiden 1999): It is an iterative and template based approach for off-the-shelf evaluation and selection. In PORE it is not clear how requirements are specified in the evaluation process and how irrelevant products are eliminated.
- **COTS-based Requirement Engineering (CRE)** (Alves & Castro 2001): This process incorporates quality requirements assessment as a way for making accurate COTS selection.
- **COTS Aware Requirement Engineering (CARE)** (Chung, Cooper & Courtney 2004): The CARE approach works upon concepts in available methodologies including Rational Unified Model (RUP), Model Based Architecture and Software Engineering (MBASE) and (ACquisition of REquirements/Procurement Oriented Requirements Engineering (ACRE/PORE) with the aim to propose a process-oriented framework which supports the iterative matching, ranking, and selection of COTS components.

Above mentioned methods rely on pre-structured and established criteria based on fixed requirements which are not an appropriate approach in context of SOSE (Perrone 2004), due to the dynamic nature of software development in SOSE where system is made of loosely coupled services. Because there are differences between services and components (e.g. platform independence, dynamic discovery and composition), these solutions are considered inadequate in service oriented paradigm (Breivold & Larsson 2007).

2.1.3 Service Oriented Software Engineering Methodologies

Since 2005, Service Orientation has received a great deal of attention from various areas of computing research (Kontogogos & Avgeriou 2009; Papazoglou 2003; Papazoglou & Van Den Heuvel 2006; Papzoglou & van den Heuvel 2007; Ramollari, Dranidis & Simons 2007). Over the time period, a significant amount of research has been conducted and many methods, tools and techniques have emerged in large projects. Some of the notable and relevant ones are briefly described below:

- **SeCSE** (Maiden 2006a): *Service Centric System Engineering* project had the aim to create free and open source methods, tools and techniques for system integrators and service providers to support the cost effective development and use of dependable services and service centric applications. Their main objective is to provide a mechanism where discovered services can be used for improving and refining the initial requirements and thus bringing better alignment of requirements and business needs to the services and vice versa. The initial requirements are first converted into goal models (Maiden 2006a) or use cases (Jones et al. 2005; Zachos, Maiden & Howells-Morris 2008; Zachos, Maiden, et al. 2006; Zachos et al. 2007; Zachos, Zhu, et al. 2006) which are ultimately translated into service queries (Maiden 2006a). These

queries are executed to find the relevant services in service registry to repository. The services found by the search are used for enhancing and improving the requirements and the process work iteratively till an optimally aligned service is found. However, during the industrial validation of SeCSE, the practitioners were facing difficulties in using the search query results to refine the initial requirements (Zachos, Maiden & Howells-Morris 2008). Therefore SeCSE solutions are only partially applicable to real industrial setting (Zachos, Maiden & Howells-Morris 2008).

- **IBM SOMA** (Arsanjani 2005; Arsanjani et al. 2007): IBM has proposed ***Service Oriented Modeling and Architecture (SOMA)*** which is an end-to-end software development method for building SOA based solutions. They provide guidance on identification of services just like objects are identified in Object Oriented Software Development. Although the steps used for modelling are described in this proposal, but the details regarding activities are not given and no approach has been discussed on how the services are identified.
- **SENSORIA** (Wirsing & Hölzl 2011): ***“Software Engineering for Service Oriented Overlay Computers”*** had the aim to develop a new approach for service oriented software engineering with existing theories, techniques and methods. Their focus is on complete SDLC in Service oriented paradigm, from requirements to deployment including re-engineering of legacy systems. The proposed methods and tools make use of mathematical theories and models for ensuring correctness of the procedure and allowing a semi-automatic design process.
- Other related solutions: Tsai et al. (2007) have discussed Service Oriented Software Engineering and proposed a new framework. Xiang et al. (2007) have proposed Service Requirement Elicitation Mechanism (SREM), which is based on Service

Requirements Modeling Ontology (SRMO), they have taken basic concepts from agent-oriented modeling framework *i** (*i* star). Value based software development concepts are used in Value Gap Model for eliciting requirements for service components (Lim et al. 2007). Jamshidi et al. (2008) focus on the service oriented development by considering business models. Their approach lacks considerations for the basics of the process model e.g. business rules, requirements and process. Adam et al. (2008) also propose to use business processes for identifying the services at right level of abstraction and granularity. Their proposed method is based on business process driven requirements engineering with variability and correlation techniques (Adam, Riegel & Doerr 2008). These approaches make an assumption that the business process models will have complete details of business processes which is hard to achieve (Huerger et al. 2014). Birkmeier et al. (2013) have proposed a systematic identification method for web service that relies on business process models. However the technique depends on the analysts' judgement for identification of the initial set of functionalities from business process that requires to be automated and grouped into one logical set for implementation by a service (Birkmeier et al. 2013). This can lead to different results by different analysts (considering their level of expertise and domain knowledge) even for a same project.

Attempts to provide an overview of existing approaches over this time period are also emerged that analyse the state of the art and identify the gaps. For example, Klose, Knackstedt and Beverungen (2007) compared nine design approaches of SOSE, Kohlmann et. al. (2007) compared six, Ramollari, Dranidis and Simons (2007) compare ten methods and Kohlborn et. al. (2009) compares 30 approaches. According to these comparisons, it is evident that all these solutions from the research community are diverse in nature and they are not sharing any

common grounds in their solutions (Kohlborn et al. 2009a, 2009b; Kontogogos & Avgeriou 2009; Ramollari, Dranidis & Simons 2007). They vary in their adoption of SOA concepts, delivery strategies, coverage of development lifecycle, dealing with stakeholders, and their adoption of existing processes, approaches, techniques and notations (Kohlborn et al. 2009a, 2009b). Most of them (with exception of IBM) do not have industrial validation and adoption, and there is a lack of significant empirical work regarding the validation of these approaches (Gu & Lago 2009; Papazoglou 2003).

According to the comparison of the 30 SOSE approaches in (Kohlborn et al. 2009b), the primary focus of all these solutions is on the technological aspect of SOSE, whereas the systems are used in social and organizational settings. It has long been recognized in the software engineering community that one of the major reasons of project failures is often attributed to people related issues rather than technology related problems (Kunda & Brooks 1999; Mitroff & Linstone 1993). This makes the role of RE critical in the successful outcome of projects since RE is the most communicative rich activity of software development and is human focused.

2.2 SERVICE ORIENTED REQUIREMENTS ENGINEERING

Requirements have been defined in many different ways in the literature. Sommerville and Sawyer define a requirement as:

“a capability that stakeholders want or a statement of a system service or constraint”
(Sommerville & Sawyer 1997).

Davis defines a requirement as:

“externally observable characteristics of a desired system” (Davis 2013).

By amalgamating these definitions for the sake of simplicity we can describe a ‘*requirement*’ as an externally observable behavior or property of a system or service that is needed, wanted, or desired by some user or stakeholder.

Requirements Engineering (RE) deals directly with the stakeholders of the system and is considered a crucial part of software development for achieving successful outcome and high quality of the end product (Hsia, Davis & Kung 1993). It establishes the goals and objectives of the system by consulting with as many relevant stakeholders as possible. If these goal and objectives are not articulated correctly, the end product cannot fully satisfy the intended users, no matter how much time and resources are spent for the development. Zave defines (RE) as:

“the branch of software engineering concerned with the real-world goals for, functions of, and constraints on software systems. It is also concerned with the relationship of these factors to precise specifications of software behaviour, and to their evolution over time and across software families.” (Zave 1997).

Traditionally RE was considered to be a sequential process that starts with requirements elicitation, and proceeds to modeling, analysis, specification, agreement, along with evolution and management (Nuseibeh & Easterbrook 2000). The complete set of requirements for a system is captured in a requirement specification. Ideally requirements specification should be unambiguous, complete, consistent, correct, verifiable, modifiable, traceable, feasible, minimal, not redundant, quantified/precise, agreed, closed (Boehm 1984; Byrne 1994; Davis et al. 1993; Martin 1998; Zowghi & Gervasi 2002). Requirement Engineering has evolved with a research span of more than 40 years. The four decades of research has delivered a significant outgrowths in terms of a number of processes, tools, techniques, methods and frameworks (Cheng & Atlee 2007). However the field of RE still faces a considerable number of

challenges (Cheng & Atlee 2007; Davis 2013; Nurmuliani, Zowghi & Williams 2004; Nuseibeh & Easterbrook 2000; Zowghi & Gervasi 2002).

The term Service Oriented Requirements Engineering (SORE) was first coined by Eck and Wieringa in 2003, to show that it is different from traditional RE due to the separation of service development (by service provider) and Service Oriented software development (by service consumer). Service-Oriented solutions have to consider both service provider and service consumer (Eck & Wieringa 2003). The service provider needs to understand the functional and non-functional aspects of the service being offered, which has to compete in marketplace with other services. This requires understanding of potential consumers of that service. For service consumers, the challenge is to find the correct solution to the business needs of the organization. The discovery of the appropriate web services for a composite web service is a crucial issue (Gu & Lago 2010; Huergo et al. 2014). In SOSE services are present online in a ready to use state and the focus of RE in SOSE is primarily on matching between these services and system requirements. To develop a system from the existing web services, we need to have a clearer understanding of user requirements and of the available services. This makes RE in SOSE different and more challenging than RE in traditional Software Engineering.

Traditional RE processes are not easily applicable to SOSE due to its main differences with the traditional software development by separation of service development and service based development (Eck & Wieringa 2003, Flores et. al. 2010). Considering the crucial role RE plays in SDLC, it is worthwhile to note that the traditional RE methods if applied in SOSE will exacerbate the existing problems of RE due to the difference in the nature of development style. In SORE, an analyst will not only have to deal with the issues of traditional RE, but will also have to face issues related to identification of service (e.g. service performance metrics,

unclear or incomplete service specification, socio-technical issues of service usage). Considering the promises proposed for systems developed in service oriented paradigm (cost effective, reduce time effort, re-usability, agility, platform independence, loose coupling etc.) a new RE Process is required, which should be tailored to the service-oriented paradigm in software development (Flores et. al 2010).

2.3 CHALLENGES OF SORE

Many of the proposed SOSE solutions do not consider the stakeholders or users in their analysis phase, and even if they do, the details of their involvement in the SOSE lifecycle are not provided (Kohlborn et al. 2009b). According to the systematic review of the challenges of SOSE performed by Gu and Lago the focus of the research community on RE related issues have not been adequate (Gu & Lago 2009). The current research lacks comprehensive service analysis methods that can combine both the technical and social aspect of the identification and analysis of services (Kohlborn et al. 2009a, 2009b; Kontogogos & Avgeriou 2009; Ramollari, Dranidis & Simons 2007). There has not been any widely accepted standards for the RE process in this domain which motivates further exploration and research in this emerging area.

Many methods, tools, and techniques have been proposed over time to bring into reality the promises of service oriented software development. Published literature indicates that this new field is still struggling to overcome different challenges over the past decade (Gu & Lago 2010; Huergo et al. 2014; Stojanović & Dahanayake 2005).

My literature review and analysis resulted in identifying 10 most frequently mentioned or cited challenges that were reported till 2010 (Though the literature review was updated at the time of thesis writing, only the list of challenges described here are from my previous analysis). I

did not consider the frequency of reporting an issue or challenge in the literature as a measure for being critical. All challenges were considered equal in importance. The ranking of the identified challenges was performed later in the online survey (Chapter 3). Following sub sections describes these challenges from the literature.

2.3.1 Knowledge Management in SOSD

Software engineering knowledge is dynamic in nature and there are many factors which contribute to its evolution like; technology, organizational culture, changes in needs of organization and change in software development practices etc. Software processes are considered to be knowledge processes. Software development can be improved by recognising related knowledge content and structure, as well as appropriate knowledge and engaging in planning activities, which would improve the performance of organization (Aurum, Daneshgar & Ward 2008; Bjørnson & Dingsøyr 2008; Rus, Lindvall & Sinha 2002). KM is reported to support these core activities of software engineering: Document management, Competence management and expert identification, Software reuse (making developers aware of existing contents).

According to Pilat and Kaindl (Pilat & Kaindl 2011), RE can be viewed as a knowledge process. It involves the conversion of tacit knowledge related to requirements and domain into explicit knowledge. The RE activities of the project can greatly benefit from the knowledge stored from the previous projects from similar domains and contexts. Integrating KM techniques and tools in SOSD lifecycle is considered helpful for the analysts in future projects during RE phase when the evaluation of reusable services takes place either from within organization or from third party service provider. They can make more informed decisions for service selection during the early phase of software development. Therefore adopting KM perspective is considered to support handling the challenges of SORE. However,

implementation of KM strategy is considered challenging in the literature due to the following reasons:

- *A lot of time, efforts and resources are required before the actual benefits become visible (Rus, Lindvall & Sinha 2002)*
- *Most of the knowledge in SE is not in explicit form (Rus, Lindvall & Sinha 2002)*
- *SE activities are more related to technical knowledge management and while the behavioural or human aspect of knowledge remains in the background (Swan, Scarbrough & Preston 1999).*

Making Knowledge Management an integral part of SORE is challenging but it can help dealing with existing challenges of SORE (Maximilien & Singh 2004; Woitsch & Karagiannis 2005). The philosophy of service orientation is built on the idea of software reusability and agility of the process. The designers and developers must know what solutions are available in order to develop right system, with correct process. The required knowledge is about available services, previous decisions and their results, constraints of using any tool/technique/method, service interdependencies etc. Knowledge Management has been proved helpful in core activities of traditional software engineering (Aurum, Daneshgar & Ward 2008; Bjørnson & Dingsøyr 2008; Lindvall & Rus 2002). Considering SOSE as a sub field of software engineering, knowledge management process if integrated into all activities of SOSE, would improve the RE process and would be helpful in tackling the issues of RE in SOSE. Not equivocally, but the idea has been supported by some of the researchers in different ways. In (Guo et al. 2008), Knowledge Management Process (KMP) is considered important to accomplish tasks of Business Process Management (BPM) in Service-oriented Architecture (SOA). In (Huang, Yang & Calmet 2006), the authors have highlighted the need for novel approaches for sharing service knowledge and application specific information. Knowledge is required to build trust among distributed parties on heterogeneous platforms, when we do

automated composition (Koumoutsos & Thramboulidis 2009). Knowledge management can improve cooperative work among services (Jichen & Ming 2009; Kojima, Funaki & Inoue 2009). XML messaging data if managed can provide information regarding web service dependency by the calls one service make to the others (Basu, Casati & Daniel 2007).

2.3.2 Non Functional Requirements

NFR, which also includes the quality attributes for software, are tremendously challenging to elicit (Glinz 2007). Their importance in influencing the design and development process has been acknowledged both in traditional software development as well as SOSD (Wang, Sun & Yang 2012). The main difference regarding NFR gathering and assessment in traditional and service oriented SE is that due to the highly distributed nature of service-oriented applications, which makes it even more challenging to handle NFR (Galster & Bucherer 2008b). The reusable, distributed, and loosely coupled services require new approaches for dealing with NFR in SOSD (Galster & Bucherer 2008b; Wang, Sun & Yang 2012).

Due to the black box nature of most of the services, capturing and evaluating non-functional requirements is a challenging task in SORE. NFR can be used as an essential measure for evaluating and making selection among the multiple available candidate services (Andreozzi, Montesi & Moretti 2003; Galster & Bucherer 2008b; Ran 2003; Tsai et al. 2007; Zachos, Dobson & Sawyer 2008; Zhou & Niemela 2006)

2.3.3 Iterative Discovery of Services

Requirements elicitation is a challenging task itself regardless of the software development methodology. Traditionally RE faced challenges like; regarding stakeholders (Decker et al. 2007; Regnell et al. 2001; Spanoudakis & Zisman 2001), capturing, modelling and analysing Non Functional Requirements (Decker et al. 2007), reuse of requirement models (Nuseibeh &

Easterbrook 2000), formal representation of requirements transformed from natural language (Kaindl 1993), requirement change and evolution (Nuseibeh & Easterbrook 2000), and conflict resolution in requirements (Spanoudakis & Zisman 2001). In SORE an iterative discovery process is required, where using initial informal and incomplete requirements that have been elicited can be used to search for available services and the resulting service specifications can be used to refine the requirements (Maiden 2006b; Zachos & Maiden 2008; Zachos, Maiden & Howells-Morris 2008; Zachos, Maiden, et al. 2006; Zachos et al. 2007). This is considered beneficial in the initial phases of development process while requirements are being elicited from the stakeholders. The initial requirements are usually incomplete and to align business requirements to a service that fulfils the business needs accurately is problematic. With an iterative process, the development team has the opportunity to present closely related services to the customers for their feedback. The services work as prototypes and help in completing the requirements set. However it is a challenging task and requires intensive analysis and communication with the customers.

2.3.4 Alignment of Requirements and Services

An important task for business analysts in service-oriented requirements engineering is to align service descriptions or specifications with requirements. This requires performing a trade-off analysis between cost and various facets of flexibility, reusability and performance of the service to name but a few. This is considered challenging as the services are not usually described at the right level of granularity. Service granularity (sometimes referred to as abstraction level), is about the degree of modularity of service (Papazoglou & Van Den Heuvel 2006), and refers to the service size and the scope of functionality a service exposes (Adam, Riegel & Doerr 2008; Kulkarni & Dwivedi 2008). The level of granularity is

considered appropriate from a technical point of view if a service can accomplish a business task in a single invocation. Services are considered either fine-grained or coarse-grained (Papazoglou & Van Den Heuvel 2006). Fine granularity would offer more flexibility in customizing the system but also results in more effort on integrating small modules (granules). A coarse-grain service would typically be expected to carry out more functions but due to increase in the exchange of data and messages, this may present a more complex interface (Steghuis 2006). From the consumers' point of view, the choice of an acceptable granularity of services for alignment also presents an economic problem. Providing a large number of fine-grained services would reduce development and maintenance cost and would potentially lead to higher level of reusability of services. However, it will increase the costs and complexity for service composition (Adam, Riegel & Doerr 2008; Heinrich et al. 2011). On the other hand, very coarse grained services would lower its reuse as the functionality might be too overloaded for the actual need of most consumers and therefore might be suitable only for small customer segment (Heinrich et al. 2011). To achieve the acceptable level of alignment, trade-offs need to be made between cost and required functionality (Kulkarni & Dwivedi 2008). The process of alignment in SORE has the following two aspects (Gehlert, Bramsiepe & Pohl 2008);

- *Requirement to service alignment: finding services that closely match the requirements, and*
- *Service to requirement alignment: modifying and adjusting requirements to make better use of existing services*

Understanding of the level of granularity of a service is very important for accurate alignment to the requirements. For aligning requirements to services, there can be three main scenarios as

shown in Figure 3 (Gehlert, Bramsiepe & Pohl 2008); fully aligned, not aligned, or partially aligned. The challenge arises when the decision has to be made for partial alignment. Partial alignment has three cases;

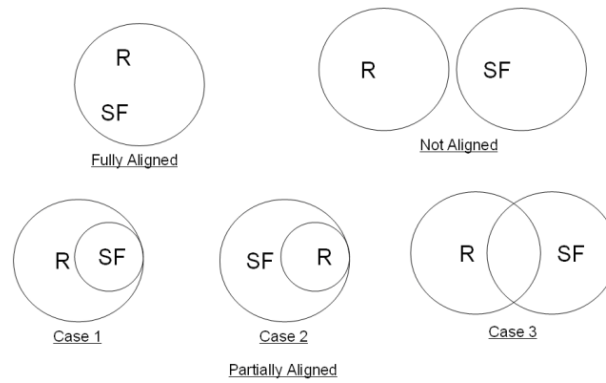


Figure 3 Five scenarios of alignment of service functionality (SF) and requirements (R)

1. *Service functionality fulfils only a part of the requirement (service is too fine grained causing performance related issues e.g. integration problem, delays in interaction among multiple services)*
2. *Service functionality offers more than requirement specifics (service is too coarse grained increasing cost)*
3. *Service functionality and requirements overlap (causing increase in cost and integration issues)*

Dealing with partial alignment requires a decision making process for the selection of a service, based on trade-offs between functional/non-functional requirements and cost, but also a range of criteria e.g. service should also take into account different levels of service granularity in order to promote reuse and, at the same time, to provide enough flexibility to enable service composition and orchestration without significant performance loss (Adam, Riegel & Doerr 2008; Demirkan et al. 2009; Huergo et al. 2014).

For any service identification methodology it is essential to examine the services from multiple perspectives i.e. business, technology and organization (Huergo et al. 2014). Many solutions in the past have been proposed but they all focus primarily on the technical aspect of

this challenge (Arsanjani 2005; Gu & Lago 2010; Huergo et al. 2014; Klose, Knackstedt & Beverungen 2007; Kohlborn et al. 2009a, 2009b). Therefore effective mechanisms are required to locate the correct service according to the customers' requirements (Gu & Lago 2009; Huergo et al. 2014; Spanoudakis, Zisman & Kozlenkov 2005). SOSE also requires automated and dynamic service discovery based on customers' requirements specifications (Spanoudakis, Zisman & Kozlenkov 2005), and a high level language support is essential for requirement specification especially in an automated process (Brereton 2004; Lichtenstein, Nguyen & Hunter 2007).

In consideration with the importance of the alignment of the services to requirements in SORE, significant research has been conducted over the last decade. The main objective of alignment methods is to deal with a multi criteria scenario where the service has to be correct in functionality, granularity, abstraction, reuse, and flexibility. In the last five years, literature surveys have emerged that review and compare the existing alignment methods and identify the strengths and limitations of the proposed approaches (Birkmeier, Klöckner & Overhage 2009; Boerner & Goeken 2009; Cai, Liu & Wang 2011; Gu & Lago 2010; Kohlborn et al. 2009b; Vale et al. 2012; Zadeh et al. 2012).

The proposed approaches for aligning requirements and services have employed a variety of techniques, e.g. (Gu & Lago 2010; Huergo et al. 2014):

- Algorithm: by using heuristics or formal rules in proposing the solution (Azevedo et al. 2009; Dwivedi & Kulkarni 2008; Jain, Zhao & Chinta 2004; Jamshidi, Sharifi & Mansour 2008; Kim & Doh 2007, 2009; Mani et al. 2008; Wang, Xu & Zhan 2005; Zhang, Liu & Yang 2005; Zhang & Yang 2004)

- Guidelines: informal suggestions, criteria or policies (Huayou et al. 2009; Inaganti & Behara 2007; Kim & Doh 2007; Klose, Knackstedt & Beverungen 2007; Kohlmann & Alt 2007; Ricca & Marchetto 2009; Yun et al. 2009)
- Analysis: a systematic evaluation based on reasoning and synthesizing (Amsden 2007; Chen et al. 2005; Cho et al. 2008; Fareghzadeh 2008; Kohlborn et al. 2009a; Lee, Muthig & Naab 2008)
- Ontology: conceptualization and representation of the domain knowledge (Abu-Matar & Gomaa 2011; Alizadeh & Mohsenzadeh 2011; Caetano, Silva & Tribolet 2010; Chen et al. 2009; Huayou et al. 2009; Jin & Zhu 2008; Kang, Song & Baik 2008; Kim & Suhh 2010; Wen et al. 2010; Yousef et al. 2009)
- Pattern: a repeated solution to a repeated problem (Baghdadi 2006)
- Information manipulation: A text process techniques for identifying or eliciting useful information, such as information retrieval or textural similarity analysis (Aversano, Cerulo & Palumbo 2008).
- Value Analysis and Service Responsibility Analysis: identify services from the explicitness of participant's interaction (Andersson, Johannesson & Zdravkovic 2009; Dinh & Nguyen-Ngoc 2010; Gordijn, Yu & van der Raadt 2006; Ilayperuma & Zdravkovic 2010; Kaabi, Souveyet & Rolland 2004; Klose, Knackstedt & Beverungen 2007; Lee et al. 2011; Lo & Yu 2007; Samavi, Yu & Topaloglou 2008; Weigand et al. 2009)
- Business process: aligning requirements business processes and then to services using business process models (Adam, Riegel & Doerr 2008; Azevedo et al. 2014; Birkmeier et al. 2013; Jamshidi, Sharifi & Mansour 2008)

There are two major gaps in all these proposed approaches:

- They require a certain degree of formalism which is not feasible in situations of over choice i.e. identification and selection of a service in a multi-criteria and overload of choice. When there are large numbers of candidate services available with more or less similar functionality and other attributes, matching it to various business and customer needs and perspectives can be a very challenging task with formal techniques.
- There is a significant amount of work available in research literature on the service identification and analysis, but none of them give any details of the involvement of stakeholders or human actors with the service e.g. (Abdelaziz, Mustapha & Mohammed 2011; Abdelkader, Malki & Benslimane 2013; Alahmari, De Roure & Zaluska 2010; Asadi et al. 2011; Bao et al. 2010; Birkmeier et al. 2013; Brzostowski et al. 2010; Fuhr et al. 2013; Guan, Feng & Ma 2012; Kazemi, Rostampour, Azizkandi, et al. 2011; Kazemi, Rostampour, Jamshidi, et al. 2011; Kim & Suh 2010; Kim & Doh 2013; Komondoor et al. 2012; Lee, Muthig & Naab 2010; Lee et al. 2011; Liu et al. 2013; Medeiros, de Almeida & de Lemos Meira 2010; Meertens, Iacob & Nieuwenhuis 2010; Nakamur et al. 2011; Ren & Wang 2010; Souza et al. 2011; Stewart & Chakraborty 2010; Upadhyaya, Khomh & Zou 2012; Weigand 2011; Zadeh et al. 2012; Zhang et al. 2010). It was discussed earlier that in aligning requirements and services, it is necessary that the method should combine both the technical and social aspect of the identification and analysis of services (Kohlborn et al. 2009a, 2009b; Kontogogos & Avgeriou 2009; Ramollari, Dranidis & Simons 2007). Lack of customers, user and/or stakeholders' involvement will lead to dissatisfaction with the end product, no matter how sound the technology was used. Technical perspective of any issue is just a single view of a multifaceted problem (Kunda & Brooks 1999;

Mitroff & Linstone 1993). The technology is important, but how to make the best use of that technology to satisfy those who will ultimately use the system is as important.

2.3.5 Requirements Change Management

Requirements Change Management (RCM) in traditional software development is an essential part to make the software up to date and acceptable to the customers and dynamic market needs. Requirement change is considered inevitable during software development life cycle. The system has to undergo frequent changes and updates in order to continuously meet with the customers' changing needs and demands, and addition of new features. These changes to the existing system are not easy to implement and it requires good management efforts to avoid system failure. The system has to work reliably even though unexpected changes are inevitable to the requirements. Therefore when a change request arrives, it is necessary to understand the type of change, its impact of the scope and level of effect on the entire system and what strategies are required to deal with this change request. This impact analysis leads to the decision making for that change request (Li et al. 2012). According to the literature, the distributed and highly dynamic nature of the service oriented paradigm makes RCM a challenging issue in SOSD (Di Nitto et al. 2008; Papazoglou 2008; Wang & Wang 2013). Customers' needs and requirements change over time. There is a need for a specific mechanism that can redesign and redeploy the composition of services in SOSE when requirements change and evolve (Lichtenstein, Nguyen & Hunter 2007).

2.3.6 Lack of standard RE process for SOSD

There is no standard acceptable RE process defined for service oriented development. The analysts apply the traditional practices which may not be suitable for SORE (Pulier & Taylor

2006). Traditional SDLC models are not directly applicable for service oriented software development life cycles due to main differences in architectural style of development (Gu & Lago 2007, 2010; Huergo et al. 2014). In SOSD additional considerations are required from the point of view of both service providers and consumers for dealing with requirements, alignment of requirements and business process and eventually to services.

2.3.7 Testing of Service Oriented Systems

Testing the resulting system is crucial activity during software development lifecycle. With only specifications and interface details available, the usual software testing techniques may not be applicable in service oriented domain. New mechanism and techniques are required for services testing that are focused primarily on systems build with SOSD lifecycle (Canfora & Di Penta 2009; Shaban, Dobbie & Sun 2009; Tsai et al. 2008).

2.3.8 Semantic Gaps in specifications

It is inevitable to have some semantic gaps when different services are brought together from hybrid environments and composed together (Lichtenstein, Nguyen & Hunter 2007). Semantic gap arises with difference of interpretations from same service specification description and leading to incorrect matching of requirements and services. There is a need for a mechanism or process that can handle this heterogeneity of different platforms and hide the underlying technological details when the services work together, in order to achieve true platform independent SOA based development.

2.3.9 Service Dependency Discovery

Service composition should be able to give a mechanism at design time to avoid deadlocks in service invocation. It is therefore required to have a mechanism for predicting service

dependencies in their communication is discovered at run time (Basu, Casati & Daniel 2007). However it is challenging task to find service dependencies of online third party services, unless they are integrated and deployed in the system.

2.3.10 High level language support

To discover a service it is necessary to fully understand the requirements. There is a need for an easy to understand high level language for requirement engineering in SOSD (Brereton 2004; Lichtenstein, Nguyen & Hunter 2007), that can help overcome the semantic gaps of service specifications from different platforms. The conversion of user requirements in formal specification is difficult in service oriented paradigm due to lack of sufficient technical support. Query languages limit the capability of fully specifying user requirements for service discovery. The existing techniques are not quiet sufficient for describing requirements in SORE.

2.4 Chapter Summary

RQ1.1: What are the challenges of Service Oriented Requirements Engineering reported in published literature?

Table 1 summarizes the results from the literature review and gives the list of challenges of SORE for RQ1.1. The list is not ranked as it was created by collecting the challenges from literature. This list was used in the online survey (Chapter 4).

1	Integration of Knowledge Management strategy to SOSD life cycle
2	Non-functional Requirements gathering and assessment
3	Iterative service discovery Process
4	Alignment of business requirements and services
5	Requirement Change Management
6	Lack of standard RE Process
7	Testing service oriented systems
8	Semantic gaps in specifications
9	Automated dependency discovery
10	High Level Language Support

Table 1 List of challenges identified from literature review

CHAPTER 3: ONLINE SURVEY

The second step of our research inquiry in problem investigation phase was to conduct a quantitative study with the help of an online survey. For our study, to answer RQ1.2, the most appropriate and cost effective design was an online survey where we were able to target the global population comprising of practitioners and researchers working on service oriented projects. Surveys are mostly suitable for approaching a large sample from a population for surface level feedback and agreement. An effective survey in any research is designed to make it appropriate, cost effective and resilient to biases (Pfleeger & Kitchenham 2002).

Online Surveys are widely used for systematic data collection method for targeting a population through internet and eliciting their responses through a web interface. It is a faster and easier way of conducting a survey. It offers the following advantages:

- 1) Easy for data collection: Through internet it is easier to connect to all kinds of people from around the world. Therefore online surveys can be easily conducted by inviting thousands of people (e.g. through mail lists and social groups) and it is easy for respondents to reply through a web page interface.
- 2) Lower cost: Online surveys are comparatively lower in cost and faster in data collection than the traditional paper and mail surveys. Various free and low cost online tools are available that enables a designing web interfaces for survey with far less time and effort.

- 3) Database input and analysis: The web interface in online survey can be easily be connected to a back end database and hence the responses to the questionnaire can be directly stored which makes analysis easier even when the response rate is high.
- 4) Better response rate: It is easier to target a huge population online throughout the world with the help of various social media groups and mailing lists, and hence online surveys can comparatively have higher response rates.

3.1 OBJECTIVE OF SURVEY

The aim of this study is to get an insight into the experiences of those working on Service Oriented Software projects either as practitioners or as researchers (working in industrial settings) pertaining to the challenges of RE in SOSE which are listed in Table 1. The main interest was in exploring how critical in nature these challenges are. The results of the survey were reported in (Bano & Ikram 2011; Bano, Ikram & Niazi 2013).

3.2 SURVEY DESIGN

The study was guided by RQ1.2;

RQ1.2: What are the challenges of Service Oriented Requirements Engineering considered important by the practitioners working on Service Oriented projects?

The instrument for the survey was a questionnaire. Based on the challenges given in Table 1, I created a questionnaire to measure the agreement level for these factors (see questionnaire in Appendix A). The items in this questionnaire used the Likert scale of five levels (from Strongly Agree to Strongly Disagree) to measure the agreement level of the respondents. A

pilot study was conducted to further improve the questionnaire. For pilot study, five people were selected from the university (colleagues of my supervisor), and 10 responses were collected after launching the survey online and sending emails to the practitioners whose profiles were checked from LinkedIn¹ groups. This helped in removing ambiguities in the design of questions and also was a rehearsal for data collection, storing and analysis. An updated version of questionnaire was put online for actual survey.

In our case, the target population set is not defined and random sampling was not an option. Therefore, like other online surveys (Kitchenham & Pfleeger 2002), our design is subjected to self-selection bias. We did a non-probabilistic and convenient sampling because the required respondents were scattered across the globe and randomization was not possible. The invitations letters were sent through emails to the practitioners and the researchers around the world. Their selection criterion was that their experience should be related to SOA, SOSE, Web Services, and Service Engineering. The email IDs were collected from research papers, and also the survey link was posted on all groups related to service orientation on LinkedIn.

3.3 SURVEY RESULTS

The survey was performed as a cross sectional study and the duration of the survey was from 16th December 2010 to 23rd January 2011. The survey contained demographic questions to filter out the responses from the respondents that were not from relevant target population (10 responses were discarded). In the end 117 responses were selected from all around the world. Complete results of the survey are presented in Appendix B.

¹ <http://www.linkedin.com/>

Figure 4 shows the geographical distribution of the respondents. More than half of them are from Europe and North America. In Figure 5 presents the number of years of experience the respondents had in software development field. Figure 6 shows the job roles that the respondents had at the time they responded to the survey.

Based on the results from the survey, top five challenges were selected for the in-depth qualitative study. The aim was to narrow down the scope of the research for the thesis. Challenge 6 to 10 in Table 2 scored below 60% (sum of strongly agree and agree) and were dropped from the list for further investigation. Responses to the similar measurement construct were added and their average was calculated for the agreement level of the respondents. Table 2 and Figure 7 summarize the analysis of the results of survey calculated from the data presented in Appendix B. Table 3 represents the challenges that remained for further exploration in the next phase of interviews from the practitioners in industry.

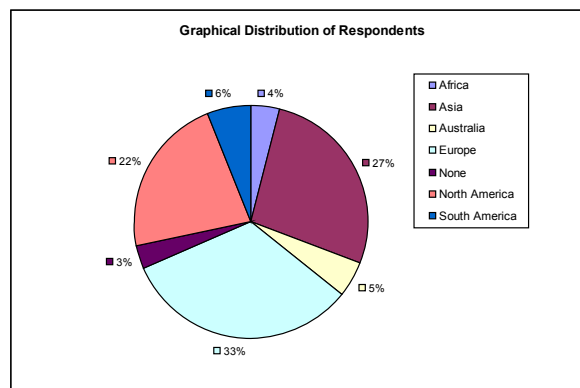


Figure 4 Geographical Distribution of the respondents

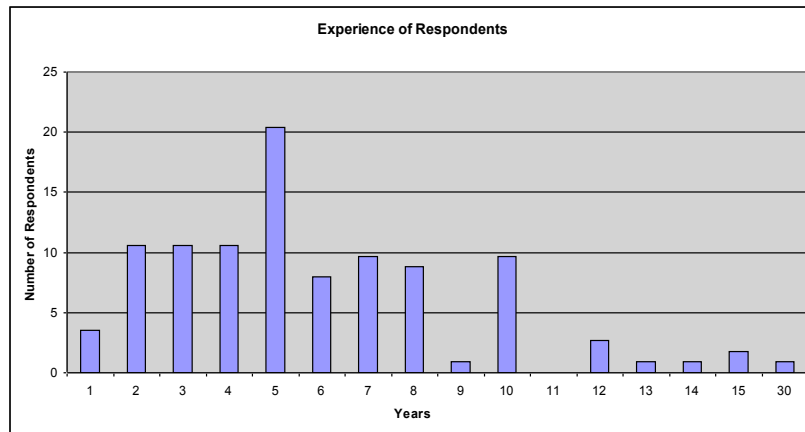


Figure 5 Numbers of years of experience of the respondents

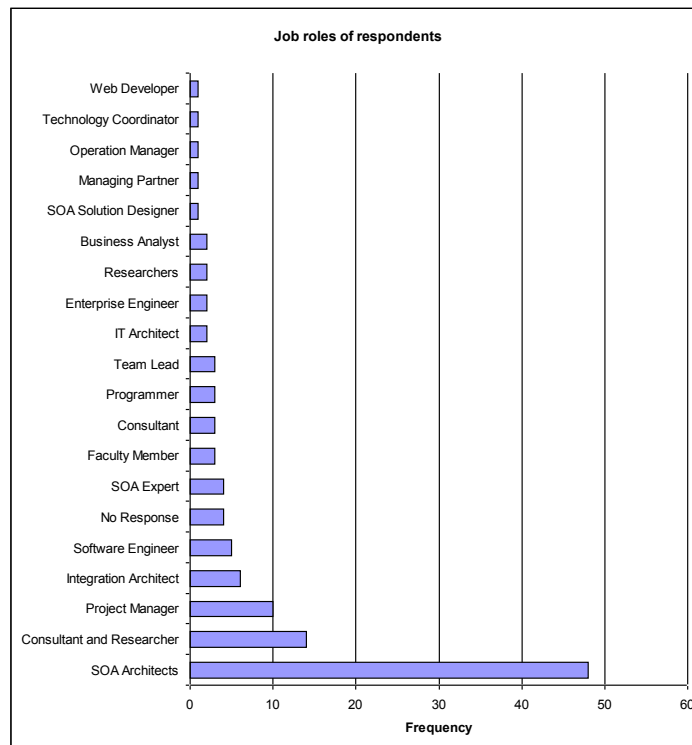


Figure 6 Job Roles of the respondents

Sr#	Measurement Factors	Percentages on Lickert Scale of five for 117 responses				
		SA	A	N	D	SD
1	Alignment of business requirements and services	32	44	16	5	3
2	Integration of Knowledge Management strategy to SOSD life cycle	29	47	17	6	1
3	Iterative service discovery Process	28	47	16	7	2
4	Requirement change management	20	41	21	15	3
5	Non Functional Requirements gathering and assessment	19	41	21	15	4
6	Semantic gaps in specifications	15	37	28	17	3
7	Testing of service oriented system	23	32	29	13	3
8	Automated dependency discovery	19	38	27	12	4
9	Lack of standard RE process for SOSD	20	34	35	9	2
10	High Level Language Support	8	28	29	27	8

Table 2 Percentages of Agreement for Measurement Factors (SA=Strongly Agree, A=Agree, N=Neutral, D=Disagree, SD=Strongly Disagree)

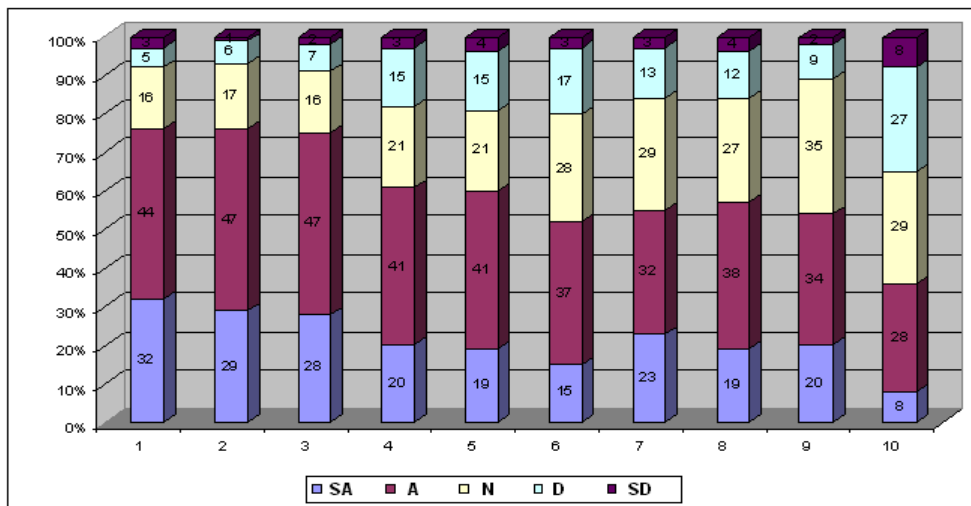


Figure 7 Percentages of the results for the issues presented in Table 2

3.4 Chapter Summary

In this chapter the findings from the literature review were presented to the practitioners in an online survey. Table 3 answers RQ1.2 by giving list of challenges were considered more

important. These top five challenges that were used for the next step in the industrial interview study to carry out in-depth analysis.

1	Alignment of business requirements and services
2	Integration of Knowledge Management strategy to SOSD life cycle
3	Iterative service discovery Process
4	Requirements Change Management
5	Non Functional Requirements gathering and assessment

Table 3 List of challenges ranked from online survey

CHAPTER 4: INTERVIEWS WITH PRACTITIONERS

Face to face interviews play a vital role in exploratory research for gaining a deeper understanding of a phenomenon by investigating the views, beliefs, experiences and/or motivations of individual. In qualitative research in software engineering, interviews with practitioners have been used extensively for understanding a problem in the real world setting. Interviews are considered an important data collection method in exploration of the problem where detailed insights are required from individual participants facing the problems.

Interviews can have different designs according to the context of inquiry (e.g. structured, semi-structured), depending on the available knowledge of the domain and whether the questions to be asked are open ended or close ended. Semi-structure interviews are helpful in situations where key questions are available to set the scope of interview, but allow flexibility to the interviewer for pursuing further details according to the responses from the interviewees.

I conducted face-to-face interviews as a final step of the investigation of problem space. The online Survey (Chapter 3) provided us with a surface level understanding of the top five RE challenges and issues in SOSD (Table 3). Interviews were selected for a deeper understanding of these challenges in a real life context. The online survey confirmed the top challenges of SORE but could not reveal why practitioners find these challenging. Furthermore, the details of the actual process followed by the analysts when they were performing SORE, was not articulated in the survey.

4.1 INTERVIEW STUDY DESIGN

The interviewees were selected from software companies based in Sydney. The criterion for their selection was that the interviewee should be a practitioner in the industry and should have the experience of working as a development team member in a service oriented project. The practitioners were initially approached using social networking (through links provided by supervisors) and later followed by snow-ball or referral sampling technique. The study was guided by RQ1.3 and 1.4;

RQ1.3: What is the most important issue and challenge of Service Oriented Requirements Engineering?

RQ1.4: What are the reasons for the top issue and challenges of Service Oriented Requirements Engineering?

The interviews were semi structured and open ended. Based on the refined list of challenges from the online survey (Table 3), I designed the semi-structured interview instrument. The interviewees were presented with the results of survey and briefed about the study (Appendix G: Information Sheet). They were asked to confirm if they had faced those provide their views with reference to the examples of the service oriented projects they had experienced and what were the reasons that made them issues or challenges. Though the interview questions were focused on the top five issues identified in online survey but for further understanding I took advantage of the face-to-face interview style to ask follow up questions wherever it was required. Out of 14, six had the experience of being business analyst, and 8 as project managers. Six had additional experience as developers in SOSE projects. To approach the practitioners in the industry for interview, it was mandatory to get approval from Human

Research Ethics Committee (HREC) at UTS. The HREC approval, consent form and information sheet for the study can be found in Appendix G along with the link to UTS HREC policies. The names of the interviewees, the companies and the projects will not be disclosed as per confidentiality requirement for the ethics approval of this research. Preliminary results of interview were published in (Bano & Zowghi 2012) and complete version was published in (Bano et al. 2014a).

All 14 interviews took place during June-August 2012 in Sydney and each lasted between 30 minutes to one hour. They were audio recorded and later transcribed. The transcripts of the interviews were analysed using NVivo² software for the thoughts and concepts presenting for each of the issues using thematic analysis (Cruzes & Dyba 2011). Initially the transcripts were scrutinized for data reduction by removing the irrelevant text from the responses. The first step of analysis was to code in order to combine all the answers related to the specific issue on which the interviewees responded. This was followed by careful reading and reflection to create additional codes to find the answer for RQ1.4 (i.e. reasons for the challenges). The analysis process was carried out by iterative coding of the interview transcripts and continuous discussion with the supervisor on the findings and results.

4.2 RESPONDENTS' PROFILES

The 14 interviewees, who participated in this study, had diverse job experience in various IT based companies. Following are the profiles of their job experience;

1. Program Manager at a Telecom Company in Sydney; who also owns a small consultancy company where the two Business Analysts are present in Sydney and rest

² http://www.qsrinternational.com/products_nvivo.aspx

of the development team is in India. The Interviewee had 20 years of working experience in Software industry in Sydney and has managed various Service Oriented Projects.

2. Independent ICT consultant in a large organization; also having past experience of working as Project Manager, Senior Business Analyst and Developer.
3. Business Architect; having over 10 years of experience working in Software industry as a Programmer, Business Process Analyst, Business Analyst, and IT Consultant. Currently the focus of his work is on integrated context-aware adaptive cloud computing environments (e.g. integrated cloud, social networks, mobile computing) for e-Government and e-Business Solutions.
4. SOA integration specialist; who has worked on 4 SOA based projects in Canada.
5. Systems Engineering Manager; Director of a Systems Engineering and Safety Management Consulting Company.
6. Senior Equity Trading System Development Architect; having experience of building low level mission critical, fault tolerant systems as well as web n-tier based enterprise systems using Service Oriented Architecture based design patterns in finance, telecommunications, retail industries, research organizations.
7. Director of IT Consultancy company in Sydney; has over 20 years of experience in the IT industry, in Australia and the UK. The interviewee worked in sales and delivery, focusing specifically on SOA-related activities.
8. Business Analyst at IT based company providing solutions to Educational Sector; experience of working on multiple SOA related projects in UK and Australia.

9. Knowledge Engineer and Interim CTO (Chief Technology Officer), Coach, consultant and trainer in agile development, IT Leadership, project management, business analysis and business process improvement.
10. SOA Service Design Team Lead and Integration Architect/ Lead SOA Service Designer with more than 15 years of experience as Solution Architect, Designer and Developer.
11. Product Delivery Manager, Managing development team, ensuring delivery of software product in an agile and lean manner, grow and directing the team to be more efficient and self-running.
12. Director of IT Consultancy Company in Sydney, with experience of Enterprise Architect, J2EE Manager and Senior Java Architect.
13. Developer in IT based company in Sydney for the last two years; mainly responsible for the detailed designed and implementation of the projects and does not have direct influence on the decisions related to the RE phase but works alongside with business analysts in the team to provide guidance on the technical feasibility of the system requirements.
14. Business Analyst in IT based company in Sydney with seven years of experience of working on SOA based projects.

4.3 Results

In the following, the aggregated results are presented that emerged after analysis with respect to the challenges of SORE as given in Table 2. After discussing the results a comparison is presented of the three studies carried out during problem analysis phase.

4.3.1 Alignment of business requirements and services

The main difference between SORE and traditional RE is the additional task for a business analyst to align service descriptions with business requirements. The interviewees confirmed that the alignment of business requirements and services was considered to be the most challenging activity in SORE. For the correct alignment of requirements and business processes to services it is necessary to fully understand the level of abstraction and granularity of services. The respondents pointed out that this issue is not new to service oriented domain (as claimed in most of the literature on SORE) and is also faced during component based software development but does get exacerbated in service oriented domain due to the fact that the services are developed free of context so they can be used in multiple projects.

A deeper analysis of the responses for this challenge showed that most of the reasons behind this activity being challenging are those that are also present in traditional RE i.e. incomplete and ambiguous requirements, communication problems with stakeholders etc. Lack of human centred approaches and ignoring the real users in SOSD makes this task more challenging due to the software being developed from the third party services and hence the inherent difficulty in involving the users in development lifecycle.

In the literature review and survey, the challenges were considered equal and on the same level of abstract. However, it was pointed out by the practitioners that the other four challenges of SORE (i.e. Knowledge Management, Non-Functional Requirements, Requirement Change Management, and Iterative Discovery) are in fact part of the alignment process on a different level of abstraction. Alignment is not merely a service selection; it is an iterative process for discovering services by evaluating both functional and non-functional of the service against customer requirements. Increased level of knowledge is necessary for better

alignment of services making informed analysis and decisions. And if either the customer requirements or the selected service is changed, to manage the change the re-alignment is carried out.

4.3.2 Knowledge Management

KM requires organizational strategy for identifying, acquiring, storing, and sharing the knowledge to improve the business and benefit to the organization. The interviewees pointed out that it is critical for the service oriented projects to take initiatives for implementing a well-defined KM strategy to meet demands of dynamic market conditions where there is inevitable change in technology and human resource. In the last 20 years many methods, tools and techniques for KM have been proposed in the research literature. All the interviewees confirmed they use knowledge management tools to assist them in various activities of software development managing and sharing requirements' documentations and artefacts with the team members. Different tools are being used for this purpose e.g. JIRA, SharePoint, Google docs and wikis. Only two respondents mentioned having a clear organization level strategy for knowledge management. Others considered it as an overhead for the development team. The respondents described the benefits of using knowledge management strategy for SORE. KM strategies are considered to be helpful in:

- *alignment of requirements and services and vice versa*
- *re-usability of services and business processes*
- *requirement change management (keeping track of versions, impact analysis)*
- *gap-analysis*
- *document management*
- *sharing experiences and lessons learned from previous projects*
- *project management and scheduling*

- *better understanding of people, process and product related to the project*

All these benefits come with the challenges of implementing a KM practice along with software development. According to the respondents, for small organizations KM brings overhead for the development team in terms of knowledge codification efforts. The respondents referred to it as: *“tedious hard work consuming a whole day for filling up various data forms”*. For the development team, there seems to be a need for great deal of visible effort for invisible benefits. The organizations have to keep track of the Knowledge Base (KB), and specialized personnel are needed for that purpose, whose task is to make sure that the KB is up to date. The identified challenges by the respondents in this category are;

- *time, cost and effort is required for implementation of a knowledge management strategy*
- *the benefits are visible after some times and for the technical members of the team it is overhead*
- *managing the knowledge base to keep it tidy and maintained*

According to the overall analysis of our results, all of the above stated benefits are those that are achieved by integrating knowledge management activity in any software development methodology and are not specific to SOSD.

4.3.3 Iterative service discovery process

According to the practitioners they do follow the iterative service discovery process for carrying out the alignment of requirements and services. The process is mostly carried out with the help of agile methodology. It helps the development team to increase their understanding of clients' business requirements (both functional and non-functional), and of available services. This understanding is necessary for a better alignment of services to the requirements.

The respondents pointed out some concerns that arise with the iterative process. If the development team is using services within their organization, then they already know about the possible solutions. In the iterative process, service providers try to encourage and coerce the customers into accepting the available services by presenting them as prototypes. By this strategy they enforce the alignment of services and requirements.

4.3.4 Non-functional requirements

According to the interviewees, NFR play a crucial role during alignment of business requirements and services for trade-off analysis and service selection. The respondents have considered elicitation and implementations of NFR more challenging in SOSD due to various reasons, e.g. Context independent development of services, lack of trust on third party software.

4.3.5 Requirements change management

One of the promised benefits of service orientation is to have loosely coupled services integrated in such a way that it would make it easy to implement a change in the system. According to the respondents the technological changes are easier to implement in service oriented software projects. Substituting a service with another in a system is technically easy. The challenging part is the analysis of the impacts of change on the system. The practitioners are using the same techniques and methods in service oriented projects as used for change management in traditional software development. The real challenge in implementing a change in service oriented systems is the modification of the functionality within a service especially when a service is being used by multiple users in multiple contexts.

4.4 Comparison of the three studies

The analysis of the results of our survey and interviews reveals some insights about the challenges of SORE from the industry's perspective. First, though most of the challenges identified in the research literature also exist in the practice of SORE but they are not explicitly caused by the service oriented development as claimed in the literature. These challenges are all the same as RE for traditional and component based software development (See Table 4).

Sr#	Literature Review	Online Survey	Interviews Study
1	Alignment of business requirements and services	Yes	Challenging but same as faced during RE in CBSD
2	Integration of KM strategy to SOSD life cycle	Yes	Same as using KM tools in any SE development methodology, helpful in alignment process
3	Iterative Discovery Process	Yes	Part of alignment process
4	Requirement Change and Evolution	Yes	The process is same as traditional RCM, Part of alignment process
5	NFR gathering and Assessment	Yes	Part of alignment process
6	Semantic gaps in specifications	Not challenging	
7	Service Testing	Not challenging	
8	Service Dependency Discovery	Not challenging	
9	Lack of standard RE process for SOSD	Not challenging	
10	High Level Language/Tool Support	Not challenging	
11	Not mentioned	Not mentioned	Lack of human centred approaches
12	Not mentioned	Not mentioned	Lack of common understanding of service oriented concepts by researchers and practitioners

Table 4 Comparison of results in Literature Review, Survey and Interviews

Second, the research community has provided different solutions to these challenges but most of them have not been applied in industry. Like other fields of software engineering, SORE

also suffers from a significant gap between the research and practice. Any research that cannot be applied and be aligned to the objectives, goals and strategies of the current industrial practices would be of limited use (Davis and Hickey 2002). Table 4 is the result of our comparison of the findings from Literature review, survey and the interviews to highlight the existing gap in the research and practice of SORE. This will help the research community of SORE to identify and understand the ‘real’ industry problems and provide solutions for them, rather than working on invalidated designs and continue producing research artefacts without real industrial evaluation and feedback.

Third, the respondents expressed that the real problem is with gathering requirements from clients and customers regardless of whether or not the project would be service oriented. Over the last ten years improvements have been made as a result of research in technologies and standard protocols for network infrastructure to support distributed development and deployment of services. But the research community has largely ignored the related social aspects of SORE. The respondent informed us that in practice the actual users of the service are not considered during the development process. In most cases, a customer representative or a subject matter expert is carefully selected to join the development team to provide feedback. This results in user dissatisfaction and sometimes in project failure. Most of the problems in RE (whether service oriented or not) are caused due to inadequate requirements and the dissatisfaction of customers with the end product.

The results indicate that for practitioners the alignment of requirements and services is the top challenge of SORE and other challenges as part of this top challenge. The last question of problem phase was **RQ1.4: What are the reasons for the top challenges of Service Oriented Requirements Engineering?**

In order to answer RQ1.4, the reasons presented in the responses of the interviewees for the top challenge were aggregated. Alignment of requirements to services is considered to be the most challenging and problematic task in SORE due to the following reasons:

Lack of Context: The services are designed and developed free of context to target the needs of larger group of customers. It is sometimes challenging to align the context free services, to the requirements of a project, which has a specific contextual details attach to it.

Missing Information: The specifications published by the service providers may not provide all the information that is required by the analysts to make the decision for its selection.

Mismatch in the Level of Abstraction: Service specifications may not be providing the information and the details about its functionalities at the same level of abstraction as the requirements.

Mismatch in the Level of Granularity: Service granularity refers to the range of functionalities offered by the service. Services can either be fine-grained (focused, limited functionality) or coarse-grained (broader functionality). Fine granularity offers more flexibility and reusability in customizing the system but also results in increasing the effort and cost of integration. A coarse-grained service is typically expected to carry out more functions but would also exchange more messages and data. This reduces the reusability as the functionality might be too overloaded for the actual need of most consumers.

Paradox of choice: Over the past few years the number of online services has increased exponentially. The analysts now face the problem of ‘over choice’

while selecting a service from a huge number of available options that offer more or less similar functionalities. With situations where hundreds of alternative choices are available, the decision making for service selection becomes very difficult.

4.5 Reflections on findings

After the analysis of interviews, the three step exploratory research has culminated in the following points:

1. Clear understanding and implementation of SOSD methodologies seems to be lacking in research and practice.
2. Many of the challenges reported in the literature are not considered important by the practitioners working in the industry.
3. The challenges of service oriented RE are not significantly different in their nature from those present in RE for traditional software development and component-based development.
4. The most focused aspect of the SOSD by researcher is the technical considerations, whereas the practitioners appeared to be more concerned about the challenges caused by the social factors.
5. The alignment of business requirements and services is the most challenging part and the success of the resultant system depends on the accurate of decision for service selection.

Technical perspective of any issue is just a single view of a multifaceted problem. According to (Mitroff & Linstone 1995), every problem has three perspectives which are interlinked:

Technical, Organizational or Social, and Personal or individual. Based on the results from our interview study, the issue of alignment of requirements and services can be classified in these three aspects as following:

- Technical aspect: where the main concerns especially for developers, are related to the tools, techniques, methods and processes that can help in achieving the objectives.
- Organizational aspect: This focuses on policies and decisions that give directions for achieving objectives. The role of the project manager is to deal with this aspect throughout software development lifecycle.
- Individual aspect: which would focus on the customers/clients and the social and psychological factors that would help them understand the business dynamics for achieving their objective. Business/Requirements analysts and consultants are more focused on this aspect in early phases of development.

It is important that the decision and acceptance of selection should consider the value of the service to its users. The focus of research in this field has been largely on technological aspect of service orientation. But equally important is the acceptance of the solutions provided to users developed under this paradigm.

PART I: SUMMARY

Part I of the thesis was based on the following goal of the research strategy:

Research Goal 1: Explore and define the problem and scope of the research by investigating both theory and practice in service oriented requirements engineering.

To achieve Research Goal 1, this phase was guided by the following main research question:

RQ1. What are the challenges of Service Oriented Requirements Engineering?

This question was further divided into four parts. The answers to these questions provides the summary to the entire first phase.

RQ1.1: What are the challenges of Service Oriented Requirements Engineering reported in published literature?

- 1 *Integration of Knowledge Management strategy to SOSD life cycle*
- 2 *Non-functional Requirements gathering and assessment*
- 3 *Iterative service discovery Process*
- 4 *Alignment of business requirements and services*
- 5 *Requirement Change Management*
- 6 *Lack of standard RE Process*
- 7 *Testing service oriented systems*
- 8 *Semantic gaps in specifications*
- 9 *Automated dependency discovery*
- 10 *High Level Language Support*

RQ1.2: What are the challenges of Service Oriented Requirements Engineering considered important by the practitioners working on Service Oriented projects?

- 1 *Alignment of business requirements and services*
- 2 *Integration of Knowledge Management strategy to SOSD life cycle*
- 3 *Iterative service discovery Process*
- 4 *Requirements Change Management*
- 5 *Non Functional Requirements gathering and assessment*

RQ1.3: What is the most important issue and challenge of Service Oriented Requirements Engineering?

Answer: Alignment of Requirements and Services is considered by the practitioners as top issue of SORE. The other four issues (in table 2) are considered as being embedded in and part of the alignment process.

RQ1.4: What are the reasons for the top issue and challenges of Service Oriented Requirements Engineering?

Answer: Alignment of requirements to services is considered to be the most challenging and problematic task in SORE due to the following reasons:

- *Lack of Context*
- *Missing Information*
- *Mismatch in the Level of Abstraction*
- *Mismatch in the Level of Granularity*
- *Paradox of choice*

Service Oriented software development has offered a way for the developers to reuse existing software services to build systems while reducing the time and cost of development. In the Service Oriented Requirements Engineering (SORE) there is an additional task of alignment of requirements and services in order to find the best matched service to the requirements of

the stakeholders while making a trade-off between cost, functional and non-functional requirements.

Service selection is an important decision making process that effects the outcome of the resulting system. Various solutions proposed for selection of services (e.g. model based transformation (Gehlert, Bramsiepe & Pohl 2008), iterative process (Zachos, Maiden & Howells-Morris 2008), and granularity analysis (Heinrich et al. 2011; Kulkarni & Dwivedi 2008; Steghuis 2006)), but they mainly focus on the technical side of the problem of alignment and do not provide satisfactory solutions to the challenge of alignment described above. Technical solutions are only one part of the multifaceted problem of service selection. Technology plays an important role in providing solutions but it is equally important to take into account the acceptance of a solution by the people who will ultimately use the resulting system. Without customers' satisfaction a system may not succeed, no matter how well the technology was utilized.

Limitations of the studies in Part I

This section discusses the limitations in the design and conduct of the studies carried out in problem analysis phase which can have potential impact on the outcomes and interpretations of the results.

First, the literature review was conducted in 2010, and by the time I was writing the thesis (2014), other challenges in SORE may have surfaced that would have been missed in my review. I have updated the literature review during the thesis writing but I did not necessarily focus on identifying additional challenges. Hence the initial list of challenges remained those as analysed in 2010. However, these challenges were still considered important by other

researchers in last five years as well. Therefore my work still stand in harmony with the recent literature in SOSE.

Second, regarding the design and conduct of the online survey, there is a threat to the validity due to sampling procedure which like any other online surveys (Kitchenham & Pfleeger 2002), it is subjected to self-selection bias due to the fact that there was a non-probabilistic and convenient sampling. To ensure construct validity I carried out a pilot testing of the initial survey design with 20 responses received. This helped in improving the questionnaire instrument. The survey provided only surface level agreement of the practitioners and lacked contextual details. For external validity, the results of the survey were used for qualitative interview study in order to gain deeper insights.

Third, the interviews were conducted with practitioners in various software companies in Sydney which may limit the scope and the context of the results. However, this threat was mitigated by having participants with broad levels of industry experience. To ensure the construct validity of the interview design, I carried out four interviews (two with faculty members at UTS and two with practitioners) as pilot study before actual interview study, to familiarize myself with the current industrial terms, improve my questioning techniques, and learning how to analyse the transcripts of the interviews. Also considering the fact that the interview study was the third step of problem analysis, therefore the results are at the end compared with those from literature review and survey to create a complete picture from the mix method research strategy in part I.

In next section, I explore the concept of user involvement and propose a method that utilizes using this concept. The objective of the method is to help analysts in dealing with the challenges of alignment of requirements and services by exploiting the benefits of the user involvement.

PART II

PROPOSED SOLUTION

PART II: PROPOSED SOLUTION

In Part I, it was reported that the practitioners considered alignment of requirements and services the most challenging part of SORE. The interview study revealed that the practitioners face more human related challenges in the alignment of requirements and services. This motivates a need for a new method of alignment that can provide a user centred solution to help analysts in overcoming challenges of alignment in SORE.

In this Part, I explore the concept of user involvement in the alignment process by conducting a systematic literature review of the existing empirical literature on the topic of user involvement in software development.

“Users’ involvement” has been the focus of much research over three decades and has been studied in various disciplines from different perspectives and has been intuitively and axiomatically accepted to play a positive key role in users’ satisfaction and ultimately leading to the system success (Abelein & Paech 2014; Cavaye 1995; He & King 2008; Ives & Olson 1984; Kujala et al. 2005). In service oriented paradigm, active user involvement is needed in order to provide systems that can be customised for individual user needs (Seyff, Graf & Maiden 2010b). Recently online past user feedback and sentiment analysis has gained interest in various areas of software engineering research e.g. Requirements Elicitation (Galvis Carreño & Winbladh 2013; Seyff, Graf & Maiden 2010a, 2010b), Software Evolution (Pagano & Bruegge 2013; Pagano & Maalej 2013), Software Quality (Chen & Liu 2011). Sentiment analysis (opinion mining) is used for calculating and monitoring the attitude and behaviour of the previous users’ feedback, comments and reviews available on the online social media. The

benefits of the past user feedback and sentiment analysis are not being fully utilized in the alignment process of service oriented development.

Utilising the benefits of user involvement, I propose a method that can help analysts in making informed decisions and to overcome the challenges of alignment during service selection. The construction of the proposed method ARISE (Alignment of Requirements and Services) is grounded in the findings and systematic analysis of the literature on the relationship between user involvement and system success. ARISE is designed following Situational Method Engineering guidelines.

Part II consists of chapter 5, a systematic review of the existing literature on user involvement, and chapter 6, proposing the ARISE method that incorporates previous users' feedback into the process of alignment of requirements and services.

CHAPTER 5: SYSTEMATIC LITERATURE REVIEW

In this chapter I present the results of the systematic literature review (SLR) that I conducted to explore the relationship between user involvement and system success (UI-SS). The aim was to gain complete knowledge of the background of the concepts of the UI-SS before proposing them to overcome the challenges of alignment in SORE. The complete results of the analysis of SLR were published in (Bano & Zowghi 2013a, 2013b, 2015). In the SLR I had investigated the concept from various dimensions but in this chapter I will be presenting only those aspects that are relevant to the proposed solution of the thesis. The SLR was conducted following the guidelines of Evidence Based Software Engineering (Kitchenham & Charters 2007). The original protocol developed for the SLR is given in Appendix H. According to the guidelines the researchers are required to give details of the planning and execution process of the systematic review in order to show the rigor of the review and make the results reliable and transparent. These two phases of the SLR are presented in full details in Appendix C. In this chapter only the findings from the SLR to answer RQ 2.1, 2.2 and 2.3 are presented.

5.1 Background of UI-SS relationship

Since the late 70s, it is believed that user involvement in system development ensures system success (Abelein & Paech 2014; Cavaye 1995; He & King 2008; Ives & Olson 1984). The idea can be traced to organizational management research, including group problem solving, interpersonal communication and individual motivation. The satisfaction and acceptance of the system by those who will ultimately use it, is considered as a critical success factor for the

project (Clavadetscher 1998; Drew Procaccino et al. 2002; Wagner & Piccoli 2007). There have been numerous studies that have supported this concept e.g. (Cavaye 1995; He & King 2008; Hwang & Thorn 1999; Ives & Olson 1984; Kujala 2003). Users typically have significant knowledge of the application domain, the tasks they perform, work practices, context of the system use and their behaviour and preferences. This form of knowledge is often tacit in nature and thus difficult to be articulated with typical elicitation techniques. User involvement in SDLC facilitates understanding of their work environment and can improve the quality, accuracy and completeness of their requirements (El Emam, Quintin & Madhavji 1996; Ives & Olson 1984; Kujala 2003).

Various methods and techniques have been proposed that provide solutions for effective user involvement. Agile methods (e.g. extreme programming), Joint Application Development (JAD), Effective Technical and Human Interaction with Computer based Systems (ETHICS) are examples of the well-known techniques (Muller, Haslwanter & Dayton 1997). For four decades the researchers were interested to investigate the axiomatic notion of a positive UI-SS relationship (Cavaye 1995; He & King 2008; Hwang & Thorn 1999; Ives & Olson 1984; Kujala 2003). Ives and Olson reviewed 22 empirical studies for the period 1959-1981 (Ives & Olson 1984), Cavaye extended the review of Ives and Olson for the period of 1982-1992 with additional 19 studies (Cavaye 1995), He and King analysed 82 empirical studies, for the period 1974-2007 (He & King 2008), Hwang and Thorn performed meta-analysis of 25 empirical studies for the period of 1976-1996 (Hwang & Thorn 1999), Bachore and Zhou synthesized the findings from 46 studies (not all of them are empirical) published during 1977-2008 (Bachore & Zhou 2009).

Although all these researchers have advocated a positive UI-SS relationship but have also pointed out that it is not a simple and direct relationship and various confounding factors are to be considered when evaluating the concepts of user involvement (Barki & Hartwick 1989; Barki & Hartwick 1994b; Cavaye 1995; Ives & Olson 1984; McKeen, Guimaraes & Wetherbe 1994).

“User involvement in software development and system success” is an intricate and labyrinthine combination of four different concepts that need to be analysed separately in their individual and distinctive definitions for better understanding.

First, the concepts related to the term “Users”, are not considered harmoniously in all the empirical studies (Iivari, Isomäki & Pekkola 2010). Users play various types of roles in organization. The typical understanding of a user is someone who would be actually using the system and her/his work and environment in some way would be affected by the system. But defining the “user” for a project depends on the participatory methods and techniques adopted during the project. For example, Participatory Design (PD) community defines users as *“the operational workers who are affected by the system, this does not include the manager”*, but in Joint Application Development (JAD), users are *“any non IS/non-technical individuals in the organization who are affected by the system, this includes managers”* (Carmel, Whitaker & George 1993).

Second, “Involvement” is used inconsistently in literature as a synonym for “participation” and “engagement”. The first clear distinction between user involvement and user participation was given by Barki and Hartwick (Barki & Hartwick 1989). They defined user involvement as *“a subjective psychological state reflecting the importance and personal relevance of a system to the user”* and user participation *“a set of behaviors or activities performed by users in the*

system development process". Therefore it is not necessary that the users who are involved in the project should also participate and perform activities. Whereas, "user engagement" has been used synonymously in the literature as an additional term to both the concepts of involvement and participation (Hwang & Thorn 1999).

Third, "Software Development" is a life cycle that comprises of various phases, includes many activities and is affected by various dynamic and progressive factors such as methodologies used, application domains where software will be situated, and technological changes (Cavaye 1995). It is widely believed that involving users during early phases of development like requirements elicitation contributes most to accurately capturing their needs (El Emam, Quintin & Madhavji 1996; Kujala 2003). But it is also important to involve users in other stages of the SDLC, such as design and testing, when these requirements are transformed into technical solutions (Carmel, Whitaker & George 1993). In different phases of SDLC various types and levels of participation of users are required. For example, senior management may be required to be involved throughout development, and middle management and other employees (such as Subject Matter Experts), would be required for their contribution during problem identification, requirements elicitation, design and testing (Cavaye 1995). Uncertainty of project, type of system and project complexity are important contributors that determine the phases of SDLC for user involvement, the required level and degree of involvement and the types of activities they carry out in each phase (Kim & Lee 1986).

Fourth, defining and exactly measuring "System Success" is not addressed uniformly in the literature. Among the popular factors used for this measurement are users' acceptance and satisfaction with the system (DeLone & McLean 1992), which are highly contextual and situational.

With such a multi-faceted UI-SS relationship, the objective of my review is to find out how many of the empirical studies report positive impact of user involvement on system success. The SLR was exploratory in nature. The aim was to find all the empirical papers published from 1980 to 2012 that investigated and evaluated user involvement in software and system development. During planning phase of our SLR, with the help of a pilot study I developed 9 questions for exploration (Bano & Zowghi 2015), but in this chapter I will report results for the following three research questions only:

RQ2.1: Is there any relationship between user involvement and successful software systems?

RQ2.2: What are the benefits of user involvement in Software Development Lifecycle?

RQ2.3: Is user involvement beneficial in Requirements Engineering?

The SLR resulted in 87 studies for the period of 1980-2012. Appendix C gives the details of SLR planning and execution. In the following section the answers to the research questions analysed from the resulting empirical studies.

5.2 Results from Systematic Literature Review

RQ 2.1: Is there any relationship between user involvement and the successful software systems?

To answer RQ2.1, I analysed the findings of all the 87 studies to extract their outcome of UI-SS relationship investigation. I chose to provide a higher level picture of UI-SS relationship to answer RQ2.1 rather than going into the details of how the users were involved in those studies or how the system success was measured. These details are considered out of scope of the thesis topic and are presented in full details in (Bano & Zowghi 2015). On a higher

abstraction level, there were three types of findings from the empirical studies about UI-SS relationship:

1. *Positive*: indicates that user involvement positively contributes to system success
2. *Negative*: indicates that user involvement causes problems in software development to such an extent that may hinder system success
3. *Uncertain*: it cannot be determined that user involvement contributes to or hinders system success

To give a more comprehensive picture of the results obtained, the frequencies are further mapped against research methodology adopted to obtain results, and the decades to which that publication belongs.

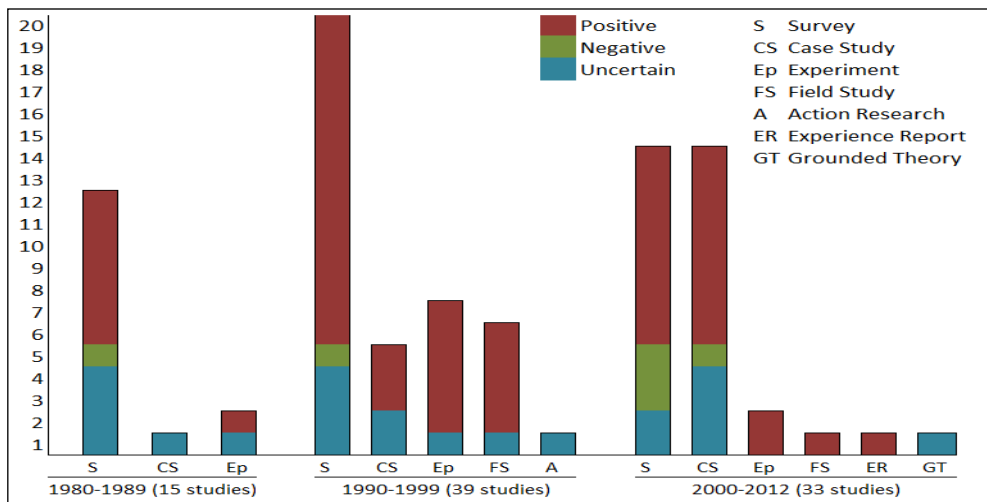


Figure 8 Relationship of users' involvement and system success

Fig 8 shows the breakdown of the frequencies of the results. Out of 87 studies retrieved in systematic review, 59 show positive impact of users' involvement on system success and they make up 68% of the results. 7 studies are reporting negative results whereas 21 are uncertain on the issue. Out of 59 papers showing positive results, 31 used survey research method,

which is almost 53% of the positive results. Analysing the detailed breakup shows that from 1990s onwards, the research is showing more positive results. But during the first period, the trend was different. Overall, the results of the SLR have shown positive impact of user involvement on system success. 32% studies have shown negative or uncertain results. This variation are due to the fact that data was collected at different stages of SDLC, organisations were of different sizes, projects were developing different types of systems, could have had varying degree of complexity and the software development methodologies were varied.

RQ 2.2: What are the benefits of user involvement in Software Development Lifecycle?

During the extraction of the list of benefits of user involvement it was found that they were considered from different perspective by the researchers. Obviously, the focus of all the studies was to achieve system success by involving users. What exactly was meant by “system success” was highly contextual to the empirical study. “User satisfaction” is the most widely used alternative to measure system success in the majority of empirical studies.

I began by extracting the list of benefits because most authors were using benefits as criteria for determining system success. Creating a flat list of all the extracted benefits of user involvement revealed that these benefits are perceived from different points of view. For example, some researchers were only interested in the psychological stance of this benefit as perceived by the users who are involved while others were focusing on managerial or methodological aspects. This led to the conclusion that there are multiple views of benefits, problems, and challenges of the UI-SS relationship. I further developed a classification of these views and attitudes to use in analysis and referred to them as “perspectives” with the help of thematic coding and analysis techniques (Krippendorff 2012) from the relevant coded text. The details of the thematic analysis are given in detail in (Bano and Zowghi 2015) and

are briefly described in Appendix C. These names are the most commonly used phrases from the literature that describe the relevant positions or views of user involvement. Table 5 summarizes all the benefits of user involvement from all five perspectives as discussed in this section.

Benefits of user involvement	
Benefits from Psychological Perspective	• User system satisfaction • User system acceptance • Facilitating change • Better user's attitude towards system • Increasing perceived relevance to the system by users • Increasing user motivation • Increasing customer loyalty • Assist in maintaining long term relationship with users
Benefits from Managerial Perspective	• Better Communication • Improved Management Practice • Developing realistic expectation • Reducing cost of the system • Helping in conflict resolution
Benefits from Cultural Perspective	• Increased system usage • Facilitating knowledge sharing • Improving user's skills
Benefit from Political Perspective	• Democracy in workplace
Benefits from Methodological Perspective	• Better understanding of user requirements • Improving quality of resultant application • Improving quality of design decisions • Helping in overcoming in implementation failure

Table 5 Benefits of user involvement from SLR

1) Psychological perspective

One of the main factors in defining system success is users' satisfaction, i.e. considering a psychological state that comes when users perceive that they have control over the system development process (Barki & Hartwick 1989). Therefore involvement (where users may not be participating or engaged) actually gives users' satisfaction by their sense of control. The other psychological factors that play a role in user involvement are their *willingness to participate*, their *capability which ultimately impacts their interest*, and their *characteristics and attitudes* (Cavaye 1995). From our analysis, following list of benefits of user involvement from psychological point of view were reported in the literature:

- User satisfaction: Users will favour a system more if they are involved in its development and feel satisfied with using it (Amoako-Gyampah & White 1993; Bakalova & Daneva 2011; Barki & Hartwick 1994a; Barki & Huff 1990; Baroudi, Olson & Ives 1986; Doll & Torkzadeh 1990; El Emam, Quintin & Madhavji 1996; Foster Jr & Franz 1999; Hawk & Dos Santos 1991; Heiskari & Lehtola 2009; Hunton 1996a; Jarvenpaa & Ives 1991; Lawrence & Low 1993; Leonard-Barton & Sinha 1993; Olson & Ives 1982; Palanisamy & Sushil 2001a; Palanisamy & Sushil 2001b; Rondeau, Vonderembse & Ragu-Nathan 2002; Steinbart & Accola 1994; Vadapalli & Mone 2000; Yoon, Guimaraes & O'Neal 1995)
- User system acceptance: Users approve that the system is developed according to their workplace needs and requirements (Doll & Torkzadeh 1990; Doll & Torkzadeh 1989, 1991; El Emam, Quintin & Madhavji 1996; Foster Jr & Franz 1999; Robey & Farrow 1982; Torkzadeh & Doll 1994; Wagner & Newell 2007; Wu & Marakas 2006)

- Facilitating change: Involved users will not resist using a new system in their work environment (Franz & Robey 1986; Hunton 1996a, 1996b; Igbaria & Guimaraes 1994; Wastell & Sowards 1995)
- Better users' attitude towards system: Involved users will show positive attitude when using the system (Franz & Robey 1986; Hunton 1996a, 1996b; Igbaria & Guimaraes 1994; Wastell & Sowards 1995)
- Increased perceived relevance to the system by users: Involved users considered themselves more informed about the system and think that the system is relevant (Igbaria & Guimaraes 1994)
- Increasing users' motivations: Involved users will be more motivated to use the system (Rondeau, Vonderembse & Ragu-Nathan 2002)
- Increasing customers' loyalty: Involved users will have higher degree of trust in the development team (Heiskari & Lehtola 2009)
- Assisting in maintaining long term relationship with users: Involved users will have more interaction with the development team. This helps maintain long term relationships between users/ customers and development team (Heiskari & Lehtola 2009)

2) Managerial perspective

The users are not to be merely involved, their involvement and participation has to be properly managed to achieve the desired results of bringing about system success. The focus of management is the identification of users or their representatives, selecting a method or technique for their “effective” involvement, and managing their participation in the required activities to ensure the achievements of objectives (Wagner & Piccoli 2007). Managers have

to take into account who should be involved in what stages of development, the allocation of financial resources needed, and to ensure higher level of management commitment and support (Wagner & Piccoli 2007). From analysis, following list of benefits of user involvement from managerial point of view were reported in the literature:

- Better communication: User involvement will lead to increase in interaction between users and development team and will facilitate more effective communication (Foster Jr & Franz 1998; Hartwick & Barki 2001; Howcroft & Wilson 2003; Igarria & Guimaraes 1994; Korkala, Pikkarainen & Conboy 2009; Niès & Pelayo 2010)
- Improved management practice: By involving the users in the development, the management will face less resistance by giving the users sense of dignity of knowing that they are important for the system (Meador, Guyote & Keen 1984; Rondeau, Vonderembse & Ragu-Nathan 2002)
- Developing realistic expectation: Users will have a more informed idea of the features of the system being developed (Baronas & Louis 1988; Bjerknes & Bratteteig 1995)
- Reducing cost of the system: Decreasing the risk of too many changes after implementation by involving users in the project (Hawk & Dos Santos 1991; Robey & Farrow 1982)
- Helping in conflict resolution: User involvement can help resolve disagreements that may arise between users and developing teams (Baronas & Louis 1988)

3) Political perspective

The degree of power given to users during their project involvement will undoubtedly determine their extent and degree of influence on the outcome of the project. The level and degree of involvement can be affected by organizational or political influence especially when

it comes to power of decision-making and implementing changes. There can be potential conflicts between users and the development team and it is imperative that conflict resolution strategies are available when this occurs. Following benefit of user involvement from political point of view is reported in the literature:

- Democracy of workplace: Giving users the ability to influence decisions and give them sense of empowerment so that they feel the ownership of the system and have a sense of control over the development process (Bjerknes & Bratteteig 1995; Choe 1998; Iivari 2006; Jarvenpaa & Ives 1991; Kautz 2010; Kujala 1 2008; Rondeau, Vonderembse & Ragu-Nathan 2002)

4) Cultural perspective

Although the findings from SLR reveal that the concept of culture has not been studied as widely and as frequently as other factors but it remains as one of the effective perspectives that needs to be addressed in user involvement. The overall purpose of user involvement can be different when linked to different cultural contexts, be it national, organisational or project cultures. Organizational culture influences the consideration of why and how to involve users. The two most famous cultural based practices are Scandinavian Participatory Design with strong Marxist flavour and American Joint Application Development (Carmel, Whitaker & George 1993; Iivari 2004; Kujala 2003). The benefits of user involvement from cultural perspective are reported as following:

- Increased system usage: Having the sense of involvement will help in the increase system usage in the workplace environment (Barki & Hartwick 1994a; Barki & Huff 1990; Baroudi, Olson & Ives 1986; Doll & Torkzadeh 1990; Foster Jr & Franz 1998;

Franz & Robey 1986; Gould & Lewis 1985; Hartwick & Barki 1994; Igarria & Guimaraes 1994; Kim & Lee 1986; King & Rodriguez 1981; Olson & Ives 1981; Palanisamy & Sushil 2001b; Yoon, Guimaraes & O'Neal 1995)

- Facilitating knowledge sharing: Learning from users about their work place practices, domain, organization and teaching them about the system being developed (Amoako-Gyampah & White 1993; Bjerknes & Bratteteig 1995; Franz & Robey 1986; Heinbokel et al. 1996; Howcroft & Wilson 2003; Lin & Shao 2000; McKeen & Guimaraes 1997; Pekkola, Kaarilahti & Pohjola 2006; Saleem 1996; Wilson et al. 1997)
- Improving users' skill: Training the users for system utilization (Doll & Torkzadeh 1990; Doll & Torkzadeh 1989, 1991; Steinbart & Accola 1994)

5) Methodological perspective

The main factor for selection of particular method for user involvement depends on the intensity of involvement required in the software development process. Other factors that play a role in this selection are varying degrees of project complexity, and available technological resources (Cavaye 1995). For informative role (where users only provide information related to the end product), interviews, focus groups, and surveys can be used. For participative role (where users are performing activities during development and have some power to influence decision making), agile methods, and Participatory Design techniques can be used. For consultative role (where users have to provide feedback or reviews), meetings can be arranged (Damodaran 1996). Muller et. al. (Muller, Haslwanter & Dayton 1997) has provided the taxonomy for 61 participatory practices encompassing various stages of SDLC. According to Cavaye (Cavaye 1995), what makes us chose one method or technique over others depends on

what is referred to as the underlying philosophy for user participation such as functionalist versus the neo-humanist paradigm (Cavaye 1995). Following benefit of user involvement from methodological point of view is reported in the literature:

- Better understanding of users' requirements: Eliciting more accurate requirements from the users of the systems (Amoako-Gyampah & White 1993; Brodbeck 2001; Choe 1998; Doll & Torkzadeh 1990; Doll & Torkzadeh 1991; El Emam, Quintin & Madhavji 1996; Hanssen & Fægri 2006; Heiskari & Lehtola 2009; Howcroft & Wilson 2003; Hunton 1996a; Kujala et al. 2005; Lin & Shao 2000; McKeen & Guimaraes 1997; McKeen, Guimaraes & Wetherbe 1994; Palanisamy & Sushil 2001a; Pekkola, Kaarilahti & Pohjola 2006; Robey & Farrow 1982; Rondeau, Vonderembse & Ragu-Nathan 2002; Saleem 1996; Sioukas 1995)
- Improving quality of resultant application: By involving the users the non-functional aspects of the system such as functional suitability, reliability, usability, performance, efficiency, compatibility, security, maintainability and portability can be elicited which may not have been expressed explicitly hence improving the quality of the system (Brodbeck 2001; Doll & Torkzadeh 1989; El Emam, Quintin & Madhavji 1996; Foster Jr & Franz 1998; Hawk & Dos Santos 1991; Hunton 1996a; Hunton & Beeler 1997; Leonard-Barton & Sinha 1993; McKeen, Guimaraes & Wetherbe 1994; Olson & Ives 1981, 1982; Palanisamy & Sushil 2001a; Saleem 1996; Sioukas 1995; Torkzadeh & Doll 1994; Wu & Marakas 2006)
- Improving quality of design decisions: Based on the level of users understanding, skills and their workplace environment the decisions for the design of the system will be better informed (Doll & Torkzadeh 1990; Doll & Torkzadeh 1989; Foster Jr & Franz 1998; Hawk & Dos Santos 1991; Jarvenpaa & Ives 1991; Kujala 1 2008;

Palanisamy & Sushil 2001a; Pekkola, Kaarilahti & Pohjola 2006; Torkzadeh & Doll 1994; Wastell & Sowards 1995; Wilson et al. 1997)

- Helping in overcoming in implementation failures: Having the sense of involvement will help in the increase system usage in the workplace environment (Tait & Vessey 1988)

RQ 2.3: Is user involvement beneficial in Requirements Engineering?

User involvement in software development requires resources and careful management. According to various researchers, if the users are effectively involved in early phases of development their involvement may not be required in subsequent phases and hence the time and cost can be reduced. User involvement or participation in one stage of SDLC is said to influence the level of participation in the subsequent stages (Palanisamy & Sushil 2001b). Effective user involvement in early stages of SDLC can be more important and beneficial than other stages (Kujala 1 2008; Kujala et al. 2005), and after effective involvement of users in RE further involvement may not be required in subsequent phases (Wu & Marakas 2006).

Requirements analysis phase is concerned with discovering accurately what the users want from the systems to be developed. But it is difficult to get good quality requirements which are accurate and unambiguous. Giving users a chance to participate in the development is said to improve the quality of the system by providing a complete assessment of users' information requirements (El Emam, Quintin & Madhavji 1996; Kujala 1 2008; Kujala et al. 2005; McKeen & Guimaraes 1997). Users may not be able to articulate their needs about the system explicitly as much of their understanding about their practices and work environment is tacit. With properly managed users' participation, the users would be able to tell if their requirements are correctly translated to the design or implementation phase. The challenges that are faced during users' involvement (e.g. Communication Problems, Misunderstandings,

conflict etc (Gallivan & Keil 2003; Heinbokel et al. 1996)) are mostly those that are to be handled in requirements analysis phase of development. (McKeen & Guimaraes 1997)

User involvement in requirements gathering phase has a positive effect in bringing user satisfaction which leads to system success. Various requirements engineering researchers have investigated the benefits of users involvement from different perspectives (Baresi, Maiden & Sawyer 2008; Castro-Herrera et al. 2008; Dörr et al. 2007; Ghezzi & Tamburrelli 2009; Gibson 2004; Kujala 2003; Kujala et al. 2005; Pagano & Maalej 2013; Robinson 2003; Seyff, Graf & Maiden 2010b; Todoran, Seyff & Glinz 2013; Zachos & Maiden 2008). According to the results of SLR, there is an overall positive impact of users' involvement throughout SDLC on capturing users' accurate requirements.

5.3 User Involvement in Alignment of Requirements and Services

Damodaran has considered user involvement as falling on some point on the continuum from informative, through consultative, to participative (Damodaran 1996). These levels are not restricting the type of involvement or physical presence of the user. On the contrary, the form of involvement basically describes the way in which the users are involved. Damodaran has identified three levels of involvement (Damodaran 1996):

Informative: “users provide and/or receive information. In other words, users are indirectly affecting the system design process, instead of physically participating in the design activities”

Consultative: “users comment on a predefined service or range of facilities. In the context of this article, predefined service or range of facilities are considered as any type of artifact produced or developed during the design process”

Participative: “users influence decisions relating to the whole system. To directly influence the decision-making process of system design, a concrete participation in the design process is assumed. Users are most likely an integrated part of the design team residing in the development organization’s facilities, but most importantly, part of the system design process.”

In consultative and informative roles, the users are required to provide the necessary information that can impact the decision making processes of the system development. In service oriented paradigm, user involvement is needed in order to provide systems that can be customized for individual user needs (Seyff, Graf & Maiden 2010b). Although other users of the service may not be known and available at the time of service based design and development but there is significant amount of feedback, reviews and comments available of individual services on social media, forums and blogs by the previous users of the service.

For service oriented development, the past users of the service can be approached through their ‘voice’ from online resources and their feedback can be analyzed to elicit the require information. If we consider the benefits of user involvement enlisted in Table 5, the benefits from methodological perspective are a catalyst for motivating user feedback in service oriented development process. The other perspectives (i.e. psychological, managerial, cultural, and political) are from the specific view point of a customer who is actually participating in the development process. The knowledge and experience of past users of the service can

provide a valuable source of information for the analysts in requirements engineering activities. This is evident both in literature (section 2.3.1) and in practice (section 4.3.2).

In recent years, there has been a substantial body of research for proposing methods, tools and techniques on collecting and analyzing online past users' feedback, comments and review for extracting useful information (Galvis Carreño & Winbladh 2013; Hao, Li & Chen 2010; Harman, Jia & Zhang 2012; Pagano & Bruegge 2013; Pagano & Maalej 2013; Seyff, Graf & Maiden 2010a, 2010b) (e.g. data mining, information retrieval, crowd sourcing, parsing, sentiment analysis). The user comments and feedback have been major sources of evolution in product line release in case of mobile apps (Chen & Liu 2011; Fu et al. 2013; Galvis Carreño & Winbladh 2013).

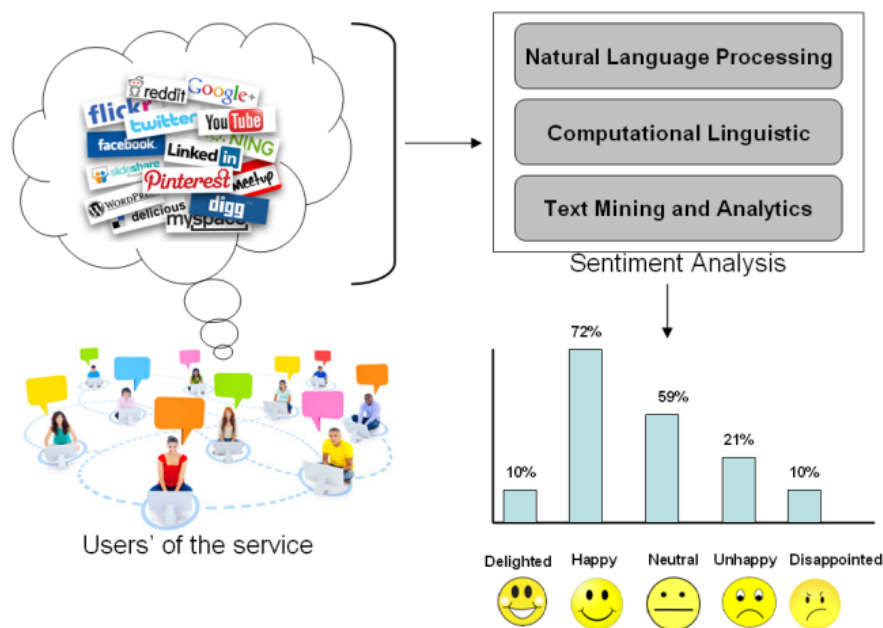


Figure 9 Working of a Sentiment Analysis Tool

Various Sentiment analysis tools (Pang & Lee 2008) are available that are designed using Natural Language Processing, Computational Linguistics, Text mining and analytics capabilities for calculating quantitative values of various users' attitude and behaviour towards

a particular phenomenon or a product by using past user feedback and comments (Figure 9). Generally *“Sentiment analysis (also known as opinion mining) is the field of study that analyses people’s opinions, sentiments, evaluations, appraisals, attitudes, and emotions towards entities such as products, services, organizations, individuals, issues, events, topics, and their attributes (Liu 2012) pp. 7”*.

Past user feedback and sentiment analysis offers the decision-makers the ability to monitor the voice of people in form of their feedback, reviews and comments in order to make more informed decisions. In service oriented domain, past user feedback can serve these purposes:

- *Providing the information about the previous users’ satisfaction based on their past experience of using the service. This will also reflect users’ trust of service provider (if the service is from third party). While analysing past users’ satisfaction it is important to consider the context in which the previous users have used the service. User feedback without context may not be useful at all (Schneider et al. 2010),*
- *User feedback can be used for filling the gaps in service specification where the information is missing against the checklist that is developed in previous steps. Service specification may not be at the same level of abstraction as customer requirements in giving details about functional and non-functional capabilities of service. User feedback can help in identification of missing information in service specification (Pagano & Bruegge 2013).*
- *Overcome challenges of alignment in SORE; The past users’ feedback and sentiment analysis can help the analysts in overcoming the challenges of alignment process by:*
 - *Collecting contextual data based on the previous usage of the service*
 - *Finding and retrieving the missing information in service specification*

- *Comparing the service specification details against the real use of the service to bring the requirements and service specification on the same level of abstraction*
- *Eliciting past users' satisfaction level with the service and the reputation of service providers*
- *Monitor the popularity of a particular service among the users in case of multiple similar choices*
- *Making better informed decisions for service selection*

This provides motivation for proposing a method for Alignment of Requirements and Services (ARISE) which utilises use of past users' feedback, sentiments and comments in the decision making process for the service selection.

5.4 Chapter Summary

The aim of my exploration was to investigate if the concepts of user involvement can be utilized in overcoming challenges of alignment in SORE. User involvement in service oriented requirements engineering through the comments and sentiments of past users of the service can provide an additional source of information that can help in overcoming the challenges of alignment of the requirements and services in SORE (from Part I).

In the next chapter the details of the construction of the proposed ARISE method are presented that incorporates user feedback in the process of alignment.

CHAPTER 6: ARISE (ALIGNMENT OF REQUIREMENTS AND SERVICES)

In the previous chapter, results from the SLR revealed that user involvement in system development and especially in requirements engineering activities has a positive impact on the successful outcome of the system for yielding benefits from multiple perspectives. In service oriented paradigm, the available on online feedback from the past users can provide additional sources of information for the analysts in service selection. Incorporating past user feedback is a form of user involvement that can be applied in the process of alignment. For practical implementation of this idea, this chapter, presents the ARISE method that I have designed using situational method engineering guidelines. This chapter is mainly guided by RQ2.4.

RQ2.4: How can we apply the existing theories of “user involvement” in Service Oriented Requirements Engineering?

6.1 Requirements for a new method

In problem definition phase (Part I) of the thesis it was established that the practitioners considered the alignment of requirements and services as most challenging due to the following reasons:

- Lack of context in service descriptions or specifications
- Incomplete information in service descriptions or specifications
- Misalignment in level of granularity in customer requirements, and service descriptions or specifications

- Misalignment in level of abstraction in customer requirements, and service descriptions or specifications
- Paradox of choice with huge number of services offering similar functionality

The literature review and practitioners responses revealed that human related issues have not received adequate attention in the current solutions to the alignment challenge. In chapter 5, the results of the SLR have shown a positive impact of user involvement in software development (especially during requirements engineering activities) on system success. In service oriented paradigm, in addition to users' involvement during requirements elicitation, the previous users of the services that are under consideration can be involved in the process of alignment in informative or consultative roles through their voice (e.g. feedback, comments, reviews etc.) available from online sources.

From all these observations, the following requirements for a new method emerged:

Method Requirement 1: *The method should provide a mechanism for involving past users experiences with the service during the process of alignment*

Theoretical Justification: Evaluating a service only with the information advertised by the service providers in their repositories or online catalogues, may not always lead to an optimal decision for service selection. Past users of the service have experience and knowledge of the actual working of the service. Their feedback, comments and reviews are a valuable additional source of information for increasing knowledge of the analysts about service functionality besides the advertised service specification or description from the service provider. This information can help analysts in dealing with the challenges of missing information in service descriptions, misalignment in the level of abstraction between customer requirements and service descriptions, popularity and trust of past users on a service.

Method Requirement 2: <i>The method should be flexible to be adopted for different project contexts.</i>
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Theoretical Justification: A specific alignment method may not be applicable to various project contexts and situations. Therefore there is a need for a situational method that can be customized for different types of projects. This motivated me to follow the Situational Method Engineering (SME) guidelines for designing methods in software engineering which are customizable for different projects situations. The proposed solution ARISE method utilises SME approach in its design to make it iterative and flexible. SME provides a systematic and flexible approach to tailor methods for software development activities according to project requirements at run time (Henderson-Sellers & Ralyté 2010).

SME requires availability of a method base (MB) for the project team which is a kind of a lookup table where different methods (method chunks) are listed along with their associated situational factors (when to use them), as well as the required supporting tools or techniques. The MB is dynamic in nature and can grow with the new projects and methods being introduced. According to the project context and situations the suitable method chunks are then selected by following the process guidelines and combined to tailor a method for the project at hand (Brinkkemper, Saeki & Harmsen 1998).

Method Requirement 3: <i>The method should include the steps for granularity analysis of the available services</i>

Method Requirement 4: <i>The method should provide means for dealing with paradox of choice where number of available services to be analysed is huge.</i>
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Theoretical Justification: In any alignment method a service is analysed against customer requirements for various criteria e.g. functionality, quality attributes (delay, reliability, availability etc.), and cost. However with huge number of services on the one hand and multiple criteria from customers on the other, a systematic approach is required for service specification or description evaluation against requirements so that a manageable sample of highly relevant service can be selected for further evaluation. Multi Criteria Decision Analysis (MCDA) provides guidelines for decision making in complex situations where a trade-off is required among multiple criteria (Vetschera 2006). This was the motivation for using MCDA in my proposed method. This approach has been extensively applied and researched in Management Sciences for the selection of suppliers. It helps the analysts in making more informed decisions for service selection based on the perceived relative importance of customer requirements. Typically it involves selection of one choice among multiple available candidate alternatives with the help of a systematic and sound evaluation. Due to the multiple criteria to satisfy in the decision making process, it is only possible to find optimal choice rather than perfect choice. MCDA have been found to be helpful in software engineering for the following reasons (Vetschera 2006):

- With multiple criteria analysis it is possible to involve various stakeholders and customers along with their different needs and requirements and constraints, while prioritizing the value these requirements have for the system
- Aggregating different criteria from different perspectives together for evaluation towards a common objective

6.2 ARISE method

Figure 10 shows the high level view of ARISE (Alignment of Requirement and Services) method. The method takes input of customer requirements, available service specifications, and past user feedback. The analyst uses ARISE to find the optimally aligned service among available options that best fits the customer preferences.

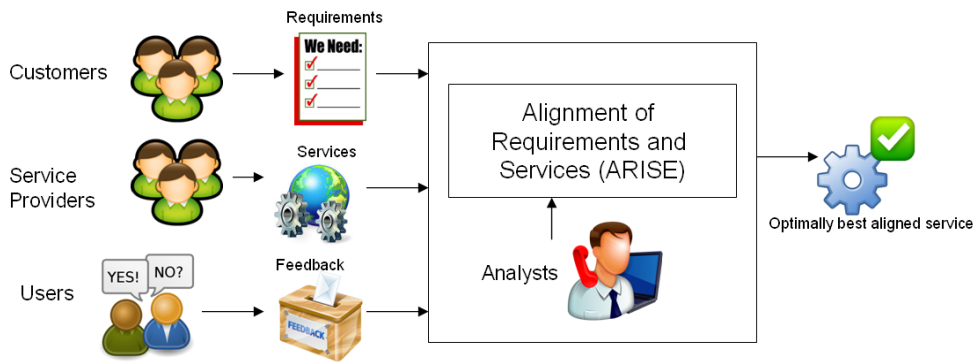


Figure 10 Proposed Method for Alignment of Requirements and Services

The ARISE method involves four different actors in the process of alignment:

Customers: are the project sponsors for whom the service oriented software system is being developed, who have supplied the requirements, and will actually use this system in future. As with any software development projects, the customers in the project participate in various activities like requirements elicitation, modification, and prioritisation based on their preferences

Service Providers: offers the services and advertises specifications or descriptions for the services they provide by publishing them either online or in the relevant organizational repository

Past users: are those who have experience of using a particular service in the past and have either provided feedback on online resources or can provide (post deployment) feedback when requested. This group can include the analysts, developers, designers who have previous experiences of actually using a particular service in software development. Their feedback is either collected from online resources (if available) or elicited directly from the users (if approachable).

Analysts: are those who perform requirements elicitation, requirements prioritization, service searching, service specifications analysis and making decisions for service selection in current project at hand by following the steps of the ARISE method.

The optimally aligned service here is defined as the one that satisfies maximum set of customer requirements (both functional and non-functional) according to their preferences while at the same time has good reputation with the past users.

6.3 Designing ARISE with Situational Method Engineering

There were two main objectives that motivated me to use Situational Method Engineering (SME) guidelines for designing my proposed method:

- 1) To adhere to ISO/IEC 24744 standard for designing software engineering methods.
- 2) To provide flexibility of tailoring the alignment process model according to a particular project situations and contexts.

Method Engineering (ME) focuses on designing, constructing and evaluating methods, tools and techniques by selecting and assembling existing methods called as ‘method fragments’ or ‘method chunks’. The objective is to improve the usefulness of software development methods by proposing a standard where methods are created in consideration with the context of organization and their project ‘situations’. SME is a form of ME applied in specific project situation. One static method cannot be adopted in every project context and hence the SME provides guidelines to tailor methods that are flexible and can be adopted in various project situations. “*Situation*” here is defined as a combination of context and project type (Bucher et. al. 2007). The design of the method requires a method base (MB) support, which stores the knowledge about available methods and their associated tools and the situations for their use. The construction of a method is carried out by

- Analysing the project characteristics to define the situation
- Selecting the method fragments from MB that suits the situation
- Integrating the methods together to create a new method for the specific project

Going into the details of SME constructs and their relationships, is out of the scope of my thesis, they have been thoroughly covered in the SME literature and standards. In this section I will only cover the mapping of ARISE method design to the above mentioned two objectives. SME guidelines recommend a three tiered structure for designing methods (Henderson-Sellers & Ralyté 2010).

- 1) On the top level is the method meta-model that represents the components and rules for constructing instances of methods.
- 2) Second level has a specific instantiation (a method) that is derived from the method meta-model.
- 3) On the third level is an instance of the method with in a specific project situation.

In this chapter the details of the first two levels are presented. Method instantiation is carried out with the help of an observational case study and is presented in chapter 7.

The three tiered structure of my proposed approach is presented in Figure 11 that shows the connection of the three layers. The tiered structure was designed following the SME guidelines (Coulin, Zowghi & Sahraoui 2006; Henderson-Sellers 2002).

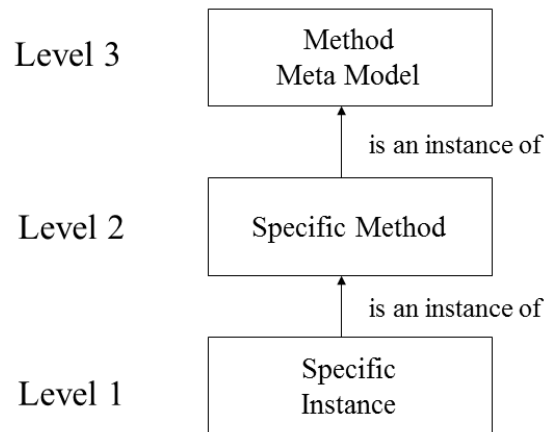


Figure 11 three tiered representation of alignment method

6.3.1 Meta-Model

The meta-model (level 3 in Figure 11) provides guidelines for deriving methods and process models. It consists of meta “types” or “classes”. The meta model for my proposed approach is derived from the three classes of interconnected meta elements in ISO/IEC 24744 standard i.e. Producers, Work Units, Work Products. These three main classes are the standard for developing meta-models of the processes for software engineering (Gonzalez-Perez & Henderson-Sellers 2008). Figure 12 shows the relationship among these three meta classes and Table 6 present the definition as given in ISO/IEC 24744 standard.

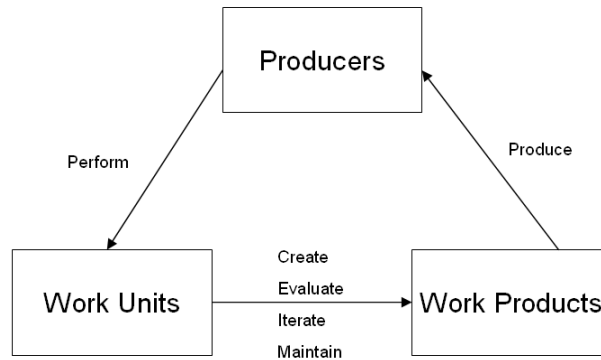


Figure 12 Three interconnected meta-elements

Figure 13 represents the overall meta-model of the previously developed alignment methods (Galster & Bucherer 2008a; Gehlert, Bramsiepe & Pohl 2008; Gu & Lago 2010; Huergo et al. 2014; Zachos, Maiden & Howells-Morris 2008). Figure 14 represent the meta-model of the proposed ARISE method highlighting the extension and enhancement.

Definition of meta classes from ISO/IEC 24744 (Commission 2007) and their sub types	
PRODUCERS	1. <i>Role</i> (a collection of responsibilities that a producer can take), 2. <i>Tool</i> (an instrument that helps another producer to execute its responsibilities in an automated way). 3. <i>Person</i> (allows taking into account individual persons at the endeavor level.)
WORK PRODUCTS	1. <i>SoftwareItem and HardwareItem</i> (a piece of software or hardware, respectively, that is of interest to the endeavour), 2. <i>Model</i> (an abstract representation of some subject that acts as the subject's surrogate for some well-defined purpose) 3. <i>Document</i> (a durable depiction of a fragment of reality) 4. <i>CompositeWorkProduct</i> (an aggregate of other elements)
WORK UNITS	1. <i>Process</i> (large-grained, operating within a given area of expertise) 2. <i>Task</i> (small-grained, focusing on what must be done in order to achieve a given purpose) 3. <i>Technique</i> (small-grained, focusing on how the given purpose may be achieved).

Table 6 ISO/IEC 24744 standard Meta Classes

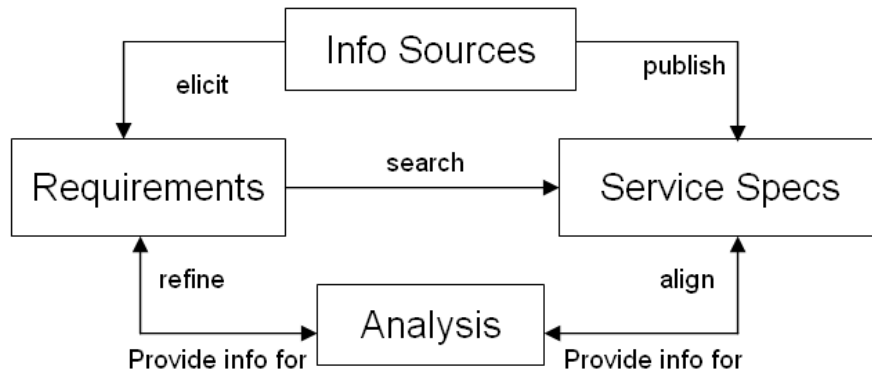


Figure 13 The Meta Model of alignment method of existing approaches

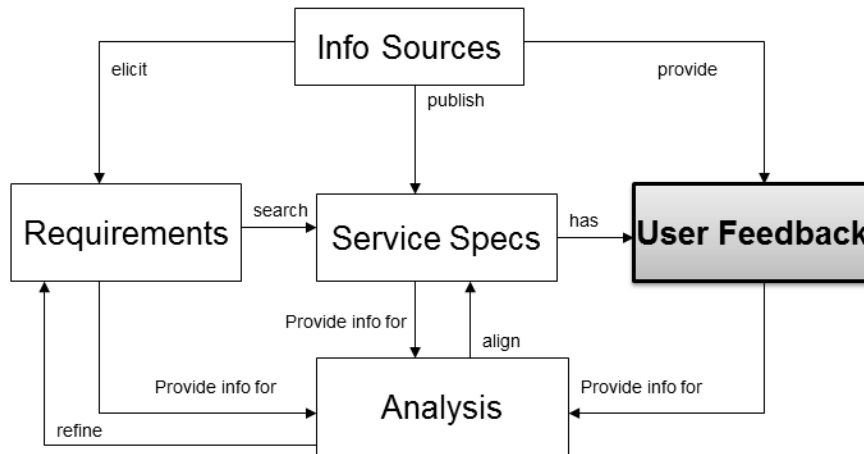


Figure 14 The Meta Model of alignment method

Table 7 shows the mapping of the classes in ARISE (from Figure 13, 14) to the standard classes of ISO/IEC 24744 (Figure 12) and gives the descriptions of all the elements involved.

Classes in Alignment Meta Models	Description of classes in Alignment Meta Models	Mapping to the ISO/IEC 24744 meta class
INFO SOURCES	The people or objects that provide required information or knowledge. E.g. customers, users, repositories, analysts, past user feedback, and documents	PRODUCERS
REQUIREMENTS	Requirements for the project that are used for searching available services	WORK PRODUCTS
SERVICE SPECIFICATIONS	Describing the functionalities offered by the service	
USER FEEDBACK	Provided by past users of the service	
ANALYSIS	Analysing the collected information	WORK UNITS

Table 7 Description of Meta classes in alignment method (Figure 13, 14) and their mapping to ISO/IEC 24744 Meta classes

6.3.2 Process Model

The Meta-model (Figure 14) provides the guidance for deriving the propose method of alignment ARISE, which is only one of the instances that can be derived from the Meta-Model. Table 8 shows the elements derived from the meta-model that are required to design the process model for ARISE method. Figure 15 shows the Process model for ARISE method.

Elements		Mapping to Alignment Meta Model
Actors		INFO SOURCES
Repositories Method Base		
Documents / Information		REQUIREMENTS, SERVICE SPECS, USER FEEDBACK
Analysis Activities		ANALYSIS

Table 8 Elements of Process Model

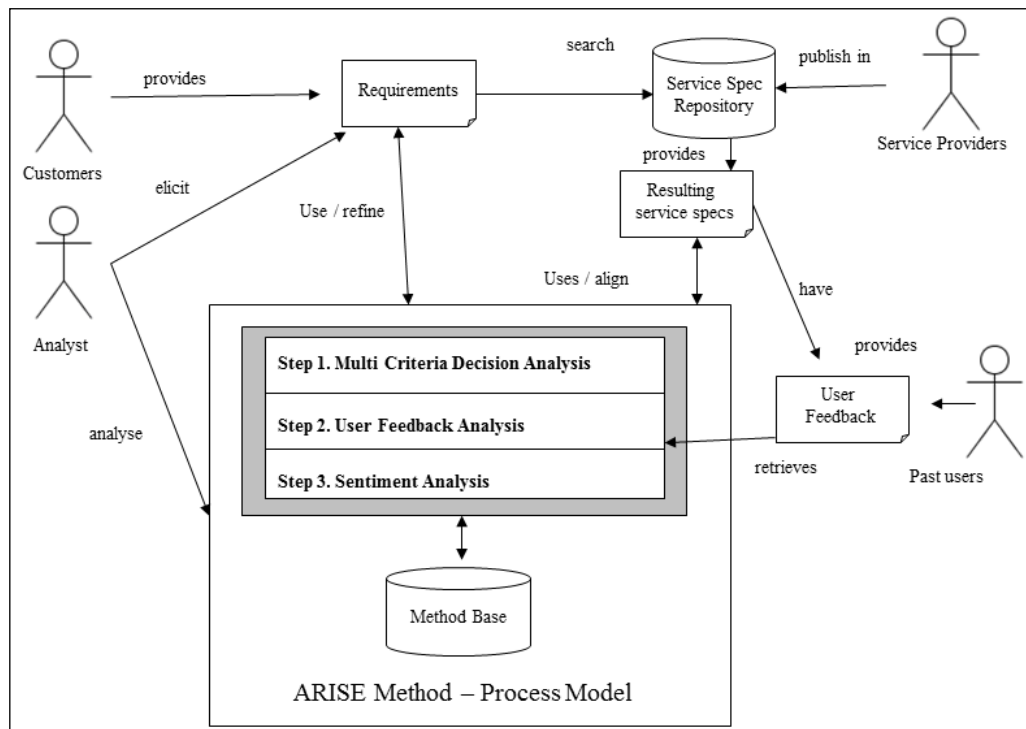


Figure 15 Process Model for ARISE

The process of alignment in ARISE method starts with the elicitation of an initial set of requirements from customers represented by R such that $R = \{R_1, R_2, R_3 \dots R_X\}$ where X is the total number of requirements. Using the requirement set the analyst would search for available related services from accessible service repositories (local or global). Resulting services from this search are represented by $S = \{S_1, S_2, S_3 \dots S_Y\}$ where Y is number of services found against requirement set R . The analysis in the ARISE method comprises of three interconnected and iterative steps: Multi Criteria Decision Analysis, User Feedback Analysis, and Sentiment Analysis. At this step the suitable “method chunks” are to be selected from the method base for each of the three analysis steps according to the project situation and context to tailor a situational and contextual instance of ARISE method. This provides the flexibility to ARISE method to be adopted for various project situations.

6.3.2.1 Multi Criteria Decision Analysis

The first step requires the analysts to evaluate all service specifications for granularity level against requirements and score them for their level of granularity using MCDA (Vetschera 2006). MCDA is used for decision making in situations where a trade-off is required among multiple criteria. It helps the analysts in making more informed decisions. The proposed method ARISE makes use of MCDA for scoring and ranking of services during alignment process. This step aims to score and rank the service set S in order to select the service that provides maximum functional range against requirements R i.e. a service that provides more coverage of requirement set. This step helps in filtering a sample of most relevant services from the set of available services which is manageable for further analysis.

During this step the customer needs are to be analyzed from multiple perspectives (e.g. Organizational, Technical (Functional, non-Functional), Economical, and Project related etc.) in order to develop a requirement checklist. The analyst converts the requirements into a checklist and assigns the weights to the checks based on customer preferences. The set of requirement checks is represented by $C = \{C_1, C_2, C_3 \dots C_K\}$ and the weights against these checks is represented by $W = \{W_1, W_2, W_3 \dots W_K\}$ where K is the number of checks in the requirements list. These weights provide prioritisation of the requirements based on customer preferences.

Various MCDA methods are available for different situations which can be made available in the Method Base. The most commonly used method of MCDA is Additive Weights method which in its simplest form assigns weights as multipliers to their respective checks or criteria (based on customer preferences) and then all scores for one option are added. The service with highest score is considered to be possibly best aligned among available options based on

customer preferences. The assumption is that quantifiable weights are to be provided in the same unit of measurement for scoring by the customer based on their prioritization of the requirements. If not possible, then Aspiration level Methods (Vetschera 2006) are available where the preferences are considered in their natural way rather than converting them all into one scoring level. A more dynamic approach is Outranking Method (Vetschera 2006) which takes a more dynamic perspective and constructs preferences based on the information of available decision alternative rather than creating them before the actual analysis and decision making.

While scoring services, there can be three main scenarios of alignment for a specific requirement from set R : fully aligned, totally misaligned, or partially aligned. The scores for alignment (i.e. C) can be calculated by evaluating a service in one of these three scenarios: fully aligned (score 1), totally misaligned (score 0), or partially aligned (score between 0 to 1). For a service S_i from the set of services S the score is represented by $Score(S_i)$ which is calculated by adding all the answers to the K number of requirement checks in set C for that service according to the following formula.

$$Score(S_i) = \sum_{i=1}^K ((C_i) * (W_i))$$

Equation 1 Additive Weights in MCDA

Once the scores are calculated, the analyst can filter the sample highest scoring services that are most relevant to the requirements according to customer preferences. This will reduce the over burden of further analysis.

6.3.2.2 User Feedback Analysis

User feedback can be collected:

1. Directly from online sources if the users are unknown and not approachable
2. Elicited directly from the known and approachable users.

While aligning the services against requirements, there is a possibility that some information (especially performance related) might be missing in service specification. The analyst is required to assess the missing information (for its type and context) because it will be extracted from the feedback of previous users of the service. If new information is found then the analyst can go back to step 1 and update the MCDA scores for that specific service evaluation. There are various methods (and associated tools and techniques (e.g. feature extraction, information retrieval, crowd sourcing, survey and questionnaire etc.)) available for feedback collection based on the situational factors related to the availability of past users and the format in which the feedback is available (blogs, forums, twitter etc.). The user feedback can help the analysts in alignment process with

- Finding the missing information in service specifications or descriptions as advertised by the service providers, this would further help in
 - Matching level of granularity of requirements and services by increasing the knowledge about service specifications or descriptions
 - Matching level of abstraction of requirements and services by increasing the knowledge about service specifications or descriptions
- Collecting contextual data based on the previous use of the service
- Eliciting past users' satisfaction level with the service and the reputation of service providers
- Comparing the service specification details against the real use of the service

6.3.2.3 Sentiment Analysis

The process makes use of existing methods and tool in the fields of natural language processing, text analysis and computational linguistics in order to identify and retrieve required information from the sources. This provides quantifiable scores for ranking and comparison of product from different suppliers by using the online user comments and feedback and ratings as the source. Various sentiment analysis approaches and associated techniques and tools are available for gauging the reputation of a service by monitoring the sentiments of the users regarding that service. The selection of any specific depends on the situation regarding the type of input and output information required by the analyst.

Once the MCDA scores and sentiments scores are available, a comparison can be made among the services. For all Y number of services, the highest service score among the set S that has high sentiment scores as well, would be considered optimally aligned service according to the customer preferences.

6.4 Chapter Summary

In this chapter I have presented ARISE method for aligning requirements and service specification that exploits the benefits of user feedback. In designing the process model for ARISE, the two main objectives for using SME (described at the start of section 6.3) are achieved. First, ARISE method is derived from the meta-classes of ISO/IEC 24744 and therefore all elements adhere to the standard guidelines. Second, with the availability of Method Base, ARISE can be tailored for different project contexts and situations by selecting appropriate methods.

PART II :SUMMARY

Research Goal 2: Propose a method based on existing theory of “user involvement and system success” by investigating the existing literature

To achieve Research Goal 2, this phase was guided by the following main research question:

RQ2: Does involving user feedback help in overcoming the top challenges of alignment in Service Oriented Requirements Engineering?

Answer: Yes, user involvement in service oriented requirements engineering through the comments and sentiments of past users of the service can provide an additional source of information that can help in overcoming the challenges of alignment of the requirements and services in SORE

The main question was further divided into following parts:

RQ2.1: Is there any relationship between user involvement and successful software systems?

Answer: 68% of the empirical literature published during 1980-2012 shows positive impact of user involvement on system success.

RQ2.2: What are the benefits of user involvement in Software Development Lifecycle?

Answer: according to the literature user involvement has been reported to be beneficial from multiple perspectives, see Table 5 for aggregated results.

RQ2.3: Is user involvement beneficial in Requirements Engineering?

Answer: yes. According to SLR results effective user involvement in requirements engineering activities is beneficial.

RQ2.4: How can we apply the existing theories of “user involvement” in Service Oriented Requirements Engineering?

Answer: In service oriented paradigm the users of the service can be involved in the process of alignment in informative or consultative roles through their voice (feedback, comments, reviews etc. on online resources). I have proposed ARISE method using SME guidelines that exploits the benefits of user involvement during alignment process.

Limitations of Part II

In part II, though SLR was conducted by rigorously following the guidelines of EBSE (Kitchenham & Charters 2007) to ensure the completeness of resulting studies, there would still be some papers that may not have been included in the data collection that I was not aware of due to their unavailability in electronic resources. In the SLR I eliminated the term “stakeholder” as a variant of the term “user” in the search string. I did that intentionally because not all stakeholders are considered users of the software. Participants are often selected from among stakeholders based on the benefits they can bring to the system development because not all stakeholders carry equal relevance to the software systems (Markus & Mao, 2004). In developing the categories of perspectives (for categorizing the benefits of user involvement), the names given to the themes that emerged from our analysis were inspired by and adapted from what has already been published in relevant papers. I believe that these categories can be further validated by triangulation. An effective method for

this task is card-sorting exercise employing independent participants from research or practitioner community.

In Part III, chapter 7 will present the practical implementation of ARISE method in a case study. Chapter 8 presents details of the tool support for ARISE method.

PART III

INSTANTIATION

PART III: INSTANTIATION

Part I described the investigation of the problem space and defined the research objective of the thesis. Part II has given the background and the design of the proposed solution. In Part III, the implementation of ARISE method is described in two chapters. Chapter 7, gives the details of an observational case study that instantiated the ARISE method in a real life project. The aim of the case study was to observe the working of ARISE method and to collect data to see if it helps in overcoming the challenges of alignment in SORE. Chapter 8 presents automated tool support for ARISE method in two steps; the granularity analysis and scoring of the services with the help of Knowledge Graphs Tool, and sentiment and user comments analysis with the Evaluator Tool.

CHAPTER 7: CASE STUDY

Case study research methodology involves a detailed and holistic investigation of a phenomenon in its real life context (Robson 2002; Runeson & Höst 2009; Yin 2003). It is well suited for empirical research in software engineering as the objects of the study are contemporary phenomena, which are hard to investigate in isolation from its real life context (Runeson & Höst 2009). Due to the emphasis on the contextual data from real world scenarios, the case studies may not be effective enough to generate the same results like controlled experiment. However they are best for observations and providing a deeper understanding of the phenomenon under study. A well-defined case study is clearly structured and pre-planned with clear indication of the elements (Robson 2002; Runeson & Höst 2009) such as a defined objective of the case study, research questions or hypothesis, description of the case being studied, data collection sources and planning, data analysis, results and threats to the validity of the study.

7.1 The objective of the case study

For instantiation of the ARISE method, I chose to conduct a case study. The case study was guided by RQ3 (Chapter 1):

RQ3: Does the proposed method help analysts in overcoming challenges of alignment in Service Oriented Requirements Engineering?

It was perceived to be an appropriate methodology due to the following reasons;

1. To observe the working of the method on a project, and to refine and improve ARISE method by applying the steps using data from real world

2. To validate the idea of involving user feedback in the service selection process for overcoming challenges of alignment in SORE

The case study was observational in nature. This case study presents the practical implementation of the ARISE method in a real world project and the effect of involving user feedback in overcoming the challenges of service selection process are identified. The hypothesis that guided the design of the case study is based on RQ3 as follows:

“User feedback assists in overcoming challenges of aligning requirements and services”

7.2 Case description

The case was provided by one of the business analyst (BA) who had previously participated in the interview study and was willing to help in the validation of the ARISE method. I explained the proposed solution to the BA so that the case can be identified based on the industrial experience of the BA where data can be collected from a real world project. I designed and performed the entire case study in consultation with the BA.

The case selected for the evaluation of the ARISE method involved the selection of a Short Message Service (SMS) gateway service for an existing website. SMS gateway services enable websites to send and receive text or multimedia messages from a web browser over telecommunication network to a mobile device with simple invocation of the remote service API while hiding all the underlying technical and infrastructure details. These services provide a ubiquitous and seamless way to the developers to approach roaming users allowing communication capabilities from the websites. The gateway services also act as a translator from one network protocol to another and connect different SMS centres that handle various operations such as receiving, storing, or forwarding SMS to the desired destination mobile

network. These services have given a great opportunity for the companies to stay connected to their clients via their mobile devices.

The website in this case belongs to a gym that required the SMS facility in their online system to contact its registered members considering that it is faster to approach them through SMS rather than email. There are currently 500 registered members. All of the members are located in Sydney. The gym needs to send single, group, or broadcast messages only in Australia to its members for different notification purposes such as registration expiry, new offers, change in timings etc. The frequency of sending one SMS to a member of gym is higher than sending bulk messages to all the members. Most of the services provide cheaper rates when SMS are sent in bulk, Therefore the gym is looking for a service that provides cheaper rates per one SMS as well. In addition to the cost and the basic functional requirements, the reliability and timely communication are the top priorities especially when sending activation codes to mobile phones for online registration of new members. Table 9 shows the 28 checks created based on customer requirements that were used for evaluation of the services. The table also shows the weights assigned to the checks based on the customer preferences (ranging from 3 to 15).

Manual online searches³ resulted in 92 eligible SMS gateway service providers. Appendix D shows names and web address of all the resulting services where the service providers have advertised the functionality of the services. Evaluation of 92 services against 28 checks created a complex and challenging scenario for decision making as many of the services offered more or less the same functionality within the close price range.

³ The searches were conducted in June 2014.

Ri	Requirement check description	Wi
1	Service supports outgoing text messages in Australia	15
2	Service should not have any hardware or SIM requirements	15
3	Service should be highly reliable with 99.9% message delivery	10
4	Cost of service should not be more than 0.3 AUD per SMS	10
5	There should be no set up cost	10
6	There should be no hidden charges	10
7	All charges (tax) should be included in credit for SMS	10
8	There should be no expiry on SMS credit	10
9	Payment should be done by credit card or Bpay	10
10	Service API should provide SOAP and HTTP support	10
11	Service API should support PHP script	10
12	No customization should be required in service	10
13	Service should be compatible with any web browser	10
14	Automatic connection should be established with every API call	10
15	Service should provide simple authentication on every API call	10
16	Service supports text messages in English	10
17	Service supports basic 160 characters per message	8
18	Service supports sending a text message to one member with notification text	8
19	Service supports sending a text message to on member with validation code	8
20	Service supports sending a text message to a group of members with notification text	8
21	Service supports sending a text message to all the members with notification text	8
22	Service supports text composed by the administration	8
23	SMS transmission delay should be between 3 to 7 seconds	8
24	Service should offer contacts management	8
25	Service supports retrieval of send messages record	6
26	Service shows notification of message delivery	6
27	Service shows message delivery failure notification	6
28	Service should provide schedule message delivery in case of holidays	3

Table 9 Prioritized checklist from customer requirements

7.3 Design and Execution of the Study

The case study was exploratory and observational in nature. First objective of the study was to observe the instantiation of the ARISE method for refinements and improvements. The second

objective was to evaluate the effectiveness of past users' feedback in service selection to find out if it assists in overcoming challenges in alignment of requirements and services in SORE. As summarized at the end of part I Problem Definition, the main challenges of alignment were:

- an overload in number of services creating a paradox of choice
- missing information in service specification or description which gives rise to difference in the
 - o level of granularity of requirements and services
 - o level of abstraction of requirements and services
- lack of user involvement in service selection process

In the analysis of case study these issues were the main focus of observation from the data generated from application of ARISE. In order to analyse the difference that past users' comments and feedback would make on the outcome of the evaluation results the ranking of services before and after analysing user feedback and comments were compared.

Following section describes all the steps that were carried out for the execution of ARISE method as proposed in part II (Chapter 6).

Step 1: Multi Criteria Decision Analysis

As the first step, 92 services were evaluated on a three scale scoring scheme, against the requirements checklist as given in Table 9. The scores were calculated based on the information provided in the service descriptions on the corresponding websites and API documents (where available) provided by the service provider related to the functionality of the services. If a service fulfilled a particular requirement it was given a score of 1, if not then 0 and 0.5 for partial fulfilment. Appendix E shows the granularity analysis results for all 92 services.

In this case Additive Weight method of MCDA was used for evaluation of services. Individual scores for the requirements were multiplied to their respective weights (from customer preferences) and at the end scores for all the requirements were added to calculate the final score for a service. Following Algorithm was applied for the evaluation of service descriptions based in Equation 1 in 6.3.2.1 and scoring them against the requirements:

```

Service Specification Set = {  $S_1, S_2, S_3 \dots S_{92}$  }
Requirements Check Set = {  $R_1, R_2 \dots R_{28}$  }
Requirements Weights = {  $W_1, W_2, \dots W_{28}$  }
For  $i=1$  to 92
    For  $j=1$  to 28
        If Service  $S_i$  fulfills Requirements  $R_j$  then
             $Score\_Service(i,j) = 1 * W_j$ 
        If Service  $S_i$  does not fulfills Requirements  $R_j$  then
             $Score\_Service(i,j) = 0 * W_j$ 
        If Service  $S_i$  partially fulfills Requirements  $R_j$  then
             $Score\_Service(i,j) = 0.5 * W_j$ 
    Total_Score_  $S_i$  += Sum (Score_Service( $i,j$ ))
Rank (Service Set)
    
```

Appendix F shows the final scores after second step of evaluation of the services against requirements.

Step 2: User Feedback Analysis

For the requirements checks of Table 9, if the information was not given by service provider in the service specification or description (this happened for requirements checks 6, 7 (Table 9) where service descriptions were ambiguous or incomplete to be evaluated), online forums and blogs were searched where reviews were available about the services. The comments and textual data was analysed with keyword searching to find out the required information.

Though I was only able to retrieve the missing information for 10 services (for payment related issues), but considering the fact that the task manually was performed (which was laborious and time consuming), it was clear that using sophisticated information retrieval tools would help significantly in this task. Appendix F shows the updated scores after retrieval of the missing information. Once the scores were calculated for all services and they were ranked, it was possible to reduce the sample of eligible services to a more manageable size for further evaluation by ignoring the low scoring services. I selected top 18 services for further evaluation that scored above 200 and satisfied more requirements (see Table 10).

Step 3: Sentiment Analysis

The next step was to get the quantitative values for the user feedback, reviews and comments from online sources with the help of sentiment analysis tools. After researching for a tool that would provide both quantitative and qualitative data regarding a service, I selected an online tool “socialmention.com”. This tool is designed for tracking any mention for the identified keywords in video, blogs, events, news, bookmarks, hashtags (#) and even audio files. With the results from online mention of the keywords (name of every service as shown in Appendix D) the tool calculates the sentiment scores. It categorizes the results into three types of sentiments i.e. positive, neutral, and negative. It also gives values for “Passion” which is a measure of the likelihood that people who are talking about the product or service will use the product repeatedly, and for “Reach” which is the measure of the range of influence of the product or service. Socialmention.com also provides links to the comments and information where that term or keyword has been mentioned. Not all of the text that mentioned the service was eligible as “past user comments or feedback”. By skimming through the retrieved textual

data from the useful comments were available for 6 services out of the selected sample of 18 services which will be discussed further in results section (See Table 11).

7.4 Results of the case study

In this section we discuss results of the case study in relation to the objectives of the study.

7.4.1 Comparison of results with and without user feedback

The first thing observed during the instantiation of ARISE in the case study was that it is not practical for evaluating the service specification or descriptions against requirements by following formal techniques, due to the huge number of available services and semantic heterogeneity in service descriptions by various service providers. However when compared to the service descriptions given in natural languages by the service provider, there are certain specific information that may not have been described. For example in the case study, some of the service descriptions were not clear about their payment mode and tax inclusion details. This information was retrieved later from the past users feedback and comments.

The services were ranked according to the scores calculated after incorporating the customer preferences. Service 76 scored highest and hence can be considered the most relevant to the requirements (see Appendix E and F). Table 10 shows the ranking of the services (that scored above 200) after step 2 of ARISE. Service 76 made it to the top of the list. The Table 11 shows the sentiment analysis scores for this sample of top 18 services. The table 11 shows that only certain services are popular among existing users of the service based on reach, passion and number of positive comments. These include service 76, 71, 15, 1, 2 and 9.

Service	Name	Link	Score
76	Via SMS	http://viasms.com.au/	252
19	Intel tech	http://inteltech.com.au	250
68	Skebby	http://www.skebby.com	247.5
71	Direct SMS	http://www.directsms.com.au/	245
86	Ready to SMS	http://www.readytosms.com.au/	242
23	Messente	https://messente.com/	237.5
66	Click send	http://clicksend.com.au/	232
5	SMS broadcast	https://www.smsbroadcast.com.au/	230
15	Bulk SMS	http://www.bulksms.com	228.5
34	Clock work SMS	http://www.clockworksms.com/	228.5
61	HQ SMS	http://www.hqsms.com/	220.5
1	Clickatell	http://www.clickatell.com.au/	219.5
83	Red oxygen	http://redoxygen.com/	217.5
18	Nexmo	https://www.nexmo.com/	214.5
53	Essendex	http://www.esendex.us/Services/SMS-API	214.5
3	Exe TEL SMS	http://www.exetel.com.au/corporate/sms	210.5
2	SMS global	http://www.smsglobal.com/web-sms/	209.5
9	Twilio	http://www.twilio.com/sms	203.5

Table 10 Top 18 services with their scores above 200

Service i	Socialmention.com				
	Passion	Reach	Sentiment Frequency of comments		
			Positive	Neutral	Negative
76	66%	2%	10	7	1
19	0%	3%	1	3	0
68	40%	3%	3	5	0
71	94%	20%	3	17	0
86	0	0	0	0	0
23	0	0	0	0	0
66	0	2%	0	1	0
5	0	5%	4	1	0
15	11%	5%	53	19	1
34	0	8%	0	4	0
61	0	2%	0	1	0
1	51%	8%	63	27	0
83	88%	4%	2	15	0
18	0	2%	0	1	0
53	0	2%	0	1	0
3	0	0	0	0	0
2	28%	10%	11	19	0
9	33%	9%	7	26	0

Table 11 Results from “Socialmention.com” on 20th December 2014 for one month

When the comments for all these 18 services were retrieved with the help of web crawler and were further analysed it was found that there was a lot of irrelevant “noise” in those comments. They required further cleansing and parsing. The comments were analysed with “content analysis” technique and they were coded for the functionality for which the comment was reported. The comments were further categorized into positive and negative. Positive comments were all praising their respective service and not providing any useful information. However the negative comments were more informative. These comments were mainly about the quality and performance of the service such as delay time, reliability of the service to deliver the message. Table 12 shows the analysis of the negative comments that were available for 6 services.

Service i	Negative comments		
	Delay	Delivery	Payment
76	-	-	Pricing not clear
5	Significant amount of delays encountered	Message was lost	-
15	-	-	Payment with credit card and credential stolen
1	-	Problems in getting message delivery notifications	Payment problems
2	-	Not reliable in sending messages, sometimes messages are lost	-
9	-	-	Doesn't accept payments from all countries

Table 12 User negative comments about services

With all this available information, service 71 (Direct SMS) appear to be optimally aligned with customer requirements, in terms of maximum coverage of the preferred requirements, as well as good reputation with the past users (no negative comment were found for service 71 from past users, Table 12). Whereas without sentiment analysis scores and user comments, service 76 (Via SMS) appeared to be the best match.

7.4.2 Challenges of alignment in SORE

Which service gets finally selected, is contextual and can vary in different projects. The main objective here was to observe if this additional source of information (user comments) were helping the analysts in overcoming the challenges of alignment in SORE for making informed decisions for service selection. The observations regarding the reasons that made alignment process challenging are discussed in following:

7.4.2.1 Paradox of choice

In the case study, there were a substantial number of related services to select from. Although with MCDA scoring and ranking (multiplication with the weights) the sample size can be reduce by eliminating totally irrelevant services, however this is a laborious and time consuming task when done manually. Automation of this step is a must in ARISE and it was felt that an NLP tool would be a natural choice in these kind of scenarios where due to large number of services formal comparison may not be possible.

7.4.2.2 Missing information in service specification

In this case the comparison of requirements was done with service descriptions in natural language rather than with formal or technical documents. There were instances where the service providers were not giving fine details of the functionality e.g. in the case study, modes of payment for the service and tax related information. Also every service provider had their own way of advertising their service giving rise to the diversity in semantic of the descriptions with which a specific requirement was to be compared. User comments are a good source of information that can help in retrieving the missing information regarding the functional range of the service to complete the scoring for sparse table in the granularity analysis. It was

observed that mostly it is the non-functional requirements that are missing, whereas the basic functionality was described almost by all the service providers. Once again, this task requires automation as well. There are sophisticated information retrieval tools available that can help the analysts in this step.

7.4.2.3 Lack of user involvement

Past user feedback and comments are both providing way of involving them into the service selection decision process. As described in details in chapter 2 and 6, the involvement of users and customers does create a positive psychological impact and thus leads to a successful outcome. Therefore the service selection with ARISE can lead to an increase in the level of satisfaction of the customers with the system. These experiences of past users are a form of knowledge that can be brought into the alignment process for making more informed decisions.

7.4.3 Refinements and improvements in the proposed method

The case study was helpful in refining ARISE since some problems were observed in the sequence of the steps, that were corrected and the method was modified. The modifications were related to the steps of granularity analysis and use of user feedback for updating of scores. Initially granularity analysis was considered separate step but during instantiation, it was found to be part of MCDA.

7.5 Chapter Summary

This study was helpful in refining the proposed method by showing the details of all the steps required to be carried out in practice. The study has demonstrated that evaluating a service merely with the information advertised by the service provider in their online descriptions may not always lead to an optimal decision for service selection. The social media presents a new opportunity for monitoring trends and sentiments of users towards a particular service among a large pool of options. Users who have the past experience of using a service can provide valuable information that can be helpful in decision making process.

The study reported in this paper was carried out with two specific aims:

- Refinement and improvement in the ARISE method
- Validation of the effectiveness of past user feedback in the service selection process

The major contribution of the ARISE method is the involvement of the voice of past users with the help of sentiment analysis in the service selection process as well as utilising MCDA in the decision analysis. The case study enabled me in achieving both aims. Firstly, the conduct and the results of this study have helped in refining and improving the ARISE method. Secondly, this study has shown that the user feedback analysis provides additional source of information for the analysts for making more informed decisions for alignment of requirements and services. It does help in overcoming the challenges of alignment as investigated previously in the thesis, and hence prove the hypothesis that guided the case study. It was also helpful in designing and developing of our supporting tool to reduce the information overload and assist the analysts to simulate the results for evaluating different options.

This study has used both quantitative scores provided by the sentiment analysis tools along with the qualitative data in form of user comments and feedback about the service usage by previous users. The result of this qualitative analysis in combination with the quantitative scores has provided a more complete picture of each service resulting in the most optimal selection.

The case study identified the high level requirements for designing automated tool support for the ARISE method. Chapter 8 will give details the design and working of Knowledge Graph based NLP (KG-NLP) tool and a web interface (EVALUATOR) that implement ARISE.

CHAPTER 8: TOOL SUPPORT FOR ARISE

This chapter presents the details of the tools that were designed and used for the automation of some parts of the ARISE method. The automation was performed in two steps. For granularity analysis an existing approach i.e. Knowledge Graph based NLP tool (Ferrari et al. 2014) was reused and extended to be applied to my case study data presented in Chapter 7. To support other steps of ARISE, I designed a tool EVALUATOR that can guide the analyst through all the steps of the ARISE.

8.1 NEED FOR AUTOMATION

The results of the case study revealed an obvious need for automation of ARISE. I searched for NLP tools (that are used in requirements engineering and reported in empirical studies with promising results) that can suit my purpose for alignment of service descriptions to the requirements in natural language without formalism and with less time. The main objective was that the tool should be able to compare service descriptions to the requirements and calculate scores based on their similarity. Having established the need for an NLP tool to support the ARISE method (considering that the case study had both requirements and service specifications in natural language), while attending the International Requirements Engineering Conference (RE 2014) I came across such a tool (Ferrari et al. 2014). Developing NLP tool was not in the scope of my current research therefore I sought for collaboration with Alessio Ferrari from the research team in Pisa, Italy who were undertaking the projects of using NLP tools in various areas of requirements engineering. They had previously developed an approach using Knowledge based Graphs (KG) (Ferrari et al. 2014). The tool is coded in Python. During our discussion it was decided that the same tool could be extended with

information retrieval (IR) techniques for service selection and be applied on the case presented in chapter 7. The objective was to evaluate the effectiveness of the natural language processing tool in the service selection process using KG approach. After meeting and discussion it was decided to modify the tool and apply it on the case study data. We conducted the following three types of experiments to check the accuracy and speed of the technique in comparison to the manual work conducted in my case study (Chapter 7).

- a) Ranking of services with respect to all requirements and comparison to manual results.
- b) Ranking of services with respect to individual requirements and prioritization, showing highest scoring service for each requirement
- c) Impact of user comments on the overall scores

8.2 GRANULARITY ANALYSIS WITH NLP TOOL

In chapter 2, I presented an overview of the existing approaches to alignment of services and requirements. They all require certain degree of formalism (e.g. XML) for comparing the requirements and service and do not provide solution using natural language processing.

For the ARISE method a very effective automation of the alignment process would be to use an NLP tool that can help reduce the very large set of relevant services to a smaller set of highly related services. The analysts can further evaluate the smaller set of services based on user feedback and sentiment analysis. In this case, both requirements and descriptions of service functionality are required to be expressed in natural language which also reduces the efforts of formalization for the analysts.

8.2.1 Knowledge Graphs (KG) based NLP

The idea behind the Knowledge Graphs based NLP approach is that a service specification is likely to satisfy a set of requirements if it shares semantically related natural language content with the customer requirements. To support the computation of the semantic proximity between a requirement and a service specification, the approach relies on the modeling of the domain knowledge required for the interpretation of the requirements by means of Knowledge Graphs (KGs) (Ferrari & Gnesi 2012; Ferrari et al. 2014). Using only the text included in the requirements and the text of the service descriptions as advertised by the service providers is not sufficient to provide an acceptable ranked list of services during automation. Instead, domain-knowledge has to be included in the computation to have a ranked list that can be profitably used by the requirements engineer. A Knowledge Graph (KG) is automatically constructed from a set of documents with domain knowledge of the customer requirements. Then, the NL requirement and the service specification are expanded with the concepts included in the KG based on the documents from domain knowledge e.g. Wikipedia web pages. This serves two purposes; first, it gives the tool the contextual information regarding requirements for better interpretation of the service descriptions. Second, this enables the tool to deal with the situations where different terminologies are used for describing similar concepts. In our case a requirement and a service description could use different terminology to refer to the same concepts, and a service could satisfy a requirement even if it does not share any term with it. For example, a requirement such as “Service shows message delivery failure notification” (requirement 26 in Table 9), could be satisfied by a service description that states “You know when your SMS has not been received”. Domain-specific query expansion approaches have been defined to deal with these problems in information retrieval, see (Bhogal, Macfarlane & Smith 2007) for a review of the approaches and (Chauhan et al.

2013; Díaz-Galiano, Martín-Valdivia & Ureña-López 2009) as examples of more recent works.

Their similarity is finally computed as the number of shared concepts in the KG. The higher the number of shared concepts in the KG, the higher is the degree of satisfaction of a requirement by the service specification. Given a set of requirements and a large number of service specifications, the approach can retrieve the services that have the highest degree of matching with the set of requirements.

8.2.2 Experiments of KG-NLP

Web crawling tool was used to retrieve all the online service descriptions through their URL to compare them to the requirements. A set of documents was selected to build the knowledge graph. Such set was selected by automatically downloading the textual content of the Wikipedia pages that were associated to the terms included in the requirements. The downloaded documents were briefly reviewed to discard irrelevant pages. Additional domain documents were included for those technical terms that were considered more relevant, namely "HTTP", "PHP", "SMS gateway service", "SMS", "SOAP". In total, there were 28 documents, 23 automatically selected and 5 manually added for domain knowledge.

8.2.2.1 Ranking of Services for all requirements

Table 13 (left) reports the top 15 services together with their ranking according to the manual assessment (Appendix E, without prioritization), while Table 13 (right) reports the top 15 services obtained with the automatic approach by applying KG-NLP tool. The services in common in the two lists are highlighted in bold in the right table. The two lists share 8 out of 15 services, which imply an accuracy of 53%. Such a value, together with the tangible results

presented in Table 13, can give us confidence on the effectiveness of the method: if we consider an analyst who searches for the best service that satisfies a set of requirements, she can have confidence that the top results of the approach will be likely to be suitable for its needs. Then, she can manually review the top results to select the best service according to her knowledge. Table 14 summarize the time taken for various activities of the experiment.

Service	<i>K</i>	Service	<i>K</i>
Intel Tech	27.5	Messente	7.58
Skebbby	27.5	One API 4 SMS	6.25
Direct SMS	27	Red Oxygen	5.84
Via SMS	27	Intel Tech	5.82
Messente	26.5	Click Send	5.75
Ready to SMS	26	Wave Cell	5.74
Click Send	25	Cdyne	5.62
Bulk SMS	24.5	Budget SMS	5.61
Clock Work SMS	24.5	Plivo	5.47
Red Oxygen	24.5	Clock Work SMS	5.46
Clickatell	24	SMS Global	5.35
SMS Broadcast	24	M4U	5.25
SMS Global	23.5	TXT Nation	5.25
Essendex	23.5	Nexmo	5.16
Nexmo	23.5	Bulk SMS	5.09

Table 13 (Left) Manual Ranking of services (Right) Ranking of services with KG-NLP

Activity	Time
Graph Creation	8-9s
Requirements Interpretation	5s
Service Interpretation	17min
Graph Distance Evaluation	0.4s
Ranking Evaluation	0.01s

Table 14 Time taken by KG-NLP for experimentation

8.2.2.2 Ranking of services for individual requirements

Besides the ranking of the services with respect to the sum of the scores for all the requirements, the tool also generates alternative list showing services scoring top for individual requirements due to semantic similarity of the description. This list is useful for

MCDA scoring where the requirements are prioritized according to the weights assigned on customer preferences.

8.2.2.3 Impact of past user feedback on service ranking

We performed another experiment with KG-NLP tool to evaluate the impact past users' comments can make on the ranking of the services. We selected a sample of five services only where there was sufficient user feedback available online. This experiment included ranking the five services using KG-NLP tool with and without the user comments to compare the results. The input documents were user requirements, service descriptions, domain documents, user positive comments and user negative comments. The positive comments were used for increasing the score for a specific functionality in graph nodes for which the comment was made whereas the negative comments were decreasing the scores. Table 15 shows ranking of the services resulted by application of KG-NLP and it is clear that after incorporating user comments and feedback the ranking has changed. We have not yet performed this experiment with the complete set of services. This part of our collaborative research is still in progress. But we found the technique to be efficient in parsing the user comments automatically for finding the positive or negative sentiments attached to a specific functionality within a minute (for five services).

With user feedback	Without user feedback
Twilio	SMS Broadcast
SMS Broadcast	Twilio
SMS Global	Clickatell
Clickatell	SMS Global
Tropo	Tropo

Table 15 Comparison of service ranking with and without user comments

8.2.3 Results and conclusions

The main contribution of these exploratory experiments is the automation of matching requirements against big set of service specifications with KG tool on natural language. Regarding the accuracy of the results against the manual evaluation of service specifications based on human judgment, at the moment in the top 15 ranked services with highest similarity to the requirements (TABLE 13), 8 can be found in both lists which are a manageable size for an analyst to select one service from. We consider the initial results promising. It is clear that KG-NLP tool helps the analysts in addressing the challenges of alignment of SORE.

8.2.3.1 Level of Granularity

The KG based technique semantically matches the functional attribute of the service specifications to requirements to assess the functional range of the service against the requirements. The ranked list generated by the tool shows the coverage of all the requirements by a particular service. That service may not be the best for any requirements but can have more coverage of the requirements in comparison. Besides the ranked list generated by the tool in the experiment, we can also retrieve the list of services scoring highest against individual requirements. This list would be helpful for analyst in requirements prioritization.

8.2.3.2 Paradox of choice

With the help of KG tool, any number of services can be automatically reduced to the sample of manageable size for an analyst to choose from.

8.2.3.3 Lack of context

KG tool constructs knowledge graph based on domain knowledge related to the requirements which contains contextual information for requirements to be used for matching against service specifications or descriptions.

8.3 EVALUATOR

The observational case study helped me in drafting the specification for a software tool that can support ARISE method. The aim of the tool is to assist the analysts with all the steps and provide a visual display of the quantitative and qualitative results at the same time.

8.3.1 Goals for the tool support for ARISE

Figure 16 shows a high level concept of what was required from the tool for ARISE. It requires the analyst to enter the set of requirements and service names (or specifications); the tool uses external service for automatically calculating sentiment analysis and retrieving past user comments from internet. The tool would follow the steps of ARISE to convert the input into results. The results would be displayed in a graph with both scores and textual comments.

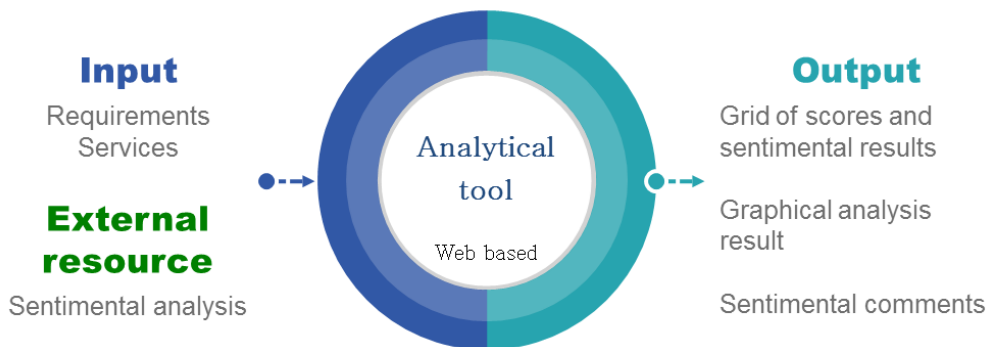


Figure 16 EVALUATOR tool support for ARISE

The following requirements for the tool were identified from the case study:

1. Provide graphical interface to input requirement checklist and additional description and their associated weights for prioritization.
2. Provide graphical interface to input service names, specification and additional data (online links, SLA, API description).

3. Easy navigation to move back and forth in performing steps of ARISE
4. Provide a grid interface for entering scores for all the services against every requirement in checklist.
5. Provide facility to connect to online sentiment analysis sites and provide sentiment analysis data and popularity index of the services
6. Provide facility for retrieving user comments and qualitative data of the services
7. Show graphs and charts for calculating scores for all the services using the ARISE method
8. Enable back and forth navigation and editing
9. Maintain database for a specific project

8.3.2 Characteristics of EVALUATOR

Two Master level students were selected for the implementation of this tool. I participated as a customer and at times as business analyst for the tool development. Agile development methodology was followed for analysing, designing and implementing EVALUATOR. It was developed by using HTML5⁴ and Javascript⁵ for client side scripting, and PHP⁶ for server side scripting. The database support was provided with MySQL⁷. The interface for displaying results was supported by Highcharts⁸ service API and x10hosting⁹ web server was used for uploading and deploying the EVALUATOR¹⁰.

⁴ http://www.w3schools.com/html/html5_intro.asp

⁵ <http://www.w3schools.com/js/>

⁶ <http://php.net/>

⁷ <http://www.mysql.com/>

⁸ <http://www.highcharts.com/>

⁹ <https://www.x10hosting.com/>

¹⁰ The tool is hosted on the following web address: <http://evaluator.x10host.com/>

8.3.3 Web Interface for EVALUATOR

In the following we provide the screen shots of the EVALUATOR tool which are in sequence to the steps of the ARISE method (Chapter 6).

The home page is standard interface that provides options for login or creating new account. Also gives brief description of the method and a brief introduction to the tool. Help regarding the working of the tool is also available.

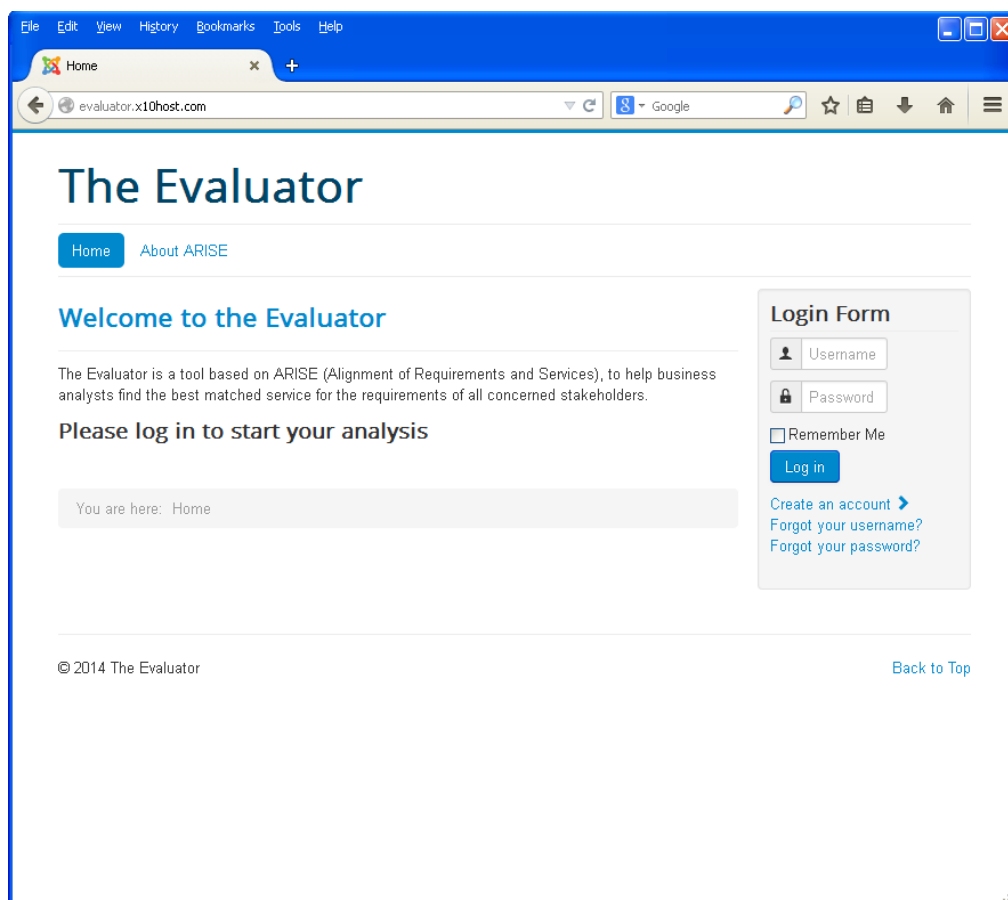
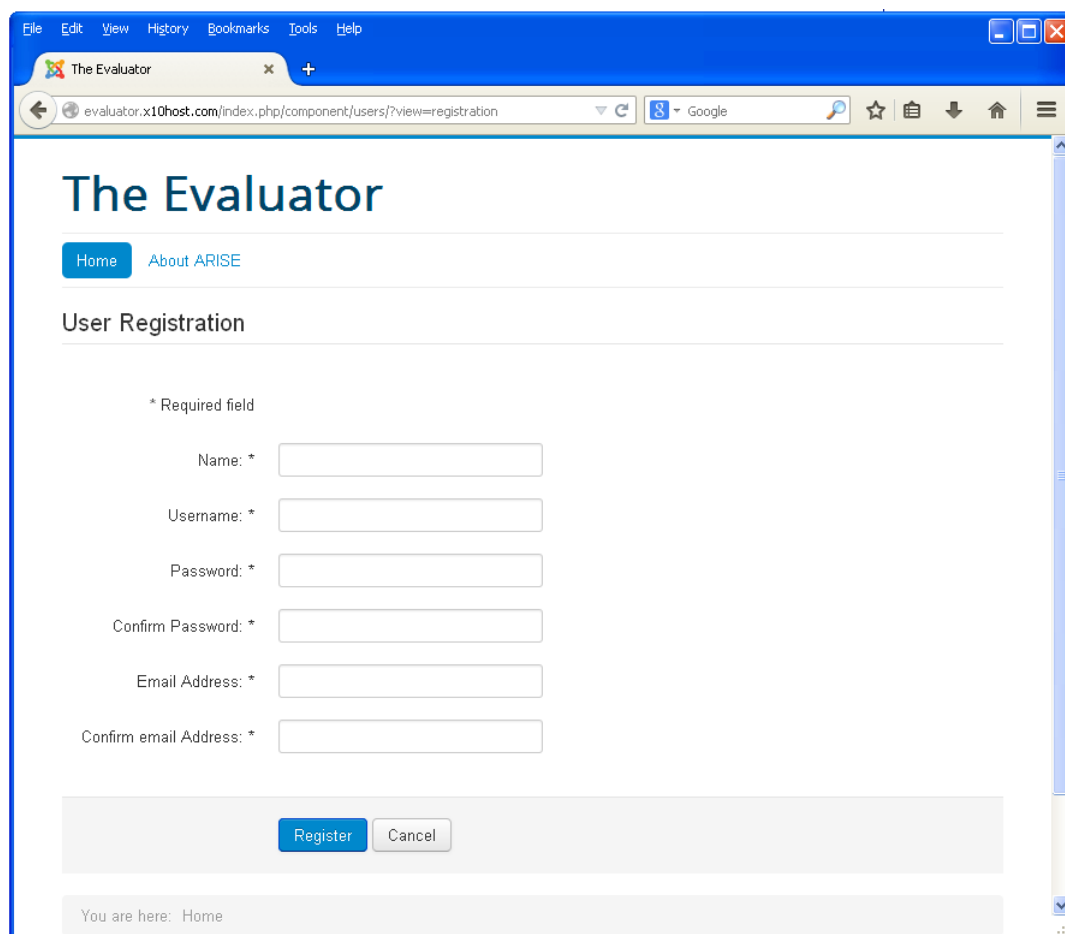


Figure 17 Evaluator Home Page



The screenshot shows a web browser window with the title "The Evaluator". The address bar displays the URL "evaluator.x10host.com/index.php/component/users/?view=registration". The page features a navigation bar with "Home" and "About ARISE" links. Below this, the "User Registration" section contains a form with the following fields: "Name: *", "Username: *", "Password: *", "Confirm Password: *", "Email Address: *", and "Confirm email Address: *". Each field is accompanied by a small asterisk indicating it is a required field. At the bottom of the form, there are "Register" and "Cancel" buttons. A breadcrumb trail at the very bottom reads "You are here: Home".

The Evaluator

Home About ARISE

User Registration

* Required field

Name: *

Username: *

Password: *

Confirm Password: *

Email Address: *

Confirm email Address: *

Register Cancel

You are here: Home

Figure 18 Evaluator Registration

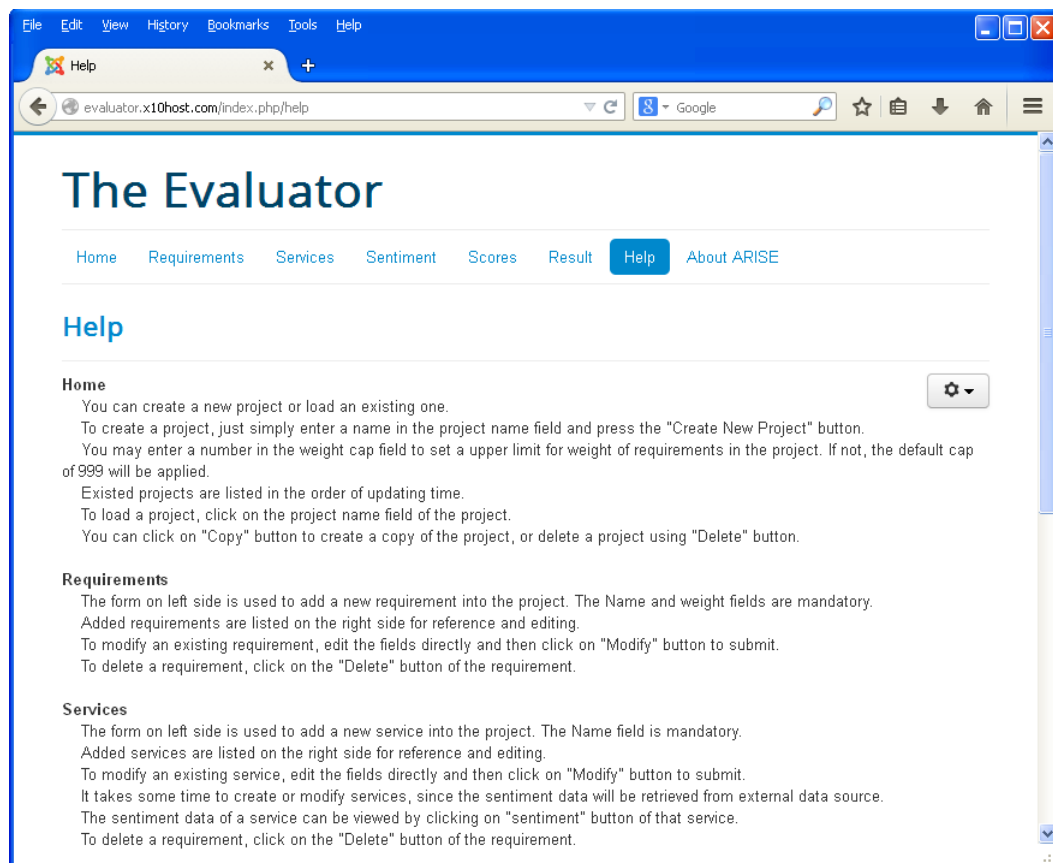


Figure 19 Evaluator Help

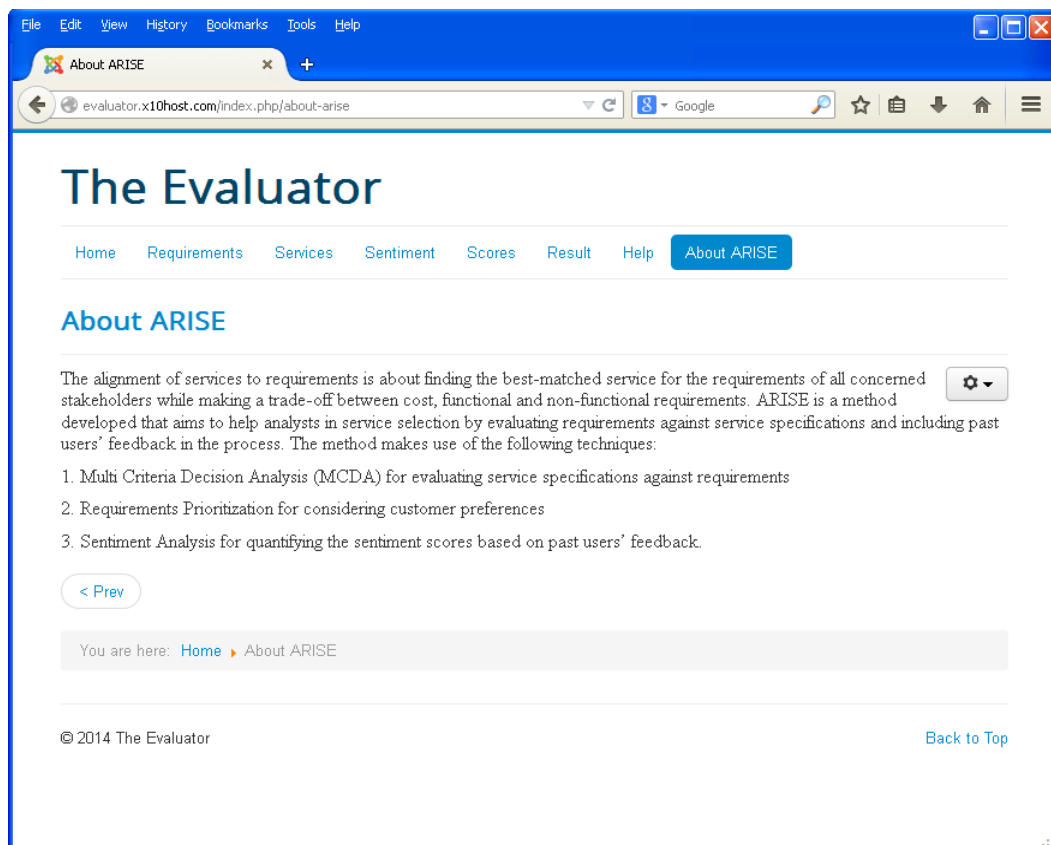


Figure 20 Evaluator ARISE explanation

Once the login is successful, a new project can be created. Also the previously stored projects can be retrieved from the database. The analysts can set values for requirements prioritization while they create the project. These are used for creating a range of MCDA weights that can be assigned to the requirements for calculating scores for the services.

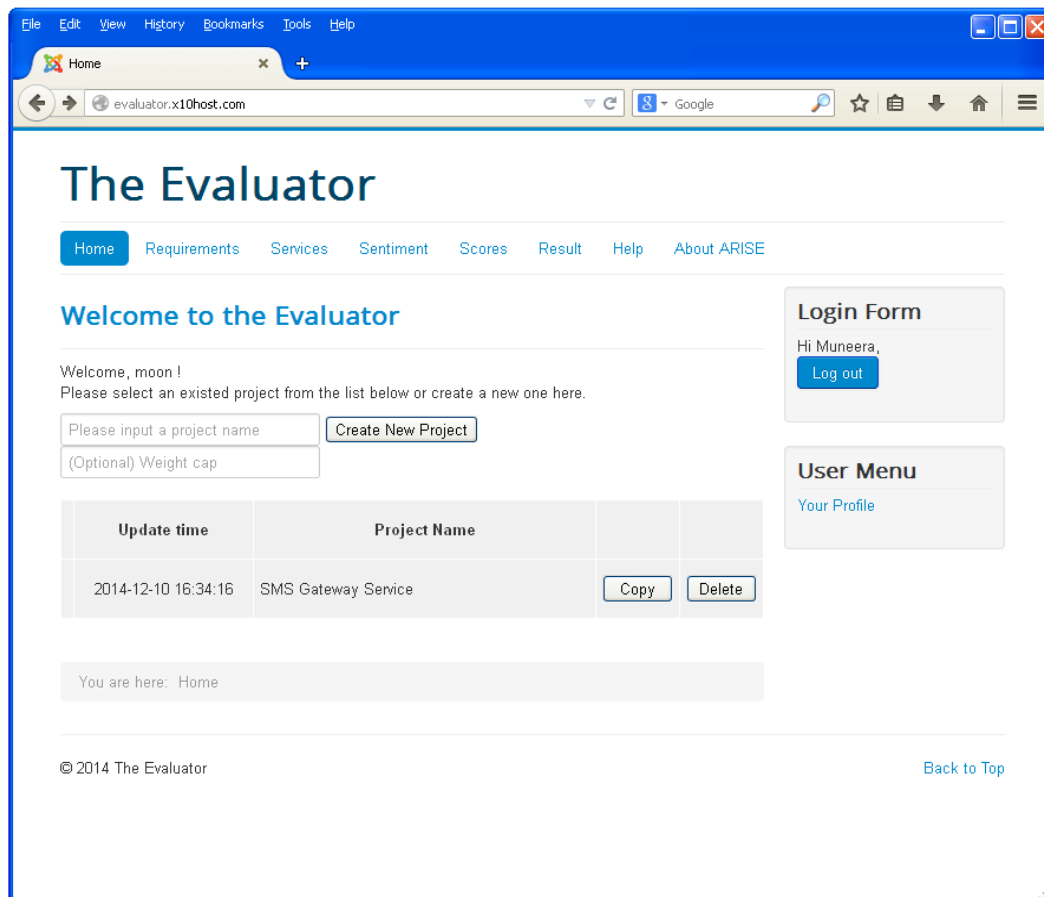


Figure 21 Evaluator after sign in

Next tab is an input interface for requirements statements, weights and additional description or notes for further explanation. These weights are used for MCDA ranking as customer preferences for scoring services.

The Evaluator

Home Requirements Services Sentiment Scores Result Help About ARISE

Input Requirements

New Requirement

Requirement Name

Requirement Weight 0 - 15

Requirement Description

Add

1. Requirement Name:

Service supports outgoing text mes:

Modify

Weight:

15

Delete

Description:

If it is not an Australian based company then partial scores are to be assigned.

2. Requirement Name:

Service should not have any hardwa

Modify

Weight:

15

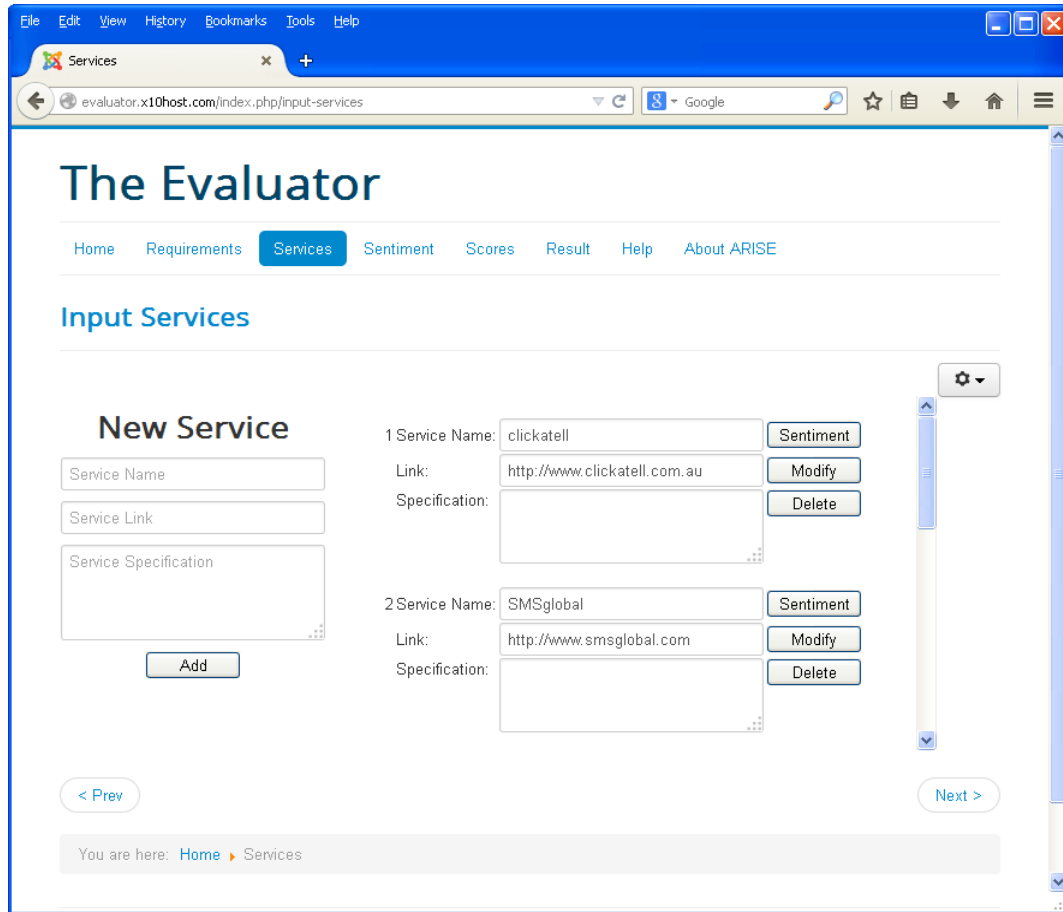
Delete

Description:

Next >

Figure 22 Evaluator Requirements Input Page

The next interface is for entering the names and URL of web services, and optionally the descriptions can be directly entered to database.



The screenshot shows a web browser window with the address bar displaying 'evaluator.x10host.com/index.php/input-services'. The page title is 'The Evaluator'. The navigation menu includes 'Home', 'Requirements', 'Services' (highlighted), 'Sentiment', 'Scores', 'Result', 'Help', and 'About ARISE'. The main heading is 'Input Services'. On the left, there is a 'New Service' section with input fields for 'Service Name', 'Service Link', and 'Service Specification', followed by an 'Add' button. On the right, there are two service entries. Entry 1: '1 Service Name: clickatell', 'Link: http://www.clickatell.com.au', and 'Specification:' (empty). Entry 2: '2 Service Name: SMSglobal', 'Link: http://www.smsglobal.com', and 'Specification:' (empty). Each entry has 'Sentiment', 'Modify', and 'Delete' buttons. At the bottom, there are '< Prev' and 'Next >' buttons, and a breadcrumb trail 'You are here: Home > Services'.

Figure 23 Evaluator Service Input Page

The sentiment analysis is automatically calculated by interacting with socialmention.com API by providing names of the services and getting both sentiment scores as well as past users' comments (which are displayed in results). The values are stored in database once they are generated. The analysts can update them later for new scores according to the time, as the sentiments can vary over the web each day, even each hour.

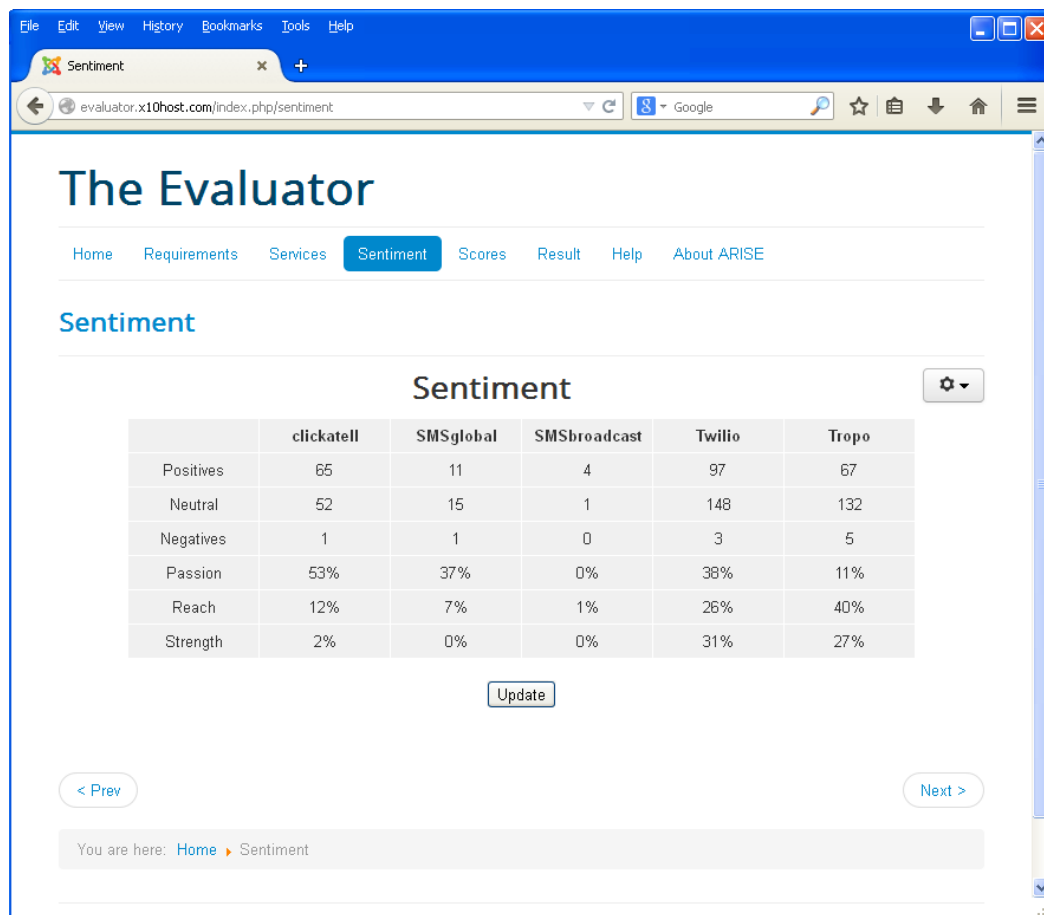


Figure 24 Evaluator Sentiment Analysis Computation

Analysts can enter the scores for the services based on their granularity level to the requirements.

#	Requirements	Weight	clickatell	SMSglobal	SMSbroadcast	Twilio	Tropo
1	Service supports outgoing text messages in Australia	15	1 *15= 15	1 *15= 15	1 *15= 15	1 *15= 15	1 *15= 15
2	Service should not have any hardware or SIM requirements	15	1 *15= 15	1 *15= 15	1 *15= 15	1 *15= 15	1 *15= 15
3	Service should be highly reliable with 99.9% message delivery	10	0 *10= 0	0 *10= 0	0 *10= 0	0.5 *10= 5	0.5 *10= 5
4	Cost of service should not be more than 0.3 AUD per SMS	10	0.5 *10= 5	0.5 *10= 5	0.5 *10= 5	0.5 *10= 5	0.5 *10= 5
5	There should be no set up cost	10	1 *10= 10	1 *10= 10	1 *10= 10	1 *10= 10	1 *10= 10

Figure 25 Evaluator Granularity Analysis Score Input

23	SMS transmission delay should be between 3 to 7 seconds	8	0.5	*8= 4	0.5	*8= 4	0.5	*8= 4	0.5	*8= 4	0.5	*8= 4
24	Service should offer contacts management	8	1	*8= 8	1	*8= 8	1	*8= 8	1	*8= 8	1	*8= 8
25	Service supports retrieval of send messages record	6	0.5	*6= 3	0.5	*6= 3	1	*6= 6	1	*6= 6	1	*6= 6
26	Service shows message delivery message	6	1	*6= 6	0.5	*6= 3	0	*6= 0	0.5	*6= 3	0.5	*6= 3
27	Service shows message delivery failure notification	6	0.5	*6= 3	0.5	*6= 3	1	*6= 6	1	*6= 6	1	*6= 6
28	Service should provide schedule message delivery in case of holidays	6	1	*6= 6	1	*6= 6	1	*6= 6	0	*6= 0	0	*6= 0
SUM				228		225		223		225		220

Submit

< Prev

Next >

You are here: [Home](#) > Scores

Figure 26 Evaluator Granularity Analysis Score Input

The interface for results combines all the results into one compact display. The orange line is indicative of the granularity scores of the services. The bars shows the frequency of positive (blue bar), negative (black bar) and neutral (green bar) comments i.e. how many were retrieved from the online resources. Placing the mouse cursor over any of the bar will show the count. By clicking on the bar the actual text of the comments can be reviewed along with the hyperlink to the actual source of the comment. Scrolling down on the same page (of results), the count for additional sentiment variables from *socialmention.com* strength, passion and reach is given.

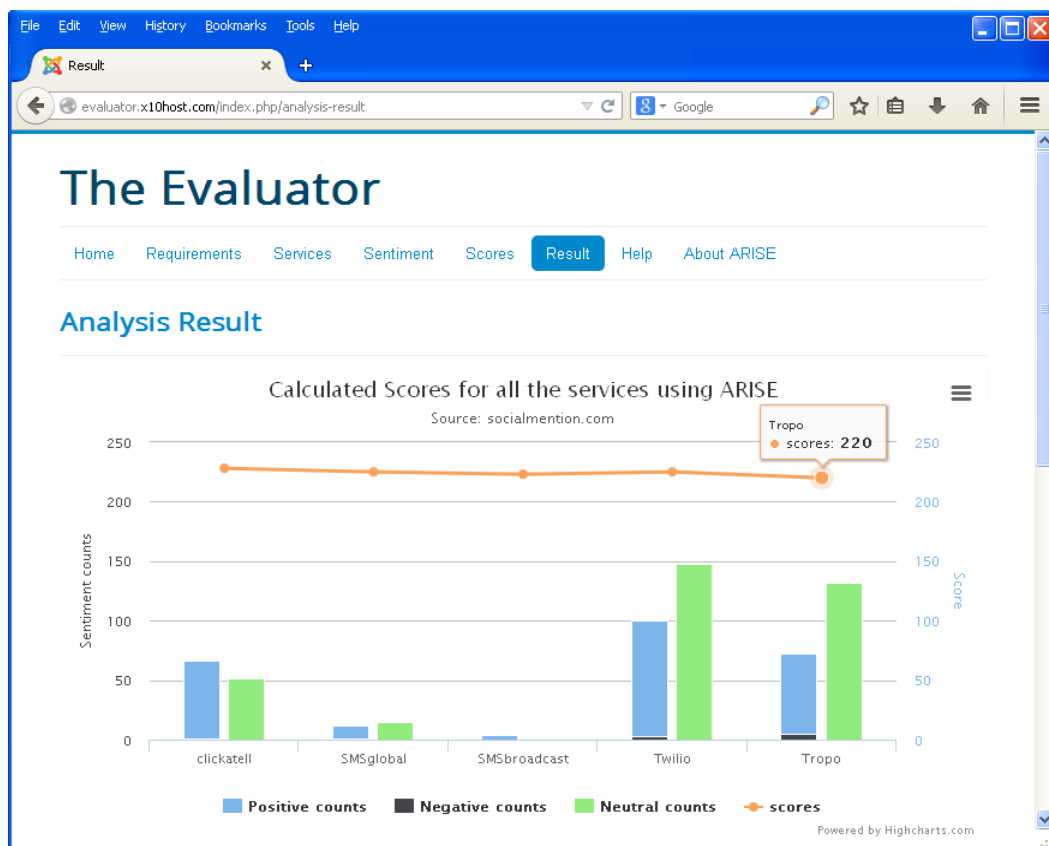


Figure 27 Evaluator Analysis Results

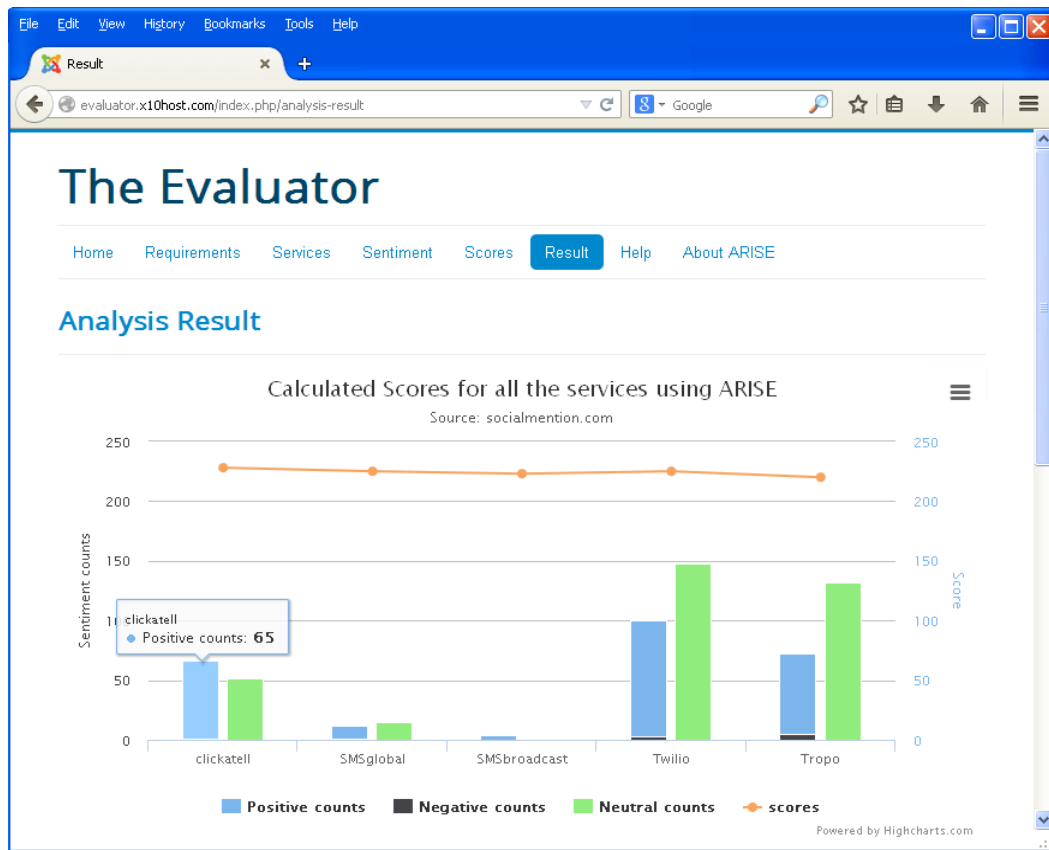


Figure 28 Evaluator Analysis Results

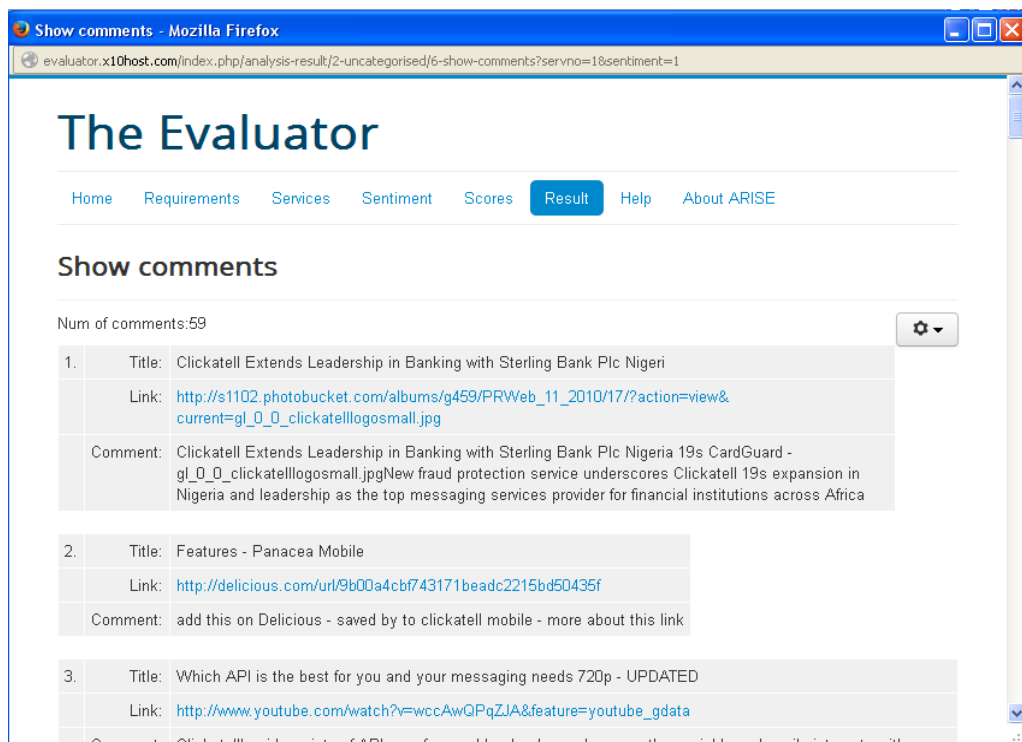


Figure 29 Evaluator Analysis Results – User Comments

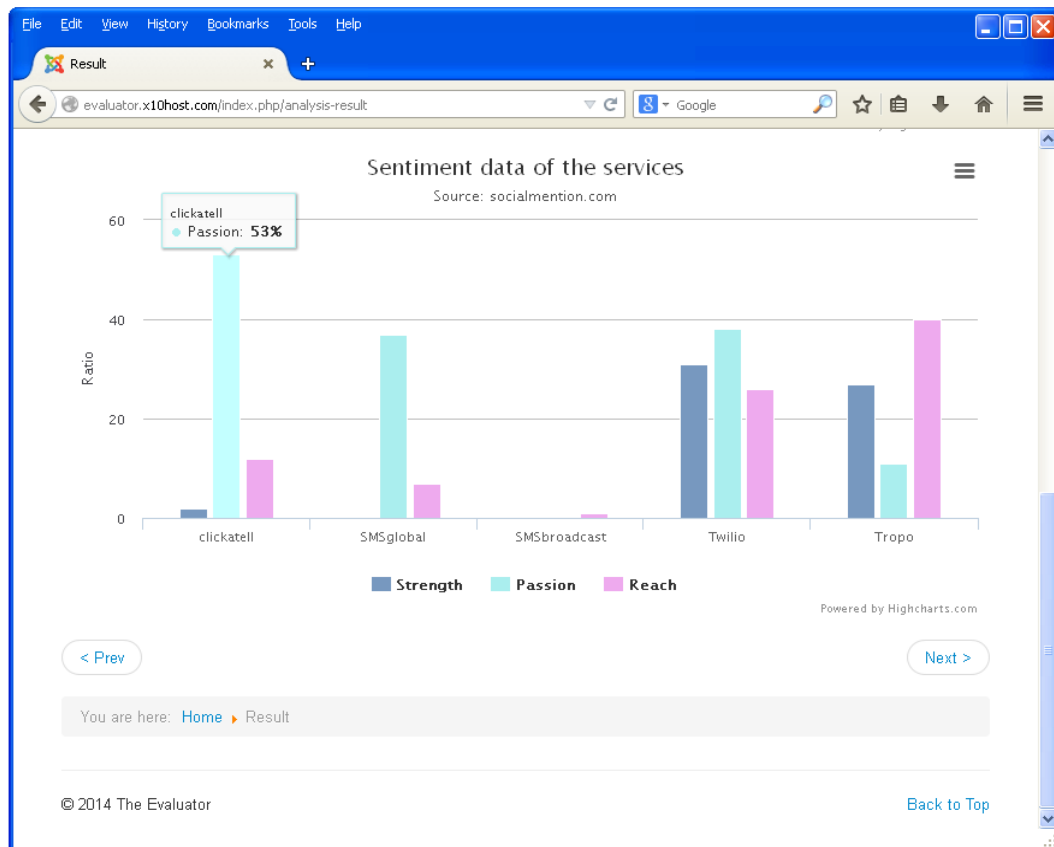


Figure 30 Evaluator Analysis Results – Sentiment Analysis

SUMMARY PART III

Research Goal 3: To evaluate the applicability and effectiveness of the proposed method in an empirical study

The third phase was guided by following research question:

RQ3: Does the proposed method help analysts in overcoming challenges of alignment in Service Oriented Requirements Engineering?

The instantiation of ARISE in case study with real life data indicates that the past user knowledge and experiences expressed through their comments, reviews and feedback is indeed effective in assisting the analysts in making more informed decisions. And the tool support can further reduce the time and effort for analyst in analysing the large data.

Limitations of the studies in Part III

In part III, the case study design (presented in Chapter 7) was a single case and single unit of analysis and therefore the results may face threats to the validity in terms of analytical generalization (Yin 2003). To mitigate this threat, it is recommended to replicate the study (Yin 2003). This was not possible during the time frame of this thesis and is considered for the future directions from this work.

The second threat to validity of the case study results is the fact that I, as researcher, participated in the design and conduct of the study. Therefore researcher's bias can play a confounding role. However I was carrying out the study in consultation with a Business Analyst (who had participated in the interview study previously), and the data was provided

from a real project. In the design and execution of the case study, the granularity analysis is the only part where human judgment was required based on the available service descriptions. I made the assumption that almost similar results in scoring the services should be expected when others would evaluate the relevant service descriptions.

During the experimentation with KG-NLP (conducted in collaboration with Alessio Ferrari) and comparing to the manual results (From Chapter 7) there were some differences in the results. It would be interesting to note the differences in both manual and automated for evaluation that has contributed to difference in results. As part of future directions for our research we will be addressing both of these issues as described below to assess the extent to which these variables impact the results of experiments:

- The tool only used the first page of the websites for service specifications (automatically read first page of the URL) to match them against the requirements set. Whereas in manual evaluation, I was trying seek more information to score the services by navigating through multiple WebPages. Similar technique can be implemented in KG tool to traverse the relevant links on the first page to retrieve further information.
- For the manual evaluation scoring was performed in scale of three (0, 0.5, 1) based on service specification satisfying a particular requirement (unsatisfied, partially satisfied, fully satisfied), whereas the tool was scoring the services on continuous scale (from 0 to 1) based on semantic similarity.

In the next chapter, the conclusion to the thesis is presented along with revisiting the major contributions, implication of my thesis on research and industry. Future research directions are presented along with reflection on the thesis.

CHAPTER 9: CONCLUSION AND FUTURE WORK

In Chapter 1, I presented the overview of the thesis by summarizing the problem, the proposed solution and the structure of the thesis. The research has been presented in three parts according to the research strategy. Part I presented the investigation of the problem space and scoping it to a specific research problem. This part consisted of Chapter 2, 3 and 4 that described in details the literature review, online survey and interview study respectively, for investigation of the challenges of SORE. Part II presented the research conducted for proposed solution. This part consists of chapter 5 that presented a systematic literature review on user involvement and system success, and chapter 6 proposing the ARISE method developed using situational method engineering. Part III consisted of chapter 8 and 9 that described a case study and tool support for the ARISE method respectively. In this chapter, thesis contributions are revisited and the implications of the contributions for research and practice and finally future research directions are presented.

9.1 Thesis Objectives (revisited)

The research in this thesis was conducted in three parts based on the three high level research goals:

Research Goal 1: Explore and define the problem and scope of the research by investigating both theory and practice in service oriented requirements engineering.

To achieve this goal, Part I was guided by the following main research question:

RQ1. What are the challenges of Service Oriented Requirements Engineering?

The systematic and mixed method research approach of the problem definition phase helped in finding that alignment of requirements and services was the top challenge for practitioners in SORE. It also helped in understanding the causes for making alignment a challenging task. This question was further divided into four parts.

RQ1.1: What are the challenges of Service Oriented Requirements Engineering reported in published literature?

Chapter 2 provided a comprehensive survey of literature to establish a background and context for the challenges of service oriented requirements engineering. The findings from the literature were summarized as follows:

- 1 *Integration of Knowledge Management strategy to SOSD life cycle*
- 2 *Non-functional Requirements gathering and assessment*
- 3 *Iterative service discovery Process*
- 4 *Alignment of business requirements and services*
- 5 *Requirement Change Management*
- 6 *Lack of standard RE Process*
- 7 *Testing service oriented systems*
- 8 *Semantic gaps in specifications*
- 9 *Automated dependency discovery*
- 10 *High Level Language Support*

RQ1.2: What are the challenges of Service Oriented Requirements Engineering considered important by the practitioners working on Service Oriented projects?

In Chapter 3, the results of an online survey were presented to rank the challenges from literature review, by practitioners. Following are the top five challenges of SORE:

- 1 *Alignment of business requirements and services*
- 2 *Integration of Knowledge Management strategy to SOSD life cycle*
- 3 *Iterative service discovery Process*
- 4 *Requirements Change Management*
- 5 *Non Functional Requirements gathering and assessment*

RQ1.3: What is the most important challenge of Service Oriented Requirements Engineering?

In Chapter 4, the results of an interview study with practitioners revealed alignment of requirements and services as the most challenging issue of SORE. The analysis of the data from interviews revealed that the other four issues are in fact part of the alignment process.

RQ1.4: What are the reasons for the top challenges of Service Oriented Requirements Engineering?

In Chapter 4, from the interviews with practitioners the reasons for the alignment of requirements to services as the top challenging task in SORE were discovered as follows:

- *Lack of Context*
- *Missing Information*
- *Mismatch in the Level of Abstraction*
- *Mismatch in the Level of Granularity*
- *Paradox of choice*

The practitioners pointed out that they were having more trouble with the social and human related aspect of SORE rather than the technical.

Research Goal 2: Propose a method based on existing theory of “user involvement and system success” by investigating the existing literature

To achieve Research Goal 2, this phase was guided by the following main research question:

RQ2: Does involving user feedback help in overcoming the top challenges of alignment in Service Oriented Requirements Engineering?

User involvement in service oriented requirements engineering through the comments and sentiments of past users of the service can provide an additional source of information that can help in overcoming the challenges of alignment of the requirements and services in SORE. The main question was further divided into following parts:

RQ2.1: Is there any relationship between user involvement and successful software systems?

In chapter 5 the systematic literature review revealed that 68% of the empirical literature published during 1980-2012 shows positive impact of user involvement on system success.

RQ2.2: What are the benefits of user involvement in Software Development Lifecycle?

In Chapter 5 the results of SLR revealed that the published literature indicates that the user involvement yields various benefits from multiple perspectives.

RQ2.3: Is user involvement beneficial in Requirements Engineering?

According to the SLR results effective user involvement in requirements engineering activities is beneficial.

RQ2.4: How can we apply the existing theories of “user involvement” in Service Oriented Requirements Engineering?

In service oriented paradigm the users of the service can be involved in the process of alignment in informative or consultative roles through their voice (feedback, comments, reviews etc. on online resources). The findings of the SLR confirmed that the user

involvement leads to system success. These concepts were the basics for proposing the ARISE method. In Chapter 6, I presented the design of the proposed a method ARISE using SME that incorporates past user feedback to assist the analysts in overcoming the challenges of alignment.

Research Goal 3: To evaluate the applicability and effectiveness of the proposed method in an empirical study

The third phase was guided by following research question:

RQ3: Does the proposed method helps analysts in overcoming challenges of alignment in Service Oriented Requirements Engineering?

Chapter 7 presented an instantiation of the ARISE method that produced promising results in indicating that the past user knowledge and experiences expressed through their comments, reviews and feedback is indeed effective in assisting the analysts in making more informed decisions. In Chapter 8 the tool support for ARISE is presented.

9.2 Summary of thesis findings

A great deal of research efforts has been put into the directions of achieving the true spirit of Service Orientation from academia and industry alike (Gu & Lago 2010; Huergo et al. 2014). In the Service Oriented RE there is an additional task of alignment of services to requirements (Gehlert, Bramsiepe & Pohl 2008). With the exponential growth in the number of available services, finding the most suitable service (that satisfies the customers' requirements) among available options is becoming challenging for the analysts (Garofalakis et al. 2004). Based on the findings from my systematic analysis of the literature, a quantitative study (online survey),

and qualitative study (interviews with practitioners), alignment of requirements to services was found to be the most challenging and problematic task in SORE.

The current solutions for the alignment (e.g. (Adam, Riegel & Doerr 2008; Galster & Bucherer 2008a; Gehlert, Bramsiepe & Pohl 2008; Gu & Lago 2010; Huergo et al. 2014; Papazoglou & Van Den Heuvel 2006; Steghuis 2006; Zachos, Maiden & Howells-Morris 2008)) are focused primarily on the technological aspect of the problem. Involving the people who have the past experience of using a service can provide valuable information that can be helpful in decision making process (Kokash, Birukou & D’Andrea 2007). In service oriented paradigm the involvement of user feedback was found to be in need of further consideration. I have designed and developed the ARISE method where I investigated the benefits of user feedback analysis on the process of alignment and have evaluated that ARISE can help the analysts in overcoming the challenges of alignment. The requirements for the ARISE method were derived from the findings of the survey and interview study. The method was then designed and developed following SME guidelines. The evaluation of the effectiveness of ARISE method was carried out by conducting a case study of its instantiation. The method is supported with an online tool support EVALUATOR to reduce the manual effort of analysis and with Knowledge Graph based NLP tool for automatically performing semantic similarity of the service descriptions with requirements in natural language.

9.3 Thesis contributions (revisited)

As discussed in Chapter 1, the thesis contributes to the existing body of knowledge in six major ways. In the following I revisit the contributions of my research as follows:

1. A comprehensive analysis of the service oriented requirements engineering with the help of a mixed method approach (Literature Review, Quantitative Survey, Qualitative Interviews).
2. Systematic literature review of user involvement in software development of the past three decades and aggregating the results in describing the benefits of user involvement from various perspectives.
3. Designing and developing the ARISE method with Situational Method Engineering guidelines by incorporating past user feedback to overcome challenges of alignments in SORE.
4. Instantiation of the ARISE method in observational case study with data from real life project.
5. Providing automated tool support for the ARISE method with KG-NLP and EVALUATOR.

9.4 Implications for research

This thesis has significant implications for body of knowledge for the research in three ways:

1. Regarding the problem definition phase, I have investigated the challenges of SORE thoroughly and have identified various gaps.
2. In solution space, besides proposing the ARISE method, I have presented the analysis of the empirical literature reported in three decades 1980-2012, on user involvement and system success. It was helpful for my thesis to confirm that user involvement does lead to system success, but it also opened up new dimensions of the research in this area which are fully explored in (Bano & Zowghi 2015).
3. The use of Knowledge Graph based NLP tool for granularity analysis in this thesis is an innovative approach for alignment of services and requirements.

9.5 Implications for industry

One of the major criticisms of the research community is about the validity of the problem and acceptance and applicability of the solution in real world or industry (Davis & Hickey 2002; Wieringa 2005). In my thesis I have attempted to bridge the gap by following the mix method approaches of following not only literature but also eliciting knowledge from the practitioners in industry. The practitioners participated in the problem definition phase through the online survey and interview study for providing confirmation and understanding of the challenges of SORE. This has further assisted in scoping the research problem in this thesis. The proposed solution was implemented on a real world scenario provided by a practicing BA in a case study.

9.6 Future research directions

Currently I continue my collaboration with the research team from Pisa for enhancing the KG-NLP tool not only for improving its accuracy but also for fully automating ARISE by integrating other modules of searching for services, sentiment and user feedback analysis. The work includes definitions of the heuristics applied in manual service evaluation thus applying them in KG-NLP tool for making the tool to understand how an analyst would score a service.

Considering the problem space investigation, I only selected the top challenge among those identified i.e. alignment of requirements and services for the scope of my thesis. There are other important challenges that were identified by practitioners I interviewed, that need further exploration and empirical investigation. These include the requirements change management,

handling non-functional requirements, knowledge management and iterative service discovery. These concepts provide further opportunities of exploration in future research.

Some of the practitioners that I interviewed were also interested in the solution and there is a future plan of conducting another case study in collaboration with them.

The systematic literature review has shown various dimensions of user involvement. I was only interested in its application on the alignment process, but the findings from literature (Bano & Zowghi 2015) show other potentials for future research. These include degree and level of user involvement, perspective of user involvement, tools and methods used for involvement, and benefits and problems of user involvement.

9.7 Reflections

When I started my doctoral degree, I did not have a specific research problem provided by my supervisor and was asked to explore and scope my research in area of Service Oriented Requirements Engineering. Therefore it was an exploration stage for me with a broad starting point, where every step contributed to my knowledge that made the scope clearer for me as I proceeded. The problem analysis phase and the Systematic Literature Review both turned out to be extremely useful tools for my training to critically analyse not only someone else's research but also my own. Reflecting on the research work conducted in this thesis, I can now analyse my own work and see for myself that few of the areas would have improved with slight changes to the conduct of research. First, during online survey, if I had kept the submission link open for longer duration, the number of responses would have increased which may or may not have affected the ranking. Second, if I had more time and resources, during interview study more participants could have been interviewed to delve deeper into the

challenges of SORE. It was arduous at times that I spent considerable period on problem analysis that I could have spent instead in replicating the case study with different project data. However towards the end of the thesis I appreciate the fact that this was a beneficial exercise that has made me a self-learner by giving me the training and ability of problem analysis and triangulation by gathering data from literature, academic resources as well as from industrial participants.

9.8 Concluding Remarks

This thesis has addressed an important and challenging issue in service oriented requirements engineering, one that concerns the optimal alignment between services and requirements, while exploiting the benefits of past users feedback in the alignment process. It has reiterated the usefulness of a particular mode of users' involvement in software development.

The requirements for a novel alignment method in SORE were elicited through a three stage mixed method problem analysis approach. The ARISE method for aligning requirements and services was inspired by the result of an extensive Systematic Literature Review and designed using the guidelines of Situational Method Engineering. The usefulness of the ARISE method was demonstrated through its instantiation with a real life case study.

I believe that the work presented in this thesis has achieved significant steps towards a better understanding of some of the challenging and crucial issues in SORE. In developing the work reported in this thesis, diverse threads from different research disciplines were brought together. The novel application of these theories and practices has opened up a new and fruitful area of research for which this thesis is a starting point.

The proposed ARISE method and its corresponding successful instantiation represents a realistic approach to addressing the challenges of alignment in SORE. Such work is only of

value to the wider software engineering community if it can eventually find its way into practice and be of some practical use to analysts.

Alford suggests that successful technology transfer depends on four factors (Alford 1994): (1) not having too complex an idea, (2) an ability to show immediate benefits of the idea, (3) an ability to try a small part of it at a time and gradually extending its scope, and (4) an understanding of whether the idea is an extension to known technology, so as to utilize existing skills, or requires completely “new” ones. The idea of the ARISE method although rigorous and practical, is fundamentally very simple. This thesis has been able to demonstrate through a real life case study what the immediate benefits of the ARISE method are. Furthermore, I have taken an incremental engineering approach in tool support for ARISE method by starting with the design and implementation of a web interface as well as integration with an existing NLP tool based on Knowledge Graphs. This has provided further suggestions on how to integrate ARISE with other components from existing research results and the commercially available technology. It is envisaged that the subsequent phases of this research will involve close collaboration with RE practitioners and I hope that as a result of this enabling research, alignment process will be better informed and have recourse to more effective and sophisticated tools and techniques for service oriented requirements engineering.

-----||| *The End* |||-----

APPENDIX A: THE SURVEY QUESTIONNAIRE

Following is the questionnaire that was presented in online survey to the practitioners to elicit their agreement level for the challenges of SORE gathered from the literature. The question items are presented along with their measurement factor to which the agreement level of the practitioners (Appendix B) was later aggregated for their ranking.

Issues and Challenges of Service Oriented Requirements Engineering

Demographic Questions:

Your Job Role: _____

Number of years of experience in Service Oriented Development: _____

Your nature of experience in Service Oriented Projects: _____ (Practitioner/Researcher)

Country where you had worked on Service Oriented Projects: _____

Questionnaire items:

Q#	Question Items	Measurement Factor
1	A prior knowledge of available services leads to a better understanding of system requirements.	Knowledge Management/ Alignment of requirements and service
2	To increase the knowledge of available services, service discovery should be performed in parallel to requirements engineering.	Knowledge Management/ Iterative Discovery Process
3	Flexible requirements help the designer in matchmaking between requirements and available services.	Alignment of requirements and service
4	A prior knowledge of available services helps to reduce the efforts in bringing a match between user requirements and available services.	Alignment of requirements and service
5	Semantic gaps are inevitable when we have to match user requirements to the published specification of services.	Semantic gaps in specifications
6	Automated service discovery produces better results than manual discovery process.	Alignment of requirements and service
7	In automated service discovery, testing the services is necessary as we cannot always trust published specification of services.	Alignment of requirements and service

8	Due to semantic differences in published specification of services, automated discovery may not yield accurate results.	Semantic gaps in specifications / Alignment of requirements and service
9	High level language, dedicated for service oriented paradigm is required for specifying user requirements.	High Level Language Support
10	The conversion of user requirements in formal specification is difficult in service oriented paradigm due to lack of sufficient technical support.	High Level Language Support
11	Query languages limit the capability of fully specifying user requirements for service discovery.	High Level Language Support
12	Performing service discovery in iteration with requirement analysis helps in completing system requirements.	Iterative Service Discovery
13	Uncertain market conditions are a major cause of change in service requirements.	Requirement change management
14	To compete with other services, service engineering should have creativity and innovation as a part of requirement engineering phase.	Innovation and Creativity in RE
15	Integrating Knowledge Management (KM) in Service Oriented software development life cycle would help in reducing the efforts required for re-composition.	Knowledge Management
16	Selected services if belong to hybrid platform, can cause integration problems during composition.	Semantic gaps in specification
17	Knowledge management helps in overcoming most of issues of requirements engineering.	Knowledge Management
18	Non Functional Requirements (NFR) cannot be specified in query while discovering web services.	Non functional Requirements
19	NFR provides criteria for service selection when multiple services are available for one requirement.	Non functional Requirements
20	Gathering NFR is mandatory in automated discovery and selection process.	Non functional Requirements
21	Instead of testing individual services against single requirements, the composed system should be tested against system requirements.	Testing Service Oriented Systems
22	Deadlocks can happen during composition execution due to services having interdependencies.	Automated dependency discovery
23	Prior knowledge of service interdependencies would lead to secure composition.	Knowledge Management
24	Lack of standard requirements engineering Process for SOSD is the major cause of issues faced by designers working on service oriented projects.	Lack of standard RE process for SOSE

APPENDIX B: RESULTS FROM ONLINE SURVEY

Q#	Question Items	Responses		
1	A prior knowledge of available services leads to a better understanding of system requirements. Agreement Level: 86%	Strongly Agree	46	39%
		Agree	55	47%
		Neutral	6	5%
		Disagree	5	4%
		Strongly Disagree	5	4%
2	To increase the knowledge of available services, service discovery should be performed in parallel to requirements engineering. Agreement Level: 76%	Strongly Agree	40	34%
		Agree	49	42%
		Neutral	17	15%
		Disagree	7	6%
		Strongly Disagree	4	3%
3	Flexible requirements help the designer in matchmaking between requirements and available services. Agreement Level: 54%	Strongly Agree	23	20%
		Agree	40	34%
		Neutral	37	32%
		Disagree	13	11%
		Strongly Disagree	4	3%
4	A prior knowledge of available services helps to reduce the efforts in bringing a match between user requirements and available services. Agreement Level: 88%	Strongly Agree	43	37%
		Agree	60	51%
		Neutral	12	10%
		Disagree	1	1%
		Strongly Disagree	1	1%
5	Semantic gaps are inevitable when we have to match user requirements to the published specification of services. Agreement Level: 63%	Strongly Agree	26	22%
		Agree	48	41%
		Neutral	27	23%
		Disagree	15	13%
		Strongly Disagree	1	1%
6	Automated service discovery produces better results than manual discovery process. Agreement Level: 33%	Strongly Agree	14	12%
		Agree	25	21%
		Neutral	51	44%
		Disagree	22	19%
		Strongly Disagree	5	4%
7	In automated service discovery, testing the services is necessary as we cannot always trust published specification of services. Agreement Level: 72%	Strongly Agree	35	30%
		Agree	49	42%
		Neutral	19	16%
		Disagree	10	9%
		Strongly Disagree	4	3%
8	Due to semantic differences in published specification of services, automated discovery may not yield accurate results.	Strongly Agree	19	16%
		Agree	60	51%

	Agreement Level: 67%	Neutral	23	20%
		Disagree	11	9%
		Strongly Disagree	4	3%
9	High level language, dedicated for service oriented paradigm is required for specifying user requirements.	Strongly Agree	12	10%
		Agree	39	33%
		Neutral	39	33%
	Agreement Level: 43%	Disagree	18	15%
		Strongly Disagree	9	8%
10	The conversion of user requirements in formal specification is difficult in service oriented paradigm due to lack of sufficient technical support.	Strongly Agree	13	11%
		Agree	28	24%
		Neutral	17	15%
	Agreement Level: 35%	Disagree	47	40%
		Strongly Disagree	12	10%
11	Query languages limit the capability of fully specifying user requirements for service discovery.	Strongly Agree	4	3%
		Agree	33	28%
		Neutral	44	38%
	Agreement Level: 31%	Disagree	29	25%
		Strongly Disagree	7	6%
12	Performing service discovery in iteration with requirement analysis helps in completing system requirements.	Strongly Agree	26	22%
		Agree	60	51%
		Neutral	20	17%
	Agreement Level: 73%	Disagree	9	8%
		Strongly Disagree	2	2%
13	Uncertain market conditions are a major cause of change in service requirements.	Strongly Agree	18	15%
		Agree	42	36%
		Neutral	31	26%
	Agreement Level: 51%	Disagree	23	20%
		Strongly Disagree	3	3%
14	To compete with other services, service engineering should have creativity and innovation as a part of requirement engineering phase.	Strongly Agree	35	30%
		Agree	46	46%
		Neutral	26	22%
	Agreement Level: 76%	Disagree	6	5%
		Strongly Disagree	4	3%
15	Integrating Knowledge Management (KM) in Service Oriented software development life cycle would help in reducing the efforts required for re-composition.	Strongly Agree	37	32%
		Agree	57	49%
		Neutral	21	18%
	Agreement Level: 81%	Disagree	2	2%
		Strongly Disagree	0	0%
16	Selected services if belong to hybrid platform, can cause integration problems during composition.	Strongly Agree	10	9%
		Agree	44	38%
		Neutral	35	30%
	Agreement Level: 47%	Disagree	23	20%

		Strongly Disagree	5	4%
17	Knowledge management helps in overcoming most of issues of requirements engineering. Agreement Level: 51%	Strongly Agree	17	15%
		Agree	42	36%
		Neutral	40	34%
		Disagree	17	15%
		Strongly Disagree	1	1%
18	Non Functional Requirements (NFR) cannot be specified in query while discovering web services. Agreement Level: 35%	Strongly Agree	11	9%
		Agree	31	26%
		Neutral	33	28%
		Disagree	30	26%
		Strongly Disagree	12	10%
19	NFR provides criteria for service selection when multiple services are available for one requirement. Agreement Level: 76%	Strongly Agree	27	23%
		Agree	62	53%
		Neutral	17	15%
		Disagree	9	8%
		Strongly Disagree	2	2%
20	Gathering NFR is mandatory in automated discovery and selection process. Agreement Level: 69%	Strongly Agree	29	25%
		Agree	51	44%
		Neutral	25	21%
		Disagree	10	9%
		Strongly Disagree	2	2%
21	Instead of testing individual services against single requirements, the composed system should be tested again system requirements. Agreement Level: 63%	Strongly Agree	31	26%
		Agree	43	37%
		Neutral	24	21%
		Disagree	15	13%
		Strongly Disagree	4	3%
22	Deadlocks can happen during composition execution due to services having interdependencies. Agreement Level: 66%	Strongly Agree	14	12%
		Agree	63	54%
		Neutral	25	21%
		Disagree	10	9%
		Strongly Disagree	5	4%
23	Prior knowledge of service interdependencies would lead to secure composition. Agreement Level: 73%	Strongly Agree	27	23%
		Agree	59	50%
		Neutral	21	18%
		Disagree	7	6%
		Strongly Disagree	3	3%
24	Lack of standard requirements engineering Process for SOSD is the major cause of issues faced by designers working on service oriented projects. Agreement Level: 55%	Strongly Agree	24	21%
		Agree	40	34%
		Neutral	41	35%
		Disagree	10	9%
		Strongly Disagree	2	2%

APPENDIX C: SYSTEMATIC LITERATURE REVIEW

According to the SLR guidelines it is necessary to explicitly explain the planning and execution procedure of SLR to display the transparency and rigor of the process and make the results reliable and repeatable. In this appendix, the planning and execution of the systematic review is given for further information of the reader.

C.1 SYSTEMATIC LITERATURE REVIEW PLANNING

None of these previously conducted reviews were following the EBSE guidelines (Kitchenham & Charters 2007). An SLR based on the guidelines follows a rigorous and scrupulous procedure for search and selection of the sample studies in review. It is methodical and meticulous process of collecting and collating the acceptable quality published empirical studies based on a systemic protocol to reduce bias and provide transparency to the process. The process is formally documented and hence repeatable.

The SLR based on the guidelines proposed in (Kitchenham & Charters 2007) consists of three main steps; Planning, Execution and Reporting. I followed the guidelines and carried out all the proposed phases of SLR starting from the development of protocol which outlined all the details of our primary and secondary search strategy, study selection criteria, quality assessment of finally included studies, data extraction strategy to answer our research question, data synthesis and analysis planning. The protocol was pilot tested for evaluating the completeness of our search string, and correctness of inclusion/exclusion criteria and data extraction strategy. After pilot testing the updated version of the protocol was sent to the external reviewers (including Kitchenham), and the recommended changes (especially related to the scope of the study) were accommodated in the final version of protocol.

The SLR was exploratory in nature. The aim was to find all the empirical papers published from 1980 to 2012 that investigated and evaluated user involvement in software and system development. During planning phase of our SLR, with the help of a pilot study I developed 9 questions for exploration (Bano & Zowghi 2015), but in this thesis the findings for the answers to three related questions are discussed only.

- (1) Is there any relationship between user involvement and the successful software systems?*
- (2) What are the benefits of user involvement in Software Development Lifecycle?*
- (3) Is user involvement beneficial in requirements engineering?*

The review was based on three major terms (user, involvement, software development) which resulted in the following search string;

ON ABSTRACT ((user OR customer OR consumer OR “end user” OR end-user) AND (involv* OR participat* OR contribut*)) AND (“software development” OR “software project” OR “IS” OR “information system” OR “IT” OR “information technology” OR “SDLC” OR “product development” OR “IT adoption” OR “IT diffusion”))

I executed this search string by customizing it according to the ACM Digital Library, IEEE xplore, Science Direct, Google Scholar, Citeseerx, Springerlink, and MIS Quarterly, Association of Information System electronic Library (AISel), INFORMS online (Operation Research and Management Sciences), Journal of Management Science, Journal of Information System Research, Journal of Operations Research. I searched the DBLP¹¹ publication profiles of some authors who were highly cited for their work on users’ involvement. They were: E.

¹¹ <http://www.informatik.uni-trier.de/~ley/db/>

Mumford, H. Barki, J. Hartwick, M. H. Olson, J. J. Baroudi, B. Ives, G. Torkzadeh, W. J. Doll, R. Hirschheim, Khalid El Emam, L. A. Keppleman, J. D. McKeen, and S. Kujala.

I scanned references of three specific literature reviews to check for missing papers in our results. My reason for the selection of these three reviews was based on the high quality of the journals they were published in; they had a high citation index and covered the last four decades;

- B. Ives and M. H. Olson, 'User involvement and MIS success: a review of research', *Management science*, vol. 30, no. 5, pp. 586–603, 1984.
- L. M. Cavaye, 'User participation in system development revisited', *Information & Management*, vol. 28, no. 5, pp. 311–323, 1995.
- J. He and W. R. King, 'The role of user participation in information systems development: Implications from a meta-analysis', *Journal of Management Information Systems*, vol. 25, no. 1, pp. 301–331, 2008.

For studies that have been published in conferences and an extended version as journal articles, we only selected their journal versions. To make the review more focused and manageable, I also excluded papers where users' involvement or participation was considered as only one factor among many for system success or users' involvement was not the main focus.

I excluded a few studies that were extremely low quality and some who have plagiarized the works of others. I used the journal and conference ranking of Excellence of Research in Australia (ERA 2010^{12, 13}) for assessing the quality of our selected papers. From the overall

¹² www.arc.gov.au/xls/era2010_journal_title_list.xls

¹³ www.arc.gov.au/xls/era2010_conference_list.xls

search process (from online databases as well as manual search), after discarding duplicates, applying study selection criteria and excluding non-related and low quality papers, I was left with 87 empirical studies. The full details of the process execution and results are presented in (Bano & Zowghi 2015). In the SLR, I did not differentiate between “user involvement” and “user participation” due to the following reasons:

1. The included studies were not homogeneous in their making distinctions between the concepts of “user involvement” and “user participation” as described by Hartwick and Barki (Barki & Hartwick 1989).
2. I consider participation as a form of involvement. Because the users who participate in development activities are a subset of the users who are considered involved. Both involved and participating users then belong to the larger set of stakeholders (Markus & Mao 2004), i.e. Participating Users $\subset$ Involved Users $\subset$ Stakeholders.

Coding technique was used manually to identify the relevant text in the finally included papers while reading the entire paper. Later we transformed the codes to NVivo software and further performed thematic coding and analysis (Cruzes & Dybå 2011), to answer the research questions. In synthesis I was interested to divide the results against two criteria: the year of publication (divided in three decades), and research method utilized by the study in producing the results. The reason for analyzing year of the publication was to see the overall trends in three decades for temporal view and to compare our results with the previous reviews. The reason for choosing research method for analysis was because as it has been pointed out in

ERA (<http://www.arc.gov.au/era/>) is administered by Australian Research Council which aims to identify and promote excellence across the full spectrum of research activity in Australia's higher education institutions. It also provides a comprehensive overview of the quality of research undertaken in higher education institutions across the country, in an international context. In ERA ranking, the journals and conferences are ranked into five categories based on their quality (A, A, B, C, UR (unranked)).*

(Cavaye 1995; Ives & Olson 1984), choice of research method may give rise to conflicting results.

We developed the categories for the perspective of user involvement to answer RQ3, based on their objective of involving users. To address this question, our initial focus was primarily on understanding the goals and objectives for involving users in system development. But it soon became clear that focusing on goals and objectives in isolation does not provide a coherent and complete view and that we must also take into account the needs and perceived benefits of user involvement. While we were analysing the literature for these factors we also noticed that to achieve the goals of user involvement there are many problems and challenges that need to be investigated in tandem.

We began by reviewing the papers to answer the question: “why involve users?” The most obvious and widespread answer to this question is “to achieve system success”. But it was apparent that everyone has different view of what system success really means. There were many views and positions found in the literature on this topic. So, we began by extracting the list of benefits because most authors were using benefits as criteria for determining system success. Creating a flat list of all the extracted benefits of user involvement revealed that these benefits are perceived from different points of view. For example, some researchers were only interested in the psychological stance of this benefit as perceived by the users who are involved while others were focusing on managerial or methodological aspects. This led us to conclude that there are multiple views of benefits, problems, and challenges of the UI-SS relationship. We thus decided to build a classification of these views and attitudes to use in our analysis and we refer to them as “perspectives”. These perspectives will provide a typology to classify benefits, problems and challenges for user involvement. We named these perspectives

with the help of thematic coding and analysis techniques from the relevant coded text. These names are the most commonly used phrases from the literature that describe the relevant positions or views of user involvement.

C.2 SYSTEMATIC LITERATURE REVIEW EXECUTION

By executing the search string on selected resources, we retrieved a total of 2776 papers in the results for primary searches. By following the study selection criteria from both primary and secondary searches, a sample of 87 empirical studies was retrieved for final inclusion. Figure C.1 shows the search and selection process during execution.

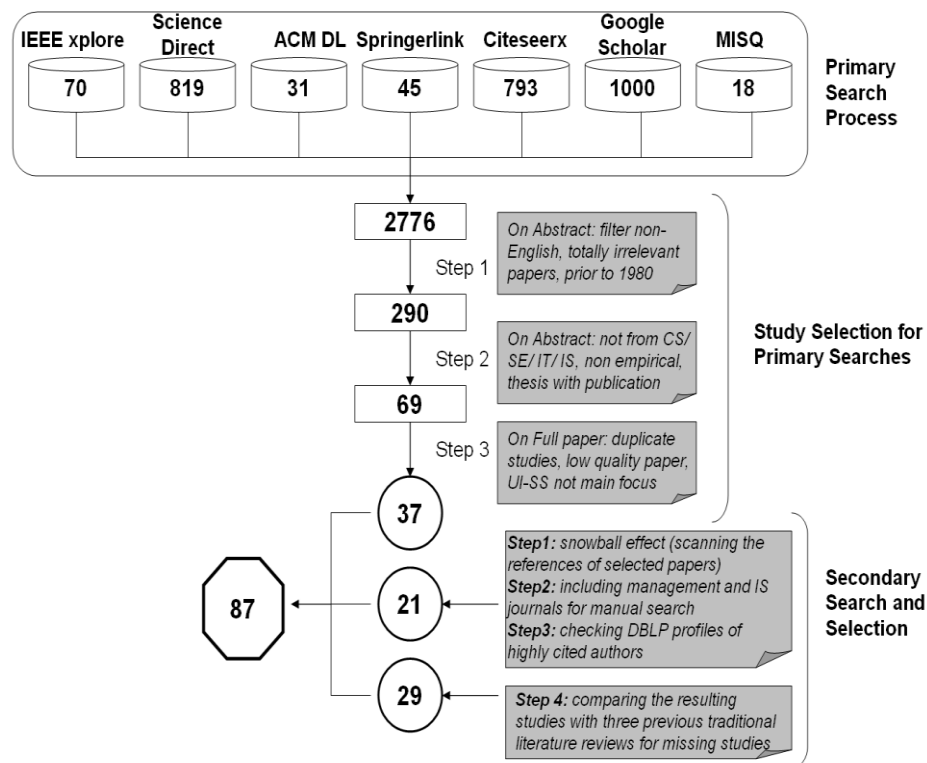


FIGURE C.1 SLR EXECUTION PROCESS

Out of 87, 39 papers are from A* ranked journals and 16 from A ranked journals/conferences, which indicates overall high quality of the results (Figure C.2).

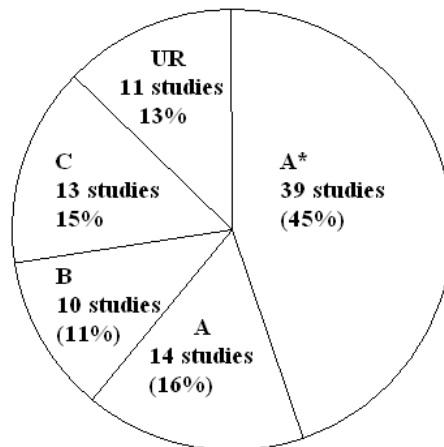


FIGURE C.2. ERA RANKING OF RESULTANT STUDIES

Out of 87 studies, 15 belong to first decade (1980-1989), 39 belong to second (1990-1999) and 33 belong to third decade (2000-2012).

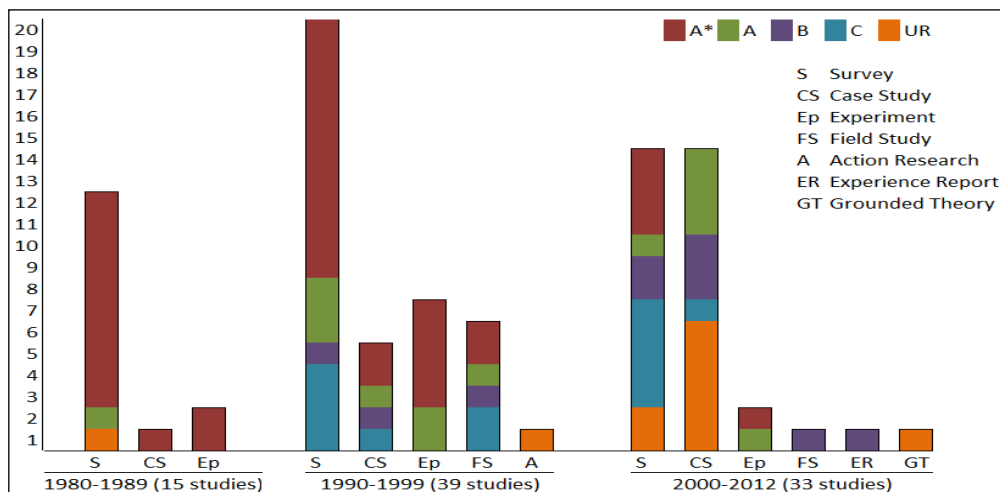


FIGURE C.3 SUMMARY OF CHARACTERISTICS OF INCLUDED STUDIES (NUMBER OF STUDIES WRT DECADE, RESEARCH METHOD AND ERA RANKING)

Our collection has 46 surveys, 20 case studies, 11 experiments, 7 field studies, one action research, one experience report and one grounded theory (Figure C.4).

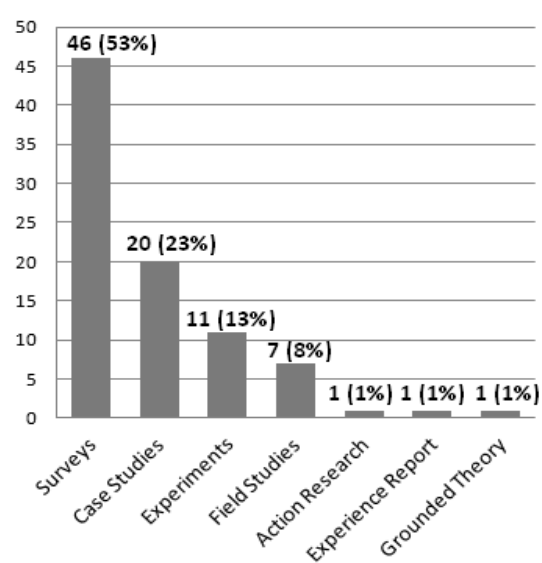


FIGURE C.4 RESEARCH METHODS IN RESULTANT STUDIES

APPENDIX D: AVAILABLE SERVICE SET

The following table shows the list of available SMS gateway services that were found from online searches. These were evaluated for customer requirements in the case study. The service SR# given below is used to identify a service in Appendix E and F.

Sr#	Service name	Link
1	Clickatell	http://www.clickatell.com.au/products/communicator.php
2	SMS global	http://www.smsglobal.com/web-sms/
3	Exe TEL SMS	http://www.exetel.com.au/corporate/sms
4	Message net	http://www.messagenet.com.au/web-sms-gateway.aspx
5	SMS broadcast	https://www.smsbroadcast.com.au/
6	Burst SMS	http://burstsms.net/
7	Tropo	https://www.tropo.com/
8	UTbox	http://www.utbox.net/sms-email/
9	Twilio	http://www.twilio.com/sms
10	Froline SMS	http://www.frontlinesms.com/
11	Envaya SMS	http://sms.envaya.org/
12	Rapid SMS	https://www.rapidsms.org/
13	SMS sync	http://smssync.usahidi.com/
14	Mblox	http://www.mblox.com/
15	Bulk SMS	http://www.bulk sms.com/int/w/solutions_http_to_sms.htm
16	SMS xchange	http://www.smsxchange.com/main/default.asp
17	Text anywhere	http://www.textanywhere.net/developers/
18	Nexmo	https://www.nexmo.com/
19	Intel tech	http://inteltech.com.au
20	Plivo	https://www.plivo.com/docs/
21	Sendhub	https://www.sendhub.com/
22	Mogreet	https://developer.mogreet.com/
23	Messente	https://messente.com/
24	Sent.ly	http://www.sent.ly/
25	Text marketer	http://www.textmarketer.co.uk/
26	Message bird	https://www.messagebird.com/en/
27	Sparrow SMS	http://api.sparrowsms.com/platform/docs/
28	Fowiz text messaging	http://www.fowiz.com/

29	AT&T SMS API	https://developer.att.com/apis/sms-mms
30	Verizon	http://developer.verizon.com/content/vdc/en/
31	Orange SMS	http://www.orangepartner.com/content/orange-apis-message
32	Vodafone Multitext SMS API	http://vodafoneessaging.com.au/smser
33	Trumpia	http://trumpia.com/
34	Clock work SMS	http://www.clockworksms.com/
35	SMSified	http://smsified.com/
36	Eztexting	http://www.eztexting.com/developers/
37	Message media	http://www.message-media.com/
38	Text marks	https://www.textmarks.com/front/dev/
39	Text local	http://www.textlocal.com/simple-developer-sms-api
40	Firefox web SMS	https://developer.mozilla.org/en-US/docs/WebAPI/WebSMS
41	Text magic	http://www.textmagic.com/app/pages/en/products/bulk-sms-gateway-api
42	Oventus	https://www.ovens.com/developer/getting-started-api/
43	Txt tools	https://www.txttools.co.uk/preloginjsp/developers.jsp
44	Apifon	http://apifon.com/service/sms-api
45	My net fone	https://www.mynetfone.com.au/Business/Enhanced-Services/MyText-SMS/API
46	TM4B SMS gateway	http://www.tm4b.com/sending-sms/sms-api.php
47	SMS country	http://www.smscountry.com/productdetails.aspx
48	Developer garden	http://www.developergarden.com/en/apis/apis-sdks/global-sms-api/
49	Dial my calls	http://www.dialmycalls.com/texting.html
50	Telapi	http://www.telapi.com/
51	Message net	http://www.messagenet.com.au/service-solutions_web-email-sms-software.aspx
52	Carousel SMS	https://carouselsms.com/
53	Essendex	http://www.esendex.us/Services/SMS-API
54	SMS gateway	http://www.msgateway.ca/
55	Upside wireless	http://www.upsidewireless.com/api.htm
56	AQL SMS API	http://aql.com/sms/integrated/sms-api/
57	GSMA	http://www.gsma.com/oneapi/sms-restful-netapi/
58	Tele sign mobile	http://www.telesignmobile.com/SMS-API.pmx
59	Avetio SMS SPI	https://www.avetio.com/smsapi
60	Zipwip API	http://www.zipwhip.com/api
61	HQ SMS	http://www.hqsms.com/help-api/https-api-interface
62	One API 4 SMS	http://www.oneapi4sms.com/
63	Cdyne	http://www.cdyne.com/api/phone/sms/
64	Swift SMS Gateway	http://www.swiftmsgateway.com/api.php

65	Wave cell	http://www.wavecell.com/
66	Click send	http://clicksend.com.au/
67	Earth SMS	http://www.earthsms.net/
68	Skebby	http://www.skebby.com/sms-bulk-solutions/sms-business-services/
69	Expert texting	http://www.experttexting.com/
70	Ausie SMS	http://www.aussiesms.com.au/sms-gateway.php
71	Direct SMS	http://www.directsms.com.au/
72	Tatango	http://www.tatango.com/services/bulk-sms-gateway
73	SMS matrix	http://www.smsmatrix.com/?sms-gateway
74	SMS central	http://www.smscentral.com.au/sms-gateway/
75	Neural	https://www.neural.com.au/sms
76	Via SMS	http://viasms.com.au/
77	My cool SMS	http://www.my-cool-sms.com/en/
78	Budget SMS	http://www.budgetsms.net/
79	M4U	http://www.m4u.com.au/api-sms-gateway.html
80	Intelli software	http://www.intellisoftware.co.uk/sms-gateway/
81	Telstra	http://www.developer.telstra.com/web/third-party/messaging
82	Gateway 160	http://www.gateway160.com/
83	Red oxygen	http://redoxygen.com/
84	Dialogue	http://www.dialogue.net/api/sms-api
85	Sumo text	http://www.sumotext.com/sms-gateway.html
86	Ready to SMS	http://www.readytosms.com.au/
87	TXT nation	http://www.txtnation.com/solutions/gateway/
88	Free SMS craze	http://www.freemscraze.com/api.html
89	SMS roaming	http://www.smsroaming.com/
90	Panacea mobile	http://www.panaceamobile.com/
91	Text impact	http://www.txtimpact.com/sms-gateway-api/
92	My mobile API	http://www.mymobileapi.com/webservices.aspx

APPENDIX E: GRANULARITY ANALYSIS (RANKED)

The table below shows the granularity analysis scoring of whether a service fully satisfy customer requirement (score 1), partially satisfy a requirement (0.5) or do not satisfy the requirement (0). On x axis are the service SR# (see Appendix D) and on y axis are the customer requirements from the case study. The table is sorted according to the total result showing coverage of the requirements by the services.

Services	Customer Requirements																												Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
76	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	27
19	1	1	1	0.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	27.5
68	0.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	27.5
71	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	27
86	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	26
23	0.5	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	26.5
66	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	25
5	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	24
15	0.5	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	24.5
34	0.5	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	24.5
61	0.5	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	23.5
1	0.5	1	1	1	1	0	0.5	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	24
83	0.5	1	1	1	1	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24.5
18	0.5	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	23.5
53	0.5	1	1	1	1	0	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	23.5
3	0.5	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	22.5
2	0.5	1	0	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	23.5
9	0.5	1	1	1	1	0	0.5	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	22
70	1	1	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	20
81	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22

Alignment of Requirements and Services (ARISE)

73	0.5	1	0	1	1	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	20.5	
91	0.5	1	0	1	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	20.5	
7	0.5	1	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	19.5	
8	1	1	0	1	1	0	1	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	20	
36	0.5	1	0	1	1	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	20.5	
17	0.5	1	0	0	1	0	0	0.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	20	
16	0.5	1	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	0	19.5	
65	0.5	1	0	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	20.5	
32	1	1	1	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	19	
44	1	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	20	
41	0.5	1	0	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	18.5	
62	0.5	1	0	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	19.5	
69	0.5	1	0	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	19.5	
77	0.5	1	0	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	19.5	
78	0.5	1	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	19.5	
51	1	1	0	0	1	1	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	0	19	
75	1	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	19	
59	0.5	1	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	19.5	
29	0.5	1	1	1	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	19.5
84	0.5	1	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	19.5
6	0.5	0	0	1	1	0	0	1	1	1	1	1	0.5	1	1	1	1	1	1	1	1	1	0	1	0	0	0	1	19	
85	0.5	1	0	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	18.5	
90	0.5	1	0	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	18.5	
45	1	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	0	18	
74	0	1	1	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20	
57	0.5	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	0	17.5	
39	0.5	1	0	1	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	16.5	
10	0	1	0	1	1	0	0.5	0	1	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	0	1	1	1	0	17.5
11	0	1	0	1	1	0	0.5	0	1	1	1	1	1	0	1	1	1	1	1	1	1	0	0	1	0	0	1	1	0	17.5
12	0	1	0	1	1	0	0.5	0	1	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	0	1	1	1	0	17.5

Alignment of Requirements and Services (ARISE)

13	0	1	0	1	1	0	0.5	0	1	1	1	1	1	0	1	1	1	1	1	0	0	1	0	0	1	1	1	0	17.5	
21	0.5	1	0	0	1	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	17.5	
4	1	1	1	0	1	0	0	0	1	1	0	1	0.5	0	0	1	1	1	1	1	1	1	1	0	1	1	0	0	0	16.5
20	0.5	1	0	1	1	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	16.5
55	0.5	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	16.5
58	0.5	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	16.5
30	0	1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	17
56	0.5	1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	0	16.5
42	0.5	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	15.5
46	0.5	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	15.5
52	0	1	0	1	1	0	0.5	0	0	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	0	1	1	1	0	16.5
63	0	1	0	1	1	0	0.5	0	0	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	0	1	1	1	0	16.5
64	0	1	0	1	1	0	0.5	0	0	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	0	1	1	1	0	16.5
82	0	1	0	1	1	0	0.5	0	0	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	0	1	1	1	0	16.5
27	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	16
33	0	1	0	1	1	0	0.5	0	1	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	0	0	1	0	0	15.5
43	0	1	0	1	1	0	0.5	0	1	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	15.5
67	0	1	0	1	1	0	0.5	0	1	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	15.5
26	0.5	0	0	0	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	0	16.5
48	0.5	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	15.5
60	0.5	1	0	0	1	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	15.5
35	0	1	0	1	1	0	0.5	0	0	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	0	1	0	1	0	15.5
47	0	1	0	1	1	0	0.5	0	0	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	0	0	1	1	0	15.5
54	0	1	0	1	1	0	0.5	0	0	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	0	1	0	1	0	15.5
25	0.5	0	0	0	1	0	0	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	16.5
40	0	1	0	1	1	0	0.5	0	1	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	14.5
72	0	1	0	1	1	0	0.5	0	1	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	14.5
80	0	1	0	1	1	0	0.5	0	1	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	14.5
38	0.5	1	0	0	1	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	14.5
24	0	1	0	1	1	0	0.5	0	0	1	0	1	1	0	1	1	1	1	1	1	0	0	1	0	0	1	1	1	0	15.5

Alignment of Requirements and Services (ARISE)

92	0	1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	15
31	0	1	0	1	1	0	0.5	0	0	1	1	1	1	0	1	1	1	1	1	0	0	1	0	0	1	0	0	0	14.5
50	0	1	0	1	1	0	0.5	0	0	1	1	1	0	0	1	1	1	1	1	0	0	1	0	0	1	0	1	0	14.5
37	0	1	0	1	1	0	0.5	0	0	1	1	1	1	0	1	1	1	1	1	0	0	1	0	0	0	0	0	0	13.5
87	0.5	1	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	13.5
28	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0.5	1	1	1	1	1	1	1	0	0	1	0	0	1	14.5
49	0.5	0	0	1	1	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	12.5
89	0.5	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	9.5
14	0.5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	8.5
88	0.5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	8.5
79	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	8

APPENDIX F: MCDA SCORES (RANKED)

Following table shows the ranking of the services after multiplied with the respective weights of the requirements according to the customer preferences as shown in the case study.

Ranking	Services	Customer Requirements																												Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
1	76	15	15	10	10	10	10	10	10	10	10	10	10	10	10	10	10	8	8	8	8	8	8	8	8	6	6	6	0	252
2	19	15	15	10	5	10	10	10	10	10	10	10	10	10	10	10	10	8	8	8	8	8	8	8	8	6	6	6	3	250
3	68	7.5	15	10	10	10	10	10	10	10	10	10	10	10	10	10	10	8	8	8	8	8	8	8	8	6	6	6	3	247.5
4	71	15	15	10	0	10	10	10	10	10	10	10	10	10	10	10	10	8	8	8	8	8	8	8	8	6	6	6	3	245
5	86	15	15	10	10	10	10	10	0	10	10	10	10	10	10	10	10	8	8	8	8	8	8	8	8	6	6	6	0	242
6	23	7.5	15	10	10	10	10	10	10	10	10	10	10	10	0	10	10	8	8	8	8	8	8	8	8	6	6	6	3	237.5
7	66	15	15	10	0	10	10	10	10	0	10	10	10	10	10	10	10	8	8	8	8	8	8	8	8	6	6	6	0	232
8	5	15	15	10	10	10	0	10	10	10	10	10	10	10	10	10	10	8	8	8	8	8	8	8	8	0	6	0	0	230
9	15	7.5	15	0	10	10	10	10	10	10	10	10	10	10	10	10	10	8	8	8	8	8	8	8	8	6	0	6	0	228.5
10	34	7.5	15	0	10	10	10	10	10	10	10	10	10	10	10	10	10	8	8	8	8	8	8	8	8	6	0	6	0	228.5
11	61	7.5	15	0	10	10	10	10	10	10	10	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	6	0	220.5
12	1	7.5	15	10	10	10	0	5	0	10	10	10	10	10	10	10	10	8	8	8	8	8	8	8	8	6	6	6	0	219.5
13	83	7.5	15	10	10	10	0	0	10	0	10	10	10	10	10	10	10	8	8	8	8	8	8	8	8	6	6	6	3	217.5
14	18	7.5	15	10	10	10	10	0	0	0	10	10	10	10	10	10	10	8	8	8	8	8	8	8	8	6	6	6	0	214.5
15	53	7.5	15	10	10	10	0	0	10	10	10	0	10	10	10	10	10	8	8	8	8	8	8	8	8	6	6	6	0	214.5
16	3	7.5	15	0	10	10	10	10	10	0	10	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	6	0	210.5
17	2	7.5	15	0	10	10	0	10	0	10	10	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	6	6	3	209.5
18	9	7.5	15	10	10	10	0	5	0	10	10	10	10	10	0	10	10	8	8	8	8	8	8	8	8	6	6	0	0	203.5
	70	15	15	0	10	10	10	10	10	0	0	10	10	10	10	10	10	8	8	8	8	8	8	0	8	0	0	0	0	196
	81	15	15	10	0	0	0	0	0	0	10	10	10	10	10	10	10	8	8	8	8	8	8	8	8	6	6	6	3	195
	73	7.5	15	0	10	10	0	0	10	0	10	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	6	0	190.5

Alignment of Requirements and Services (ARISE)

	91	7.5	15	0	10	0	0	10	0	10	10	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	6	0	190.5
	7	7.5	15	0	10	10	0	10	10	0	10	10	10	10	10	10	10	8	8	8	8	8	8	0	8	0	0	0	0	188.5
	8	15	15	0	10	10	0	10	0	0	10	0	10	10	10	10	8	8	8	8	8	8	0	8	6	0	6	0	188	
	36	7.5	15	0	10	10	0	0	10	0	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	0	3	187.5	
	17	7.5	15	0	0	10	0	0	5	10	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	6	0	185.5	
	16	7.5	15	0	0	10	0	0	10	10	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	0	0	184.5	
	65	7.5	15	0	10	10	0	0	0	0	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	6	3	183.5	
	32	15	15	10	0	10	0	0	0	0	10	10	10	10	10	10	8	8	8	8	8	8	8	0	0	6	0	0	182	
	44	15	15	0	0	10	0	0	0	0	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	6	3	181	
	41	7.5	15	0	0	10	10	10	0	10	10	10	10	10	10	10	8	8	8	8	8	8	0	0	0	0	0	0	180.5	
	62	7.5	15	0	10	10	0	0	0	0	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	6	0	180.5	
	69	7.5	15	0	10	10	0	0	0	0	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	6	0	180.5	
	77	7.5	15	0	10	10	0	0	0	0	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	6	0	180.5	
	78	7.5	15	0	0	10	0	0	0	10	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	6	0	180.5	
	51	15	15	0	0	10	10	0	0	10	10	0	10	10	10	10	8	8	8	8	8	8	0	0	6	0	6	0	180	
	75	15	15	0	0	10	0	0	0	0	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	6	0	178	
	59	7.5	15	0	0	10	0	0	0	10	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	0	3	177.5	
	29	7.5	15	10	10	0	0	0	0	0	10	0	10	10	10	10	8	8	8	8	8	8	8	0	6	6	6	0	176.5	
	84	7.5	15	10	0	0	0	0	0	0	10	10	10	10	10	10	8	8	8	8	8	8	8	0	6	6	6	0	176.5	
	6	7.5	0	0	10	10	0	0	10	10	10	10	10	5	10	10	8	8	8	8	8	8	0	8	0	0	0	3	171.5	
	85	7.5	15	0	10	0	0	0	0	10	10	0	10	10	10	10	8	8	8	8	8	8	0	8	6	0	6	0	170.5	
	90	7.5	15	0	10	0	0	0	0	0	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	6	0	170.5	
	45	15	15	0	0	10	0	0	0	0	10	10	10	10	10	10	8	8	8	8	8	8	0	0	6	0	6	0	170	
	74	0	15	10	0	0	0	0	0	0	10	0	10	10	10	10	8	8	8	8	8	8	8	8	6	6	6	3	170	
	57	7.5	15	0	0	10	0	0	0	0	10	10	10	10	10	10	8	8	8	8	8	8	0	0	6	0	6	0	162.5	
	39	7.5	15	0	10	0	0	0	10	0	10	10	10	10	10	10	8	8	8	8	8	8	0	0	0	0	0	0	160.5	
	10	0	15	0	10	10	0	5	0	10	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	6	6	6	0	160
	11	0	15	0	10	10	0	5	0	10	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	6	6	6	0	160
	12	0	15	0	10	10	0	5	0	10	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	6	6	6	0	160
	13	0	15	0	10	10	0	5	0	10	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	6	6	6	0	160

Alignment of Requirements and Services (ARISE)

21	7.5	15	0	0	10	0	0	0	0	10	0	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	0	3	157.5
4	15	15	10	0	10	0	0	0	10	10	0	10	5	0	0	10	8	8	8	8	8	8	0	8	6	0	0	0	157
20	7.5	15	0	10	10	0	0	0	0	10	0	10	10	10	10	10	8	8	8	8	8	8	0	0	6	0	0	0	156.5
55	7.5	15	0	0	10	0	0	0	0	10	10	10	10	10	10	10	8	8	8	8	8	8	0	0	6	0	0	0	156.5
58	7.5	15	0	0	10	0	0	0	0	10	10	10	10	10	10	10	8	8	8	8	8	8	0	0	6	0	0	0	156.5
30	0	15	0	0	0	0	0	0	0	10	10	10	10	10	10	10	8	8	8	8	8	8	0	8	6	0	6	0	153
56	7.5	15	0	0	0	0	0	0	0	10	10	10	10	10	10	10	8	8	8	8	8	8	0	0	6	0	6	0	152.5
42	7.5	15	0	0	10	0	0	0	0	10	10	10	10	10	10	10	8	8	8	8	8	8	0	0	0	0	0	0	150.5
46	7.5	15	0	0	10	0	0	0	0	10	10	10	10	10	10	10	8	8	8	8	8	8	0	0	0	0	0	0	150.5
52	0	15	0	10	10	0	5	0	0	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	6	6	6	0	150
63	0	15	0	10	10	0	5	0	0	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	6	6	6	0	150
64	0	15	0	10	10	0	5	0	0	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	6	6	6	0	150
82	0	15	0	10	10	0	5	0	0	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	6	6	6	0	150
27	0	15	0	0	0	0	0	0	10	10	10	10	10	10	10	10	8	8	8	8	8	8	0	0	6	0	0	0	149
33	0	15	0	10	10	0	5	0	10	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	0	6	0	0	148
43	0	15	0	10	10	0	5	0	10	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	0	0	6	0	148
67	0	15	0	10	10	0	5	0	10	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	0	0	6	0	148
26	7.5	0	0	0	10	0	0	10	10	10	10	0	0	10	10	10	8	8	8	8	8	8	0	0	6	0	6	0	147.5
48	7.5	15	0	0	10	0	10	0	0	0	0	10	10	10	10	10	8	8	8	8	8	8	0	0	6	0	0	0	146.5
60	7.5	15	0	0	10	0	0	0	0	10	0	10	10	10	10	10	8	8	8	8	8	8	0	0	6	0	0	0	146.5
35	0	15	0	10	10	0	5	0	0	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	6	0	6	0	144
47	0	15	0	10	10	0	5	0	0	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	0	6	6	0	144
54	0	15	0	10	10	0	5	0	0	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	6	0	6	0	144
25	7.5	0	0	0	10	0	0	10	10	10	0	0	0	10	10	10	8	8	8	8	8	8	0	8	6	0	0	3	142.5
40	0	15	0	10	10	0	5	0	10	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	0	0	0	0	142
72	0	15	0	10	10	0	5	0	10	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	0	0	0	0	142
80	0	15	0	10	10	0	5	0	10	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	0	0	0	0	142
38	7.5	15	0	0	10	0	0	0	0	10	0	10	10	10	10	10	8	8	8	8	8	8	0	0	0	0	0	0	140.5
24	0	15	0	10	10	0	5	0	0	10	0	10	10	0	10	10	8	8	8	0	0	8	0	0	6	6	6	0	140
92	0	15	0	0	0	0	0	0	0	10	10	10	10	10	10	10	8	8	8	8	8	8	0	0	6	0	0	0	139

Alignment of Requirements and Services (ARISE)

	31	0	15	0	10	10	0	5	0	0	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	6	0	0	0	138
	50	0	15	0	10	10	0	5	0	0	10	10	10	0	0	10	10	8	8	8	0	0	8	0	0	6	0	6	0	134
	37	0	15	0	10	10	0	5	0	0	10	10	10	10	0	10	10	8	8	8	0	0	8	0	0	0	0	0	0	132
	87	7.5	15	0	0	0	0	0	0	0	10	0	10	10	10	10	10	8	8	8	8	8	8	0	0	0	0	0	0	130.5
	28	0	0	0	0	0	0	0	0	0	10	10	10	10	10	5	10	8	8	8	8	8	8	0	0	6	0	0	3	122
	49	7.5	0	0	10	10	10	10	10	0	0	0	0	0	0	0	10	8	8	8	8	8	8	0	0	0	0	0	0	115.5
	89	7.5	0	0	10	0	0	0	0	0	10	0	0	0	0	0	10	8	8	8	8	8	8	0	0	0	0	0	0	85.5
	14	7.5	0	0	0	0	0	0	0	0	10	0	0	0	0	0	10	8	8	8	8	8	8	0	0	0	0	0	0	75.5
	88	7.5	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10	8	8	8	8	8	8	0	0	0	0	0	0	75.5
	79	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	10	8	8	8	8	8	8	0	0	0	0	0	0	68

APPENDIX G: ETHICS APPROVAL FROM HREC UTS¹⁴

Eth: HREC Approval Letter - UTS HREC 2012-114A

Ethics Secretariat [Research.Ethics@uts.edu.au]

Sent: Friday, June 08, 2012 12:41 PM

To: Didar Zowghi

Cc: Muneera Bano; Research Ethics

Dear Didar and Muneera,

At its meeting held on 4/06/2012, the UTS Human Research Ethics Expedited Review Committee reviewed your application for your project and considered it to be low risk. I am pleased to inform you that ethics approval is now granted.

Your approval number is UTS HREC REF NO. 2012-114A

You should consider this your official letter of approval. If you require a hardcopy please contact the Research Ethics Officer (Research.Ethics@uts.edu.au).

Please note that the ethical conduct of research is an on-going process. The National Statement on Ethical Conduct in Research Involving Humans requires us to obtain a report about the progress of the research, and in particular about any changes to the research which may have ethical implications. This report form must be completed at least annually, and at the end of the project (if it takes more than a year). The Ethics Secretariat will contact you when it is time to complete your first report.

I also refer you to the AVCC guidelines relating to the storage of data, which require that data be kept for a minimum of 5 years after publication of research. However, in NSW, longer retention requirements are required for research on human subjects with potential long-term effects, research with long-term environmental effects, or research considered of national or international significance, importance, or controversy. If the data from this research project falls into one of these categories, contact University Records for advice on long-term retention.

If you have any queries about your ethics approval, or require any amendments to your research in the future, please do not hesitate to contact the Ethics Secretariat at the Research and Innovation Office, on 02 9514 9772.

Yours sincerely,

Professor Marion Haas
Chairperson
UTS Human Research Ethics Committee

C/- Research & Innovation Office
University of Technology, Sydney
Level 14, Tower Building
Broadway NSW 2007
Ph: 02 9514 9772
Fax: 02 9514 1244

Web: <http://www.research.uts.edu.au/policies/restricted/ethics.htm>

¹⁴ <http://www.gsu.uts.edu.au/policies/research-ethical-conduct-humans.html>



CONSENT FORM

I _____ agree to participate in the research project (approval number **UTS HREC REF NO 2012-114A**) being conducted by Ms. Muneera Bano of the University of Technology, Sydney for her degree PhD in Software Engineering.

I understand that the purpose of this study is to gain an understanding of the challenges of service oriented requirements engineering

I understand that my participation in this research will involve my opinions and insights on the challenges of service oriented requirements engineering based on my experience as a practitioner working in the industry.

I am aware that I can contact Ms. Muneera Bano (Muneera.Bano@uts.edu.au) or her supervisor Prof. Dr. Didar Zowghi (Didar.Zowghi@uts.edu.au) if I have any concerns about the research. I also understand that I am free to withdraw my participation from this research project at any time I wish, without consequences, and without giving a reason.

I agree that Ms. Muneera Bano has answered all my questions fully and clearly.

I agree that the research data gathered from this project may be published in a form that does not identify me in any way.

_____/____/____

Signature (participant)

_____/____/____

Signature (researcher)

NOTE:

This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer (ph: +61 2 9514 9772 Research.Ethics@uts.edu.au) and quote the UTS HREC reference number. Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.



Information Sheet

Service Oriented Requirements Engineering: Interview Study

Dear Sir/Madam

My name is Muneera Bano and I am a doctoral candidate in Faculty of Engineering and Information Technology, at University of Technology, Sydney. I am currently conducting research on exploring the challenges of service oriented requirements engineering faced by practitioners. This information sheet will provide you an overview of the information of the interview study for which I am inviting you to participate. The consent form is attached with the information sheet in case you agree to participate.

Service Orientation is a new way of developing software with promises of Reusability of existing components, Agility, Loose coupling, Cost effectiveness, less time required for development, and Platform independence. To ensure these benefits the software is presented as a service available over the Internet and is developed using Service Oriented Architecture. Required software service can be selected, leased, and used. The traditional software development processes are not all applicable in this scenario. In Service Orientated Software Development, on one hand we have software requirements and on the other the available ready-to-use software services. How well these two are matched together would determine the success of the resulting system.

Currently I am investigating challenges faced by analysts during Service Oriented Software Development. I have already conducted a literature survey and a questionnaire based web-survey to identify what the practitioners and researchers have to say on this matter. The results of these surveys have informed us that further exploration is needed to fully understand this multi-faceted phenomenon. Therefore, we are interested to conduct industrial interviews with senior Business Analysts who have experience of working on service-oriented projects. The interviews will be informal and conversational and will last approximately 30 minutes.

The interview will mainly focus on the following five questions:

Based on your experiences in service oriented project development, did you face the following challenges?

1. *Alignment of requirements and services*
2. *Knowledge management in service oriented requirements engineering*
3. *Iterative service discovery*
4. *Non-functional requirements analysis in SORE*
5. *Requirements change management in SORE*

Which one of the above described challenge do you consider as top challenge of service oriented requirements engineering and why?

If you are interested in participating in this study, you can contact me (Muneera.Bano@uts.edu.au) or my supervisor Prof. Dr. Didar Zowghi (Didar.Zowghi@uts.edu.au).

You are under no obligation to participate in this research.

Yours sincerely,

Muneera Bano
Muneera.Bano@uts.edu.au

School of Software
Faculty of Engineering and Information Technology
University of Technology Sydney

APPENDIX H: SYSTEMATIC LITERATURE REVIEW PROTOCOL

A Systematic Literature Review Protocol for User Involvement in Software Development and System Success

Versoin 5
Date: 5th June 2012

Didar Zowghi

Didar.Zowghi@uts.edu.au

Muneera Bano

Muneera.Bano@uts.edu.au

Human Centred Technology Design (HCTD)
FEIT, School of Software
University of Technology Sydney

TEAM STRUCTURE

Dr. Didar Zowghi

Professor of Software Engineering
Faculty of Engineering and Information Technology
University of Technology, Sydney
Didar.Zowghi@uts.edu.au

Principal Investigator, Supervisor, Secondary Reviewer, Author

Muneera Bano

PhD Scholar
Human Centered Technology Design (HCTD)
Faculty of Engineering and Information Technology
University of Technology, Sydney
Muneera.Bano@uts.edu.au

Co-Investigator, Student, Primary Reviewer, Author

Abstract

Context

Lack of user involvement in software development is considered as one of the top reasons for the failure of the project. Users should be involved throughout the software development lifecycle and should not be regarded as pure consumers, to whom only finished product would be delivered. In reality, the users are never considered as a part of development process or the system in a systematic way, with exception of the agile methods.

Objective

The overall objectives of this project are to explore potential difficulties encountered by users in the adoption and use of new software systems in the workplace. This investigation will be carried out by researching the entire software development lifecycle and its adoption from both technical and social perspectives. The focus is on what roles (if any) the extent and degree of users (and community) involvement play on the successful usage and adoption of software systems.

In this SLR we are interested to investigate the existing published empirical literature to find out the purpose of the user involvement, the stages of the software development process where users are involved, and the variation in the intensity of the user involvement across various stages of software development process, and the means through which feedback and information can be collected from users.

Method

We are performing a Systematic Literature Review using the guidelines of Evidence Based Software Engineering. We will be carrying out all the steps to gather the required evidences that meet our study objectives.

Expected outcomes

From the results of our systematic review, we hope to find answers to our questions to enhance our understanding for further exploration.

KEYWORDS

1. User Involvement
2. User participation
3. Software Development
4. Systematic Literature Review

INTRODUCTION

It is well known fact that software systems frequently do not work as expected, and little is known about the nature and extent of experiences of disruption, frustration, and difficulties encountered amongst computer users. Even software developed and managed according to well-known software development ‘best practices’, may produce unexpected disruptions and dissatisfied users.

We do not have a comprehensive theory for the involvement of users and their communities in the software development lifecycle. On the one hand, software development processes focus on a small number of representative users to give input and feedback in requirements related activities. Contributing to other activities such as testing, documentation, integration, or design is less likely. On the other hand, user feedback mechanisms in software systems are not standardized and rather ad hoc. Typically “core features” of software are perceived to be more important than those requested by users. Communication channels that allow for collaboration among users or between users and developers are usually decoupled from software systems and their development infrastructure.

The primary focus for our investigation is the interaction of social and technical aspects of software development and the potential effects of that interaction in relation to the extent of user involvement and their feedback mechanisms. The aim is to empirically investigate this complex socio-technical phenomenon. Our research involves conducting case studies of software development and software usage, so that we can collect valuable data through observation of software development tasks and interviews with as many relevant stakeholders and project team members as possible within the entire software development lifecycle. We will start this research during the period when a new software system is being planned and user requirements are being elicited. We would then observe the design and implementation phases of the software under development, and remain for a short time after its adoption to analyse the impact. We will record all positive and negative issues that arise, and the ways these problems and successes are handled by the development team.

In this study we are going to perform a systematic review to collect empirical evidences about user involvement in software development life cycle and its impact on the IT adoption. We will follow the guidelines provided by Barbara Kitchenham for Evidence Based Software Engineering [1]. Systematic Reviews provide a rigorous method for collecting and collating the empirical studies for a focused research inquiry. As we are interested in finding out the

state of the art on empirical research about user involvement in different stages of software development, Systematic Reviews should prove to be very effective.

BACKGROUND AND MOTIVATION

In 1995 Standish survey of 350 companies on over 8000 software projects in the US published in “Chaos” reported that 31% canceled before they were completed and only 9% were delivered on time and cost. Top three factors for success: User involvement, Executive management support, Clear statement of requirements. While top three factors for failure were: Lack of user input, Incomplete requirements and Specifications, Changing Requirements and Specifications. But what is “user involvement”? and “what is “lack of user input”? We don’t seem to have any well understood and universally accepted definition for these.

Currently there is no study available that aggregates the empirical work regarding user involvement in software projects. To create a sound base for further exploration, we are performing this Systematic Review with following objectives;

Purpose of involvement.

Why are users involved in software development processes?

Stages of involvement.

At what stages of the software development processes are users mostly involved?

Intensity of involvement.

How does the intensity of user involvement vary across various stages of the development process?

Modes of involvement.

What are the means through which input and information are obtained from the users?

Management of user involvement

How is participation of user in software development projects managed, if at all?

Cooperation between the users and development team

What is the nature and degree of cooperation between the users (communities) and the development team?

RESEARCH QUESTIONS

Our study is guided by one main and the seven sub research questions. The first question will be used to conduct a Systematic Literature Review and from the findings of the review, the answers to the seven sub questions will be provided.

RQ1: What is the state-of-the-art on “user involvement” in software development projects?

RQ 1.1: What does “involvement of users” mean in software development projects?

RQ 1.2: What roles (if any) software users play in the software development life cycle?

RQ 1.3: How much “user involvement” in software development is considered enough?

RQ 1.4: Is there any relationship between the degree and extent of user involvement and the successful adoption and usage of software systems?

RQ 1.5: What are the modes of user involvement?

RQ 1.6: How is the user involvement in software development projects managed?

RQ 1.7: Are the users and development team really cooperating in the software development activities?

SEARCH STRATEGY

Following steps will be performed in order to search for the relevant studies:

1. We will derive major search terms from the Research Question(s).
2. From Major terms, we will identify relevant terms and synonyms and alternative spellings that are used in published literature. The resulting terms will be connected using Boolean operators to construct a search string.
3. We will select a range of online databases, conference/journal proceedings for searching. The search string will be customized for the online databases' interfaces. The string will be applied on abstracts. The searches will be open for all dates.

4. We will store the results (citations and abstracts) using Endnotes¹⁵ and Zotero¹⁶. For every database we will maintain a separate library. For sharing the final set of included papers we will be using Mendeley¹⁷ online and desktop version.

Major search terms

Based on our main research question, we have following three major search terms:

1. User
2. involvement
3. Software Project

Search String

From the major search terms, we have identified following alternative terms to construct our search string:

A	B	C
User Customer Consumer End user End-user	Involv* (Involvement, involve, involved, involving, >>) Participat* (participation, participate, participating, participated, >>) Contribut* (contribution, contribute, contributing, contributed, >>)	Software Development Software Project IS Information System IT Information Technology SDLC Product Development IT Adoption IT Diffusion

Concatenating the terms we get following search string:

ON ABSTRACT ((user OR customer OR consumer OR “end user” OR end-user) AND (involv* OR participat* OR contribut*) AND (“software development” OR “software project” OR “IS” OR “information system” OR “IT” OR “information technology” OR “SDLC” OR “product development” OR “IT adoption” OR “IT diffusion”))

The string will be modified for different online databases as per requirement while keeping the logical order consistent.

¹⁵ www.endnote.com

¹⁶ <http://www.zotero.org/>

¹⁷ <http://www.mendeley.com/>

NOTE: We have not included the term “stakeholder” as a variant of the term “user”. We had following reasons to justify our decision;

- Not all stakeholders are the end users of the software product
- Not all stakeholders carry equal relevance to the software product [for reference: (1) Robertson, (2) Alexander]

Online Databases

We will apply the search string on a range of databases to ensure that we do not miss any related study. Following data bases and conference/journal proceedings have been selected for our searches.

- ACM Digital Library (<http://dl.acm.org/>)
- IEEE xplore (<http://ieeexplore.ieee.org>)
- Science Direct (<http://www.sciencedirect.com/>)
- Google Scholar (<http://scholar.google.com.au/>)
- Citeseerx (<http://citeseerx.ist.psu.edu/>)
- Springerlink (<http://www.springerlink.com/>)
- MIS Quarterly (<http://www.misq.org/>)

All studies will be given an identification number based on the search engine from which it was retrieved. These identification numbers will be used to create a tracing link among various documents.

STUDY SELECTION CRITERIA

Once all the results are obtained from all selected sources, we will apply the selection criteria to filter out the irrelevant studies. Primary Reviewer will apply criteria on all papers and Secondary Reviewer will randomly check among the results to reduce selection bias. Any issues related to selection of a paper will be resolved by discussion.

Following criteria will be applied in steps;

1. *IF ('the result is a book chapter/thesis/general article') THEN EXCLUDE ELSE GOTO step 2*

2. IF ('the study is investigating user involvement in IT/CS/SE/IS project') THEN
GOTO step 3 ELSE EXCLUDE
3. IF (' the paper is giving results based on EMPIRICAL investigation and not on
personal opinions and general surveys') THEN INCLUDE ELSE EXCLUDE

Duplicate citations (papers) will be discarded prior to applying the selection filter. They will be given the identification numbers from all the search engines from which it was retrieved. If more than one paper is using/describing results from same study, or is we have multiple publications from one study for conference and extended journal versions, they will be treated as one study.

Based on the retrieved results, we will perform secondary searches by scanning and reviewing the references and citations at the end of the papers. Those papers that would stand eligible for consideration will be treated with the same inclusion/exclusion criteria set for primary search selection. The resultant studies will be associated with the parent paper for trace from which it was retrieved.

Once the selection process is complete, new final identification numbers would be given to the included studies.

QUALITY ASSESSMENT CRITERIA

The quality of the study will be based on the research methodology adopted to produce the empirical results. Primary Reviewer will apply the quality checklist on the selected studies and secondary reviewer will check randomly and apply the criteria and evaluate if any differences arise. The differences will be solved after discussion.

We are expecting following different kinds of studies in our results:

1. Case studies
2. Survey
3. Observation field studies
4. Experience reports
5. Ethnographic studies
6. Action research
7. Experiments

The studies will be evaluated for their reporting as that is the only mean of quality assessment available to us. We will use the quality checklist provided by Barbara Kitchenham in the guidelines [1] and also the one developed by one of the team member (Muneera Bano) while conducting another SLR [2] [3].

Quality Checklist	
Generic	
Are the aims clearly stated?	YES/NO
Are the study participants or observational units adequately described?	YES/NO/PARTIAL
Was the study design appropriate with respect to research aim?	YES/NO/PARTIAL
Are the data collection methods adequately described?	YES/NO/PARTIAL
Are the statistical methods justified by the author?	YES/NO
Is the statistical methods used to analyze the data properly described and referenced?	YES/NO
Are negative findings presented?	YES/NO/PARTIAL
Are all the study questions answered?	YES/NO
Do the researchers explain future implications?	YES/NO
Survey	
Was the denominator (i.e. the population size) reported?	YES/NO
Did the author justified sample size?	YES/NO
Is the sample representative of the population to which the results will generalize?	YES/NO
Have “drop outs” introduced biasness on result limitation?	YES/NO/NOT APPLICABLE
Experiment	
Were treatments randomly allocated?	YES/NO
If there is a control group, are participants similar to the treatment group participants in terms of variables that may affect study outcomes?	YES/NO
Could lack of blinding introduce bias?	YES/NO
Are the variables used in the study adequately measured (i.e. are the variables likely to be valid and reliable)?	YES/NO
Case Study	
Is case study context defined?	YES/NO
Are sufficient raw data presented to provide understanding of the case?	YES/NO

Is the case study based on theory and linked to existing literature?	YES/NO
Are ethical issues addressed properly (personal intentions, integrity issues, consent, review board approval)?	YES/NO
Is a clear Chain of evidence established from observations to conclusions?	YES/NO/PARTIAL
Experience Report	
Is the focus of study reported?	YES/NO
Does the author report personal observation?	YES/NO
Is there a link between data, interpretation and conclusion?	YES/NO/PARTIAL
Does the study report multiple experiences?	YES/NO

Some of the checklist items will be graded on yes/no and few with partially. Scores will also be assigned according the grades, 1 for Yes, 0 for No and 0.5 for Partial. The total sum of the scores will be used for the quality assessment of studies.

The decision about the ranking of the studies based on the quality score will be taken after we get the results. We wish to include all selected papers for analysis, as a part of our exploratory research. But we would check for the significance of the difference that low quality papers are making on the overall analysis. Also the quality of conference/journal where the paper is published would be taken into account if we have to make a decision for including a low quality paper.

{During the data extraction phase, if any paper is found to have been plagiarised, it will be discarded.}

DATA EXTRACTION

We will design data extraction forms in MS Word to input the information we require from the papers to answer our research questions. There will be two forms, one for generic information and the other would be for specific information.

Following data will be extracted for generic form;

1. Title
2. Authors
3. Journal or conference

4. Name of journal or conference
5. Type of conference or journal
6. Publication year
7. Full citation
8. Geographical location (where the study was conducted)
9. Type of study (research method)

Following data will be extracted for specific form to answer our research questions;

RQ 1.1	Definition/description/understanding of “user involvement” given in the paper
RQ 1.2	Roles of user involvement in different stages of software development life cycle e.g. project team member, business analyst, tester, subject matter experts etc.
RQ 1.3	How many activities in the SDLC users had been involved in (to measure level of involvement) e.g. Contribution time: how much time has users contributed to any specific activity as well as overall Measure of willingness of the user to contribute Contribution quality: qualitative vs quantitative contribution etc.
RQ 1.4	Is there any relationship between the degree and extent of user involvement and the successful adoption and usage of software systems? (to be assessed by the reviewers)
RQ 1.5	What are the modes of user involvement? Categorised based on stages of SDLC, e.g. in RE: elicitation activities, reviews, inspection. Design: reviews, useability. Test: UAT, etc
RQ 1.6	Is the users involvement in software development projects managed? Any evidence on management of participation and if so, strategies used.
RQ 1.7	Cooperation evidence: Are the users and development team really cooperating in the software development activities?

DATA SYNTHESIS AND ANALYSIS

After completion of data extraction we will aggregate the results to make it ready for further analysis. There will be two kinds of analysis we would perform; general and specific. For general analysis we would find out the following patterns in our results;

1. Frequency of publication in following periods to assess the trend of investigation over the past 30 years.
 - a. 1980 – 1990
 - b. 1991 – 2000
 - c. 2001 – 2010
 - d. 2011 – till date
2. Frequency of type of study (Research Methodology)
3. Frequency of study with respect to Computing disciplinary area (IS, SE, IT, CS)
4. Frequency of geographical locations (from where the data was collected for study)
5. Frequency of journal and conference papers

6. Frequency for type of journal and conference papers
7. Verify the rank of conference/Journal based on ERA2010 table¹⁸.

We do not have any prior plan for the type of analysis that we will apply on the results from diverse studies in our results. It is due to the fact that we are performing this Systematic Review for exploration. Therefore the specific qualitative analysis technique will be decided once we have all the results available.

SLR ACTIVITY TIMELINE

Sr#	Activity	Dates and Duration	Roles of Members	Status
1	Protocol Development	16 th April – 20 th April 2012 5 days	Muneera: Protocol Development Didar: Protocol Development and Review	Done
2	Protocol Review and updates	23 rd April – 27 th April 2012 5 days	Muneera: Protocol update Didar: Final Review	
3	Primary Searches	30 th April – 4 th May 2012 5 days	Muneera: Search Process Execution	
	Study selection	7 th May – 11 th May 2012 14 th May – 18 th May 2012 10 days	Muneera: Selection Didar: Reviewer + Decision for issues in selection	
	Secondary Searches	21 st May – 25 th May 2012 5 days	Muneera: Search Process Execution	
	Data Extraction	Approximately Min: 21 days Max: 32 days	Muneera: Data Extraction Didar: Reviewer + decision for issues in data extraction	
	Quality Assessment	In parallel to Data Extraction	Muneera: Quality Assessment Didar: Reviewer	
	Conflict Resolution	In parallel to Data Extraction	Muneera + Didar	
	Data Synthesis	Approximately 14 days	Muneera: aggregation of data Didar: Analysis of aggregated data	
4	Reporting (Technical Report and conference/journal Paper)	To be decided		
		To be decided		

PILOT TESTING

We pilot tested our search string on four online databases. We applied inclusion/exclusion criteria on a sample of first 10 papers from the results of all four databases. Following table shows the summary of the process.

¹⁸ www.arc.gov.au/xls/era2010_journal_title_list.xls
www.arc.gov.au/xls/era2010_conference_list.xls

Resource	Terms used	Date	Total Results Found
Google Scholar	(user) and (involvement) and (software project) Searched only in Engineering, Computer Science, and Mathematics.	20 th April 2012	38,700
IEEE xlore	((("Abstract":user OR customer OR consumer OR end user OR end-user) AND ("Abstract":contribute OR contribution OR contributing OR involvement OR involving OR involved OR participate OR participating OR participation) AND (Abstract: software project)))	23 rd April 2012	320
Science Direct	ABSTRACT (((user OR customer OR consumer OR "end user" OR end-user) AND (involved OR involvement OR involving OR involve OR participate OR Participating OR participated OR participation OR contribute OR contributed OR contribution OR contributing) AND ("software development" OR "software project" OR "IS" OR "information system" OR "IT" OR "information technology" OR "SDLC" OR "product development" OR "IT adoption" OR "IT diffusion")))[All Sources(Computer Science)]	23 rd April 2012	818
ACM DL	(Abstract:software and Abstract:project and Abstract:involvement) and (Abstract:user or Abstract:customer or Abstract:consumer or Abstract:end-user or Abstract:"end user") and (PublishedAs:journal OR PublishedAs:proceeding)	23 rd April 2012	25

Summary of Inclusion Exclusion:

Total Sample Tested: 40
Included: 12
Excluded: 18
Pending: 7
Full papers not found: 3

Resource	Inclusion Results	Inclusion details
Google Scholar	Sample taken: first 10 4 included 1 not found 2 excluded 3 pending	Appendix 1
IEEE xlore	Sample taken: first 10 3 included 7 excluded	Appendix 2
Science Direct	Sample taken: first 10 2 included 2 not found 5 excluded 1 pending	Appendix 3
ACM DL	Sample taken: first 10 3 included 4 excluded 3 pending	Appendix 4

EXTERNAL REVIEWS

To ensure the validity of our Systematic Review process the protocol was sent for an external review to the following researchers.

1. Barbara Kitchenham a.kitchenham@btinternet.com (Professor, School of Computing and Mathematics, Keele University, UK)
2. Mahmood Niazi mkniazi@kfupm.edu.sa (Associate Professor, Department of Information and Computer Science, King Fahd University of Petroleum and Minerals, KSA)

Review from Barbara Kitchenham

Sent: Thursday, May 03, 2012 2:27 AM

To: [Muneera Bano](#)

Dear Muneera Bano

I think your protocol is very good. There are still some issues I think you need to consider:

1. Abstract Context You say "In reality, the users are never considered". However, the clear exception is in the context of eXtreme Programming. I think you need to make that point and ensure that your search strings are finding appropriate agile methods papers. E.g. you should report how many of the papers included in the pilot search were primarily addressing agile methods.

The Abstract has been modified after review. We will be assessing papers on agile methods as well.

2. Online databases. You are selecting a large number of different sources to search some of which overlap, but you are not giving yourself much time to perform the searches. You will have to deal with a large number of false positives and many duplicate papers found in different digital libraries. For example EI Compendix and SCOPUS are both general indexing services that purport to cover ACM, IEE Science Direct and Springerlink. There will be differences because some of the organization specific digital library searches will cover the body of the text, while the general indexing systems are based on title, abstract and keywords, but you will certainly get a large number of duplicates. Finding them all among the false positives is difficult unless you have very good reference management software. I would certainly advise using only one of CiteSeerX and Google Scholar - these both use the internet and reference papers that cant actually be found in reputable sources- thus causing a lot of extra work. Also you need to consider whether there are any conference venues of particular importance that you might want to search manually - note indexing services are usually a bit behind with conference proceedings.

EI Compendix and SCOPUS were removed from list of online databases as we were covering most of the databases they overlap with.

3. To assess the quality of the search process, I suggest one of you review at least two important journals manually (Didar would be the most appropriate since Didar is not doing the automated searches). The journals should be ones that publish the most papers on the topic. Speaking from personal experience it is often quicker to do a manual search than an automated search. The list of candidate papers found by the manual search should be kept separate and NOT looked at during the automated search process. Then once the first and second searches have been performed, check how many of the papers found by the manual search were found by the automated search. The percentage found is a simple measure of the quality of the search process. If you found less than 90% of the papers you need to review your search process to identify why the papers were missed and perhaps add some additional searches.

After getting the results, any relevant conference or journal will be reviewed for further manual searches.

4. You are right to consider the different types of studies and to have quality checklists appropriate for each type. However, you ought to have a plan for how you will use the results of the quality assessment. In general you can discuss any systematic weaknesses in the current set of studies, with the aim of suggesting how future studies could be improved. Quality should also influence data aggregation. There are two possibilities:

a. You can exclude low quality papers from the aggregation.

b. You can aggregate the data as a whole and then aggregate the data

including only high quality papers and see whether there are significant differences. If there are no significant differences, then you will have more primary studies to support your conclusions. If there are differences you should base your conclusions on the high quality studies, and if the low quality studies address important issues not discussed by the high quality studies, you should point out the need for better quality studies to investigate those issues.

The Quality Assessment Section was modified after the review.

5. I think your timescales for performing the searches and doing the study selection are too optimistic. It always takes me much longer than this.

Timescale is left open and flexible to changes.

6. Using the terms "customer involvement software projects" with Google Scholar I got a completely different set of papers to the ones you found using "user", at least three of which looked like candidate studies. It therefore appears that Google scholar is very vulnerable to small changes in the search strings - so you will have to do many searches based on each of the possible different strings.

Other variations were also checked in Google Scholar.

Regards Barbara

Review from Mahmood Niazi

Tuesday, April 24, 2012 8:02 PM

Comment 1: The title is not clear. Do you mean "User involvement in the IT adoption"?

Title was modified after external Review.

Comment 2: Are you going to explore user involvement in IT adoption or software development. These are two different domains.

We are interested in exploring user involvement in software development.

Comment 3: Check this based on previous comments - IT adoption of software development?

Keywords were modified after external review

Comment 4: Reference is required to support this claim

References will be provided in reporting after we are done with review process.

VERSIONS OF PROTOCOL

Version	Date (previous version)	Changes in Section	As a result of		Modified to	Date (new version)
1	20 th April 2012	Pilot Testing Appendices	Pilot Testing	Yes	Version 2	24 th April 2012
			External Review	No		
2	24 th April 2012	Title	Pilot Testing	No	Version 3	26 th April 2012
			External Review (Dr. Mahmood Niazi)	Yes		
3	26 th April 2012	Abstract Keywords Search Strategy Search Strings Online Databases Quality Assessment External Review	Pilot Testing	No	Version 4	4 th May 2012
			External Review (Dr. Barbara Kitchenham)	Yes		
4	4 th May 2012	Research Questions Data Extraction Forms Data Synthesis and Analysis	updates from Dr. Didar		Version 5	5 th June 2012

REFERENCES

- [1] B. Kitchenham, and S. Charters, "Guidelines for performing Systematic Literature Reviews in Software Engineering," Keele University and Durham University Joint Report, Technical Report: EBSE 2007-001. <http://pages.cpsc.ucalgary.ca/~sillito/cpsc-601.23/readings/kitchenham-2007.pdf>
- [2] N. Qureshi, N. Ikram, M. Bano, and M. Usman, "Empirical Evidence in Software Architecture: A Systematic Literature Review Protocol," in ICSEA 2011, The Sixth International Conference on Software Engineering Advances, 2011, pp. 534–538.
- [3] T. Ambreen, M. Usman, N. Ikram, and M. Bano, "Evidence in Requirements Engineering: A Systematic Literature Review Protocol," in ICSEA 2011, The Sixth International Conference on Software Engineering Advances, 2011, pp. 576–580.

APPENDIX 1

Inclusion/Exclusion Google Scholar – 23rd April 2012 (sample of first 10 results)

ID	Citation	Check 1	Check 2	Check 3	Status
1	T. Y. Chan and J. F. Lee, "A comparative study of online user communities involvement in product innovation and development," in <i>13th International Conference on Management of Technology IAMOT, Washington DC, April, 2004</i> , vol. 29.	Pass	Pass	Fail Discussion Required	Pending
2	M. Keil, P. E. Cule, K. Lyytinen, and R. C. Schmidt, "A framework for identifying software project risks," <i>Communications of the ACM</i> , vol. 41, no. 11, pp. 76–83, 1998.	Pass	Pass	Panel survey	Pending
3	C. L. Iacovou and R. Nakatsu, "A risk profile of offshore-outsourced development projects," <i>Communications of the ACM</i> , vol. 51, no. 6, pp. 89–94, 2008.	Pass	Pass	Pass	Included
4	D. Howcroft and B. Light, "A study of user involvement in packaged software selection," <i>ICIS 2002 Proceedings</i> , 2002.	Pass	Pass	Pass	Included
5	T. M. Somers and K. G. Nelson, "A taxonomy of players and activities across the ERP project life cycle," <i>Information & Management</i> , vol. 41, no. 3, pp. 257–278, 2004.	-	-	-	-
6	D. Dvir, T. Raz, and A. J. Shenhar, "An empirical analysis of the relationship between project planning and project success," <i>International Journal of Project Management</i> , vol. 21, no. 2, pp. 89–95, 2003.	Pass	Pass	Pass	Included
7	J. J. Baroudi, M. H. Olson, and B. Ives, "An empirical study of the impact of user involvement on system usage and information satisfaction," <i>Communications of the ACM</i> , vol. 29, no. 3, pp. 232–238, 1986.	Pass	Pass	Pass	Included
8	I. Alam, "An exploratory investigation of user involvement in new service development," <i>Journal of the Academy of Marketing Science</i> , vol. 30, no. 3, pp. 250–261, 2002.	Pass	Not from computing Discipline	-	Excluded
9	C. Mair, G. Kadoda, M. Lefley, K. Phalp, C. Schofield, M. Shepperd, and S. Webster, "An investigation of machine learning based prediction systems," <i>Journal of Systems and Software</i> , vol. 53,	Pass	Fail	-	Excluded

	no. 1, pp. 23–29, 2000.				
10	S. M. Huang, I. C. Chang, S. H. Li, and M. T. Lin, “Assessing risk in ERP projects: identify and prioritize the factors,” <i>Industrial Management & Data Systems</i> , vol. 104, no. 8, pp. 681–688, 2004.	Pass	Pass	Delphi Method	Pending

APPENDIX 2

Inclusion/Exclusion IEEE xplore – 23rd April 2012 (sample of first 10 results)

ID	Citation	Check 1	Check 2	Check 3	Status
1	E. Kheirkhah, A. Deraman, and Z. S. Tabatabaie, “A Framework for Requirements Engineering in End-User Computing,” in <i>Computer Science and Information Engineering, 2009 WRI World Congress on</i> , 2009, vol. 7, pp. 701–705.	Pass	Pass	Fail Proposing a framework for involving users in RE	Excluded
2	Jianli He, Rong Chen, and Weinan Gu, “A new method for component reuse,” in <i>Computer Science and Information Technology, 2009. ICCSIT 2009. 2nd IEEE International Conference on</i> , 2009, pp. 304–307.	Pass	Pass (?) Not the main focus	Pass	Included
3	D. M. Shawky and A. F. Ali, “A practical measure for the agility of software development processes,” in <i>Computer Technology and Development (ICCTD), 2010 2nd International Conference on</i> , 2010, pp. 230–234.	Pass	Pass	Pass	Included
4	R. Boreli, T. Iyer, C. Dwertmann, G. Sarwar, and F. Klok, “A quickly deployable platform for multi-user communications over satellite links,” in <i>Satellite and Space Communications, 2009. IWSSC 2009. International Workshop on</i> , 2009, pp. 429–433.	Pass	Fail	-	Excluded
5	A. French and P. Layzell, “A study of communication and cooperation in distributed software project teams,” in <i>Software Maintenance, 1998. Proceedings. International Conference on</i> , 1998, pp. 146–154.	Pass	Fail	-	Excluded
6	I. Hussein, M. Mahmud, and A. O. M. Tap, “A survey of usability awareness in Malaysia IT industry,” in <i>User Science and Engineering (i-USEr), 2011 International Conference on</i> , 2011, pp. 146–151.	Pass	Fail	-	Excluded
7	J. Ferreira, J. Noble, and R. Biddle, “Agile Development Iterations and UI Design,” in <i>AGILE 2007</i> , 2007, pp. 50–58.	Pass	Fail	-	Excluded
8	S. Mohammadi, B. Nikkhahan, and S. Sohrabi, “An Analytical Survey of ‘On-Site Customer’ Practice in	Pass	Pass	Pass	Included

	Extreme Programming,” in <i>Computer Science and its Applications, 2008. CSA '08. International Symposium on</i> , 2008, pp. 1–6.			(full paper review required)	
9	M. Wetterwald, Huu Nghia Nguyen, and S. Sargento, “An Early Technical Evaluation of Convergence between Cellular and Broadcast Media,” in <i>Networking and Services, 2006. ICNS '06. International conference on</i> , 2006, p. 12.	Pass	Fail	-	Excluded
10	C. J. Barencio, E. S. Specialski, and L. H. M. Pacheco, “Aspects of video and audio signals transmission in a FDDI network,” in <i>Local Computer Networks, 1995., Proceedings. 20th Conference on</i> , 1995, pp. 469–478.	Pass	Fail	-	Excluded

APPENDIX 3

Inclusion/Exclusion Science Direct – 23rd April 2012 (sample of first 10 results)

ID	Citation	Check 1	Check 2	Check 3	Status
1	N. Iivari, “‘Representing the User’ in software development—a cultural analysis of usability work in the product development context,” <i>Interacting with Computers</i> , vol. 18, no. 4, pp. 635–664, Jul. 2006.	Pass	Pass	Pass	Included
2	S. Hüsigg and S. Kohn, “‘Open CAI 2.0’ – Computer Aided Innovation in the era of open innovation and Web 2.0,” <i>Computers in Industry</i> , vol. 62, no. 4, pp. 407–413, May 2011.				
3	A. Franco, D. Maio, and D. Maltoni, “2D face recognition based on supervised subspace learning from 3D models,” <i>Pattern Recognition</i> , vol. 41, no. 12, pp. 3822–3833, Dec. 2008.	Pass	Fail	-	Excluded
4	D. C. Mowery, “50 Years of business computing: LEO to Linux,” <i>The Journal of Strategic Information Systems</i> , vol. 12, no. 4, pp. 295–308, Dec. 2003.	Pass	Pass (users as innovators)	Literature Survey	Pending
5	H.-W. Kim, H. C. Chan, and Y. P. Chan, “A balanced thinking–feelings model of information systems continuance,” <i>International Journal of Human-Computer Studies</i> , vol. 65, no. 6, pp. 511–525, Jun. 2007.	Pass	Fail	-	Excluded
6	R. Schack and T. A. Brun, “A C++ library using quantum trajectories to solve quantum master equations,” <i>Computer Physics Communications</i> , vol. 102, no. 1–3, pp. 210–228, May 1997.	Pass	Fail	-	Excluded

7	H. R. Hansen, "A case study of a mass information system," <i>Information & Management</i> , vol. 28, no. 3, pp. 215–225, Mar. 1995.	Pass	Pass (discussion required)	Pass	Included
8	D. De Chiara, V. Del Fatto, R. Laurini, M. Sebillio, and G. Vitiello, "A choreem-based approach for visually analyzing spatial data," <i>Journal of Visual Languages & Computing</i> , vol. 22, no. 3, pp. 173–193, Jun. 2011.				
9	X. Jia, J. Cao, and W. Jia, "A classification of multicast mechanisms: implementations and applications," <i>Journal of Systems and Software</i> , vol. 45, no. 2, pp. 99–112, Mar. 1999	Pass	Fail	-	Excluded
10	C. R. Weir, J. J. R. Nebeker, B. L. Hicken, R. Campo, F. Drews, and B. LeBar, "A Cognitive Task Analysis of Information Management Strategies in a Computerized Provider Order Entry Environment," <i>Journal of the American Medical Informatics Association</i> , vol. 14, no. 1, pp. 65–75, Jan. 2007. http://www.ncbi.nlm.nih.gov.ezproxy.lib.uts.edu.au/pmc/articles/PMC2215066/	Pass	Fail	-	Excluded

APPENDIX 4

Inclusion/Exclusion ACM DL – 23rd April 2012 (sample of first 10 results)

ID	Citation	Check 1	Check 2	Check 3	Status
1	Heidi J.C. Ellis and Gregory W. Hislop. 2011. Student IT services to support open source software for humanity. In <i>Proceedings of the 2011 conference on Information technology education</i> (SIGITE '11). ACM, New York, NY, USA, 307-308. DOI=10.1145/2047594.2047676 http://doi.acm.org/10.1145/2047594.2047676	Pass	Fail	-	Excluded
2	Jennie Dautermann. 1990. Putting a local information system online using pre-packaged software. In <i>Proceedings of the 8th annual international conference on Systems documentation</i> (SIGDOC '90). ACM, New York, NY, USA, 49-53. DOI=10.1145/97426.97992 http://doi.acm.org/10.1145/97426.97992	Pass	Pass	(full review required)	Pending
3	Dag Svanæs and Jan Gulliksen. 2008. Understanding the context of design: towards tactical user centered design. In <i>Proceedings of the 5th Nordic conference on Human-computer interaction: building bridges</i> (NordiCHI '08). ACM, New York, NY, USA, 353-362. DOI=10.1145/1463160.1463199 http://doi.acm.org/10.1145/1463160.1463199	Pass	Pass	(full review required)	Pending

4	Ivan Flechais, M. Angela Sasse, and Stephen M. V. Hailes. 2003. Bringing security home: a process for developing secure and usable systems. In <i>Proceedings of the 2003 workshop on New security paradigms</i> (NSPW '03), Christian F. Hempelmann and Victor Raskin (Eds.). ACM, New York, NY, USA, 49-57. DOI=10.1145/986655.986664 http://doi.acm.org/10.1145/986655.986664	Pass	Fail	-	Excluded
5	Oualid Ktata and Ghislain L'vesque. 2009. Agile development: issues and avenues requiring a substantial enhancement of the business perspective in large projects. In <i>Proceedings of the 2nd Canadian Conference on Computer Science and Software Engineering</i> (C3S2E '09), Bipin C. Desai and Carson K. Leung (Eds.). ACM, New York, NY, USA, 59-66. DOI=10.1145/1557626.1557636 http://doi.acm.org/10.1145/1557626.1557636	Pass	Fail	-	Excluded
6	Awie Leonard. 2002. Enabling end users to be more efficient during systems development. In <i>Proceedings of the 2002 annual research conference of the South African institute of computer scientists and information technologists on Enablement through technology</i> (SAICSIT '02). South African Institute for Computer Scientists and Information Technologists, , Republic of South Africa, 156-162.	Pass	Pass	(full review required)	Pending
7	Richard Berntsson-Svensson and Aybke Aurum. 2006. Successful software project and products: An empirical investigation. In <i>Proceedings of the 2006 ACM/IEEE international symposium on Empirical software engineering</i> (ISESE '06). ACM, New York, NY, USA, 144-153. DOI=10.1145/1159733.1159757 http://doi.acm.org/10.1145/1159733.1159757	Pass	Pass	Pass	Included
8	Anders Bruun, Peter Gull, Lene Hofmeister, and Jan Stage. 2009. Let your users do the testing: a comparison of three remote asynchronous usability testing methods. In <i>Proceedings of the 27th international conference on Human factors in computing systems</i> (CHI '09). ACM, New York, NY, USA, 1619-1628. DOI=10.1145/1518701.1518948 http://doi.acm.org/10.1145/1518701.1518948	Pass	Pass	Pass	Included
9	Mike Folk and Elena Pourmal. 2010. Balancing performance and preservation lessons learned with HDF5. In <i>Proceedings of the 2010 Roadmap for Digital Preservation Interoperability Framework Workshop</i> (US-DPIF '10). ACM, New York, NY, USA, , Article 11 , 8 pages. DOI=10.1145/2039274.2039285 http://doi.acm.org/10.1145/2039274.2039285	Pass	Fail	-	Excluded
10	Zornitza Bakalova and Maya Daneva. 2011. A comparative case study on clients participation in a 'traditional' and in an Agile software company. In <i>Proceedings of the 12th International Conference on Product Focused Software Development and Process Improvement</i> (Profes '11). ACM, New York, NY, USA, 74-80. DOI=10.1145/2181101.2181118 http://doi.acm.org/10.1145/2181101.2181118	Pass	Pass	Pass	Included

REFERENCES

- Abdelaziz, E., Mustapha, A. & Mohammed, S. 2011, 'A service-oriented approach for information systems development', *International IEEE Conference on Multimedia Computing and Systems (ICMCS)*, pp. 1-6.
- Abdelkader, M., Malki, M. & Benslimane, S.M. 2013, 'A heuristic approach to locate candidate web service in legacy software', *International Journal of Computer Applications in Technology*, vol. 47, no. 2, pp. 152-61.
- Abelein, U. & Paech, B. 2014, 'Understanding the Influence of User Participation and Involvement on System Success—a Systematic Mapping Study', *Empirical Software Engineering*, pp. 1-54.
- Abu-Matar, M. & Gomaa, H. 2011, 'Variability modeling for service oriented product line architectures', *15th IEEE International Software Product Line Conference (SPLC)*, pp. 110-9.
- Adam, S., Riegel, N. & Doerr, J. 2008, 'Deriving software services from business processes of representative customer organizations', *IEEE International Workshop on Service-Oriented Computing: Consequences for Engineering Requirements, SOCCER'08.*, pp. 38-45.
- Alahmari, S., De Roure, D. & Zaluska, E. 2010, 'A Model-Driven Architecture Approach to the Efficient Identification of Services on Service-Oriented Enterprise Architecture', *14th IEEE International Enterprise Distributed Object Computing Conference Workshops (EDOCW)*, pp. 165-72.
- Alford, M. 1994, 'Panel Session: Issues in requirements engineering technology transfer', *Proceedings of the First IEEE International Conference on Requirements Engineering RE'94* pp. 143-8.
- Alizadeh, K. & Mohsenzadeh, M. 2011, 'Mapping service concept and enterprise ontology in service identification', *IEEE 7th International Conference on Networked Computing (INC)*, pp. 22-7.
- Alves, C. & Castro, J. 2001, 'CRE: A systematic method for COTS components selection', *XV Brazilian Symposium on Software Engineering (SBES)*, Rio de Janeiro, Brazil.
- Amoako-Gyampah, K. & White, K.B. 1993, 'User involvement and user satisfaction: an exploratory contingency model', *Information & Management*, vol. 25, no. 1, pp. 1-10.
- Amsden, J. 2007, 'Modeling SOA: Part 1. service specification', *IBM developerWorks*.
- Andersson, B., Johannesson, P. & Zdravkovic, J. 2009, 'Aligning goals and services through goal and business modelling', *Information systems and e-business management*, vol. 7, no. 2, pp. 143-69.

- Andreozzi, S., Montesi, D. & Moretti, R. 2003, 'Web services quality', *Proceedings of the International Conference on Computer, Communication and Control Technologies (CCCT 2003)*, pp. 252-7.
- Arsanjani, A. 2005, 'How to identify, specify, and realize services for your SOA', *IBM Corporation*, February.
- Arsanjani, A., Zhang, L.-J., Ellis, M., Allam, A. & Channabasavaiah, K. 2007, 'S3: A service-oriented reference architecture', *IT professional*, vol. 9, no. 3, pp. 10-7.
- Asadi, M., Mohabbati, B., Gašević, D. & Bagheri, E. 2011, 'Developing families of method-oriented architecture', *Engineering Methods in the Service-Oriented Context*, Springer, pp. 168-83.
- Aurum, A., Daneshgar, F. & Ward, J. 2008, 'Investigating Knowledge Management practices in software development organisations—An Australian experience', *Information and Software Technology*, vol. 50, no. 6, pp. 511-33.
- Aversano, L., Cerulo, L. & Palumbo, C. 2008, 'Mining candidate web services from legacy code', *10th IEEE International Symposium on Web Site Evolution*, pp. 37-40.
- Azevedo, L.G., Santoro, F., Baião, F., Diirr, T., Souza, A., de Souza, J.F. & Sousa, H.P. 2014, 'A Method for Bridging the Gap between Business Process Models and Services', *iSys-Revista Brasileira de Sistemas de Informação*, vol. 6, pp. 62-98.
- Azevedo, L.G., Santoro, F., Baião, F., Souza, J., Revoredo, K., Pereira, V. & Herlain, I. 2009, 'A method for service identification from business process models in a SOA approach', *Enterprise, Business-Process and Information Systems Modeling*, Springer, pp. 99-112.
- Bachore, Z. & Zhou, L. 2009, 'A Critical Review of the Role of User Participation in IS Success', *AMCIS 2009 Proceedings*, p. 659.
- Baghdadi, Y. 2006, 'Reverse engineering relational databases to identify and specify basic Web services with respect to service oriented computing', *Information systems frontiers*, vol. 8, no. 5, pp. 395-410.
- Bakalova, Z. & Daneva, M. 2011, 'A comparative case study on clients participation in a traditional and in an Agile software company', *Proceedings of the 12th International Conference on Product Focused Software Development and Process Improvement*, ACM, pp. 74-80.
- Bano, M. & Ikram, N. 2010, 'Issues and challenges of requirement engineering in service oriented software development', *Fifth IEEE International Conference on Software Engineering Advances (ICSEA)*, pp. 64-9.
- Bano, M. & Ikram, N. 2011, 'KM-SORE: knowledge management for service oriented requirements engineering', *ICSEA 2011, The Sixth International Conference on Software Engineering Advances*, pp. 494-9.
- Bano, M. & Ikram, N. 2014, 'Addressing the Challenges of Alignment of Requirements and Services: A vision for User-Centered Method', *Asia Pacific Requirements Engineering Symposium (APRES 2014)*, Auckland, New Zealand, vol. 432, pp. 83-9.

- Bano, M. & Zowghi, D. 2012, 'Service Oriented Requirements Engineering: Practitioner's Perspective', *International Conference on Service-Oriented Computing - ICSOC 2012 Workshops, International Workshop on Engineering Service Oriented Application, (WESOA 2012)*, vol. 7759, Lecture Notes in Computer Science, pp. 380-92.
- Bano, M., Ikram, N. & Niazi, M. 2013, 'Requirements Engineering Challenges in Service Oriented Software Engineering: an exploratory online survey', *International Journal for Software Engineering (IJSE)*, vol. 6, no. 2, pp. 21-43.
- Bano, M. & Zowghi, D. 2013a, 'User involvement in software development and system success: a systematic literature review', *Proceedings of the 17th International Conference on Evaluation and Assessment in Software Engineering*, ACM, pp. 125-30.
- Bano, M. & Zowghi, D. 2013b, 'Users' involvement in requirements engineering and system success', *IEEE Third International Workshop on Empirical Requirements Engineering (EmpiRE)*, pp. 24-31.
- Bano, M. & Zowghi, D. 2014, 'User voice and service selection: an empirical study', *Empirical Requirements Engineering (EmpiRE) at RE 2014, Sweden*, IEEE.
- Bano, M., Zowghi, D., Ikram, N. & Niazi, M. 2014, 'What makes Service Oriented Requirements Engineering challenging? A qualitative study', *IET Software*, vol. 8, no. 4, pp. 154-60.
- Bano, M. & Zowghi, D. 2015, 'A Systematic Review on the Relationship between User Involvement and System Success', *Information and Software Technology*, vol. 58, pp. 148-69.
- Bao, L., Yin, C., He, W., Ge, J. & Chen, P. 2010, 'Extracting reusable services from legacy object-oriented systems', *IEEE International Conference on Software Maintenance (ICSM)*, pp. 1-5.
- Baresi, L., Maiden, N.A. & Sawyer, P. 2008, 'Service-Centric Systems and Requirements Engineering', *IEEE International Conference on Requirements Engineering, RE*, p. 305.
- Barki, H. & Hartwick, J. 1989, 'Rethinking the concept of user involvement', *MIS quarterly*, pp. 53-63.
- Barki, H. & Hartwick, J. 1994a, 'Measuring user participation, user involvement, and user attitude', *Mis Quarterly*, pp. 59-82.
- Barki, H. & Hartwick, J. 1994b, 'Rethinking the concept of user involvement, and user attitude', *MIS Quarterly*, vol. 18, no. 1, pp. 59-79.
- Barki, H. & Huff, S. 1990, 'Implementing decision support systems-correlates of user satisfaction and system usage', *INFOR*, vol. 28, no. 2, pp. 89-101.
- Baronas, A.-M.K. & Louis, M.R. 1988, 'Restoring a sense of control during implementation: how user involvement leads to system acceptance', *MIS Quarterly*, pp. 111-24.
- Baroudi, J.J., Olson, M.H. & Ives, B. 1986, 'An empirical study of the impact of user involvement on system usage and information satisfaction', *Communications of the ACM*, vol. 29, no. 3, pp. 232-8.

- Basu, S., Casati, F. & Daniel, F. 2007, 'Web service dependency discovery tool for SOA management', *2013 IEEE International Conference on Services Computing*, IEEE Computer Society, pp. 684-5.
- Berners-Lee, T., Hendler, J. & Lassila, O. 2001, 'The semantic web', *Scientific american*, vol. 284, no. 5, pp. 28-37.
- Bhogal, J., Macfarlane, A. & Smith, P. 2007, 'A review of ontology based query expansion', *Information processing & management*, vol. 43, no. 4, pp. 866-86.
- Birkmeier, D., Klöckner, S. & Overhage, S. 2009, 'A Survey of Service Identification Approaches- Classification Framework, State of the Art, and Comparison', *Enterprise Modelling and Information Systems Architectures*, vol. 4, no. 2, pp. 20-36.
- Birkmeier, D.Q., Gehlert, A., Overhage, S. & Schlauderer, S. 2013, 'Alignment of business and it architectures in the german federal government: A systematic method to identify services from business processes', *46th IEEE Hawaii International Conference on System Sciences (HICSS)*, pp. 3848-57.
- Bjerknes, G. & Bratteteig, T. 1995, 'User participation and democracy: a discussion of Scandinavian research on system development', *Scandinavian Journal of information systems*, vol. 7, no. 1, p. 1.
- Bjørnson, F.O. & Dingsøyr, T. 2008, 'Knowledge management in software engineering: A systematic review of studied concepts, findings and research methods used', *Information and Software Technology*, vol. 50, no. 11, pp. 1055-68.
- Boehm, B.W. 1984, 'Verifying and validating software requirements and design specifications', *IEEE software*.
- Boerner, R. & Goeken, M. 2009, 'Service identification in SOA governance literature review and implications for a new method', *3rd IEEE International Conference on Digital Ecosystems and Technologies, DEST'09*, pp. 588-93.
- Breivold, H.P. & Larsson, M. 2007, 'Component-based and service-oriented software engineering: Key concepts and principles', *33rd EUROMICRO Conference on Software Engineering and Advanced Applications*, pp. 13-20.
- Brereton, P. 2004, 'The software customer/supplier relationship', *Communications of the ACM*, vol. 47, no. 2, pp. 77-81.
- Brinkkemper, S., Saeki, M. & Harmsen, F. 1998, 'Assembly techniques for method engineering', *Advanced Information Systems Engineering*, Springer, pp. 381-400.
- Brodbeck, F.C. 2001, 'Communication and performance in software development projects', *European Journal of Work and Organizational Psychology*, vol. 10, no. 1, pp. 73-94.
- Brzostowski, K., Rekuć, W., Sobecki, J. & Szczurowski, L. 2010, 'Service discovery in the SOA system', *Intelligent Information and Database Systems*, Springer, pp. 29-38.

- Bucher, Tobias, Mario Klesse, Stephan Kurpjuweit, and Robert Winter. (2007) "Situational Method Engineering." *In Situational method engineering: fundamentals and experiences*, pp. 33-48. Springer.
- Byrne, E. 1994, 'IEEE Standard 830: Recommended practice for software requirements specifications', *Proceedings: 1st International Conference on Requirements Engineering*, p. 58.
- Caetano, A., Silva, A.R. & Tribolet, J. 2010, 'Identification of Services through Functional Decomposition of Business Processes', *Business Information Systems*, Springer, pp. 144-57.
- Cai, S., Liu, Y. & Wang, X. 2011, 'A Survey of Service Identification Strategies', *IEEE Asia-Pacific Services Computing Conference (APSCC)*, pp. 464-70.
- Canfora, G. & Di Penta, M. 2009, 'Service-oriented architectures testing: A survey', *Software Engineering*, Springer, pp. 78-105.
- Carmel, E., Whitaker, R.D. & George, J.F. 1993, 'PD and joint application design: a transatlantic comparison', *Communications of the ACM*, vol. 36, no. 6, pp. 40-8.
- Castro-Herrera, C., Duan, C., Cleland-Huang, J. & Mobasher, B. 2008, 'Using data mining and recommender systems to facilitate large-scale, open, and inclusive requirements elicitation processes', *16th IEEE International Requirements Engineering Conference, RE'08*, pp. 165-8.
- Cavaye, A.L. 1995, 'User participation in system development revisited', *Information & Management*, vol. 28, no. 5, pp. 311-23.
- Chauhan, R., Goudar, R., Sharma, R. & Chauhan, A. 2013, 'Domain ontology based semantic search for efficient information retrieval through automatic query expansion', *International Conference on Intelligent Systems and Signal Processing (ISSP)*, pp. 397-402.
- Chen, F., Li, S., Yang, H., Wang, C.-H. & Chu, W.-C. 2005, 'Feature analysis for service-oriented reengineering', *12th IEEE Asia-Pacific Software Engineering Conference, 2005. APSEC'05*, p. 8 pp.
- Chen, F., Zhang, Z., Li, J., Kang, J. & Yang, H. 2009, 'Service identification via ontology mapping', *Computer Software and Applications Conference, 2009. COMPSAC'09. 33rd Annual IEEE International*, vol. 1, IEEE, pp. 486-91.
- Chen, M. & Liu, X. 2011, 'Predicting popularity of online distributed applications: iTunes app store case analysis', *Proceedings of the 2011 iConference, ACM*, pp. 661-3.
- Cheng, B.H. & Atlee, J.M. 2007, 'Research directions in requirements engineering', *2007 Future of Software Engineering*, IEEE Computer Society, pp. 285-303.
- Cho, M.J., Choi, H.R., Kim, H.S., Hong, S.G., Keceli, Y. & Park, J.Y. 2008, 'Service identification and modeling for service oriented architecture applications', *International Conference on Software Engineering, Parallel and Distributed Systems*, pp. 193-9.
- Choe, J.-M. 1998, 'The effects of user participation on the design of accounting information systems', *Information & Management*, vol. 34, no. 3, pp. 185-98.

- Chung, L., Cooper, K. & Courtney, S. 2004, 'COTS-Aware requirements engineering: The CARE process', *Proceedings of International Workshop on Requirements Engineering on COTS (RECOTS '04)*.
- Clavadetscher, C. 1998, 'User involvement: key to success', *IEEE Software*, vol. 15, no. 2, pp. 30, 2.
- Commission, I.O.f.S.I.E. 2007, 'ISO/IEC 24744', *Software Engineering-Metamodel for Development Methodologies*.
- Coulin, C., Zowghi, D. & Sahraoui, A.E.K. 2006, 'A situational method engineering approach to requirements elicitation workshops in the software development process', *Software Process: Improvement and Practice*, vol. 11, no. 5, pp. 451-64.
- Cruzes, D.S. & Dyba, T. 2011, 'Recommended steps for thematic synthesis in software engineering', *International Symposium on Empirical Software Engineering and Measurement (ESEM), 2011*, IEEE, pp. 275-84.
- Cruzes, D.S. & Dybå, T. 2011, 'Research synthesis in software engineering: A tertiary study', *Information and Software Technology*, vol. 53, no. 5, pp. 440-55.
- Damodaran, L. 1996, 'User involvement in the systems design process-a practical guide for users', *Behaviour & information technology*, vol. 15, no. 6, pp. 363-77.
- Davis, A. 2013, *Just enough requirements management: where software development meets marketing*, Addison-Wesley.
- Davis, A., Overmyer, S., Jordan, K., Caruso, J., Dandashi, F., Dinh, A., Kincaid, G., Ledebøer, G., Reynolds, P. & Sitaram, P. 1993, 'Identifying and measuring quality in a software requirements specification', *IEEE First International Software Metrics Symposium, 1993. Proceedings*, pp. 141-52.
- Davis, A.M. & Hickey, A.M. 2002, 'Requirements researchers: Do we practice what we preach?', *Requirements Engineering*, vol. 7, no. 2, pp. 107-11.
- Decker, B., Ras, E., Rech, J., Jaubert, P. & Rieth, M. 2007, 'Wiki-based stakeholder participation in requirements engineering', *IEEE Software*, vol. 24, no. 2, pp. 28-35.
- DeLone, W.H. & McLean, E.R. 1992, 'Information systems success: the quest for the dependent variable', *Information systems research*, vol. 3, no. 1, pp. 60-95.
- Demirkan, H., Kauffman, R.J., Vayghan, J.A., Fill, H.-G., Karagiannis, D. & Maglio, P.P. 2009, 'Service-oriented technology and management: Perspectives on research and practice for the coming decade', *Electronic Commerce Research and Applications*, vol. 7, no. 4, pp. 356-76.
- Di Nitto, E., Ghezzi, C., Metzger, A., Papazoglou, M. & Pohl, K. 2008, 'A journey to highly dynamic, self-adaptive service-based applications', *Automated Software Engineering*, vol. 15, no. 3-4, pp. 313-41.

- Díaz-Galiano, M.C., Martín-Valdivia, M.T. & Ureña-López, L. 2009, 'Query expansion with a medical ontology to improve a multimodal information retrieval system', *Computers in Biology and Medicine*, vol. 39, no. 4, pp. 396-403.
- Dinh, T.L. & Nguyen-Ngoc, A.V. 2010, 'A conceptual framework for designing service-oriented inter-organizational information systems', *Proceedings of the 2010 Symposium on Information and Communication Technology*, ACM, pp. 147-54.
- Doll, W. & Torkzadeh, G. 1990, 'The measurement of end-user software involvement', *Omega*, vol. 18, no. 4, pp. 399-406.
- Doll, W.J. & Torkzadeh, G. 1989, 'A discrepancy model of end-user computing involvement', *Management Science*, vol. 35, no. 10, pp. 1151-71.
- Doll, W.J. & Torkzadeh, G. 1991, 'A congruence construct of user involvement', *Decision Sciences*, vol. 22, no. 2, pp. 443-53.
- Dörr, J., Hartkopf, S., Kerkow, D., Landmann, D. & Amthor, P. 2007, 'Built-in user satisfaction-Feature appraisal and prioritization with AMUSE', *15th IEEE International Requirements Engineering Conference, RE'07*, pp. 101-10.
- Drew Procaccino, J., Verner, J.M., Overmyer, S.P. & Darter, M.E. 2002, 'Case study: factors for early prediction of software development success', *Information and Software Technology*, vol. 44, no. 1, pp. 53-62.
- Dwivedi, V. & Kulkarni, N. 2008, 'A model driven service identification approach for process centric systems', *IEEE Congress on Services Part II*, pp. 65-72.
- Easterbrook, S., Singer, J., Storey, M.-A. & Damian, D. 2008, 'Selecting empirical methods for software engineering research', *Guide to advanced empirical software engineering*, Springer, pp. 285-311.
- Eck, P. & Wieringa, R. 2003, 'Requirements engineering for service-oriented computing: a position paper'. First International Workshop on e-Services at ICEC 2003, Pittsburgh, Pennsylvania, USA, pp. 23-28 (2003)
- El Emam, K., Quintin, S. & Madhavji, N.H. 1996, 'User participation in the requirements engineering process: An empirical study', *Requirements Engineering*, vol. 1, no. 1, pp. 4-26.
- Fareghzadeh, N. 2008, 'Service identification approach to SOA development', *Proceedings of World Academy of Science, Engineering and Technology*, vol. 35, Citeseer, pp. 258-66.
- Ferrari, A. & Gnesi, S. 2012, 'Using collective intelligence to detect pragmatic ambiguities', *20th IEEE International Requirements Engineering Conference (RE'12)*, pp. 191-200.
- Ferrari, A., Lipari, G., Gnesi, S. & Spagnolo, G.O. 2014, 'Pragmatic ambiguity detection in natural language requirements', *IEEE 1st International Workshop on Artificial Intelligence for Requirements Engineering (AIRE)*, pp. 1-8.

- Flores, F., Mora, M., Álvarez, F., Garza, L., & Duran, H. (2010). Towards a systematic service-oriented requirements engineering process (S-SoRE). In *ENTERprise Information Systems* (pp. 111-120). Springer Berlin Heidelberg.
- Foster Jr, S.T. & Franz, C.R. 1998, 'On the differences between information systems' users and analysts: Managing perceptions of systems quality', *Journal of Quality Management*, vol. 3, no. 1, pp. 63-77.
- Foster Jr, S.T. & Franz, C.R. 1999, 'User involvement during information systems development: a comparison of analyst and user perceptions of system acceptance', *Journal of Engineering and Technology Management*, vol. 16, no. 3, pp. 329-48.
- Franz, C.R. & Robey, D. 1986, 'Organizational context, user involvement, and the usefulness of information systems', *Decision Sciences*, vol. 17, no. 3, pp. 329-56.
- Fu, B., Lin, J., Li, L., Faloutsos, C., Hong, J. & Sadeh, N. 2013, 'Why people hate your app: making sense of user feedback in a mobile app store', *Proceedings of the 19th ACM SIGKDD international conference on Knowledge discovery and data mining*, ACM, pp. 1276-84.
- Fuhr, A., Horn, T., Riediger, V. & Winter, A. 2013, 'Model-driven software migration into service-oriented architectures', *Computer Science-Research and Development*, vol. 28, no. 1, pp. 65-84.
- Gallivan, M.J. & Keil, M. 2003, 'The user-developer communication process: a critical case study', *Information Systems Journal*, vol. 13, no. 1, pp. 37-68.
- Galster, M. & Bucherer, E. 2008a, 'A business-goal-service-capability graph for the alignment of requirements and services', *IEEE Congress on Services-Part I*, pp. 399-406.
- Galster, M. & Bucherer, E. 2008b, 'A taxonomy for identifying and specifying non-functional requirements in service-oriented development', *IEEE Congress on Services-Part I*, pp. 345-52.
- Galvis Carreño, L.V. & Winbladh, K. 2013, 'Analysis of user comments: an approach for software requirements evolution', *Proceedings of the 2013 IEEE International Conference on Software Engineering*, pp. 582-91.
- Garofalakis, J., Panagis, Y., Sakkopoulos, E. & Tsakalidis, A. 2004, 'Web service discovery mechanisms: Looking for a needle in a haystack', *International Workshop on Web Engineering*, vol. 38.
- Gehlert, A., Bramsiepe, N. & Pohl, K. 2008, 'Goal-driven alignment of services and business requirements', *IEEE International Workshop on Service-Oriented Computing: Consequences for Engineering Requirements, SOCCER'08*, pp. 1-7.
- Ghezzi, C. & Tamburrelli, G. 2009, 'Reasoning on non-functional requirements for integrated services', *17th IEEE International Requirements Engineering Conference, RE'09.*, pp. 69-78.
- Gibson, J.C. 2004, 'Developing A requirements specification for a web service application', *12th IEEE International Requirements Engineering Conference*, pp. 340-4.

- Glinz, M. 2007, 'On non-functional requirements', *15th IEEE International Requirements Engineering Conference, RE'07* pp. 21-6.
- Gold, N., Mohan, A., Knight, C. & Munro, M. 2004, 'Understanding service-oriented software', *IEEE Software*, vol. 21, no. 2, pp. 71-7.
- Gonzalez-Perez, C. & Henderson-Sellers, B. 2008, *Metamodelling for software engineering*, Wiley Publishing.
- Gordijn, J., Yu, E. & van der Raadt, B. 2006, 'e-Service Design Using i* and e3value Modeling', *IEEE software*, vol. 23, no. 3, pp. 26-33.
- Gould, J.D. & Lewis, C. 1985, 'Designing for usability: key principles and what designers think', *Communications of the ACM*, vol. 28, no. 3, pp. 300-11.
- Gu, Q. & Lago, P. 2007, 'A stakeholder-driven service life cycle model for SOA', *2nd international workshop on Service oriented software engineering: in conjunction with the 6th ESEC/FSE joint meeting*, ACM, pp. 1-7.
- Gu, Q. & Lago, P. 2009, 'Exploring service-oriented system engineering challenges: a systematic literature review', *Service Oriented Computing and Applications*, vol. 3, no. 3, pp. 171-88.
- Gu, Q. & Lago, P. 2010, 'Service identification methods: a systematic literature review', *Towards a Service-Based Internet*, Springer, pp. 37-50.
- Gu, Q. and Lago, P. 2011 "Guiding the selection of service-oriented software engineering methodologies." *Service Oriented Computing and Applications* 5.4 : 203-223.
- Guan, Q., Feng, S. & Ma, Y. 2012, 'A Network Topology Clustering Algorithm for Service Identification', *2012 International Conference on Computer Science & Service System (CSSS)*, IEEE, pp. 1583-6.
- Guo, J., Wang, Y., Liu, X. & Tong, H. 2008, 'A service-oriented integration model of knowledge and business processes', *IEEE International Conference on Networking, Sensing and Control, ICNSC 2008*, pp. 1674-9.
- Hanssen, G.K. & Fægri, T.E. 2006, 'Agile customer engagement: a longitudinal qualitative case study', *Proceedings of the 2006 ACM/IEEE international symposium on Empirical software engineering*, ACM, pp. 164-73.
- Hao, J., Li, S. & Chen, Z. 2010, 'Extracting service aspects from web reviews', *Web Information Systems and Mining*, Springer, pp. 320-7.
- Harman, M., Jia, Y. & Zhang, Y. 2012, 'App store mining and analysis: MSR for app stores', *9th IEEE Working Conference on Mining Software Repositories (MSR)*, pp. 108-11.
- Hartwick, J. & Barki, H. 1994, 'Explaining the role of user participation in information system use', *Management science*, vol. 40, no. 4, pp. 440-65.

- Hartwick, J. & Barki, H. 2001, 'Communication as a dimension of user participation', *IEEE Transactions on Professional Communication*, vol. 44, no. 1, pp. 21-36.
- Hawk, S.R. & Dos Santos, B.L. 1991, 'Successful system development: the effect of situational factors on alternative user roles', *Engineering Management, IEEE Transactions on*, vol. 38, no. 4, pp. 316-27.
- He, J. & King, W.R. 2008, 'The role of user participation in information systems development: implications from a meta-analysis', *Journal of Management Information Systems*, vol. 25, no. 1, pp. 301-31.
- Heinbokel, T., Sonnentag, S., Frese, M., Stolte, W. & Brodbeck, F.C. 1996, 'Don't underestimate the problems of user centredness in software development projects there are many!', *Behaviour & Information Technology*, vol. 15, no. 4, pp. 226-36.
- Heinrich, B., Henneberger, M., Krammer, A. & Lautenbacher, F. 2011, 'Granularity of services—an economic analysis', *Business & Information Systems Engineering*, vol. 3, no. 6, pp. 345-58.
- Heiskari, J. & Lehtola, L. 2009, 'Investigating the State of User Involvement in Practice', *Asia-IEEE Pacific Software Engineering Conference, APSEC'09*, pp. 433-40.
- Henderson-Sellers, B. 2002, 'Process metamodelling and process construction: examples using the OPEN Process Framework (OPF)', *Annals of Software Engineering*, vol. 14, no. 1-4, pp. 341-62.
- Henderson-Sellers, B. & Ralyté, J. 2010, 'Situational Method Engineering: State-of-the-Art Review', *J. UCS*, vol. 16, no. 3, pp. 424-78.
- Howcroft, D. & Wilson, M. 2003, 'Participation: 'bounded freedom' or hidden constraints on user involvement', *New Technology, Work and Employment*, vol. 18, no. 1, pp. 2-19.
- Hsia, P., Davis, A. & Kung, D. 1993, 'Status report: requirements engineering', *IEEE Software*, vol. 10, no. 6, pp. 75-9.
- Huang, C., Lee, G.M. & Crespi, N. 2012, 'A semantic enhanced service exposure model for a converged service environment', *IEEE Communications Magazine*, vol. 50, no. 3, pp. 32-40.
- Huang, D., Yang, Y. & Calmet, J. 2006, 'A knowledge-based security policy framework for business process management', *International IEEE Conference on Intelligent Agents, Web Technologies and Internet Commerce, International Conference on Computational Intelligence for Modelling, Control and Automation* pp. 154-.
- Huayou, S., Yulin, N., Lian, Y. & Zhong, C. 2009, 'A service-oriented analysis and modeling using use case approach', *International IEEE Conference on Computational Intelligence and Software Engineering, CiSE 2009.*, pp. 1-6.
- Huergo, R.S., Pires, P.F., Delicato, F.C., Costa, B., Cavalcante, E. & Batista, T. 2014, 'A systematic survey of service identification methods', *Service Oriented Computing and Applications, SOCA* pp. 1-21.

- Hunton, J.E. 1996a, 'Involving information system users in defining system requirements: The influence of procedural justice perceptions on user attitudes and performance', *Decision Sciences*, vol. 27, no. 4, pp. 647-71.
- Hunton, J.E. 1996b, 'User participation in defining system interface requirements: An issue of procedural justice', *Journal of Information Systems*, vol. 10, no. 1.
- Hunton, J.E. & Beeler, J.D. 1997, 'Effects of user participation in systems development: a longitudinal field experiment', *MIS Quarterly*, pp. 359-88.
- Hwang, M.I. & Thorn, R.G. 1999, 'The effect of user engagement on system success: a meta-analytical integration of research findings', *Information & Management*, vol. 35, no. 4, pp. 229-36.
- Igbaria, M. & Guimaraes, T. 1994, 'Empirically testing the outcomes of user involvement in DSS development', *Omega*, vol. 22, no. 2, pp. 157-72.
- Iivari, J., Isomäki, H. & Pekkola, S. 2010, 'The user—the great unknown of systems development: reasons, forms, challenges, experiences and intellectual contributions of user involvement', *Information systems journal*, vol. 20, no. 2, pp. 109-17.
- Iivari, N. 2004, 'Enculturation of user involvement in software development organizations- an interpretive case study in the product development context', *ACM International Conference Proceeding Series*, vol. 82, pp. 287-96.
- Iivari, N. 2006, 'Representing the User' in software development—a cultural analysis of usability work in the product development context', *Interacting with Computers*, vol. 18, no. 4, pp. 635-64.
- Ilayperuma, T. & Zdravkovic, J. 2010, 'Exploring business value models from the inter-organizational collaboration perspective', *Proceedings of the 2010 ACM Symposium on Applied Computing*, ACM, pp. 99-105.
- Inaganti, S. & Behara, G.K. 2007, 'Service identification: BPM and SOA handshake', *BPTrends*, vol. 3, pp. 1-12.
- Iribarne, L. 2004, 'Web Components: A comparison between Web services and software components', *Colombian Journal of Computation*, vol. 5, no. 1, pp. 47-66.
- Ives, B. & Olson, M.H. 1984, 'User involvement and MIS success: a review of research', *Management science*, vol. 30, no. 5, pp. 586-603.
- Jain, H., Zhao, H. & Chinta, N.R. 2004, 'A spanning tree based approach to identifying web services', *International Journal of Web Services Research (IJWSR)*, vol. 1, no. 1, pp. 1-20.
- Jamshidi, P., Sharifi, M. & Mansour, S. 2008, 'To establish enterprise service model from enterprise business model', *IEEE International Conference on Services Computing, SCC'08.*, vol. 1, pp. 93-100.
- Jarvenpaa, S.L. & Ives, B. 1991, 'Executive involvement and participation in the management of information technology', *MIS Quarterly*, pp. 205-27.

- Jichen, J. & Ming, G. 2009, 'A process-driven content-oriented integration framework for knowledge management systems', . *IEEE/INFORMS International Conference on Service Operations, Logistics and Informatics, SOLI'09*, pp. 213-8.
- Jin, Z. & Zhu, H. 2008, 'A Framework for Agent-based Service-Oriented Modelling', *IEEE International Symposium on Service-Oriented System Engineering, SOSE'08.*, pp. 160-5.
- Johnson, J. 1998, 'ChAOS: A recipe for success, 1998', *The Standish Group*.
- Jones, S., Maiden, N., Zachos, K. & Zhu, X. 2005, 'How service-centric systems change the requirements process', *Proceedings of 11th International Workshop on Requirements Engineering: Foundation for Software Quality*.
- Kaabi, R.S., Souveyet, C. & Rolland, C. 2004, 'Eliciting service composition in a goal driven manner', *Proceedings of the 2nd international conference on Service oriented computing*, ACM, pp. 308-15.
- Kaindl, H. 1993, 'The missing link in requirements engineering', *ACM SIGSOFT Software Engineering Notes*, vol. 18, no. 2, pp. 30-9.
- Kang, D., Song, C.-y. & Baik, D.-K. 2008, 'A method of service identification for product line', *Third International Conference on Convergence and Hybrid Information Technology, ICCIT'08.*, vol. 2, pp. 1040-5.
- Karlsson, L., Dahlstedt, Å. G., Regnell, B., och Dag, J. N., & Persson, A. (2007). Requirements engineering challenges in market-driven software development—An interview study with practitioners. *Information and Software technology*, 49(6), 588-604.
- Kautz, K. 2010, 'Participatory Design Activities and Agile Software Development', *Human Benefit through the Diffusion of Information Systems Design Science Research*, Springer, pp. 303-16.
- Kazemi, A., Rostampour, A., Azizkandi, A.N., Haghighi, H. & Shams, F. 2011, 'A metric suite for measuring service modularity', *IEEE International Symposium on Computer Science and Software Engineering (CSSE), 2011* pp. 95-102.
- Kazemi, A., Rostampour, A., Jamshidi, P., Nazemi, E., Shams, F. & Azizkandi, A.N. 2011, 'A genetic algorithm based approach to service identification', *IEEE World Congress on Services (SERVICES), 2011* pp. 339-46.
- Kim, E. & Lee, J. 1986, 'An exploratory contingency model of user participation and MIS use', *Information & Management*, vol. 11, no. 2, pp. 87-97.
- Kim, G. & Suhh, Y. 2010, 'Ontology-based semantic matching for business process management', *ACM SIGMIS Database*, vol. 41, no. 4, pp. 98-118.
- Kim, Y. & Doh, K.-G. 2007, 'The service modeling process based on use case refactoring', *Business information systems*, Springer, pp. 108-20.

- Kim, Y. & Doh, K.-G. 2009, *Formal identification of right-grained services for service-oriented modeling*, Springer.
- Kim, Y. & Doh, K.G. 2013, 'Use-case driven service modelling with XML-based tailoring for SOA', *International Journal of Web and Grid Services*, vol. 9, no. 1, pp. 35-53.
- King, W.R. & Rodriguez, J.I. 1981, 'Participative Design of Strategic Decision Support Systems: An Empirical Assessment', *Management Science*, vol. 27, no. 6, pp. 717-26.
- Kitchenham, B. & Charters, S. 2007, *Guidelines for performing systematic literature reviews in software engineering*, Technical report, EBSE Technical Report EBSE-2007-01.
- Kitchenham, B. & Pfleeger, S.L. 2002, 'Principles of survey research: part 5: populations and samples', *ACM SIGSOFT Software Engineering Notes*, vol. 27, no. 5, pp. 17-20.
- Klose, K., Knackstedt, R. & Beverungen, D. 2007, 'Identification of services-A stakeholder-based approach to SOA development and its application in the area of production planning', In *ECIS*, vol. 7, pp. 1802-1814.
- Kohlborn, T., Korthaus, A., Chan, T. & Rosemann, M. 2009a, 'Identification and analysis of business and software services—a consolidated approach', *IEEE Transactions on Services Computing*, vol. 2, no. 1, pp. 50-64.
- Kohlborn, T., Korthaus, A., Chan, T. & Rosemann, M. 2009b, "Service analysis - a critical assessment of the state of the art" in *Proceedings of the 17th European Conference on Information Systems (ECIS)*.
- Kohlmann, F. & Alt, R. 2007, 'Business-Driven Service Modelling-A Methodological Approach from the Finance Industry', *BPSC*, vol. 7, pp. 180-93.
- Kojima, H., Funaki, K. & Inoue, T. 2009, 'Web Service Systems for Cooperative Work Support in Knowledge Creation Processes', *Human Interface and the Management of Information. Designing Information Environments*, Springer, pp. 94-103.
- Kokash, N., Birukou, A. & D'Andrea, V. 2007, 'Web service discovery based on past user experience', *Business Information Systems*, Springer, pp. 95-107.
- Komondoor, R., Nandivada, V.K., Sinha, S. & Field, J. 2012, 'Identifying services from legacy batch applications', *Proceedings of the 5th India Software Engineering Conference*, ACM, pp. 13-22.
- Kontio, J. 1995, 'OTSO: a systematic process for reusable software component selection'.
- Kontogogos, A. & Avgeriou, P. 2009, 'An overview of software engineering approaches to service oriented architectures in various fields', *18th IEEE International Workshops on Enabling Technologies: Infrastructures for Collaborative Enterprises, WETICE'09*, pp. 254-9.
- Korkala, M., Pikkarainen, M. & Conboy, K. 2009, 'Distributed agile development: A case study of customer communication challenges', *Agile Processes in Software Engineering and Extreme Programming*, Springer, pp. 161-7.

- Koumoutsos, G. & Thramboulidis, K. 2009, 'A knowledge-based framework for complex, proactive and service-oriented e-negotiation systems', *Electronic Commerce Research*, vol. 9, no. 4, pp. 317-49.
- Krippendorff, K. 2012, *Content analysis: An introduction to its methodology*, Sage.
- Kujala, S. 2008, 'Effective user involvement in product development by improving the analysis of user needs', *Behaviour & Information Technology*, vol. 27, no. 6, pp. 457-73.
- Kujala, S. 2003, 'User involvement: a review of the benefits and challenges', *Behaviour & information technology*, vol. 22, no. 1, pp. 1-16.
- Kujala, S., Kauppinen, M., Lehtola, L. & Kojo, T. 2005, 'The role of user involvement in requirements quality and project success', *13th IEEE International Conference on Requirements Engineering, RE'05* pp. 75-84.
- Kulkarni, N. & Dwivedi, V. 2008, 'The role of service granularity in a successful SOA realization a case study', *IEEE Congress on Services-Part I*, pp. 423-30.
- Kunda, D. & Brooks, L. 1999, 'Applying social-technical approach for COTS selection', *Proceedings of the 4th UKAIS Conference*, pp. 552-65.
- Land, R., Blankers, L., Chaudron, M. & Crnković, I. 2008, 'COTS selection best practices in literature and in industry', *High Confidence Software Reuse in Large Systems*, Springer, pp. 100-11.
- Lawrence, M. & Low, G. 1993, 'Exploring individual user satisfaction within user-led development', *MIS Quarterly*, pp. 195-208.
- Lee, J., Muthig, D. & Naab, M. 2008, 'An approach for developing service oriented product lines', *12th International IEEE Software Product Line Conference, SPLC'08.*, pp. 275-84.
- Lee, J., Muthig, D. & Naab, M. 2010, 'A feature-oriented approach for developing reusable product line assets of service-based systems', *Journal of Systems and Software*, vol. 83, no. 7, pp. 1123-36.
- Lee, J., Sugumaran, V., Park, S. & Sansi, D. 2011, 'An Approach for Service Identification Using Value Co-creation and IT Convergence', *2011 First IEEE ACIS/JNU International Conference on Computers, Networks, Systems and Industrial Engineering (CNSI)*, pp. 441-6.
- Leedy, P. & Ormrod, J. 2005, 'Practical Research', *Planning and design*, vol. 8.
- Leonard-Barton, D. & Sinha, D.K. 1993, 'Developer-user interaction and user satisfaction in internal technology transfer', *Academy of Management Journal*, vol. 36, no. 5, pp. 1125-39.
- Li, J., Zhang, H., Zhu, L., Jeffery, R., Wang, Q. & Li, M. 2012, 'Preliminary results of a systematic review on requirements evolution', *16th International Conference on Evaluation & Assessment in Software Engineering (EASE 2012)*, IET, pp. 12-21.
- Lichtenstein, S., Nguyen, L. & Hunter, A. 2007, 'Issues in IT service-oriented requirements engineering', *Australasian journal of information systems*, vol. 13, no. 1.

- Lim, S.W., Lee, T., Kim, S. & In, H.P. 2007, 'The value gap model: Value-based requirements elicitation', *7th IEEE International Conference on Computer and Information Technology, CIT 2007* pp. 885-90.
- Lin, W.T. & Shao, B. 2000, 'The relationship between user participation and system success: a simultaneous contingency approach', *Information & Management*, vol. 37, no. 6, pp. 283-95.
- Lindvall, M. & Rus, I. 2002, 'Knowledge management in software engineering', *IEEE software*, vol. 19, no. 3, pp. 0026-38.
- Liu, B. 2012, 'Sentiment analysis and opinion mining', *Synthesis Lectures on Human Language Technologies*, vol. 5, no. 1, pp. 1-167.
- Liu, W., Fu, M., Luo, S. & Zou, D. 2013, 'Use Case-Based Service-Oriented Analysis and Modeling', *Advanced Technology in Teaching*, Springer, pp. 801-6.
- Lo, A. & Yu, E. 2007, *From business models to service-oriented design: a reference catalog approach*, Springer.
- Maiden, N. 2006a, 'Service centric system engineering: A2. d5 SeCSE requirements process v2. 0', *City University London*.
- Maiden, N. 2006b, 'Servicing your requirements', *Software, IEEE*, vol. 23, no. 5, pp. 14-6.
- Mani, S., Sinha, V.S., Sukaviriya, N. & Ramachandra, T. 2008, 'Using user interface design to enhance service identification', *IEEE International Conference on Web Services, ICWS'08*. pp. 78-87.
- Markus, M.L. & Mao, J.-Y. 2004, 'Participation in development and implementation-updating an old, tired concept for today's IS contexts', *Journal of the Association for Information Systems*, vol. 5, no. 11, p. 1.
- Martin, J.N. 1998, 'Overview of the EIA 632 standard: processes for engineering a system', *Proceedings of the AIAA/IEEE/SAE 17th Digital Avionics Systems Conference, 1998. DASC.*, vol. 1, pp. B32-1-9 vol. 1.
- Maximilien, E.M. & Singh, M.P. 2004, 'A framework and ontology for dynamic web services selection', *Internet Computing, IEEE*, vol. 8, no. 5, pp. 84-93.
- McKeen, J.D. & Guimaraes, T. 1997, 'Successful strategies for user participation in systems development', *Journal of Management Information Systems*, pp. 133-50.
- McKeen, J.D., Guimaraes, T. & Wetherbe, J.C. 1994, 'The relationship between user participation and user satisfaction: an investigation of four contingency factors', *MIS Quarterly*, pp. 427-51.
- Meador, C.L., Guyote, M.J. & Keen, P.G. 1984, 'Setting priorities for DSS development', *MIS Quarterly*, pp. 117-29.
- Medeiros, F.M., de Almeida, E.S. & de Lemos Meira, S.R. 2010, 'Designing a set of service-oriented systems as a software product line', *2010 Fourth IEEE Brazilian Symposium on Software Components, Architectures and Reuse (SBCARS)*, pp. 70-9.

- Meertens, L.O., Iacob, M.-E. & Nieuwenhuis, L.J. 2010, 'Goal and model driven design of an architecture for a care service platform', *Proceedings of the 2010 ACM Symposium on Applied Computing*, pp. 158-64.
- Mitroff, I.I. & Linstone, H.A. 1993, *The unbounded mind: Breaking the chains of traditional business thinking*, Oxford University Press.
- Mitroff, I.I. & Linstone, H.A. 1995, *The unbounded mind: Breaking the chains of traditional business thinking*, Oxford University Press on Demand.
- Muller, M.J., Haslwanter, J.H. & Dayton, T. 1997, 'Participatory practices in the software lifecycle', *Handbook of human-computer interaction*, vol. 2, pp. 255-97.
- Myers, M. D. (1997). Qualitative Research in Information Systems. *MIS Quarterly*, 21(2).
- Nakamur, M., Igaki, H., Kimura, T. & Matsumoto, K. 2011, 'Identifying Services in Procedural Programs for Migrating Legacy System to Service Oriented Architecture', *International Journal of Information Systems in the Service Sector (IJISSS)*, vol. 3, no. 4, pp. 54-72.
- Ncube, C. & Maiden, N.A. 1999, 'PORE: Procurement-oriented requirements engineering method for the component-based systems engineering development paradigm', *International Workshop on Component-Based Software Engineering*, pp. 130-40.
- Niès, J. & Pelayo, S. 2010, 'From users involvement to users' needs understanding: A case study', *International journal of medical informatics*, vol. 79, no. 4, pp. e76-e82.
- Nurmuliani, N., Zowghi, D. & Williams, S.P. 2004, 'Using card sorting technique to classify requirements change', *12th IEEE International Requirements Engineering Conference, 2004*. pp. 240-8.
- Nuseibeh, B. & Easterbrook, S. 2000, 'Requirements engineering: a roadmap', *Proceedings of the Conference on the Future of Software Engineering*, ACM, pp. 35-46.
- OASIS, "Reference Model for Service Oriented Architecture 1.0," 2006.
- Olson, M.H. & Ives, B. 1981, 'User involvement in system design: an empirical test of alternative approaches', *Information & Management*, vol. 4, no. 4, pp. 183-95.
- Olson, M.H. & Ives, B. 1982, 'Chargeback systems and user involvement in information systems-An empirical investigation', *MIS Quarterly*, pp. 47-60.
- Orlikowski, W.J. & Baroudi, J.J. 1991, 'Studying Information Technology in Organizations: Research Approaches and Assumptions', *Information Systems Research*, vol. 2, pp. 1-28.
- Pagano, D. & Bruegge, B. 2013, 'User involvement in software evolution practice: a case study', *Proceedings of the 2013 International Conference on Software Engineering*, IEEE Press, pp. 953-62.
- Pagano, D. & Maalej, W. 2013, 'User feedback in the appstore: An empirical study', *21st IEEE International Requirements Engineering Conference (RE), 2013* pp. 125-34.

- Palanisamy, R. & Sushil, J. 2001a, 'Empirically testing the relationships between user involvement, information waste, and MIS success', *Journal of Services Research*, vol. 1, no. 1, pp. 70-103.
- Palanisamy, R. & Sushil, J. 2001b, 'User involvement in information systems planning leads to strategic success: an empirical study', *Journal of Services Research*, vol. 1, no. 2, pp. 125-57.
- Pang, B. & Lee, L. 2008, 'Opinion mining and sentiment analysis', *Foundations and trends in information retrieval*, vol. 2, no. 1-2, pp. 1-135.
- Papazoglou, M.P. 2003, 'Service-oriented computing: Concepts, characteristics and directions', *Proceedings of the Fourth IEEE International Conference on Web Information Systems Engineering, 2003. WISE 2003* pp. 3-12.
- Papazoglou, M.P. 2008, 'The challenges of service evolution', *Advanced Information Systems Engineering*, Springer, pp. 1-15.
- Papazoglou, M.P., Traverso, P., Dustdar, S. & Leymann, F. 2008, 'Service-oriented computing: a research roadmap', *International Journal of Cooperative Information Systems*, vol. 17, no. 02, pp. 223-55.
- Papazoglou, M.P. & van den Heuvel, W.-J. 2003, 'Service-Oriented Computing: State-of-the-Art and Open Research Issues', *IEEE Computer*. v40 i11.
- Papazoglou, M.P. & Van Den Heuvel, W.-J. 2006, 'Service-oriented design and development methodology', *International Journal of Web Engineering and Technology*, vol. 2, no. 4, pp. 412-42.
- Papazoglou, M.P. & van den Heuvel, W.-J. 2007, 'Service Oriented Architecture: approaches, technologies and research issue', *VLDB Journal*, vol. 16, no. 3, pp. 389-415.
- Pekkola, S., Kaarilahti, N. & Pohjola, P. 2006, 'Towards formalised end-user participation in information systems development process: bridging the gap between participatory design and ISD methodologies', *Proceedings of the ninth conference on Participatory design: Expanding boundaries in design-Volume 1*, ACM, pp. 21-30.
- Perrone, V. 2004, 'A wish list for requirements engineering for COTS-based information systems', *COTS-Based Software Systems*, Springer, pp. 146-58.
- Pfleeger, S.L. & Kitchenham, B.A. 2002, 'Principles of survey research part 2: designing a survey', *Software Engineering Notes*, vol. 27, no. 1, pp. 18-20.
- Pilat, L. & Kaindl, H. 2011, 'A knowledge management perspective of requirements engineering', *Fifth IEEE International Conference on Research Challenges in Information Science (RCIS), 2011*, pp. 1-12.
- Pressman, R.S. 2001, 'Software engineering: a practitioner's approach', *McGraw-Hill*, pp. 466-72.
- Pulier, E. & Taylor, H. 2006, *Understanding enterprise SOA*, Dreamtech Press.

- Ramollari, E., Dranidis, D. & Simons, A.J. 2007, 'A survey of service oriented development methodologies', *The 2nd European Young Researchers Workshop on Service Oriented Computing*, p. 75.
- Ran, S. 2003, 'A model for web services discovery with QoS', *ACM Sigecom exchanges*, vol. 4, no. 1, pp. 1-10.
- Regnell, B., Höst, M., och Dag, J.N., Beremark, P. & Hjelm, T. 2001, 'An industrial case study on distributed prioritisation in market-driven requirements engineering for packaged software', *Requirements Engineering*, vol. 6, no. 1, pp. 51-62.
- Ren, M. & Wang, Y. 2010, 'Rule based business service identification using UML analysis', *The 2nd IEEE International Conference on Information Management and Engineering (ICIME), 2010*, pp. 199-204.
- Ricca, F. & Marchetto, A. 2009, 'A quick and dirty meet-in-the-middle approach for migrating to SOA', *Proceedings of the joint international and annual ERCIM workshops on Principles of software evolution (IWPSE) and software evolution (Evol) workshops*, ACM, pp. 73-8.
- Robey, D. & Farrow, D. 1982, 'User involvement in information system development: A conflict model and empirical test', *Management Science*, vol. 28, no. 1, pp. 73-85.
- Robinson, W.N. 2003, 'Monitoring web service requirements', *11th IEEE International Requirements Engineering Conference, RE'03* pp. 65-74.
- Robson, C. 2002, *Real word research*, Oxford: Blackwell.
- Rondeau, P.J., Vonderembse, M.A. & Ragu-Nathan, T. 2002, 'Investigating the Level of End-User Development and Involvement Among Time-Based Competitors', *Decision Sciences*, vol. 33, no. 1, pp. 149-60.
- Rong, W. & Liu, K. 2010, 'A survey of context aware web service discovery: from user's perspective', *Fifth IEEE International Symposium on Service Oriented System Engineering SOSE'10* pp. 15-22.
- Runeson, P. & Höst, M. 2009, 'Guidelines for conducting and reporting case study research in software engineering', *Empirical software engineering*, vol. 14, no. 2, pp. 131-64.
- Rus, I., Lindvall, M. & Sinha, S. 2002, 'Knowledge management in software engineering', *IEEE software*, vol. 19, no. 3, pp. 26-38.
- Saleem, N. 1996, 'An empirical test of the contingency approach to user participation in information systems development', *Journal of Management Information Systems*, pp. 145-66.
- Samavi, R., Yu, E. & Topaloglou, T. 2008, 'Applying Strategic Business Modeling to Understand Disruptive Innovation', *Proceedings of the 10th international conference on Electronic commerce*, ACM, p. 15.

- Schneider, K., Meyer, S., Peters, M., Schliephacke, F., Mörschbach, J. & Aguirre, L. 2010, 'Feedback in context: Supporting the evolution of IT-ecosystems', *Product-Focused Software Process Improvement*, Springer, pp. 191-205.
- Seyff, N., Graf, F. & Maiden, N. 2010a, 'End-user requirements blogging with iRequire', *Proceedings of the 32nd ACM/IEEE International Conference on Software Engineering-Volume 2*, ACM, pp. 285-8.
- Seyff, N., Graf, F. & Maiden, N. 2010b, 'Using mobile re tools to give end-users their own voice', *18th IEEE International Requirements Engineering Conference RE'10*, pp. 37-46.
- Shaban, M., Dobbie, G. & Sun, J. 2009, 'A framework for testing semantic Web services using model checking', *Fourth IEEE Workshop on South-East European Formal Methods SEEFM'09*, pp. 17-24.
- Sioukas, A.V. 1995, 'User involvement for effective customization: An empirical study on voice networks', *Engineering Management, IEEE Transactions on*, vol. 42, no. 1, pp. 39-49.
- Sommerville, I. & Sawyer, P. 1997, *Requirements engineering: a good practice guide*, John Wiley & Sons, Inc.
- Souza, A., Capelli, C., Santoro, F., Azevedo, L.G., Sampaio do Prado Leite, J. & Batista, T. 2011, 'Service identification in aspect-oriented business process models', *IEEE 6th International Symposium on Service Oriented System Engineering SOSE'11*, pp. 164-74.
- Spanoudakis, G. & Zisman, A. 2001, 'Inconsistency management in software engineering: Survey and open research issues', *Handbook of software engineering and knowledge engineering*, vol. 1, pp. 329-80.
- Spanoudakis, G., Zisman, A. & Kozlenkov, A. 2005, 'A service discovery framework for service centric systems', *IEEE International Conference on Services Computing*, vol. 1, pp. 251-9.
- Steghuis, C. "Service granularity in SOA projects: A trade-off Analysis", Master's thesis, University of Twente (2006)
- Steinbart, P.J. & Accola, W.L. 1994, 'The effects of explanation type and user involvement on learning from and satisfaction with expert systems', *Journal of Information Systems*, vol. 8, no. 1.
- Stewart, G. & Chakraborty, A. 2010, 'Service identification through value chain analysis and prioritization', *Proceedings of the 16th Americas Conference on Information Systems: Sustainable IT Collaboration around the Globe*, Association for Information Systems (AIS).
- Stojanović, Z. & Dahanayake, A. 2005, *Service-oriented software system engineering: challenges and practices*, IGI Global.
- Straub, D., Gefen, D. & Boudreau, M.-C. 2005, *The IS World Quantitative, Positivist Research Methods Website*, 2005, <<http://dstraub.cis.gsu.edu:88/quant/>>.

- Swan, J., Scarbrough, H. & Preston, J. 1999, 'Knowledge management—the next fad to forget people?', *Proceedings of the 7th European Conference on Information Systems*, vol. 1, Berrett-Koehler Publishers, pp. 23-5.
- Tait, P. & Vessey, I. 1988, 'The effect of user involvement on system success: a contingency approach', *MIS quarterly*, pp. 91-108.
- Teka, A.Y., Condori-Fernandez, N. & Sapkota, B. 2012, 'A systematic literature review on service description methods', *Requirements Engineering: Foundation for Software Quality*, REFSQ'12 Springer, pp. 239-55.
- Todoran, I., Seyff, N. & Glinz, M. 2013, 'How cloud providers elicit consumer requirements: An exploratory study of nineteen companies', *21st IEEE International Requirements Engineering Conference RE'13*, pp. 105-14.
- Torkzadeh, G. & Doll, W.J. 1994, 'The test-retest reliability of user involvement instruments', *Information & Management*, vol. 26, no. 1, pp. 21-31.
- Tsai, W.-T., Jin, Z., Wang, P. & Wu, B. 2007, 'Requirement engineering in service-oriented system engineering', *IEEE International Conference on e-Business Engineering ICEBE07*, pp. 661-8.
- Tsai, W.-T., Zhou, X., Chen, Y. & Bai, X. 2008, 'On Testing and Evaluating Service-Oriented Software', *IEEE Computer*, vol. 41, no. 8, pp. 40-6.
- Tsai, W. T., Sun, X., & Balasooriya, J. (2010, April). Service-oriented cloud computing architecture. In *IEEE Seventh International Conference on Information Technology: New Generations (ITNG)* pp. 684-689
- Turner, M., Budgen, D. & Brereton, P. 2003, 'Turning software into a service', *IEEE Computer.*, vol. 36, no. 10, pp. 38-44.
- Upadhyaya, B., Khomh, F. & Zou, Y. 2012, 'Extracting RESTful services from Web applications', *SOCA*, pp. 1-4.
- Vadapalli, A. & Mone, M.A. 2000, 'Information technology project outcomes: user participation structures and the impact of organization behavior and human resource management issues', *Journal of engineering and technology management*, vol. 17, no. 2, pp. 127-51.
- Vale, T., Figueiredo, G.B., de Almeida, E.S. & de Lemos Meira, S.R. 2012, 'A study on service identification methods for software product lines', *Proceedings of the 16th International Software Product Line Conference-Volume 2*, ACM, pp. 156-63.
- Verner, J., Cox, K., Bleistein, S., & Cerpa, N. (2007). Requirements engineering and software project success: an industrial survey in Australia and the US. *Australasian Journal of information systems*, 13(1).
- Vetschera, R. 2006, 'Preference-based decision support in software engineering', *Value-Based Software Engineering*, Springer, pp. 67-89.

- Wagner, E.L. & Newell, S. 2007, 'Exploring the importance of participation in the post-implementation period of an ES project: a neglected area', *Journal of the Association for Information Systems*, vol. 8, no. 10, p. 32.
- Wagner, E.L. & Piccoli, G. 2007, 'Moving beyond user participation to achieve successful IS design', *Communications of the ACM*, vol. 50, no. 12, pp. 51-5.
- Wang, S., Sun, Q. & Yang, F. 2012, 'Quality of service measure approach of web service for service selection', *IET Software*, vol. 6, no. 2, pp. 148-54.
- Wang, Y. & Wang, Y. 2013, 'A survey of change management in service-based environments', *Service Oriented Computing and Applications*, SOCA pp. 1-15.
- Wang, Z., Xu, X. & Zhan, D. 2005, 'Normal forms and normalized design method for business service', *IEEE International Conference on e-Business Engineering, ICEBE'05* pp. 79-86.
- Wastell, D. & Sowards, A. 1995, 'An information system profile of the UK manufacturing sector', *Journal of Information Technology*, vol. 10, no. 3, pp. 179-89.
- Webster, J. & Watson, R.T. 2002, 'Analyzing the past to prepare for the future: Writing a literature review', *Management Information Systems Quarterly*, vol. 26, no. 2, p. 3.
- Weigand, H. 2011, 'The pragmatics of event-driven business processes', *Proceedings of the 7th International Conference on Semantic Systems*, ACM, pp. 211-8.
- Weigand, H., Johannesson, P., Andersson, B. & Bergholtz, M. 2009, 'Value-based service modeling and design: Toward a unified view of services', *Advanced Information Systems Engineering*, Springer, pp. 410-24.
- Wen, B., He, K., Liang, P. & Xu, L. 2010, 'Process Semantic-enabled Customisation for Active Service Provisioning', *IEEE 13th International Conference on Computational Science and Engineering CSE'10* pp. 375-81.
- Wieggers, K.E. 1995, 'In search of excellent requirements', *The Journal of the Quality Assurance Institute*, vol. 1, no. 995, p. 1.
- Wieringa, R. 2005, 'Requirements researchers: are we really doing research?', *Requirements Engineering*, vol. 10, no. 4, pp. 304-6.
- Wilson, S., Bekker, M., Johnson, P. & Johnson, H. 1997, 'Helping and hindering user involvement—a tale of everyday design', *Proceedings of the ACM SIGCHI Conference on Human factors in computing systems*, ACM, pp. 178-85.
- Wirsing, M. & Hölzl, M. 2011, *Rigorous Software Engineering for Service-oriented Systems: Results of the SENSORIA Project on Software Engineering for Service-oriented Computing*, vol. 6582, Springer.
- Woitsch, R. & Karagiannis, D. 2005, 'Process Oriented Knowledge Management: A Service Based Approach', *Journal of UCS*, vol. 11, no. 4, pp. 565-88.

- Wu, J.-T.B. & Marakas, G.M. 2006, 'The impact of operational user participation on perceived system implementation success: An empirical investigation', *Journal of Computer Information Systems*, vol. 47.
- Xiang, J., Liu, L., Qiao, W. & Yang, J. 2007, 'Srem: A service requirements elicitation mechanism based on ontology', *IEEE 31st Annual International Computer Software and Applications Conference, COMPSAC07* vol. 1, , pp. 196-203.
- Yin, R. 2003, 'K.(2003). Case study research: Design and methods', *Sage Publications, Inc*, vol. 5, p. 11.
- Yoon, Y., Guimaraes, T. & O'Neal, Q. 1995, 'Exploring the factors associated with expert systems success', *MIS quarterly*, pp. 83-106.
- Yousef, R., Odeh, M., Coward, D. & Sharieh, A. 2009, 'BPAOntoSOA: A generic framework to derive software service oriented models from business process architectures', *IEEE Second International Conference on the Applications of Digital Information and Web Technologies, ICADIWT'09* pp. 50-5.
- Yun, Z., Huayou, S., Yulin, N. & Hengnian, Q. 2009, 'A service-oriented analysis and design approach based on data flow diagram', *IEEE International Conference on Computational Intelligence and Software Engineering, CiSE 2009* pp. 1-5.
- Zachos, K., Dobson, G. & Sawyer, P. 2008, 'Ontology-aided translation in the comparison of candidate service quality', *IEEE International Workshop on Service-Oriented Computing: Consequences for Engineering Requirements, SOCCER'08*, pp. 30-7.
- Zachos, K. & Maiden, N. 2008, 'Inventing requirements from software: an empirical investigation with web services', *16th IEEE International Requirements Engineering, 2008. RE'08.*, pp. 145-54.
- Zachos, K., Maiden, N. & Howells-Morris, R. 2008, 'Discovering web services to improve requirements specifications: does it help?', *Requirements Engineering: Foundation for Software Quality, REFSQ'08*, Springer, pp. 168-82.
- Zachos, K., Maiden, N., Zhu, X. & Jones, S. 2006, 'Does Service Discovery Enhance Requirements Specification? A Preliminary Empirical Investigation', *IEEE Service-Oriented Computing: Consequences for Engineering Requirements, SOCCER'06*,
- Zachos, K., Maiden, N., Zhu, X. & Jones, S. 2007, 'Discovering web services to specify more complete system requirements', *Advanced Information Systems Engineering*, Springer, pp. 142-57.
- Zachos, K., Zhu, X., Maiden, N. & Jones, S. 2006, 'Seamlessly integrating service discovery into UML requirements processes', *Proceedings of the 2006 international workshop on Service-oriented software engineering*, ACM, pp. 60-6.
- Zadeh, A.T., Mukhtar, M., Sahran, S. & Khabbazi, M. 2012, 'A Systematic Input Selection for Service Identification in SMEs', *Journal of Applied Sciences*, vol. 12, no. 12, pp. 1232-44.

- Zave, P. 1997, 'Classification of research efforts in requirements engineering', *ACM Computing Surveys (CSUR)*, vol. 29, no. 4, pp. 315-21.
- Zhang, Z., Liu, R. & Yang, H. 2005, 'Service Identification and Packaging in Service Oriented Reengineering', *SEKE*, vol. 5, pp. 620-5.
- Zhang, Z. & Yang, H. 2004, 'Incubating services in legacy systems for architectural migration', *IEEE 11th Asia-Pacific Software Engineering Conference* pp. 196-203.
- Zhang, Z., Zhou, D.-D., Yang, H.-J. & Zhong, S.-C. 2010, 'A service composition approach based on sequence mining for migrating e-learning legacy system to SOA', *International Journal of Automation and Computing*, vol. 7, no. 4, pp. 584-95.
- Zhou, J. & Niemela, E. 2006, 'Toward semantic qos aware web services: Issues, related studies and experience', *IEEE/WIC/ACM International Conference on Web Intelligence, 2006. WI 2006* pp. 553-7.
- Zowghi, D. & Gervasi, V. 2002, 'The Three Cs of requirements: consistency, completeness, and correctness', *International Workshop on Requirements Engineering: Foundations for Software Quality, Essen, Germany: Essener Informatik Beitiage*, pp. 155-64.