Aligning Services and Requirements with User Feedback

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***Abstract*—For analysts the alignment between the requirements and the available services presents a significant challenge in service oriented paradigm. To address this challenge various technical solutions have already been proposed. Although technical issues play an important role in this selection but organizational and social factors are equally as important in selecting an optimally aligned service for a specific requirement. The users of services are mostly ignored in the alignment process. User feedback analysis has recently gained a lot of research focus, but these benefits have not been fully explored and utilized in service oriented software development. In this paper I present a method for aligning services to requirements that is designed using the Situational Method Engineering approach and it incorporates user feedback about the services. This feedback assists the analysts in extracting required information for making informed decisions while selecting services among available options that satisfies both the user requirements and customer preferences. The method is supported by a proposed tool. The method and the supporting tool will be validated by a controlled experiment and focus group feedback from the practitioners.**

***Index Terms*—Users, Requirements, Services, Alignment**

I. Introduction

Service Oriented Software Engineering (SOSE) aims to reuse existing software components in the form of services to reduce the time, cost and effort of the development [1]. In spite of being advocated as a new architectural style of software development, SOSE has inherited the challenges of component based software development and traditional development especially in requirements engineering (RE) phase [1, 2]. In the Service Oriented Requirements Engineering (SORE) there is an additional task of alignment of services to requirements. By aligning a service to the requirements I refer to finding the best matched service for the requirements while making a tradeoff among cost, functional and non functional requirements.

Many solutions have been proposed to tackle alignment from technical perspective in service oriented domain (e.g. model based transformation [3], iterative process [4], granularity analysis [5-7]) alike. But according to our industrial interviews, practitioners are facing more challenges when dealing with users and customers rather than when dealing with technical solutions [2, 8]. Technical perspective of any issue is just a single view of a multifaceted problem [9, 10]. The technology is important, but how to make the best use of that technology to satisfy those who will ultimately use the system, is far more crucial. Without users' satisfaction and approval the results would be considered a failure no matter how advance the technology would become. There is a need for further exploration on the issue of alignment in SORE [11]. According to my qualitative industrial interview study with practitioners [2, 8], alignment of requirements to the services was pointed out as most challenging task due to the following reasons:

1. The service specifications are sometimes not at the same level of abstraction to the requirements in describing the details of functionality offered by the service. In some cases, there might be some crucial information missing in the service specification specially related to the quality attributes that might be important in customer requirements for service selection.
2. The service granularity (range of functionality offered by a service [12]) may not be at the same level as requirements. 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 [13]. A coarse-grained service is typically expected to carry out more functions but would also exchange more messages and data, and may present a complex interface [5] and reduces the reusability as the functionality might be too overloaded for the actual need of most consumers [6]. It is challenging for the analysts to find a service at the right level of granularity as it requires a trade-off analysis between cost and functional aspect as well as various facets of flexibility, reusability and performance of the service to name but a few.
3. The services are typically developed generic and context free to make them reusable and also to suite the needs of a wide range of customers. In some cases practitioners find it difficult to align context free services to the projects where the contextual details were crucial.
4. The practitioners' most frequently mentioned reason for challenges in alignment is the dissatisfaction of the customers and the users with the system being developed. Currently in service selection process, there is a lack of a proper mechanism for reusing the experience of the people who have used a service in the past. The users of a service have the real life experience of actually using the service and hence their feed back can provide very useful information for the service selection process. User

feedback involvement in system development and decision making processes has been claimed to increase users' satisfaction with the end product [14], but the benefits of the concepts of user involvement have not been fully explored and utilized in SOSE.

The current solutions for the alignment (e.g. [3-5, 12, 13, 15]), 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. The online social media presents a new opportunity for monitoring trends and sentiments of users towards a particular service among a large pool of options. In this paper I propose to explore the benefits of user feedback by designing a method that can help analysts in making better informed decisions to overcome the challenges of alignment during service selection [16]. The construction of the proposed method is grounded in the findings and systematic analysis of the literature [1, 14, 17, 18], a quantitative study (online survey) [11], and qualitative study (interviews with practitioners) [2, 8].

II. Proposed Solution

"Users' involvement" 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 and ultimately leading to the system success [14, 17, 18]. In service oriented paradigm, active user involvement is needed in order to provide personalized systems that can be customized for individual user needs [19]. There are various levels, degrees and roles proposed in literature for user involvement e.g. consultative, informative, participative etc. [17, 20]. In consultative and informative role, the 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 has been a major source of evolution of Android market and Apple store applications [21-23]. Recently online user feedback and sentiment analysis has gained a lot of interest in various areas of software engineering research e.g. Requirements Elicitation [19, 21, 24], Software Evolution [25, 26], Software Quality [23]. Sentiment analysis (opinion mining) is used for calculating and monitoring the attitude and behavior of the users' feedback, comments and reviews available on the online social media. Various Sentiment Analysis tools, techniques and methods [27], are proposed that make use of NLP, Computational Linguistics, Text mining and analytics capabilities for calculating quantitative values of various users' attitude and behavior towards a particular phenomenon or a product. The benefits of the user feedback and sentiment analysis are not being fully utilized in the alignment process of service oriented development. In my proposed method, I plan to explore the benefits of user feedback analysis on the process of alignment and to evaluate whether it helps analysts in overcoming the challenges of alignment. Figure 1 shows the high level view of my proposed method [16]. The method has to satisfy the following two major goals:

1. It should provide a mechanism to involve the user feedback during analysis for alignment of services to requirements.
2. The method should be flexible and adaptable to suit various project contexts and situations.

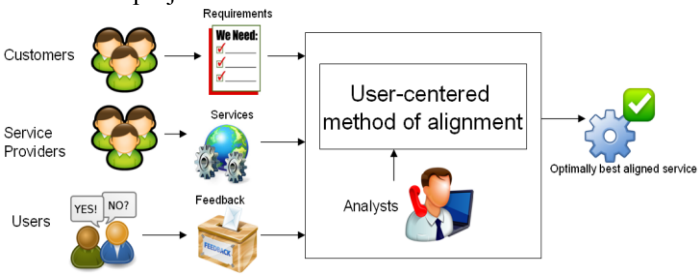

Fig. 1. Proposed Method for Alignment of Requirements and Services [16]

The best aligned service here is defined as the one that satisfies 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. The proposed method will be involving both customers and users as defined below:

Customer: *for whom the service based software system is being developed who have supplied the requirements, who are the project sponsors, and will actually use this system in future*. As with any software development projects, the customers in the project participate in various activities like for requirements elicitation, modification, and prioritisation based on their preferences. For making decisions based on customer preferences in my method, I will be following the Multi Criteria Decision Analysis (MCDA) [28] approach. MCDA is used for decision making in situations where a trade-off is required among multiple criteria. This approach has been extensively used 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.

User: *who has experience of using a particular service in the past and has either provided feedback on online resources or can provide (post deployment) feedback when requested*. This group can include the analysts, developers, designers who have past experiences of using a particular service. Their feedback is either collected form online resources (if available) or elicited directly from the users (if approachable). In recent years, there has been a substantial body of research for proposing methods, tools and techniques on collecting and analyzing users' feedback for extracting useful information form the extensive user comments and feedback available on online resources [19, 21, 24-26, 29, 30] (e.g. sentiment analysis, opinion mining, information retrieval, crowd sourcing, parsing, natural language processing). The user feedback can help the analysts in alignment process with (1)

finding out the missing information in service specification, (2) collecting contextual data based on the previous use of the service, (3) eliciting past users' satisfaction level with the service and the reputation of service providers, and (4) comparing the service specification details against the real use of the service. The benefits of user feedback analysis can help in increasing the information for analysts in making more informed decision for service selection.

III. Research Methodology

My research is exploratory in nature and is based on the following research question:

Does involving user feedback in alignment of requirements and services leads to the better service selection?

The 'better service selection' is measured based on the coverage of the functional and non-functional requirements by the proposed method in comparison with the alignment methods that does not include user feedback. The research methodology that I have followed for my thesis has three main stages: Defining Problem Space, Solution Space and Empirical Validation (Fig 2).

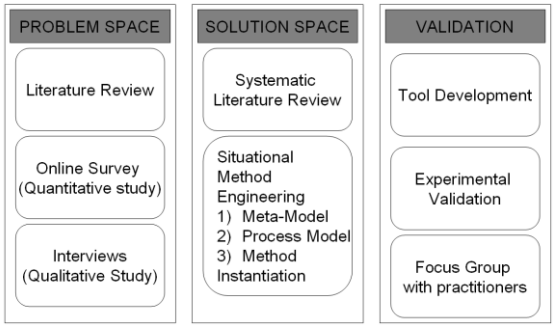

Fig. 2. Research Methodology

A. Problem Space

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 [1]. 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 [11]. 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 [2, 8]. The alignment between business requirements and services was identified as the top challenge that business analysts have to face in service oriented projects.

B. Solution Space

1) *Systematic Literature Review:* As I was interested in exploring the concepts of user involvement in alignment process, I conducted a systematic literature review of the existing empirical literature on the topic. The review resulted in 87 studies from the literature for the period of 1980-2012 [14, 17, 18]. The results show a positive impact of user involvement in terms of system success from empirical literature.

2) Situational Method Engineering (SME): Due to the dynamic nature of software development, one fix methodology for any process would not work in every context and domain. SME provides a systematic and flexible approach to tailor methods for software development activities according to project requirements at run time [31]. 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 [32]. Software development in service oriented domain 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 to involve customer and users. SME recommends a three tiered structure for designing methods [31]. On top level is the method meta-model that represents the components and rules for constructing method, second level has a specific instantiation of the method meta-model and on third level is an instance of the method for specific project situation.

a) Meta-Model: The elements in the meta-model are inspired by the the three meta-classes (Producers, Work units, work products) in ISO/IEC 24744 standard [33], which guides the development of meta-models for software engineering methods. Table I gives the definition of the elements in my proposed method's meta-model and show their mapping to the three meta-classes in ISO/IEC 24744. Figure 3 represents the meta-model of the current approaches available for alignment [3-5, 12, 13, 15], and figure 4 represent the meta-model of our proposed method by highlighting the difference with existing approaches with two new elements i.e. User Feedback and Multi Criteria Decision Analysis.

b) Process Model: From the meta-model, the process model for alignment method is derived (Figure 5). Besides the three actors that are typically involved in the alignment process (analyst, service provider, customer), our proposed method has an additional actor i.e. user.

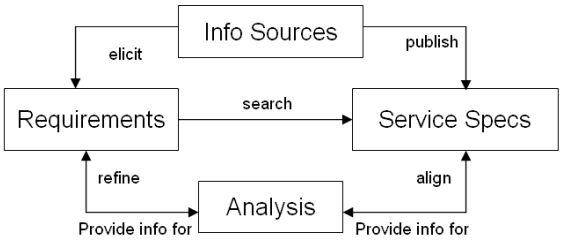

Fig. 3. The Meta Model of current methods of aligning requirements to service specification

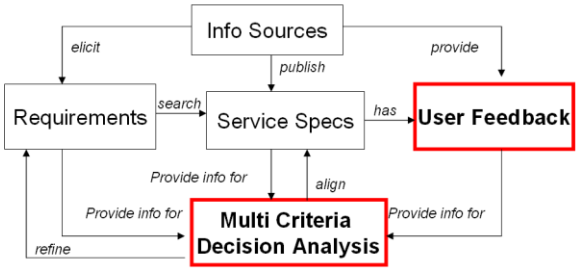

Fig. 4. The Meta Model of proposed method of aligning requirements to service specification

TABLE I. MAPPING OUR META-MODEL CLASSES TO ISO/IEC 24744

Classes in our Meta-Model	Description of classes in our Meta-Model	ISO/IEC 24744 [33] relevant meta-classes
INFO SOURCES	The people or objects that provide required information or knowledge. E.g. customers, users, repositories, analysts, knowledge base	**PRODUCERS:** *Tool* (an instrument that helps another producer to execute its responsibilities), *Person* (allows taking into account individual persons at the endeavour level.)
REQUIREMENTS	Requirements for the project that are used for searching available services	**WORK PRODUCTS:** *Document* (a durable depiction of a fragment of reality),
SERVICE SPECS	Describing the functionalities offered by the services	
USER FEEDBACK	Provided by actual users of the service, (1) either available over the web or (2) elicited	
MULTI CRTERIA DECISION ANALYSIS	Analysing the services based on customer preferences	**WORK UNITS:** *Process* (large-grained, operating within a given area of expertise), *Technique* (small-grained, focusing on how the given purpose may be achieved).

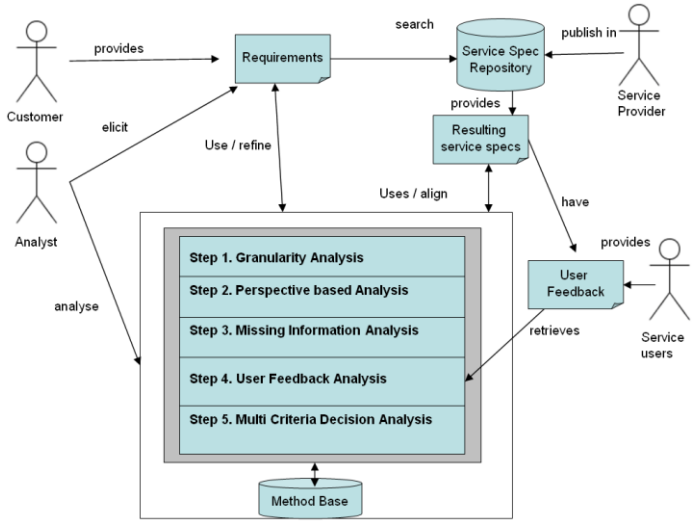

Fig. 5. Proposed Method for Aligning services to requirements [16]

The process alignment starts elicitation of an initial set of requirements from customers represented by R such that $R = \{R_1, R_2, R_3 \ldots R_X\}$ 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 can be represented by $S = \{S_1, S_2, S_3 \ldots S_Y\}$ where Y is number of services found against requirement set R. The analysis in the proposed method comprises of five interconnected and iterative steps: Granularity Analysis, Perspective based Analysis, Missing information Analysis, User Feedback Analysis, and Multi Criteria Decision Analysis.

Granularity 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. The aim is to select the service that provides maximum functional range against requirements, i.e. a service that provides more coverage of requirement set. The scores can be calculated by evaluating a service in one of the three following scenarios: fully aligned (score 1), totally misaligned (score 0), or partially aligned (score between 0 to 1). Partial alignment has further three cases for the analyst to evaluate before selecting the service; **(1)** Service functionality fulfils only 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 the requirements specifies (service is too coarse grained increasing cost), **(3)** Service functionality and the requirements overlap (causing increase in cost and integration issues).

Considering the format for service specification various methods are available (e.g. [5-7] for determining the level of granularity of service against requirements. The granularity method is represented by ***G-Method*** which is selected from MB according to the situation (e.g. format of service specification) to calculate the functional range of service specifications against requirement set R.

$$g_i = G\text{-}Method\ (S_i, R)$$

Perspective-based Analysis: During this step the requirements are to be analyzed from multiple perspectives (e.g. Organizational, Technical (Functional, non-Functional), Economical, and Project related etc.) in order to develop a checklist. The analyst converts the requirements into perspective based checklist and assigns the weights to the checks based on customer preferences. The set of checks is represented by $C = \{C_1, C_2, C_3 \ldots C_K\}$ and the weights against these checks is represented by $W = \{W_1, W_2, W_3 \ldots W_K\}$ where K is the number of checks in the perspective based checklist. The analyst evaluates service specification to provide answers to the checks in the checklist (from 0 to 1). For a service S_i from the set of services S the perspective based score is represented by P_i which is calculated by adding all the answers to the K number of checks in set C for that service according to the following formula.

$$P_i = \sum_{i=1}^{K} ((c_i) * (w_i))$$

Missing Information Analysis: While aligning the services against requirements, there is a possibility that some

information (especially performance related) might be missing in service specification. This can be due to the mismatch in the level of abstraction in describing the service functionality in specification. The analyst is required to assess the missing information (for its type and context) because it will be extracted from user feedback in the next step. Suitable methods are selected form MB for this purpose (e.g. feature extraction, information retrieval, survey questionnaire etc). If the information can not be retrieved from any sources (e.g. blog, forums, surveys), in MCDA there are methods for imprecise and incomplete information that can be applied e.g. sensitivity analysis, fuzzy goal programming [28].

User Feedback Analysis: User feedback can be collected based on two scenarios: (1) directly from online resources if available or (2) elicited directly from the users if approachable. There are various methods and associated tools/techniques available for feedback collection based on the situations and format in which the feedback is available (e.g. sentiment analysis, feature extraction, information retrieval, crowd sourcing, survey and questionnaire etc.). This feedback is serving two main purposes in my method: **(1)** providing the information about the 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), **(2)** 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 is also used for filling the gaps in service specification where the information is missing [25]. Sentiment analysis tools and methods (***US-Method)*** help in providing quantifiable scores for calculating user satisfaction u_i against a service by analysing the online or offline user comments, reviews and feedback.

$$u_i = \textit{US-Method}\ (S_i)$$

Multi Criteria Decision Analysis: Once all the information is acquired (as much as possible), the appropriate MCDA method can be applied for calculating scores for all Y candidate services. Additive weighting method is the most widely used approach to deal with multi criteria decision problems [28]. It's a simple method for multiplying the weights with the scores of the checks and then adding up to see which of the service has scored the highest. This method makes the assumption that quantifiable scores for the weights in the same unit of measurement are being provided by the customer based on their prioritization of the requirements. For example in Additive Weighting method when the customer provides the preferences for the weights for Perspective based checklist w_p and the level of granularity w_g and user satisfaction w_u to be considered for final decision, the final score for a service S_i in the set S can be calculated as following.

$$Score\ (S_i) = (P_i * w_p) + (g_i * w_g) + (u_i * w_u)$$

When the scores are calculated for all Y number of services, the highest service score among the set S will be the optimally the best aligned service according to the customer preferences.

In cases where this may not be possible, Aspiration level Methods [28] are available where the preferences are considered in their natural way rather than converting them all into one scoring level. Another more dynamic (on the run) approach is Outranking Method [28], which helps in construction of the preference based checklist by considering and evaluating different available alternative at the time of decision, rather than before the analysis.

3) Instantiation: I am currently analysing data that I have collected by instantiating my method on a real case of a service selection. The aims of this case study are twofold (1) refinement and improvement of my proposed method, and (2) preliminary validation of the idea of involving user feedback in the service selection process. The study involved the selection of an SMS gateway service for an existing website that belongs to a gym. Online searches resulted in 92 eligible options providing the SMS gateway services. From the customer requirements 28 checks were created for evaluating these services. This created a complex and challenging scenario for decision making as many of the services offered more or less the same functionality within the same price range. The requirements became further refined and more complete later when I was analyzing service specification with better understanding of the functionalities of the available services. For user feedback analysis I used a free online sentiment analysis tool socialmention.com. The preliminary results of my study have shown that in scenarios with significant number of services, it is helpful for analysts to consider additional information to select optimally aligned service to the requirements.

C. Validation

This stage of the research methodology is currently in progress. In this last phase we have three steps:

1) Tool development: By utilizing the design of the alignment method described in this paper, I am currently in the process of designing and developing an automated web based tool to support the analysts and customers in analysis and decision making by simulating the different scenarios of MCDA scoring methods.

2) Experimental Validation: In this step the method and the supporting tool will be validated in an academic experimental lab set up to evaluate the effectiveness of our proposed method. The hypothesis for this experiment is that user feedback will help the analysts in making better decision in alignment of services to requirements. The experiment will be conducted on two service oriented projects. Both projects will be developed in two instances; one using the proposed method and one without the method. The main criteria for the measurement of the effectiveness of the method are based on the coverage of the functional and non functional requirements. An additional survey questionnaire will be administered with the customers of the project to evaluate their level of satisfaction with the results from both instances of the two projects.

3) Focus group with practitioners: The web based tool and the results from the experiment will be presented to the practitioners (including the ones who already helped in problem definition and solution formulation) for feedback and

review. The aim is to triangulate the results of the experiments and to gain feedback from the people from industry through focus group method, which is a cost effective way of collecting timely feedback on new results.

IV. Conclusion and Progress

In this paper I have presented my extended proposal for a method of aligning service specification to requirements while exploring the benefits of user feedback [16]. The method is designed following Situational Method Engineering guidelines to make it flexible for adoption in various project situations. The method will be supported by a web-based tool and will be validated through a controlled experiment and focus group method. This method is based on my ongoing research driven by rigorous and systematic literature reviews [1, 14, 17, 18], a quantitative study (using online survey) [11], and a qualitative study (through interviews with practitioners) [2, 8]. Currently I am working on the design of the supporting tool that will be used in the empirical validation phase.

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