EVALUATOR: An Automated Tool for Service Selection

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Abstract. The large number of third party services creates a paradox of choice and make service selection challenging for business analysts. The enormous online reviews and feedback by the past users provide a great opportunity to gauge their sentiments towards a particular product or service. The benefits of sentiment analysis have not been fully utilized in third party service selection. In this paper we present a tool that assists the business analysts in making better decisions for service selection by providing qualitative as well as quantitative data regarding the sentiments of the past users of the service. The tool has been applied and evaluated in an observational case study for service selection. The results show that sentiment analysis helps in increasing relevant information for business analysts, assists in making more informed decisions, and allows us to overcome some of the challenges of service selection.

Keywords: Service selection · Sentiment analysis · Requirements engineering

1   Introduction

Although Service Orientation was proposed as a new style of software development to addresses some of the shortcomings of previous approaches [1], it has inherited some of the challenges of component based and object oriented development, in particular in the requirements engineering [2, 3]. 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 [4, 5]. Due to large number of online services offering similar functionality, the analysts require additional source of information for making more informed decisions for service selection [6].

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 [7, 8]. More recently, past users' feedback, reviews and comments from online sources have been considered a form of user involvement [9-11]. These offer valuable information to assist analysts in increasing their knowledge for making more informed decision for service selection [12]. The user comments and feedback have been major sources of evolution of Android market and Apple store applications [13-15]. Online user feedback and sentiment analysis has attracted great interest in various areas of software engineering

research e.g. Requirements Elicitation [15, 16], Software Evolution [11, 17], and Software Quality [13]. '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 [11], 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 product [10]. In service oriented paradigm the full extent of the benefits of this form of user involvement has not been empirically investigated [18].

In this paper, we present a tool 'EVALUATOR' that supports our previously proposed ARISE (Alignment of RequIrement and SErives) method [18, 19]. In ARISE method, we have explored the benefits of past user feedback analysis on the process of service selection and have evaluated its usefulness for analysts in overcoming the challenges of alignment. The tool aims to assist the business analysts in making better decisions for service selection by providing qualitative as well as quantitative data regarding the sentiments of the past users of the service. We have applied EVALUATOR to the data collected from an observational case study [12], to assess the utility and working of the tool. EVALUATOR automates some aspects of ARISE in order to reduce the time and effort required for implementation of the method. The results show that sentiment analysis helps in increasing information for business analysts, assists in making better informed decisions, and overcoming challenges of service selection.

2   Background

2.1   Challenges of Service Selection

Identification of the correct service is the most important step in Service Oriented Software Engineering (SOSE) [20, 21]. According to the qualitative study involving interviews with practitioners, selecting a service against customers' requirements is considered a challenging task due to the following reasons [2, 22]:

- Services are developed free of context to cater the needs of large number of customers. The lack of contextual information in service description or specification makes it challenging to decide about the suitability of the service in a particular system.
- The advertisements of the third party online services published by the service providers often provide incomplete or ambiguous information.
- The functionality offered by the services is usually not at the same level of granularity as the customers' requirements.
- The level of abstraction in description of service specifications and customers' requirements are usually not at the same level.
- Due to availability of huge number of online third party services with similar functionality and cost, it is a paradox of choice when it comes to selecting the best match service for customers' requirements.

The existing solutions for service selection are focusing more towards the technical aspect of the challenges of service selection and the social aspects are neglected to the larger extent [2, 21].

2.2   User Involvement and System Success

It has been axiomatically accepted in the existing literature of four decades that user involvement in software development leads to successful systems [8, 23, 24]. The form of involvement basically describes the way in which the users are involved. There are three levels of user involvement [25]: *Informative, Consultative and Participative.* 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, and their physical presence is not necessary. In service oriented paradigm, user involvement is needed in order to provide systems that can be customized for individual user needs [9]. Past 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.

2.3   Sentiment Analysis

In recent years, there has been a substantial body of research for proposing methods, tools and techniques on collecting and analyzing past users' feedback that is available online, comments and review for extracting useful information [11, 13-17, 26-28] (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. 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.
- 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 [17].
- 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 provided the motivation for proposing a method for Alignment of RequIrements and SErvices (ARISE) which utilises past users' feedback, sentiments and comments in the decision making process for the service selection. Next section presents brief summary of ARISE method. Full details of the method are presented in [18, 19].

3   ARISE – Service Selection with User Feedback

ARISE method [18] 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. 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"*. 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 form 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.
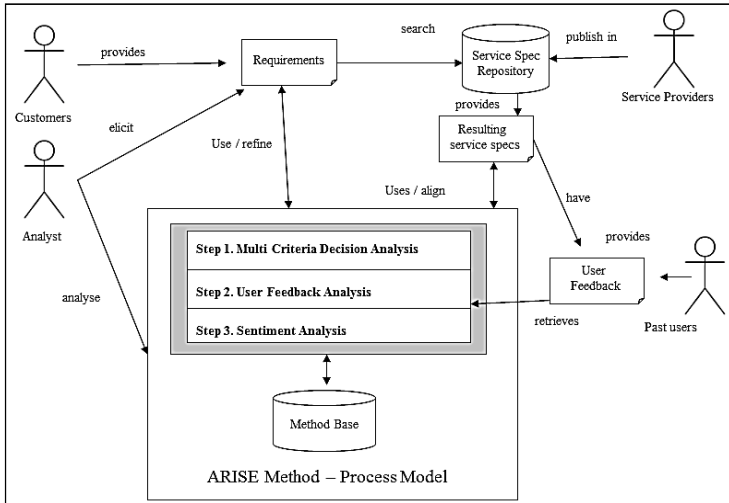
Fig. 1. Process Model for ARISE [18, 19]

Figure 1 represent the process model of ARISE method. The process of alignment in ARISE method starts with the elicitation of an initial set of requirements from customers represented by R such that $R = \{R1, R2, R3 \ldots RX\}$ 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 $S = \{S1, S2, S3 \ldots SY\}$ where Y is number of services found against requirement set R. The analysis in the ARISE method comprises of three interconnected and iterative steps [18, 19]: Multi Criteria Decision Analysis, User Feedback Analysis, and Sentiment Analysis. A "method base" is required for providing suitable tools, techniques, or methods for these three steps according to project situation and context. This provides the flexibility to ARISE method to be adopted for various project situations.

3.1   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 Multi Criteria Decision Analysis (MCDA) [29]. MCDA is used for decision making in situations where a trade-off is required among multiple criteria. 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 analyst converts the requirements into a 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

list. These weights provide prioritisation of the requirements based on customer preferences as not all the requirements are equally important for the customers. Various MCDA methods are available for different situations which can be stored 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 [29] 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 [29] 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 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 Si from the set of services S the score is represented by Score(Si) 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.

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

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.

3.2   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

3.3   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.

4   Case Study

For instantiation of the ARISE method, we have previously conducted a case study. The preliminary results of the manual implementation of ARISE method in a case study were presented in [12]. 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; (3) To find the requirements for an automated tool support for ARISE method.*

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: *"User feedback assists in overcoming challenges of aligning requirements and services".* 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 ser-

vices 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 1 shows some of the 28 checks that were created based on customer requirements that were used for evaluation of the services [12]. Manual online searches (the searches were conducted in June 2014) resulted in 91 eligible SMS gateway service providers. The list of 91 services along with the links to their descriptions is available online (http://goo.gl/CcguZM). Evaluation of 91 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. 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. When the past users' comments for all these 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. Without sentiment analysis scores and user comments, service 76 (Via SMS) appeared to be the best match. Whereas with all this available information, service 71 (Direct SMS) appeared 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.

Table 1. Prioritized checklist from customer requirements [12]

Ri	Requirement check description
1	Service supports outgoing text messages in Australia
2	Service should not have any hardware or SIM requirements
3	Service should be highly reliable with 99.9% message delivery
…	………………………………………………………………..
26	Service shows notification of message delivery
27	Service shows message delivery failure notification
28	Service should provide schedule message delivery in case of holidays

The work in case study was conducted manually and took two weeks to complete the task. This highlighted the need for automation of some of the steps. The case study was helpful in identifying the requirements for the tool support for ARISE. In next section, we present the tool 'EVALUATOR' designed to support ARISE method and describe how the data from the case study was applied in the tool.

5   EVALUATOR – Tool for Service Selection

The aim of the tool is to assist the analysts with all the steps of ARISE while automating some parts of it, and provide a visual display of the quantitative and qualitative results at the same time. EVALUATOR requires the analyst to enter the set of requirements and service names (or descriptions); the tool uses an API 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 which would be displayed in a graph with both numerical scores as well as textual comments. From the case study, it was obvious that ARISE method would require automation to make the tasks easier and less laborious for the analysts. The case study was helpful in identifying the requirements for the tool support for ARISE method and is required to provide following functionalities:

- Provide graphical interface to input requirement checklist and additional description and their associated weights for prioritization.
- Provide graphical interface to input service names, specification and additional data (online links, SLA, API description).
- Easy navigation to move back and forth in performing steps of ARISE
- Provide a grid interface for entering scores for all the services against every requirement in checklist.
- Provide facility to connect to online sentiment analysis sites and provide sentiment analysis data and popularity index of the services
- Provide facility for retrieving user comments and qualitative data of the services

- Show graphs and charts for calculating scores for all the services using the ARISE method
- Enable back and forth navigation and editing
- Maintain database for a specific project

Agile development methodology was followed for analysing, designing and implementing EVALUATOR. It was developed by using HTML5 and Javascript for client side scripting, and PHP for server side scripting. The database support was provided with MySQL. The interface for displaying results was supported by 'Highcharts' service API (http://www.highcharts.com/) and 'x10hosting' web server was used for uploading and deploying the EVALUATOR (http://evaluator.x10host.com/). In the following we provide the screen shots of the EVALUATOR tool which are in sequence to the steps of the ARISE method. The home page (Figure 2) 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. Once the login is successful, a new project can be created. Also the previously stored projects can be retrieved form 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. Next tab on screen is an input interface for requirements statements, weights and additional description or notes for further explanation (Figure 3). These weights are used for MCDA scoring and ranking as customer preferences for scoring services. The next interface (Figure 4) is for entering the names and URL of web services, and optionally the descriptions can be directly entered to database. Analysts can enter the scores for the services based on their granularity level to the requirements (Figure 5). This will automatically calculate score for individual requirement according to the customer preferences. The sentiment analysis is automatically calculated for every service by interacting with API from 'socialmention.com' by providing names of the services as input and getting both sentiments scores as well as past users' comments as output. This API is used for tracking any mention for the identified keywords in video, blogs, events, news, bookmarks, hashtags and even audio files. 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 do so repeatedly, and for "Reach" which is the measure of the range of influence of the product or service. "Strength" is the likelihood that the 'keyword' is discussed in social media within last 24 hours. These 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. The interface for results combines all the results into one compact display (Figure 6). Clicking on any resulting bar will show respective comments of users retrieved for that specific service (Figure 7).

6   Discussion

The main benefit of EVALUATOR was the automation of sentiment analysis and qualitative comments retrieval which took considerably long time when done manually. The visual aid also made it intuitively easier to see the trend among competing services by providing both qualitative and quantitative data in one compact view. 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 alignment for making informed decisions for service selection. The observations regarding some of the reasons that made alignment process challenging are discussed in following:
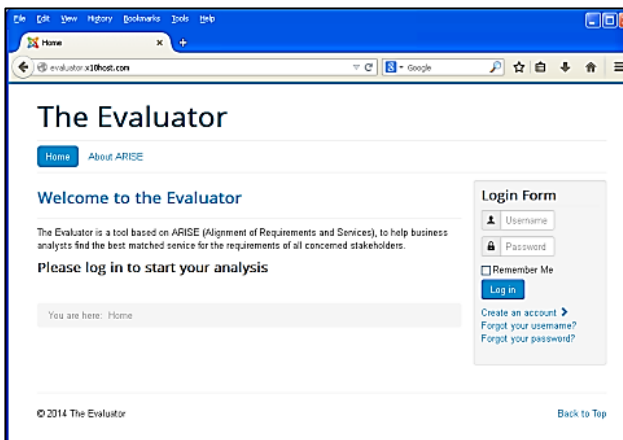

Fig. 2. EVALUATOR Home Page

- **Paradox of choice:** In the case study, there were a substantial number of related services to select from. MCDA scoring and ranking is a laborious and time consuming task when done manually. By automating this step of ARISE, it was helpful in reducing the laborious work in case where there is a huge sample of service specifications to evaluate.
- **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. 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. 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. EVALUATOR helps in retrieving the user comments for further analysis and hence makes the data available for further assessment to find missing information.
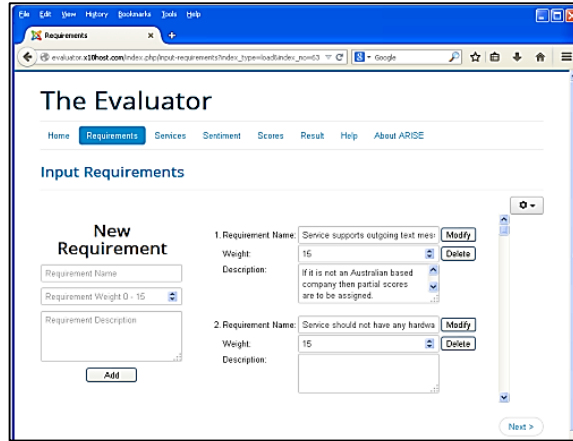
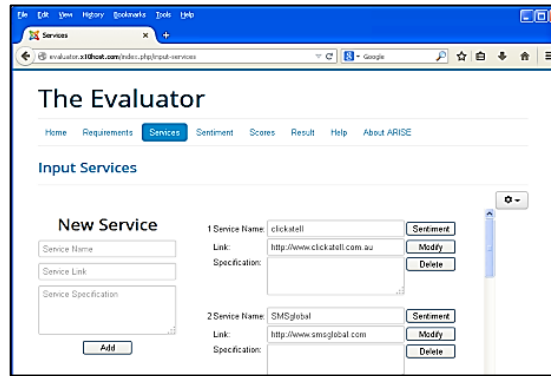**Fig. 3.** EVALUATOR Requirements Input Page
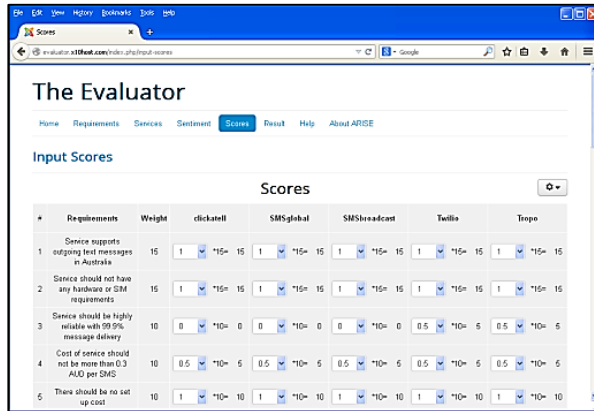

Fig. 4. EVALUATOR Service Input Page

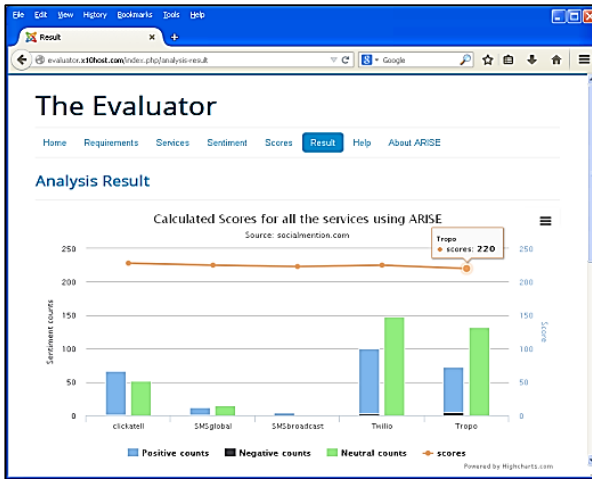**Fig. 5.** EVALUATOR Granularity Analysis Score Input

Fig. 6. EVALUATOR Analysis Results

Fig. 6.   EVALUATOR Analysis Results – User Comments

- **Lack of user involvement:** Past user feedback and comments provide ways of involving them into the service selection decision process. The experiences of past users are a form of knowledge that can be brought into the alignment process for making more informed decisions. In ARISE method the past users of the services are involved through their feedback and reviews.

7   Conclusion and Future Work

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. According to the results of the case study, it

was observed that ARISE method does help in overcoming the challenges of service selection faced by the practitioners. 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. In this paper we have presented a tool support for our previously proposed method of alignment of requirements and services (ARISE). The tool aims to assist the business analysts in making better decisions for service selection by providing qualitative as well as quantitative data regarding the sentiments of the past users of the service. The tool has been used in an observational case study for service selection. The results show that sentiment analysis helps in increasing information for business analysts, assists in making better informed decisions, and overcoming challenges of service selection.

We are currently experimenting with use of Natural Language Processing (NLP) tools to automate the step of MCDA and scoring, ranking and filtering of service specification. The idea of the approach is that a service description is likely to satisfy a requirement if it shares semantically related natural language content with it. Our future directions with EVALUATOR include integration of web crawler in EVALUATOR that can search for the service from online resources, and giving the tool ability to calculate sentiment scores for individual requirements rather than for a complete service.

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