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Context-Aware Web Service Selection – A Negotiation Model

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Abstract— ***Web services are the prominent and emerging technology for web application development that converges upon services as their basic element and permits application from different vendors to communicate with each other. A number of service providers are now providing numerous services with different quality of services and cost levels. Therefore, the tremendous growth of web services and also the divergent view of services by both the parties (service provider and service consumer) make the task of service selection a complex job. To resolve this issue on divergent view of services, and to select an appropriate services, this paper propose an egalitarian based negotiation model that aims to select a required service according to the user context by making use of trust principle on objective experiences of service consumers and thereby achieving egalitarian principle.***

***Keywords* — Service selection, Context, Negotiation, Egalitarian, ontology.**

I. INTRODUCTION

As Web services increases, many businesses are providing similar services with overlapping functionalities. Therefore, it is very difficult for users to select an appropriate service among the sea of services. With recent advancement of Web 3.0 heading to semantic web, Web Service Selection (WSS) has caught attention recently. The functional specification and interfacing aspects of Web Services deals with the issues of service provisioning and service discovery. The issue of service selection is not addressed by the initial functional specification. Service discovery deals with the process of locating or discovering related service descriptions that describes a particular web service using the Web Service Description Language (WSDL). Whereas service selection deals with choosing a service implementation among the located services to satisfy the customer need.

To make the process of service selection more appropriate service selection and composition can be automated Not only the automated system should produce an optimized composition, but it should also do so in an efficient manner. Efficient here means the context and non-functional quality of the services as specified by the user as their preferences. Context is the information that characterizes the interactions between humans, applications, and the surrounding environment. From a Web services perspective, context is defined as a set of common meta-data about the current execution status of a Web service and its capability of collaborating with peers, possibly enacted by distinct providers or customers [17].Here, context is considered as key information characterizing the customer's information, e.g., customer preferences, needs of customer, about the location, and useful information about the environment where customer operates, e.g., date, time, on-going activities and interactions with services and/or other customers. The interestingness of service selection on the Web relies on the participating entities to interact. However, selection of entities to interact is difficult. Consider a service consumer interested in receiving a service. For the service description by the consumer, there may exist a number of service providers with substantially different service offerings. Therefore the consumer's knowledge on selecting service providers including learning about past dealings with the respective providers, learning about multiple sources and final selection of service providers are open issues on service selection mechanisms. In pervasive computing, context information is usually dynamic and incomplete. This dynamic context may changes and the result lead to the non-selection of services. Service selection mechanisms also have to cope with two issues. Firstly, when executing in pervasive environments, service selection mechanisms have to deal with the question such as reducing problems on mismatch between contextual information related to the service execution and current context information.

Secondly, the non – functional quality or QoS of services [20] [21]. It represents the total time taken for a service to execute, the cost of a particular service or even the available security features and many others. Several attributes can be taken into QoS consideration at once [1]. Depending on the user's need and expectation, several quality attributes might be of importance, such as cost, response time, availability, reliability, security, throughput, reputation and so forth. W3C [4] defines various QoS attributes such as reliability, security, performance, scalability, capacity, and so on. But the evaluation of QoS attributes involves great complexity when fuzzy terms are used to express service requests in the process of service discovery. This is because the fuzzy terms may vary according to the needs and preferences of service consumers and service providers. For example, a service with its QoS 90% success rate is considered reliable for some service providers and consumers, but others may demand 99% of reliability. Similarly, a service with 7 ms response time can be considered as having good efficiency by some service participators while others may consider this

service as inefficient. Thus, there may exist different expectation between service consumers and service providers.

This paper addresses the first issue stated above by proposing an egalitarian based negotiation model for context aware web service selection. To achieve this aim, this paper makes use of trust principle on objective experiences of service consumers to select the service providers. This can be achieved with the use of context ontology. The ontology represents the details of the requested service description and the received service. Secondly, this paper propose an egalitarian negotiation model that selects a best service from the identified service providers to achieve equalism on both service consumer (end user who request the service) and service provider. A negotiation system consists of a group of software agents that communicate and autonomously make negotiation decisions on behalf of the human user. The negotiation agents in this model reduce human negotiation time and identify the requested services for service consumer by satisfying the equalism principle.

The remainder of this paper is organized as follows: Section II describes the various services election mechanisms for Web service selection. The context information on objective experiences of service consumers to identify the service providers and the negotiation model to achieve equalism between service consumers and service providers are illustrated in Section III. An example scenario to achieve equalism is described in section IV. Section V illustrates the result analysis. And, in Section VI the conclusion and the future enhancement is presented.

II. RELATED WORK

A number of mechanisms for web service selection have been carried in the literature. Simplest among them is keyword based selection. This selection mechanism searches for exact match in the UDDI registry. This works same as searching for a material in any search engine (e.g. Google, yahoo). The search for "Apple" retrieves the fruit apple, apple iphone, apple ipod etc. The existing syntactic-based service selection technologies are insufficient for building a full-fledged composite service. However, this keyword search paradigm cannot always precisely locate Web services partially because of the semantics embodied in these services. The limitations of using this mechanism in Web service is, retrieving irrelevant services to consumers.

A number of techniques for overcoming this issue are proposed. The most common approach among this is 'matchmaking' technique. It is used in situation where services with semantic descriptions for their functional attributes are needed. Several service matchmaking techniques have been developed to meet the needs of both consumers and providers. [6] [19] addressed this issue of selecting web services by maximizing user satisfaction expressed as utility functions over QoS attributes[8] and [12] developed a goal- oriented and interactive composition approach that uses matchmaking algorithms to help users filter and select services while building their composition service. In [5] functional semantic is taken into consideration thereby avoiding unsatisfied result which are not of customer interest. They proposed a composition method that explicitly specifies and uses the functional semantics of web services based on domain ontology. Here the authors have defined the functional semantics of a service as describing what a service actually does. The service functionality of a service is represented by a pair of its action and the object of the action. In [9] a hybrid semantic Web service selection of semantic services in SAWSDL based on logic based matching as well as text retrieval strategies are proposed.

Discovery is the process of locating a Web service that meets certain functional criteria. Selection is related to the process of evaluating and ranking the discovered Web services to identify the ones that fulfil a set of non-functional properties requested by the service customer. Most of the existing techniques rely on syntactic descriptions of service interfaces to find web services with disregard to non functional service parameters. K.Kritikos [7] demonstrates how this situation generates major problems. To solve this problems, Web service descriptions are enhanced with annotations of ontological concepts, semantic matching and by considering non-functional properties. In [15], a Web Service Quality Broker Architecture including Quality Broker, which provides quality negotiation environment, is proposed. A web service selection method is used to help service requester find the service provider which gives the maximum benefit and bind the service dynamically. In order to enable quality-driven web service selection [16], an open, fair, dynamic and secure framework to evaluate the QoS of a vast number of web services is proposed. All this methods do not take into account the issue of conflict on QoS characteristics between service consumers and service providers.

With the proliferation of Web services as a business solution to enterprise application integration, the QoS offered by Web services are becoming the chief priority for service providers and their service consumers. Due to the dynamic and unpredictable nature of the web, providing the suitable QoS is really a challenging task. In addition to this, selecting the right parties to interact with is a fundamental problem in open and dynamic environments. To achieve solution for this, services can be selected based on the context information. Context information focuses on consumer perspectives and also in service perspectives. The main aim of Context aware service selection is to achieve the effectiveness. When context information is used in service selection development and deployment, the description of service request and selected service description can be enriched. Context-based service selection for Web services composition has gained more advantages. A two step, context-based semantic approach to the problem of matching and selection of Web services for service composition is proposed by Aviv [3]. The author has proposed a unique technique to provide the designer with an explicit numeric estimation for service composition. Two methods for text processing called TF/IDF and Context analysis are proposed. Here, context is a set of finite sets of descriptors. A context may be a set of words defining a web service, and the weights can represent the relevance of a descriptor to the Web service. Zakaria Maamar et al [18] proposed a technique which takes into account both the context and policy for Web services composition. The role of context provides information about environment the service composition occurs. The transition

of one level to another level produce the action taken place, the context and type of policy used. Three types of policies are used in this technique namely Engagement, Mediation and Deployment. Policies are defined as ''information which can be used to modify the behavior of a system''. The structure for each type of context is defined along with its arguments. The composite level includes arguments such as label, global ontology, previous component web service, current component, next component, beginning time, and date. The semantic kevel includes arguments such as label, current composite web service, current component web service, triggered mapping function per current composite web service, triggered conversion function per current component web service, and date. A rule based context sensitive QoS model to support the changeability of QoS values and the context sensitive constraints is proposed by Tao Zhou et al [14]. The authors have contributed three important factors in their model. The first is to introduce a context sensitive QoS model and a context function *g*() to calculate the impact of context on each QoS value of a service. The second is to propose a rule model to represent context based on real world business perspective. The third is to apply the rule model in validation of service selections and changes of QoS values.

III. PROPOSED WORK

This paper compliments the previous research work by taking into account the context information on objective experiences of service consumers for selecting service providers. The negotiation model proposed in this paper aims to achieve equalism on profits or benefits between service provider and service consumer.

A. Problem Definition

It is identified from the literature that the focus to service selection is concentrating on selecting good services from the bad ones or the enormous amount of available services. This paper, first works on the objective knowledge of service consumers on selecting related service providers. When a service requestor request for a service, a number of services from the registry will be discovered. It uses the trust principle of consumer's knowledge on service providers to select the related services based on the context of the service requestor or consumer. A negotiation model is then used to select a service from related services based on egalitarianism. Egalitarianism is introduced to achieve equal profit among service consumer and service provider. Equalism or Egalitarianism in this paper is defined as service consumer and service provider should be given equal profits or benefits. Web service selection problem describe situations in which there are many agents (Service providers) who advertise different services on varying context and QoS properties in the registry to sell, and there are other agents (service consumers) who want to acquire different services that satisfy their complex requirement. To obtain an efficient solution to the service selection mechanism, this work concentrates on how to distribute the total profit among service consumer and service provider when they cooperate. The two questions that arise here are:

- How to capture the consumer's objective experiences with the service providers.
- How to distribute the total profit or benefit to service requestor and service provider.

B. Capturing Consumer's Experiences

Earlier approach to capturing experience is by means of rating – based approach [10]. The context rating is expressed in this approach. A rating-based approach focuses on the subjective opinion of the individual raters. Yet this approach deals with the problem, because the context criteria or information of the consumer using this rating based approach may be different from the context information of those who give the ratings (that is, the context of service consumers may differ during their service selection). Even if their requirements are the same, the rating of services by the service consumers may be different depending on their context. The issue that arises here is how to get rid of subjectiveness of ratings in the service selection. Consumer's interactions with service providers can be modelled as experience structure [11] to get rid of subjectiveness of ratings. This experience structure deals with objective experiences of service consumers with service providers for rating the providers. An objective experience contains the consumer's service needs and requirement and the provided service in response to the service needs. Therefore, any consumer upon receiving an objective experience from other consumer can evaluate the provider according to its own context information using the objective data in the experience. This approach removes the subjectiveness of the rating-based approaches.

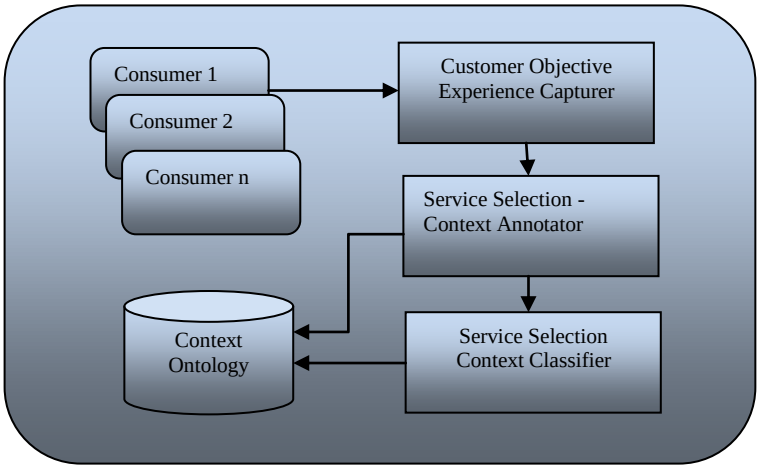

Fig. 1 Context Ontology Building

C. Building Context Ontology

Use of objective experiences requires building of context ontology. Figure 1 illustrates the process of building context ontology. The consumer's experiences with service providers are represented using ontology that also includes the context in which the service was requested. The experience from service consumers is captured and the context annotated is classified and represented in the ontology. This ontology encapsulates the fundamental concepts such as context of customer, customer needs and requirement, commitment and experience in the base level ontology, and domain specific concepts and properties. Using this ontology a service consumer can express the details of its transactions with different service providers. The core of this ontology includes descriptions on service demands, supplied services, responsibilities and fulfilments of service consumers.

D. Egalitarian based Negotiation Model

For service request R with the context specification, the process starts by first discovering a set of services namely R_1 to R_n. The mechanism service selection starts with the trust principle on objective experiences. Therefore for the services R_1 to $R_{n,}$ there may be many consumers who have experienced those services. For service R_1 there may be n consumer's experiences. All their descriptions along with context information, demand, are represented in base and domain ontology. The service consumer who request for the service, evaluate the service provider according to its own criteria using the objective data in the experience. By this way, the related service provider for a request can be identified. After the services are identified, the process of egalitarian based negotiation starts to achieve equalism on service consumer and service provider. Negotiation refers to the process by which group of agents (human or software) communicate with one another in order to reach a mutually acceptable agreement on resource allocation (distribution) [2]. Figure 2 illustrates the context-aware service selection using egalitarian negotiation model. The query processor agent process the requested query from service consumer and extracts the semantic annotations, QoS, context of the web service to be selected. This critical process focuses on deriving the exact service to be selected using domain ontology and QoS ontology which is not scope of this paper. QoS based negotiation model have been discussed in our earlier work [13].

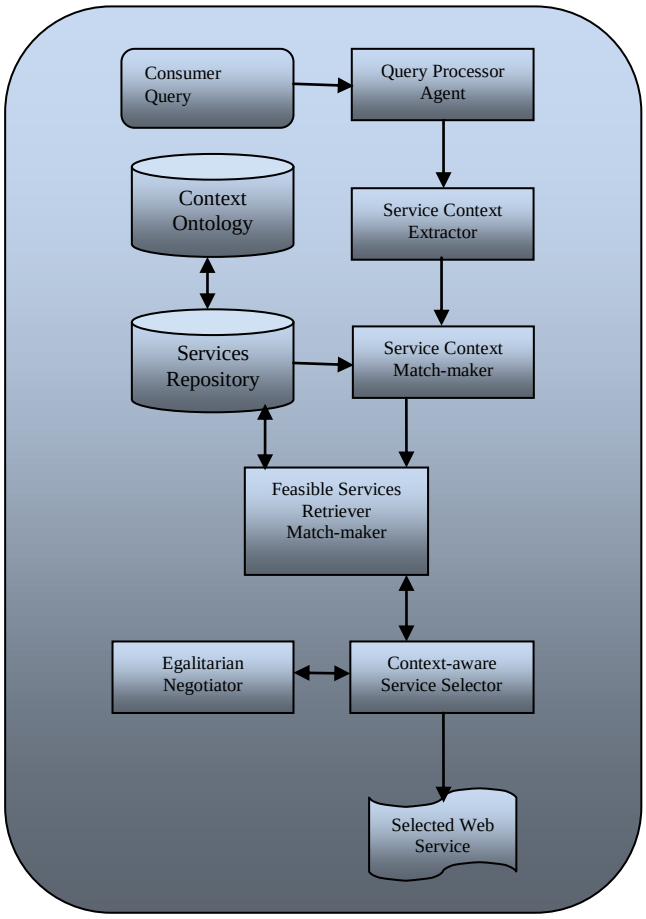

Fig.2 Egalitarian Negotiation Model

The context extractor analyses the related contexts of the service to be selected with aid of the query processor agent and prepares the contexts information of the web service. Context ontology and services have a mapping in the service repository. The services retriever establishes a mapping between the context list provided by the extractor and context information of services in the repository to produce a set of feasible services. The context-aware service selector uses the principle of egalitarianism based negotiation process so that both consumer and provider get equal profits for the appropriate selection of the service. How to distribute the profit equally to both the players of negotiation is discussed in section E.

An example scenario for negotiation is depicted with use of three agents namely buyer agent in the context of consumer, seller agent in the context of service provider, and negotiator agent for appropriate service selection.

The request from service consumer may be on the non – functional properties of services such as response time, cost etc. This is carried by buyer agent to select the required service. The buyer agent work cooperatively with seller agent to select a service that provides equal quality profit to service consumer and provider. The negotiator agent initiates the negotiation process to achieve equalism. Each agent has their specific components to select the required services. The component that is similar in all three agents is manager component which handle and control all the other components.

Buyer Agent: The look up registry provided by service context matchmaker is used to hold the previously selected feasible services. Once the request is initiated, the agent checks to see objective knowledge in the feasible service list for decision making either to accept or not. Otherwise, the query will be transmitted to negotiator agent if no objective experiences of service consumers with service providers available for negotiation.

Negotiator Agent: This agent is responsible for initiating the negotiation process. The search component in the negotiator agent maps the services provided by the service retriever with the consumer service context information for negotiation to achieve equalism. The services from different providers make the negotiator agent to initiate the negotiation between buyer agent and seller agent to select service that provide or distribute equal benefits to service consumer and provider.

Seller Agent: The Seller agent holds description about services, and consumer data. It initiates either acceptance or denial response after analysing its required specification with a specification provided by negotiator agent, every time when the negotiator agent places its service selection request.

The definition of equal profit in web service selection process is explained as follows:

Definition 1: Profit in customers view

The profit for service consumer is the quality of the service. That is, how effective and efficient the service is for building an application (takes into account both the functional and non-functional properties).

Definition 2: Profit in providers view

The profit for service provider is the amount or cost per service. That is, the cost of selling a service. The cost per service is assigned based on the effectiveness and efficiency of the service (takes into account both the functional and non- functional properties). The trust the service consumer have in provider is also a profit for service providers.

E. Distribution of Profits

Multiple QoS characteristics are involved in service selection process. Therefore, the profits of buyer and seller are quantified with numerical values in order to measure the degree of satisfaction. Let $w \epsilon R$ be the multiple I profits to be distributed among n agents (denoted i, j…). R denotes various context specified by the consumer.

$$u_i: R^d \rightarrow R \qquad \text{------- (eq 1.1)}$$

Say, $x \epsilon R^d$ is an allocation, i.e., the distribution of profits among n agents. x_i denote the profits attributed to agent I under allocation x. Preferences of individual i are represented by utility function, and is shown in (eq 1.1)

A vector of utility functions, $\{u_i\}_{i=1\ldots n}$ one for each individual, is denoted by u, and called a utility profile.

$$\sum I\ x_i \leq w \qquad \text{------- (eq 1.2)}$$

The distribution of profits is defined as (w, u); x is said to be feasible allocation of profit distribution (w, u) if, satisfies (eq 1.2) specified

$$u_i(x') > u_j(x') \Rightarrow x' = 0 \qquad \text{------- (eq 1.3)}$$

A selection of service x' is said to be equalism for a profile u if, for all agents i, j and is shown in (eq 1.3).

IV. EXAMPLE SCENARIO

An example scenario is presented here to show the working of proposed negotiation model to achieve equalism. Consider a withdrawal service request is the request from service consumer. After the process of capturing the objective knowledge with the use of ontology, a list of related service namely withdrawal services is identified. Egalitarian is applied to get a best service from the available services by specifying the non – functional property or quality of the service.

Here, in this example QoS such as Response time 3ms and Price 10$ is requested for withdrawal service. Getting this input from buyer agent, the negotiator agent search or looks for withdrawal service that matches the non-functional properties Response time 3s and Cost 10$. The negotiator agent is responsible for providing equal profit to service consumer and service provider. If a withdrawal service with Response time 2s and Cost 12$ is available, the negotiator agent initiate negotiation with the service consumer to achieve equal profit. The service consumer and service provider should cooperate to reach equal profit. Therefore, if the decision makers (consumer, provider) are satisfied with the negotiation process the service is selected. Otherwise, the process is iterated until the win-win situation is reached. Figure 3 depicts the sequence diagram of this example.

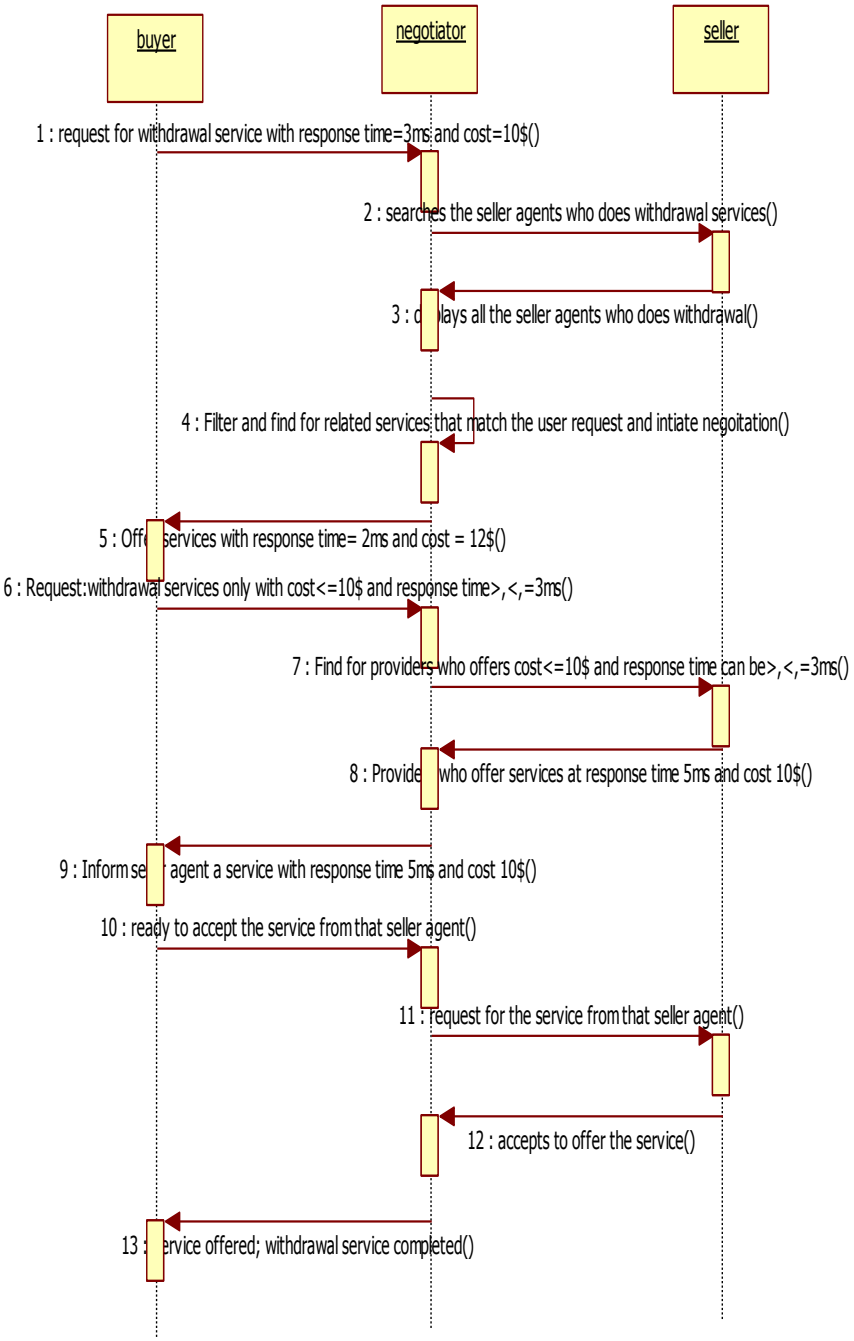

Fig.3 Sequence Diagram Showing Example Scenario

V. RESULT ANALYSIS

An online hotel booking application prototype is developed to test the system proposed. The system is tested in two perspectives. The first perspective is, what would be the performance of service selection when applying user context by making use of trust principle on objective experiences of service consumers. And, the other perspective is what would be the performance of the service selection in the absence of user context. In the first perspective, after capturing the consumers experiences, only a few set of service provider services are retrieved and therefore, the input space is limited for the negotiator to negotiate with the service consumer. The egalitarian negotiation model proposed then negotiates with the service consumers to achieve Win-Win strategy. Whereas, in the second perspective only the negotiation model is used to select the services in the absence of user context and therefore the input space is large. In the experiment, the performance of proposed model is tested first with 150 services and the service is selected in the second negotiation round with inclusion of user context and in third negotiation round in the absence of user context. With 180 services, best result is obtained in the second negotiation round with user context and in fourth negotiation round in the absence of user context, and with 200 services, the best result is obtained in third negotiation round for user context perspective and in fifth negotiation round in the absence of user context. Figure 4 illustrates this scenario.

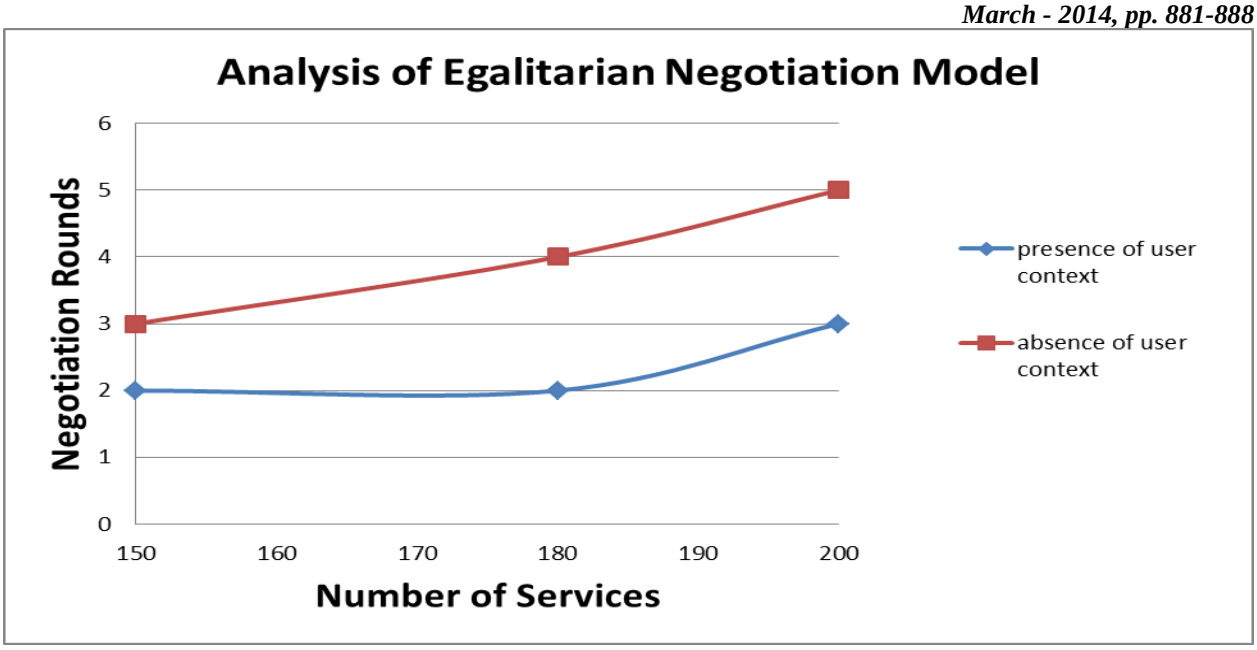

Fig.4 Analysis of the proposed model

VI. CONCLUSIONS

This paper outlines a new negotiation model and its goal is to search for a service with WIN – WIN situation between service consumer and servicer provider. The context information of services is represented in an ontology that is used to capture the objective experiences of service consumers with the service providers. This helps the egalitarian negotiation model to select the best service among the identified services by specifying the quality parameters. It is seen from the experimental study that the negotiation model works best with the presence of user context that captures the objective experiences and thereby selecting the required services in few negotiation rounds when compared with negotiation process in the absence of user context.

Future enhancement to the current work aims to apply a self-organizing neural model and thereby making the service selection process to adapt unsupervised learning techniques.

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