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# REVIEW ON SERVICE SELECTION SCHEMES BASED ON USER PREFERENCES

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## ABSTRACT

A variety of schemes for user preference-based Web Service selection has been developed over the years. Users provide their preferences and then receive related services by the service selection mechanisms using different schemes. The individual performance of these schemes may vary while using different quality measures under changed circumstances. In this review, focus is on Service Selection schemes in the Web Service selection domain. Overall, a total of seventy-six (76) studies from 2004 to 2013 have been reviewed in this paper. However, twenty-five (25) studies were selected and categorized into five (5) groups that focused on each one of the five schemes (CP-Nets, OWL, QoS, Multi-request, and Ranking) and performance related quality attributes. The findings indicate the following results of differing schemes, namely: accuracy is focused upon to a greater degree of (56%) compared to the other quality attributes, specifically: efficiency (40%), effectiveness (40%), scalability (24%) and reliability (16%) respectively.

**Keywords:** *Web Service Selection, User Preferences, Selection Scheme, Quality of Service (QoS)*

## 1. INTRODUCTION

Web Services have made a terrific impact in the field of Information Technology. It is anticipated that this will only increase in the future because they have combined the best features of component-based development and the web. Web Service selection allows a user to discover the required service based on his / her preferences. With the rapid increase of Web Services mounted on the internet, the service selection is becoming a crucial procedure to help users in identifying their required Web Services.

User preference often plays a vital role in personalized Web Service selection and AI applications[1]. It is mainly based on decisions made by individuals as to which service is appropriate according to their requirements. However it is generally agreed that users feel more comfortable and natural in expressing their preferences in a qualitative and conditional manner[2].

In selecting services the requesters need a model that sufficiently describes their preferences over the functional or non-functional characteristics of service and an appropriate approach. As such, functional and non-functional properties (QoS) are two major requirement categories in service selection (SS)[3]. In the case of SS, many solutions have been introduced in recent years [4], for example: service reputation bootstrapping[5]; Form-based interfaces[6]; Cluster services[7], etc.

Several schemes have been developed in the past years, however in this review; we have taken CP-Nets, OWL ontology, QoS, Multiple requests and ranking-based schemes so as to identify their focus on five (5) quality parameters. These parameters are, namely: accuracy, efficiency, effectiveness, Scalability and reliability. We have selected twenty-five (25) from among seventy six (76) studies based on the following inclusion exclusion criteria.

### 1.1 Inclusion Criteria

Based on the titles and abstracts of different research articles, the inclusion criteria are given below:

- Articles on User preferences-based service selection
- Articles on user preference-based service selection and composition

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- Review of papers in electronic databases
- Papers that describe schemes: CP-Nets, QoS, Ranking, Multiple Request and Owl ontology
- Papers that describe quality attributes: Reliability, scalability, efficiency, effectiveness and accuracy

### 1.2 Exclusion Criteria

The following points are included in the exclusion criteria:

- Papers on other than specified selection schemes
- Papers on other than specified quality attributes
- Papers published in languages other than English

This research pertains to user preferences considering one of the five (5) above mentioned quality parameters. Section 2 presents QoS model describing the quality attributes considered in this review.

We provide a detailed review of 5 schemes considering any one of the 5 quality attributes mentioned above in Section 3 to Section 7. In addition, we present our summary of quality attributes that have been focused on in the reviewed studies, together with their achievements, in Section 8. In Section 9 we present a discussion together with limitations of our study, followed by the conclusion in the Section 10. This study has been undertaken as a literature review. The objective of this review is to investigate the service selection schemes, especially considering the quality attributes given in the context of this study.

## 2. A QoS MODEL FOR WEB SERVICE SELECTION

The World Wide Web (www) has become a universal platform where people can publish and receive different kinds of information through standardized protocols. Meanwhile, quality-of-service (QoS) concerns are becoming vital to the global success of the Web service based computing model[8]. As there is currently no standardized description framework to include all aspects of service's non-functional characteristics. Therefore, this section provides definitions of only those quality parameters which are focused upon in this study.

- ***Accuracy*** in Web services selection context, the accuracy is defined in terms of a set of relevant services retrieved by a web search engine in response of user query[1]. Precision and Recall are important measures to calculate the accuracy.

- ***Reliability*** of Web service refers to the service provider's ability to successfully deliver requested service functionality[8]. This ability can be quantified by the probability of success in a service execution, but it is usually evaluated through the service failure rate. This rate is calculated as the ratio of execution time and mean time between failures (MTBF).
- ***Efficiency*** is special concern of web service and mainly it is measured in term of response time that refers to the measurement of the execution time and waiting time[9, 10].
- ***Effectiveness*** is the capability of producing a desired result and DIN, E defines effectiveness in[11] as "*the accuracy and completeness of users' tasks while using a system*"
- ***Scalability*** refers to the capability of increasing the computing capacity of service provider's computer system and system's ability to process more operations or transactions in a given period. It is related to performance. Web services should be scalable in terms of the number of operations or transactions supported[12].

## 3. CONDITIONAL PREFERENCE NETWORK CP-NET BASED SCHEMES

CP-net is considered as a powerful tool to represent and reason with conditional qualitative preferences under the *ceteris paribus* ('all else being equal') semantics[2] . It has been proven through the selected studies that accuracy and effectiveness had been focused upon from the period of 2008 to 2012, while commensurate concentration was not given to other quality attributes, namely: efficiency, reliability and scalability.

[1] http://en.wikipedia.org/wiki/

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In[4], Hongbing Wang et. al proposed the use of a model on user preferences for service selection. It had been designed to take into account the Conditional Preference Network (CP-Net)[2] and Recommender System (RS)[13] in order to handle incomplete or faulty user's preferences. This approach was to operate as follows: firstly, remove the conflicts in user's preferences to check its consistency; and, secondly, pass the amended preference description to the service selector in order to retrieve the user's favorite Web Service.

Hongbing Wang et. al claimed that this approach was effective; having experimented with 10,000 concrete services possessing different attribute values, in terms of performance and having better usability. However, this approach was claimed in[1] as being computationally inefficient due to the qualitative nature describing no mechanism by which to remove the ambiguity of the preferences, ignoring the importance of parent nodes relationships and having to face the problem of scalability.

The issue of Weighted CP-Nets has been introduced in[1] as a mixed approach, i.e., qualitative as well as quantitative. The authors raised two issues in the CP-Nets, namely: 1) users are unable to express their unambiguous preferences (i.e. they cannot express their level of preference); and 2) due to limited expressiveness, many service patterns are incomparable. The WCP-nets approach allows users to express their preference in an unambiguous manner. In addition, they introduced a new measurement for the degree of preference Equation (1) of any given service pattern to be calculated in linear (*Langrangian model*) or nonlinear (*Artificial Neural Networks*) methods. In support of the WCP-nets approach, the authors conducted experiments on two real datasets, specifically: Adult[2] and QWS[3].

$$V(sp) = F(w_x \ , V_x\ (sp)) \qquad (1)$$

Moreover, the authors stated that other linear or nonlinear methods may be more suitable than those used in [1] because of the previous concentration solely on adjustment of attribute weights rather than optimization.

The authors of [14] present the set of collaborative schemes (clustering, threshold and behavior) which can most effectively select the best services using a qualitative method of CP-Nets which renders incomplete user preferences. Furthermore, they have compared the proposed approach with the classical collaborative filtering approach in terms of effectiveness and computation complexity to present competitive advantages over that. This study claimed an accuracy rate of more than 85% conditional upon the threshold value ranging from 0 to 0.85 by using the *Adult* dataset.

Wang [15] proposed a novel similarity measurement method to calculate user similarity based on explicit qualitative preferences represented by CP-nets. This study was an extension of [4] having an objective to solve the similarity measurement. The authors claimed that similarity measurement is also dependent on the means by which the user preference is represented. That is why they highlighted the intension to focus on the means of user preferences as a future work.

This approach was validated by conducting two batches of experiments on two real datasets *Adult* containing 32,561 records and QWS containing 2,507 This study claimed improved accuracy of up to 0.869 for *Adult* and 0.944 for *QWS;* while, before the preference adjustment, the accuracy was low, i.e. 0.25 for both datasets.

Further in research work by Wang [16], the authors highlighted the role of service selection in terms of the user's functional or non-functional preferences in the Web Service composition world. They focused on user reluctance in providing complete preferences, as well as the hard constraints imposed by the user. Therefore, in order to resolve the problem of incompleteness, the authors presented an optimization algorithm over CP-Nets.

In this paper, validation is performed by taking 200 Web Services and the results show an increase in execution time when the number of services increases gradually. However, this study lacks clarification of results demonstrating to what extent this approach was effective and accurate.

## 4. OWL ONTOLOGY-BASED SCHEMES

OWL (Ontology Language) is a standard inaugurated by the World Wide Web Consortium (W3C)[17], it helps with logical inference and allows conclusions to be derived from ontology.

[2] http://archive.ics.uci.edu/ml/datasets/adult
[3] http://www.uoguelph.ca/~qmahmoud/qws/

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Lamparter Steffen [18] emphasized the issues of volatile user preferences for the selection of highly configurable Web Services, along with other schemes such as WS- agreement by computing several service configurations. The authors claimed through experiments that their approach introduces an overhead of only around 2 seconds, as well as increasing communication efficiency and reducing storage requirements by avoiding requested configurations.

Sohrabi [19] claimed that recent research on Web Service Composition (WSC) has highlighted the importance of optimizing user preferences using OWL and also argued that this optimization can be done offline followed by execution of at least one information collection service.

This study has proposed a preference-based Hierarchical Task Network HTN-WSC system based on[20, 21]. This would attempt to balance the transaction between online information collection and offline composition to produce an efficient composition without a vast amount of collected data. The authors claimed, through experiments focusing on the travel domain, that their approach achieved an increase in the quality of the plan. It was measured through Percent Metric Improvement (PMI) and obtained an increase of 10%, together with execution time that was five times faster.

Rohallah et. al [22] focused on service discovery with user preferences and developed semantic service matching architecture comprising four layers, namely: an agent-based approach for Web Service discovery and selection using OWL-S based on [23, 24]; QoS (*reliability, response time ,execution price* ) and customer service request.

This study has presented an agents and OWL-based approach for Web Services discovery by combining multi-agent techniques OWL-S [25], WSDL-S [26], WSML [27] and DAML-S [28] with semantic Web Services. In order to test the approach, the authors have used the Java Agent Development Framework (JADE) platform[29]. In addition, they conducted experiments for performance estimation of the system by assuming that the customer request has the same functional requirements but different QoS weights.

In a study[30], Averbakh et. al focused on the issue of semantic Web Service discovery to improve accuracy by highlighting the importance of users' feedback in search results using OWL-S services. They proposed a method of combining multiple matching criteria with users' feedback to improve the results. Furthermore, for evaluating the proposed approach, OWL-S services have been used and the proposed approach is compared with state-of-the-art matchmaking algorithms (*Logic based Match, Loss of Information, Extended Jaccard Similarity coefficient, Cosine Similarity, and Jensen-Shannon information divergence based similarity*). However, the results given in[30] indicate the downfall of the accuracy measure (*Precision*) from 97% to 66% when the number of retrieved results (N) increases from 5 to 20. Hence, it can be seen that this needs to be improved.

Yu et. al [31] focused on the issue of the difficulty faced in service discovery through keywords due to an excessive number of existing services. The authors contributed a framework extending the work done in[32] by utilizing Universal Description Discovery and Integration (UDDI) and OWL-S for syntactical service discovery and service matching using ontology and inference in order to find and integrate the services dynamically for maximum reuse.

## 5. QUALITY OF SERVICE (QoS) BASED SCHEMES

Several studies [33-38] have stated that QoS is considered as a distinctive factor in user preference-based Web Service selection. Different QoS models identifying diverse QoS properties, quantifying metrics and verification mechanisms have recently been proposed by many researchers[39-41].

Quality is measured in different aspects, e.g.: *performance*[42] in terms of response time and throughput; *business* in terms of cost and transaction support; *security* in terms of identity management and encryption support; *user experience* in terms of rating and reputation, as well as *domain specific properties*, etc. In this study we focused upon on the performance related QoS parameters that have been investigated in different studies reviewed below in the following paragraphs.

The study by Tajudeen Adeyemi Ajao [3] adopted an Enhanced QoS based Web Service Selection Model (EWSSM) in terms of user preference considerations and derivation of weights

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from the constraints specified by the users. Moreover, among the non-functional properties of the Web Services, *reliability*, *response time*, *availability* and *successability* are considered to be validated on the QWS dataset provided in[43]. The model is then validated over dataset QWS and the model's ability for the selection of optimal service is confirmed, while considering the user's preferences.

In[44], the authors claim enhancement in service selection focusing on user requirements of non-functional properties and interaction with the system. The Weighted Sum Method (WSM) for weighing user preferences is adopted from a research study[45] in which all the available non-functional properties of the available services are considered. The adapted scheme has been validated on the QWS dataset containing 364 Web Services with 14 non-functional property features. The authors argued the importance of Non-Functional Properties (NFP) based on ontological framework[46] involving qualitative or quantitative features as essential criteria for enhancing the selection process of services. The contribution of this approach was different to previous work[47, 48] in terms of the ranking model that takes users' preferences and performs fine-tuning of the selection accuracy to meet users' expectations. Although the validation is conducted over the QWS dataset however, no mention has been made of the degree to which reliability has been improved.

The authors of [49] introduced a QoS-based Web Service selection approach using Genetic Algorithm(GA) by addressing two issues, namely: genetic encoding of Web Service selection and the definition of fitness function. The authors claim a rate of above 95% of the optimal degree of their proposed approach regardless of the number of Web Services having a significant impact.

The authors in [50] presented an algorithm for the service oriented system to select appropriate services while satisfying user multiple QoS requirements. *Response time, monetary cost and trust degree* have been taken as QoS parameters. Furthermore validation of proposed algorithm is conducted through comparison with scheduling algorithms and concluded the flexibility in support of user preferences.
In[51] the authors highlight consideration of the issues like complexity, time Consumption and need of manual efforts from users of QoS based selection algorithms that causes impact on real time searching. The authors also claim their approach efficient and accurate using improved vector space model based on[52, 53] and then comparing it with well-known algorithms *Vector based* , *Vector based with consideration of user requirements* and *Sort Filter Skyline (SFS) computation*[54].

The authors point out the complexity and consideration of service selection as optimization problem They also demonstrated the high similarity 0.89 between original vector space model (DS) and DS-I ignoring the number of services while similarity between DS-I and SFS decreases from 0.9 to 0.78 with the increase in number of services and thus concluded the similar correlation while better performance of DS-I in terms of execution time.

## 6. MULTIPLE REQUEST BASED SCHEMES

Multiple User Preferences based Schemes (MUPbA) focused on involvement of more than one user in service selection specifying same/different functional or non-functional requirements. Many studies [55-60] engrossed the selection process bearing in mind the MUPbA by underscoring the issues like conflicts in preferences, multiple requests for functionally identical service and Web Services overloading etc.

Benouaret et al[61], presented Majority rule based Web Service selection approach based on the notions of dominance relationship[56]. They have focused the responsibility to decide that which is the appropriate service, when the service is to be shared among multiple parties having conflicting interests. Their approach proposed an efficient majority service skyline algorithm (MSA) that returns more manageable set of services, eliminating many inappropriate services. Then based on the synthetic datasets, taking three parameters 1: $n$ (number of discovered services), 2: $m$ (number of users), 3: $d$ (number of preferences per user), the appropriate service is selected and invoked to serve a user's request. The authors focused on the majority rule and claimed that most service selection schemes [4, 16, 18] have primarily focused on selecting appropriate service process that assist users in choosing the better service matching their preferences. This approach makes these schemes inefficient in terms of multiple users' involvement in deciding about appropriate service. In support of arguments, the authors proposed an

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algorithm MSA based on OSA (One Scan Algorithm) and TSA (Two Scan Algorithm).

In the Study by Kang and Kang [58] presented Global Optimal Service Selection for Multiple Requesters (GOSSMR) approach based on conflicts removal of more than one requests for the functionally identical Web Services . This study highlights that many schemes [62-65] focus on single request separately for the service selection and raised the issue of conflict occurrence. This approach makes previous schemes inefficient in case of multiple requests for the functionally identical Web Services and proposed a global optimal service selection method for multiple interrelated service requesters.

In order to achieve the objective, they have used *Euclidean distance* with weights to compute degree of matching of services by maximizing the sum to develop the GOSSSMR. Furthermore skyline GOSSSMR is proposed to increase the efficiency of the proposed approach. The authors argued that if several users select the similar service, there will be conflict because of limited system, which will reason long wait time for those users and wastage of resources results to lessening the QoS of the whole system or network. From the experimental results, this study has proved an improvement in the system performance in terms of execution time up to 50%.

Multiple user requests with different QoS preferences for the same functional services have also been highlighted in [59]. This study underscores the deficiency of considering the multiple user requests with different QoS preferences and proposed a method for optimal service selection with respect to multi user requests for the same functional services. To achieve the objectives, this study has implemented its approach in four steps; 1: Classification and Normalization of QoS into four types (Region, Threshold, Deviating and Linguistic), 2: Satisfaction Calculation based on prospect theory[66] , 3: Multi user selection scenario 4: optimal solution selection using Bipartite Graph. However as bipartite Graph method can find one optimal solution at a time and it would cost more if the users are not satisfied with the derived solution.

Wang et al [60] focused on the efficiency and effectiveness while considering the multi user's QoS requirements and highlighting the issue of single request avoiding the overload of Web Services in selection of the optimal services. The authors proposed a framework which at first make prediction of the missing multiple QoS values (*response time and throughput in this study*) with respect to historical QoS experience of the users and then global optimal solution is selected using proposed fast match approach. To achieve the objectives this study has been conducted over real dataset[67] and proposed framework consisted of four components search engine, collector , predictor and selector while performance is measured through Mean Absolute Error (MAE) and Route Mean Squared Error (RMSE).

Multiple requests waiting in a queue have been considered in [68] by presenting *dynamic Web Service Scheduling and Deployment Framework* (DynaShed) based on Open Grid Services Architecture specifications to support workflow management of dynamic services. The authors focused on the Web Service workflows getting inspired form workflow technology that bind distributed resources over the grid. Although the authors claim the decrease in execution time and communication cost through empirical studies but also there are limitations in terms of number of nodes and dedicated environment by blocking other users' access to resources i.e. computational resource in this study to be investigated in further research.

## 7. RANKING BASED SCHEMES

The ranking based service selection schemes play an important role in service oriented architecture especially when matchmaking mechanisms return multi identical functional services with respect to user's QoS preferences. The ranking procedure involves sorting the discovered services according to user specified different measures. QoS aware selection mechanisms[69, 70] distinguish and rank the Web Services with respect to identical functionality based on user preferences involving QoS properties [71].

Liu [72] present an extended QoS model to propose quality driven service selection. The authors give design of QoS registry where computation of QoS values is performing for each registered Web Service. The ranking of the services based on constraints related to QoS parameters and group presences is carried out by the given formula in Equation (3).

$$Rank\ (Score)\ of\ the\ web\ service\ = S * G \quad (3)$$

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Where *S* is separate regularization of QoS parameters and *G* represent QoS group preference. The authors conducted experiments on phone service provisioning domain and claimed their approach as an effective according to specified objectives. However, the proposed approach was incapable in terms of reading individual QoS properties, allowing requester to specify QoS requirements and providing of filtering based on QoS values in ranking of Web Services.

Jaeger et al [73] proposed Simple Additive Weighting Method (SAWM) to rank the services with respect to same functionality based on user's QoS preferences (*Cost, availability, execution time and reputation*) in the service selection mechanism. This method determines rank of Web Services through summation of normalized QoS values which are then multiplied by QoS preferences. The authors claimed improved execution time and availability but increase in cost is reported as well through experiments. The SAWM does not provide filtering of the functional Web Services according to QoS requirements because users were kept restricted in providing the expected QoS values for the selection.

A method for QoS based web service selection namely; 2-D Boolean array for ranking is proposed in[74]. Web Services and QoS properties were represented in rows and columns respectively in the matrix. The authors claim enhancement in selecting services by extending WS-policy standard with some ontological concept However, the proposed approach was incapable in reading the requester's preferences for the QoS properties and identifying best services with respect to multiple QoS preferences.

Web Service Selection and Ranking with QoS (WSSR-Q) has also been proposed in[75] for web description model consisting of QoS information based on Web Service Description Model WSDM-Q. The authors accomplished the approach in three steps i.e. Service Selection Algorithm (SSA-Q), Service Ranking algorithm (SSR-Q) for normalizing and computing comprehensive QoS values for services and quality describing mechanism in relation to QoS attributes. The authors claimed their approach efficient and effective in functionally similar services selection.

The issue of requester's requirements including non-functional aspects in the service selection is highlighted in[76]. The authors give a QoS model, QoS requirement format for the users by defining a tree structure (QCT), QoS broker based architecture and selection algorithm which ranks the services having similar functionalities.

The authors claimed their approach effective in terms of selecting and then ranking the Web Services based on requester's QoS requirements involving "AND" and "OR" operators. However, the proposed approach has an extending capacity for changing business and service offers by providers and user's requirements to find most profitable services in terms of requester's QoS behavior to rank the functionally similar Web Services.

## 8. SUMMARY

As we have discussed in the introduction that our study is limited to five (5) QoS parameters, so in this section we present the summary and concluding remarks about each parameter considered in selected studies to our best of knowledge. (in Figure 1), we present the summary that the quality attributes accuracy, efficiency, effectiveness, reliability and scalability fourteen (14), eight (8), ten (10), four (4), and six (6) respectively have been focused in our selected twenty-five 25 studies among eighty-one (81) collection knowledge base according to specified objective.

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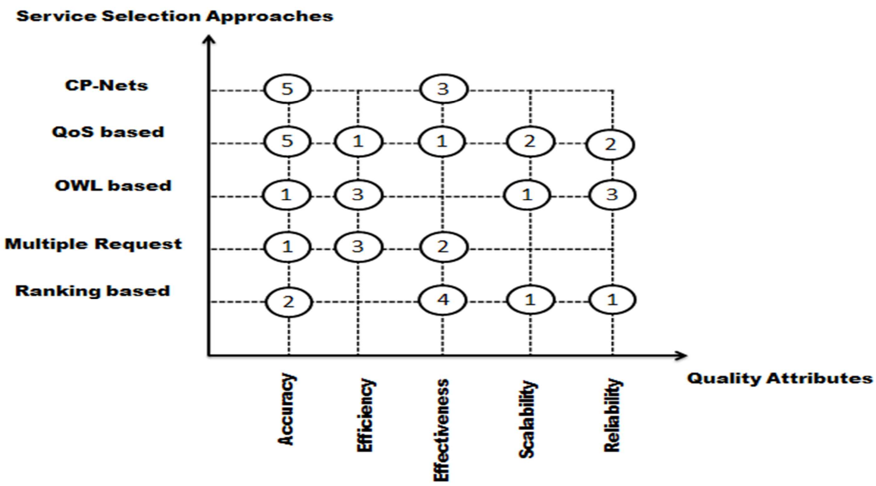


*Figure 1: SS Approaches and Quality attributes in the form of Bubble plot*

The above figure (Figure 1) shows this review study as a bubble plot; the relationship between service selection schemes is represented by the X axis and quality attributes are represented by the Y axis. The highest quality attribute focused in service selection schemes shown in the bubble plot figure indicate that accuracy is the most frequently researched attribute i.e. CP-Nets (5), QoS based(5), OWL based(1), Multiple Request (1) and Ranking based schemes(2). Efficiency has been focused in 1, 3, 3 studies using QoS based, OWL based and Multiple request based schemes respectively that define research scope in the use of CP-Nets and ranking based schemes. Effectiveness is focused in CP-Net(3), QoS based (1), Multiple Request(2) and ranking based (4) schemes highlighting its future research importance in use of OWL based service selection schemes. Scalability is the lowest quality attribute focused in service selection schemes i.e. QoS based (1), OWL based (1) and ranking based (1) developing the attraction of researchers to be focused while using CP-Nets and Multiple request based schemes. Reliability is targeted in QoS based (2), OWL based (3) and ranking based (1) studies providing a useful research area for the researchers that need to focus on CP-Net and Multiple request based schemes with reliability as specific attribute for further research investigations.

The table below (Table 3**)** presents the studies that have focused accuracy using any of the schemes reviewed in this study. Qualitative approach and quantitative schemes have been focused in different studies separately. Several authors claimed their findings appropriate according to the titles suggested.

*Table 3: Schemes considering accuracy quality attribute*

| Study # | Year | Reference | Issue | Approach | Engrossed performance attributes |
|---|---|---|---|---|---|
| **1** | 2012 | [15] | SS | CP-Nets | Accuracy (90%), Efficiency |
| **2** | 2008 | [16] | UP | CP-Nets | Accuracy(95%), execution time, effectiveness |
| **3** | 2011 | [14] | UP | Collaborative | Effectiveness, accuracy (85%) |
| **4** | 2012 | [1] | UP | WCP-Nets | Accuracy(94%), optimization |
| **5** | 2009 | [4] | UP | CP-Nets | Accuracy, efficiency, effectiveness |
| **6** | 2009 | [30] | SD | OWL-S | Accuracy, efficient |
| **7** | 2013 | [3] | SS | QoS based | Efficiency, reliability |
| **8** | 2008 | [44] | SS | QoS based | Accuracy, reliability |
| **9** | 2012 | [49] | SS | QoS based | Accuracy(95%), reliability |

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| | | | | | |
|---|---|---|---|---|---|
| **10** | 2012 | [50] | SS | Ontology | Accuracy, reliability |
| **11** | 2012 | [51] | SD | VSM | Efficiency, accuracy |
| **12** | 2010 | [76] | SD | QoS based | Accuracy, effectiveness, scalability |
| **13** | 2005 | [73] | Ranking | SAWM | |
| **14** | 2012 | [61] | SS | Majority Rule | Efficiency, execution time, accuracy |

***Legend:*** **SS=Service selection, SD=Service discovery, UP= User preference**

(Table 4) presents the studies in which the efficiency has been focused as contributing quality parameter using different schemes either qualitative or quantitative.

*Table 4: Schemes considering efficiency quality attribute*

| Study # | Year | Reference | Context/ domain | Approach | Engrossed performance attributes |
|---|---|---|---|---|---|
| **1** | 2007 | [18] | SS | Ontology | Efficiency, effectiveness, accuracy |
| **2** | 2013 | [22] | SD | Ontology | Efficiency, scalability |
| **3** | 2009 | [30] | SD | Ontology | Accuracy, efficiency |
| **4** | 2012 | [51] | SD | VSM | Accuracy, efficiency |
| **5** | 2011 | [58] | SS | GOSSMR | Execution time, efficiency |
| **6** | 2013 | [60] | SS | Matching | Efficiency, effectiveness, scalability |
| **7** | 2012 | [61] | SS | Majority Rule | Accuracy, efficiency, execution time |
| **8** | 2008 | [74] | SS | Ranking | Efficiency , scalability |
| **9** | 2009 | [75] | SR | WSSR-Q | Efficiency , effectiveness |
| **10** | 2010 | [68] | WSW | DynaShed | Efficiency |

***Legend:*** **SS=Service selection, SD=Service discovery, WSW= Web service workflow, SR= Selection & ranking**

Performance in terms of effectiveness of the system using either qualitative or quantitative schemes is presented in table below (Table 5).

*Table 5: Schemes considering effectiveness quality attribute*

| Study # | Year | Reference | Domain/ context | Issue | Approach | Engrossed performance attributes |
|---|---|---|---|---|---|---|
| **1** | 2009 | [4] | UP | Ambiguity | CP-Nets | Accuracy, efficiency, effectiveness |
| **2** | 2011 | [14] | UP | Inconsistency | Collaborative | Accuracy, effectiveness |
| **3** | 2008 | [16] | UP | Inconsistency | CP-Nets, voting semantics | Accuracy, efficiency, effectiveness |
| **4** | 2012 | [49] | SS | Optimization | QoS based , Genetic Algorithm | Accuracy, effectiveness, reliability |
| **5** | 2012 | [59] | SS | Optimization | Multiple user requests | Effectiveness |
| **6** | 2013 | [60] | SS | Optimization | Fast match | Effectiveness, efficiency, scalability |
| **7** | 2004 | [72] | SS | Optimization | e-QoS model | Efficiency, reliability |
| **8** | 2005 | [73] | Ranking | same functional services | SAWM | Accuracy, effectiveness |
| **9** | 2009 | [75] | SR | Optimization | WSSR-Q | Effectiveness, efficiency |
| **10** | 2010 | [76] | SS | Dynamic | QoS based | Accuracy, effectiveness, scalability |

***Legend:*** **SS=Service selection, UP=User preference, SR=Selection $ ranking**

(Table 6) presents the studies that have focused the performance in terms of reliability of the system using either qualitative or quantitative schemes.

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*Table 6: Schemes considering reliability quality attribute*

| Study # | Year | Reference | Domain/ Context | Approach | Engrossed performance attributes |
|---|---|---|---|---|---|
| 1 | 2013 | [3] | SS | QoS based | Efficiency, scalability, reliability |
| 2 | 2006 | [31] | SD | Ontology | Reliability, scalability, efficiency |
| 3 | 2012 | [50] | SS | Ontology | Accuracy, Reliability, scalability |
| 4 | 2004 | [72] | SS | QoS modeling | Effectiveness, reliability, accuracy |

***Legend*: SS=Service selection, UP=User preference, SD=Service discovery**

(Table 7) presents the studies that focused the performance in terms of scalability of the system using either qualitative or quantitative schemes.

*Table 7: Schemes considering scalability quality attribute*

| Study # | Year | Reference | Domain /context | Issue | Approach | Engrossed performance attributes |
|---|---|---|---|---|---|---|
| 1 | 2008 | [44] | SS | NFP | QoS based | Accuracy, reliability, scalability |
| 2 | 2007 | [3] | SS | Reliability | QoS based | Efficiency, scalability, reliability |
| 3 | 2007 | [18] | SS | Dynamic | Ontology | Efficiency, usability, scalability |
| 4 | 2010 | [19] | UP | Optimization | Hierarchical Task Network | Execution time, efficiency, Scalability |
| 5 | 2006 | [31] | SD | Difficulty | Ontology | Reliability, scalability, efficiency |
| 6 | 2008 | [74] | SS | QoS based | Ranking | Scalability, efficiency |

***Legend:* SS=Service selection, UP=User preference, SD=Service discovery, NFP= Nonfunctional properties**

## 9. DISCUSSION

In this review article, we identified twenty-five (25) studies relevant to service selection in the sources that we search. Current service selection systems have to perform suitable approach so that they can return an ordered set of appropriate / optimal services in terms of user given preferences, in order to obtain the best service that fulfills the request. However, selection schemes are joined with QoS based models that limit the expressiveness of user preferences and the non-functional properties. Generally these schemes are not interoperable, so the service selection system cannot combine different selection mechanisms to provide more flexible and expressive facilities for the defining of preferences.

The authors who considered CP-Nets for the service selection mainly focused on the accuracy and efficiency (Section 3) that opens the edge for future research to focus on the other quality parameters like effectiveness, reliability and scalability. Similarly effectiveness of the system has not been given importance like other quality parameters while using OWL ontologies (Section 4). In the use of QoS based selection schemes although all the parameters are given consideration (Section 5) but there is lot of work needed to focus the efficiency and effectiveness of the system. Reliability and scalability are not considered in the multiple requests based schemes (Section 6) as compared to other quality attributes.

In the ranking based schemes (Section 7) effectiveness has been given more choice as compared to other parameters which creates the scope for appropriate selection and performance in terms of efficiency. Some studies included in this review used evaluation methods regarding preferences ambiguity, user's reluctancy, and conflicts in preferences. Few of these had undergone through accuracy, efficiency, reliability and increased expressiveness analysis. This review does not include issues related to implementation as our objective was to focus on different methods for the service selection about user preferences and non-functional properties. In this review paper, the first category CP-Nets has been focused mainly by Hongbing Wang in different years which raised the point of objection but we considered all these paper because of different QoS parameters using different evaluation metrics.

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## 10. CONCLUSION

We have presented a review of five (5) different service selection schemes. This review was intended to investigate the trend of service selection schemes based on user preferences and quality attributes. The focus was on SSA's in the Web Service selection domain. Overall seventy six (76) studies from 2004 to 2013 are reviewed however, twenty-five (25) studies were selected in which one of the five schemes (CP-Nets, OWL, QoS, Multi-request, and Ranking) and quality attributes (accuracy, efficiency, effectiveness, scalability and reliability) are focused. These twenty-five (25) studies described the role of users' preferences in the service selection. We have divided these twenty-five (25) studies into five (5) groups with reference to approach applied. Findings indicates that accuracy has been more focused i.e. fourteen (14) representing 56% in the selected studies since 2013 as compared to effectiveness ten (10) representing 40% from year 2004 to 2013, efficiency nine (10) representing 40% since 2008, scalability six (6) representing 24% in the years 2006 to 2013 and reliability four (4) representing 16% only in years 2004, 2006, 2012 and 2013.

Moreover the research conducted in 2012 motivates researchers in Web Service selection domain however it requires that besides accuracy other quality parameters like reliability, scalability should also be considered. Furthermore our findings suggest that user preference based schemes integrating qualitative and quantitative preferences have the potential for the appropriate/optimal service selection either for individual purpose or composite system. We further plan to investigate ambiguous user preferences in the service selection as well as to explore the impact of inconsistent preferences.

## CONFLICT OF INTEREST

The authors have no conflict of interest

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