Appraisal and Analysis on Diversified Web Service Selection Techniques based on QoS Factors

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***Abstract*—Numerous monumental changes have been made in the existing web service selection to provide quality of services. The quality of service is a major bottle neck in the recent development. Hitherto various QoS based Web Service Selection Techniques exist. But these techniques lacks in functional and non-functional attributes. This paper consists with the following tasks; segregate various QoS based Web Service selection techniques with their respective merits and demerits, an extensive comparative study on different QoS aware service selection techniques with respect to the user requirements and multiple QoS properties and preferences. This paper also evaluates the performance of discussed techniques based on the strength of various QoS aware Web service selection functionalities using a set of evaluation metrics.**

Keyword-Web Service, Quality of Service, Service Selection, User Preferences

I. Introduction

Web services are depending on the concept of Service-Oriented Structure (SOA). SOA is the newest improvement of distributed processing, which allows application components, such as application functions, objects, and processes from different techniques, to be exposed as alternatives. Web services are generally paired application elements provided over Internet standard technology. The modules of Web Services are XML (eXtensible Markup Language) tagging data such that it can be exchanged between applications and platforms. SOAP (Simple Object Access Protocol) messaging protocol for transporting information and instructions between applications (uses XML). UDDI (Universal Description, Discovery and Integration specification) defines XML-based rules for building directories in which providers to register their web services. WSDL (Web Services Description Language) a standard method of describe the web services and their specific capabilities (XML). The conceptual Web services architecture [1] is defined based upon the interactions between three roles: Providing the service, Registering the service and Requesting the service.

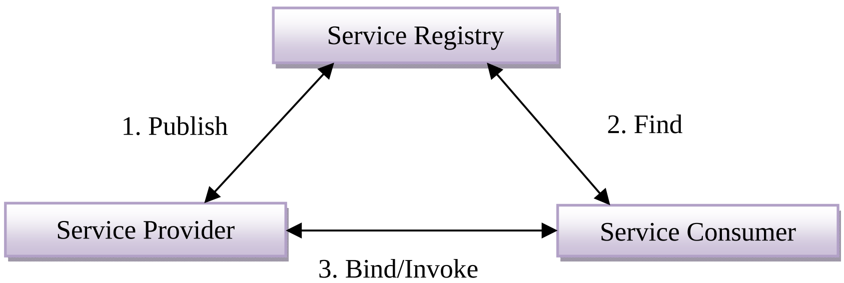

Fig. 1. Operations in Web Service Architecture

Web Service Roles: The major web service roles within the web service architecture are 1. Service provider (Publish): This is the provider of the web service to publish. The service provider implements the service and makes it available on the Internet. 2. Service requestor (Find): This is any consumer of the web service who can find the services. The requestor utilizes an existing web service by opening a network connection and sending an XML request. 3. Service registry (Bind/Invoke): This is a logically centralized directory of services which is used to bind. The registry provides a central place where developers can publish new services or find existing ones. It serves as a centralized clearinghouse for companies and their services. Quality of Service (QoS) is a decisive factor in distinguishing functionally similar Web services. Recently many researchers have proposed QoS models to define various QoS properties, measurement metrics and verification mechanisms [2, 37, and 40]. In literature, there have been investigations to define QoS aware selection models (mechanisms) to rank the Web services as per the requester's needs based on multi-agent techniques [3,4]. The QoS models and QoS aware selection mechanisms have been defined for semantic Web services by few researchers [33, 36]. The proposed QoS aware selection mechanisms distinguish and rank the functionally similar Web services based on the requester's QoS requirements involving QoS properties [5].

II. Techniques for QoS Based Web Service Selection

In literature, many researchers' focuses on various selection techniques for QoS aware Web services have been proposed. Fig. 2 denotes the classification of techniques for QoS aware Web service selection. The QoS aware Web service selection techniques are categorized based on the nature of service requester's QoS requirements. The QoS based Web service selection techniques can be classified into two categories such as Selection for a single task and Selection for the tasks of composite. The Web service selection is done for a single task whereas the second category contains an optimal selection of Web services for dissimilar tasks of the composite process. Several researchers have proposed various methods for optimal selection and duty of Web services to the basic tasks of composite process or composition plan [8].

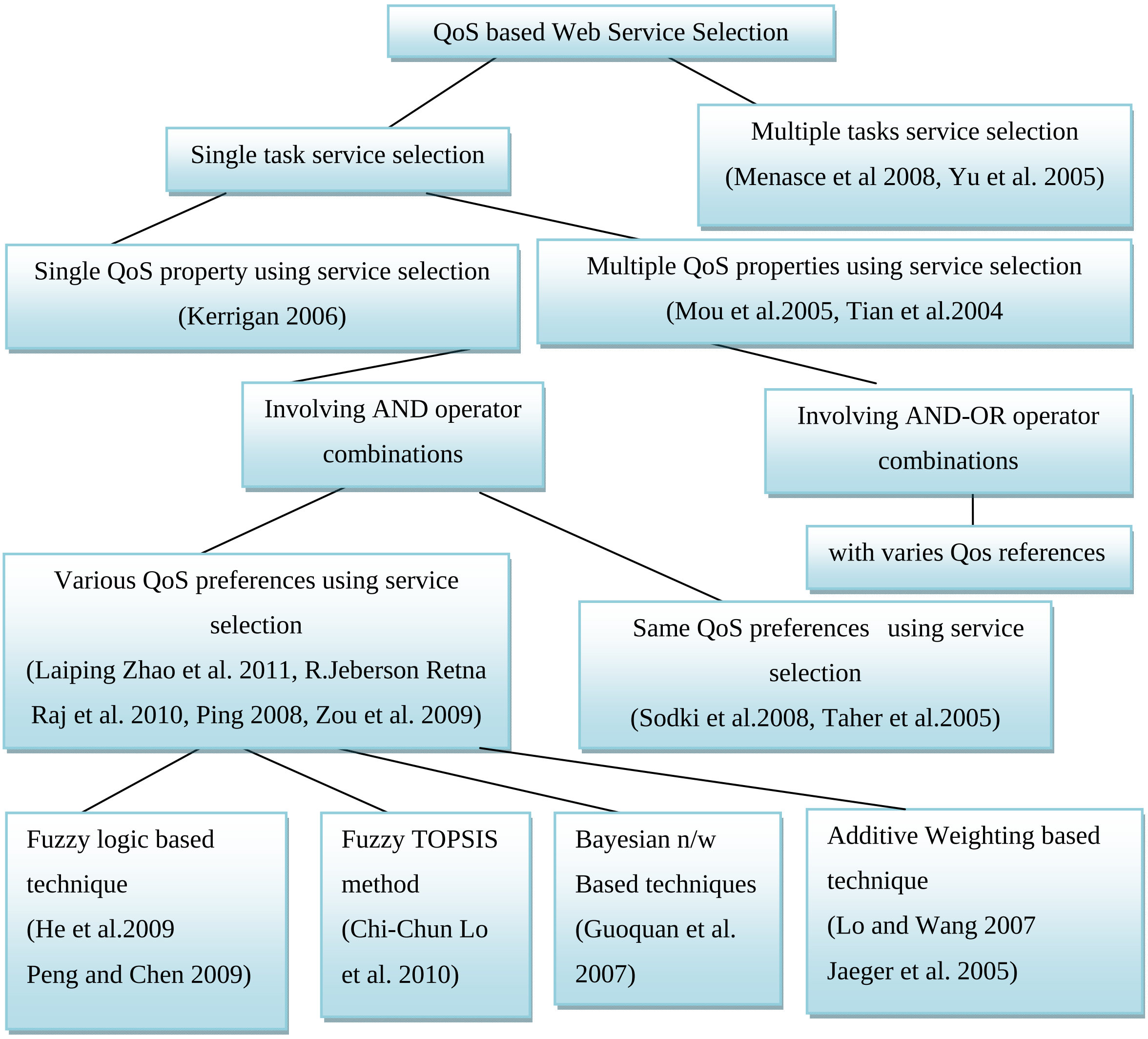

Fig. 2. Classification of QoS aware Web Service Selection Techniques

A. *Service Requester's QoS Requirement Based Selection*

In literature, numerous researchers have proposed various techniques to discover the most appropriate Web service for the specific task based on the user's QoS requirements. Kerrigan [15] proposes a selection method which discovers the best Web service for the requester based on single QoS parameter such as service price. Some efforts have been made towards the QoS aware Web service selection based on QoS requirements involving multiple QoS properties [10], [11]. A few researchers have proposed selection mechanisms which take same preference for all requested QoS properties [13]. The Web service selection mechanism for QoS requirements involving multiple QoS properties is implemented using computational concepts (principles) like Fuzzy logic [17], Genetic Algorithm [39], Fuzzy TOPSIS method [34], Bayesian Network [19], Agent based techniques [9,28, 35] and Simple Additive Weighting (SAW) methods [20]. Subsequent sub-sections provide a review of various techniques proposed for QoS based Web service selection. In such QoS aware Web service selection techniques, the requester's varied preferences for QoS properties are considered to rank the functionally similar Web services [22].

1) Extended QoS Model for Selection

Liu Y *et al.* [32], the extended QoS model and quality driven Web service selection has been proposed to differentiate QoS aware Web services. The proposed QoS model categorizes QoS properties as Generic quality criteria involving QoS properties like Execution cost, Execution time and Business related criteria consisting QoS properties like Transaction, Compensation rate. The authors present the design of QoS registry which is responsible for the computation of QoS value for each advertised Web service. The proposed selection mechanism ranks the Web services based on the constraints involving multiple QoS properties and QoS group preferences. The rank for a Web service is figured and allocated as follows. First the QoS property values are regularized separately and then in groups, based on the usability. The regularized score is then multiplied by the QoS group preference to find the final score (rank) of a Web service. Finally, the Web service with highest score is designated as the best Web service for the requester. The difficulties with this mechanism are:

- The mechanism does not read individual QoS property inclinations for the ranking of Web services.
- The ranking mechanism is defined on all QoS properties existing in the QoS model and does not allow requester to specify his requirements.
- The mechanism does not provide Web service filtering based on the requester's anticipated QoS property values or range of values.

2) QoS Based Selection Framework

Taher *et al.* [12], proposed the framework for QoS based dynamic Web service selection, which involves UDDI and other supporting components like QoS Manager and Validation Manager. The proposed service selection mechanism first normalizes the QoS values of Web services and requested QoS values using Min-Max normalization technique. The selection mechanism estimate the correlation (Euclidean distance) value between QoS values of functionally related Web services and the requester's expected QoS. The Web service with minimum Euclidean distance is selected as a best Web service for the requester's QoS requirements.

- The major problem with this mechanism is that, Euclidean distance may not find the actual best Web service in all circumstances as the Web services are not filtered based on the QoS requirements before the correlation computation.
- This problem is illustrated here with a simple example. Consider three Web services with time values 3, 2, 6 and service requester's desired value as 5. The Euclidean distance measure (correlation computation) selects the third Web service since its price value is closer to requested price as compared to other Web services.

MohdFarhanMdFudzee *et al.* [30], proposed the performance of the proposed service selection by using different QoS weighting for services improves service selection execution under various circumstances. The paper proposes a multi criteria adaptation service selection broker that provides the possibility to select the best service among the existing aspirants. Adaptive Path Determination Criteria (APDC) is proved to be substantially efficient in term of generating single optimal path and improving service selection execution.

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3) Quality Driven Web Service Selection

Hu *et al.* [13], proposed the Quality driven Web services selection mechanism involving requirements on multiple QoS properties and also proposed a decision model of QoS criteria called DQoS involving decision matrix, decision modes and set of user requirements. The authors proposed the solve Multiple Attribute Decision Making (MADM) problem by using weights method involving users preferences (weights). The weights are determined based on the four dissimilar modes. The Quality driven web services selection mechanism does not consider the client's optional (OR combinations) QoS requirements defined on multiple QoS properties.

4) Saw Method

Jaeger *et al.* [14], proposed the selection mechanism which defines a Simple Additive Weighting (SAW) method to rank the functionally similar Web services based on the user's QoS requirements. The SAW method discovers the score for Web services all the way through summation of normalized QoS values which are multiplied by QoS preferences (weight). This service selection mechanism does not filter the functionally similar Web services based on the QoS requirements as the requester does not provide desired (expected) QoS values for selection.

5) Web Service Execution Environment

Kerrigan [15], proposed the selection mechanism for Web service execution environment (WSMX) which selects the best Web service based on the requester's filtering requirements and ordering preferences defined on single QoS property such as service price. This proposed selection mechanism does not support the user's QoS requirements involving multiple QoS properties and user preferences.

6) CosmosQoS Framework

Lo and wang [20], proposed the CosmosQoS framework to fulfill the requester's QoS requirements. The CosmosQoS framework classified that the Web service reputation appraisal model which is composed of three measurement perspectives called price discrepancy, QoS deviation and historical credibility. These three parameters of estimated values are multiplied by weights and their summation is used to resolve the quality score of Web service. A higher value of score indicates the level (higher) of quality of Web services. The proposed framework does not filter the web services based on the requested Qos property values and this model takes all QoS properties of QoS model for web service distinction.

7) Matrix for Web Service Selection

Sodki *et al.* [23], proposed the QoS based Web service selection has been explored to use a two dimensional Boolean array called selection matrix for ranking. The rows of the matrix represent the Web services and the columns of the matrix represent the QoS properties. The matrix cell value is set to 1 if the QoS property requirement matches with the advertised value, 0's otherwise. The matrix row having maximum number of 1's present in it is identified and the corresponding Web service becomes the best Web service for the given QoS requirements. The major problems of this mechanism are:

- The mechanism does not read the user's preferences for the requested QoS properties.
- Most of the time the mechanism may discovers multiple Web services as best services for the user which requires identifying the best selected Web services. For example consider the user's requirements as: time < 4 and price < 100. Assume the values of time and price of three functionally similar Web services are {3, 50}, {5, 10} and {2, 70}. The service selection mechanism selects the 1st and 3rd Web service as most suitable for the requester from which the requester has to select the best Web service.

8) WSSR-Q Framework

Zou *et al.* [26], proposed the Web service selection and ranking with QoS (WSSR-Q) framework to define the Web service description model that considers service QoS information. A Web service selection and ranking with QoS (WSSRQ) framework is based on service description model. The author proposes service selection and ranking algorithm and quality updating mechanisms are concerning QoS attribute values. The selection mechanism considers the requester's desired QoS property values and QoS preferences for selection and ranking of functionally similar Web services. The proposed framework does not consider user's preference based QoS requirements (OR combinations) to rank the functionally similar Web services.

9) QoS Description and Selection

Liu G *et al.* [27], proposed the QoS description and selection model which reads the requester's QoS requirements in terms of QoS properties and user preferences to rank the Web services. The selection mechanism does not filter the Web services based on QoS constraints prior to ranking to optimize the computation. R.JebersonRetna Raj *et al.* [29], proposed the web service selection model is used to select the best services based on QoS constraints. The service provider and requester to perform publish and discover web service operations. The QoS of web service details are stored in the QoSDB by using service key. The multiple QoS attributes of a web service are used such as response time, availability, throughput, reliability, and cost are optimized and ranked by using WSSR algorithm, and the rank value will be updated and stored in the QoSDB. Laiping Zhao *et al.*. [31], proposed the Service Providers Search Engine (SPSE) algorithm, which is flexible in fulfilling multiple user-specific QoS requirements, and supporting user personalization. The proposed SPSE scheduling algorithm is quite useful for user to quickly discover the most appropriate service provider. The SPSE mechanism is scalable to be deployed into large- scale systems.

III. Analysis of Selection Techniques

The following seven metrics have been evaluated based on the strength of various QoS aware Web service selection techniques.

TABLE I
Evaluation Metrics for Web Service Selection Techniques

Evaluation Metrics	Functionality	Description
A1	User preference	Is the system getting QoS based on user preferences?
A2	Weight	Are the consumer's QoS parameter preferences (weight) considered to select the appropriate services?
A3	Functional properties	Is the web service selection mechanism that filters the web services based on the user requirements?
A4	Selection mechanism	Is there any selection mechanism is applied for numerous Web services in any special cases?
A5	Possible conditions	Is the selection technique matches accurate services in all possible conditions?
A6	Selection techniques	Is the selection techniques are based on various QoS properties?
A7	Requirements	Is the selection technique allowing the consumer to stipulate his own QoS parameter values in the requirements?

Table I presents the seven parameters are described as Evaluation metrics (A1, A2, A3, A4, A5, A6 and A7), also their functionality and its description.

TABLE II
Evaluation of Web Service Selection Techniques

QoS aware Web Service Selection Mechanism	Evaluation Criteria						
	A1	A2	A3	A4	A5	A6	A7
Liu Y *et al.* 2004	✗	✗	✗	✗	✓	✓	✗
Taher *et al.* 2005	✓	✗	✗	✗	✗	✓	✓
Hu. *et al.* 2005	✗	✓	✗	✗	✓	✓	✓
Jaeger *et al.* 2005	✓	✓	✗	✗	✓	✓	✗
Kerrigan. 2006	✓	✓	✗	✗	✓	✗	✗
Lo and Wang. 2007	✓	✓	✗	✗	✓	✓	✓
Sodki *et al.* 2008	✓	✗	✓	✓	✓	✓	✗
Liu G. *et al.* 2009	✓	✓	✗	✗	✓	✓	✓
Zou *et al.* 2009	✓	✓	✓	✗	✓	✓	✓
R.Jeberson Retna Raj *et al.* 2010	✓	✓	✓	✗	✓	✓	✓
Laiping Zhao *et al.* 2011	✓	✓	✓	✗	✓	✓	✓

In Table II, the ticked mark shows the presence of the evaluation metrics which is included in Table I.

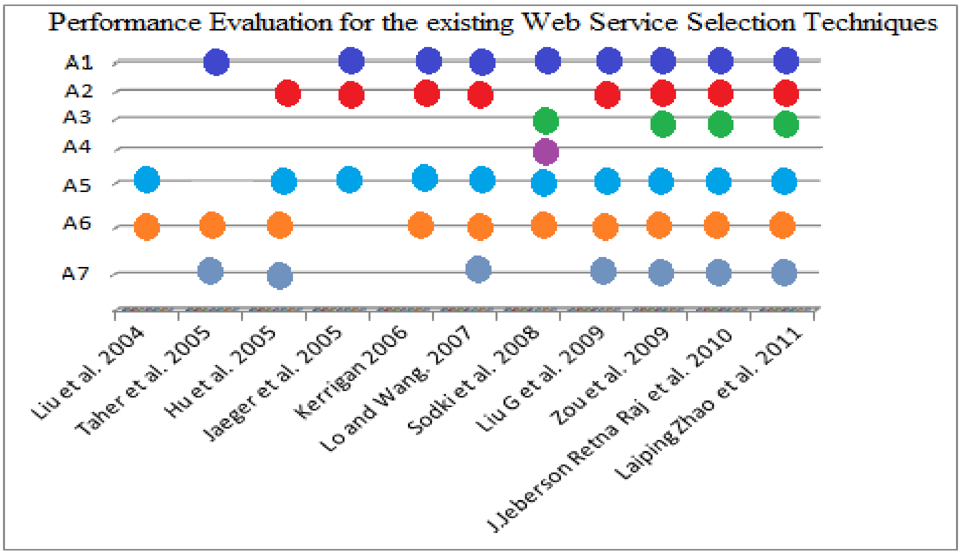

Fig. 3. Performance Evaluation for the existing Web Service Selection Techniques

The performance evaluation of the existing web service selection techniques is portrayed in Fig.3. According to the functional evaluation Metrics (A1, A2, A3, A4, A5, A6 and A7). It can be observed that most of the existing selection technique satisfies the evaluation metrics A5 (selection technique matches accurate services in all possible conditions). The second fulfilment occurs for A6 (selection techniques are based on various QoS properties). Zou *et al.* 2009, R.Jeberson Retna Raj *et al.* 2010 and Laiping Zhao *et al.* 2011 supports almost all the Evaluation metrics expect A4. From the Fig. 3, it can be perceived that the only one existing selection techniques that possess the evaluation metrics is A4 which is proposed by Sodki *et al.* 2008. A1 and A2 satisfy by most of the existing schemes.

TABLE III
Evaluation Metrics of Web Service Selection Functionality using Weightage

Evaluation Metrics	**Functionality**	**Weightage**	
A1	User preference	Very High	10
A2	Weight	Moderate	7
A3	Functional properties	Moderate	7
A4	Selection mechanism	High	9
A5	Possible conditions	Moderate -High	8
A6	Selection techniques	High	9
A7	Requirements	High	9

Depending upon the priority levels in the web service selection the evaluation metrics are assigned with weightage. These priority levels are reported in [10, 11, 13, 17, 19, 20, 22, and 34]. In general in any web service selection user preference (A1) [12, 14, 15, 20, 23, 26, 27, 29, and 31] has the highest ranking therefore it has been assigned with a weightage of 10. The next higher priorities are given for selection mechanism (A4), selection techniques (A6) and requirements (A7) [12, 13, 14, 20, 23, 26, 27, 29, 31 and 32], so which is assigned with a weightage of 9. The moderate priority is given for possible conditions (A5) [13, 14, 15, 20, 23, 26, 27, 29, 31 and 32] with weightage of 8. The least priority is assigned for weight (A2) and functional properties (A3) [13, 14, 15, 20, 23, 26, 27, 29, and 31] with weightage of 7. Table 3 depicts the weightage of evaluation metrics for normal web service selection based on [12, 13, 14, 15, 20, 23, 26, 27, 29, 31 and 32].

TABLE IV
Evaluation of Web Service Selection Techniques using Weightage

QoS aware Web Service Selection Mechanism	Evaluation Criteria (weightage)							
	A1	A2	A3	A4	A5	A6	A7	Total Weightage
Liu *et al.* 2004	0	0	0	0	8	9	0	17
Taher *et al.* 2005	10	0	0	0	0	9	9	28
Hu J. *et al.* 2005	0	7	0	0	8	9	9	33
Jaeger *et al.* 2005	10	7	0	0	8	9	0	34
Kerrigan. 2006	10	7	0	0	8	0	0	25
Lo and Wang. 2007	10	7	0	0	8	9	9	43
Sodki *et al.* 2008	10	0	7	9	8	9	0	43
Liu G. *et al.* 2009	10	7	0	0	8	9	9	43
Zou *et al.* 2009	10	7	7	0	8	9	9	50
R.Jeberson Retna Raj *et al*. 2010	10	7	7	0	8	9	9	50
Laiping Zhao *et al*. 2011	10	7	7	0	8	9	9	50

To check the performance of the existing web service selection techniques the following weightages presented in Table III are applied to the existing scheme which is reported in Table II. The overall performance evaluation using weightage is represented in Table IV.

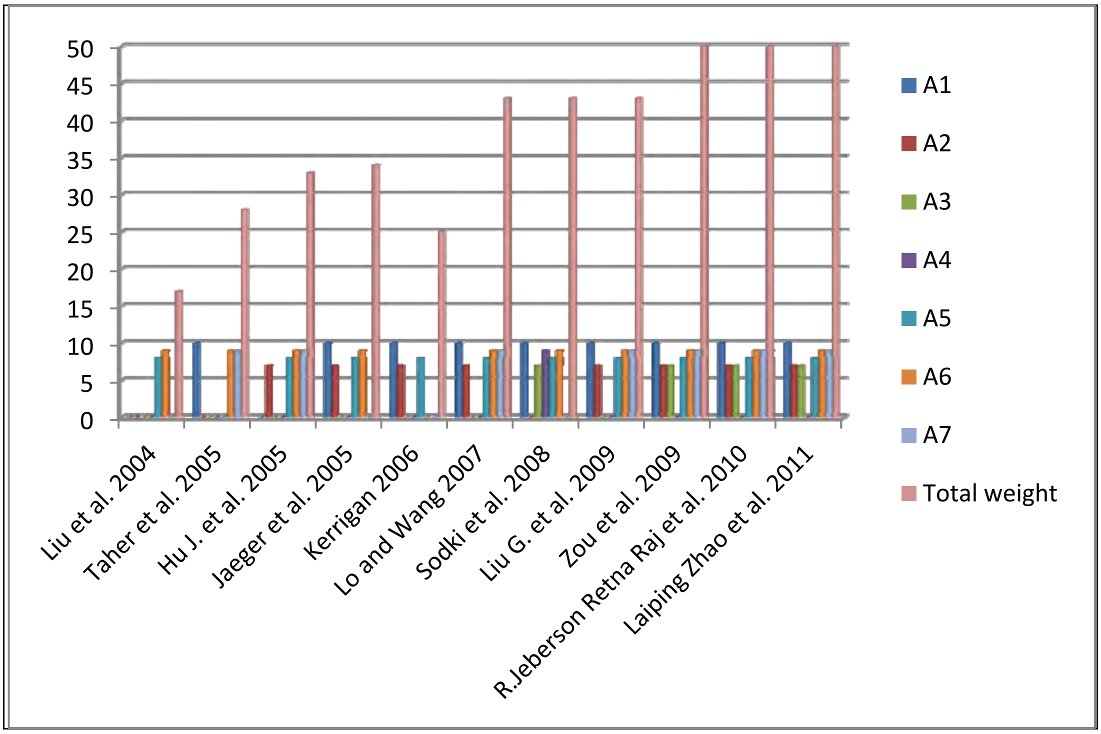

Fig. 4. Performance Evaluation for the existing Web Service Selection Techniques

The evaluation criteria weightage are defined to analyze the strength and weakness of specific QoS aware Web service selection mechanisms. The selection of QoS aware Web services based on the requester's QoS requirements, defined on the multiple QoS properties and preferences. From Fig 4. it can be observe that three proposals weightage is 50 the best case scenarios exist for Zou *et al.* 2009, R.Jeberson Retna Raj *et al.* 2010 and Laiping Zhao *et al.* 2011, but lacks in selection mechanism in special cases. The weightage 17 is the worst case scenarios exist for Liu *et al.* 2004, which is not suitable for functional and non-functional based service selection.

IV. Conclusion

In this paper, various QoS aware web service selection techniques are studied and classified based on the characteristics such as user requirements and multiple QoS properties and preferences. This paper also present a comparative study on the QoS aware Web service selection techniques and evaluated the studied techniques based on the performance of various QoS aware web service selection functionalities using a set of evaluation metrics. Fig 4. from this analysis it can be observe that three proposals Zou *et al.* 2009, R.Jeberson Retna Raj *et al*. 2010 and Laiping Zhao *et al*. 2011, but lacks in selection mechanism in special cases. The worst case scenarios exist for Liu *et al.* 2004, which is not suitable for functional and non-functional based service selection.

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