Int. J. Advance Soft Compu. Appl, Vol. 7, No. 3, November 2015
ISSN 2074-8523

QoS Based Service Selection in Cloud Environment: A Review

Wachana Khowfa[1], Onsiri Silasai[1], and Chatchada Kaewpruksapimon[2]

[1]Department of Computer Science,
Faculty of Science and Technology,
Suan Dusit University, Bangkok, Thailand
[2]Soft Computing Research Group,
Universiti Teknologi Malaysia, Johor,Malaysia
e-mail: kwachana@gmail.com, o_silasai@hotmail.com,
chatchada.kae@gmail.com

Abstract

Cloud is generally used as an alternative options that provide an on – demand services to customer and to extends their requirement with the several services published in cloud as well as without the concern of cost and security management, especially, in the era of big data. However, the growing number of available services causes an increasing in the number of similar services, furthermore, the only single service resource cannot complete the requirement from user. Therefore, it is an important to issue the composition service. To composite services together, the need of method to evaluate and select the best service candidate from the service's pool called service selection is vital. In the process of extraction the appropriate candidate, the Analytic Hierarchy Process (AHP), one of the most popular techniques of the Multi - Criteria Decision Making (MCDM) is mostly used to evaluate in multiple criteria situation. The Quality of Service (QoS) which is a numeric value available in each service is applied with AHP to resolve the problem of non-functional service selection. A result of this review indicates that the QoS based service selection with AHP can efficiency support the service evaluation and selection process. Moreover, it can be focus on applying other algorithms to enhance the performance of service selecting in cloud for a future work.

Keywords: *Cloud, Big Data, Service Selection, Quality of Service, Multi - Criteria Decision Making, AHP.*

1 Introduction

Over the last decade, cloud has been introduced in IT industry as a technology that provides an on - demand services and resources e.g. platform, information, software and infrastructures. The used of cloud extends customer's requirement with the several services published in cloud as well as without the concern of cost and security management. Especially, in this era of big data that in every second numerous of data are processed and transferred over the internet. The volume of data transferred from user via mobile used and social media for example cause big data getting bigger at the same time it creates the variety type of data which is difficulty to the data storage in term of data categorizing. The need of rapidity in data transferring or velocity means that there has to be someone provides user the greatest infrastructure and networking as well. With the implementation of resources and web services in cloud, it numerously benefits on big data. The increasing rapidly in the availability of web service published in cloud service provider i.e. health, education, business and traveling, it has fulfilled the consumers' requests. Moreover, there are web service composition lifecycle [1] that is similar with workflow - based for running web services selection. This includes planning workflow - based in each situation, choosing much single web services and combine its to web service composition to fulfill requests in each situation and monitoring while running a program. [1] [2] However, as the problem that only single service cannot complete requirement of customer, the need of combination services together is essential. Among the similar - function services, how can customer making the right decision that appropriate to their used. In addition, the growing up of available services in cloud causes a multiple in the number of similar - function services for different servers. These similar services are located in different places and have distinct values in terms of the QoS parameters. [3] Therefore, it is an essential to concern with the processing of compositing web service. To become a composite service, the need of method to analyze and select the best service candidate from the service's pool called service selection is vital. In order to extract the appropriate candidate from the group of similar services, the Multi - Criteria Decision Making (MCDM), the operational research which absolutely considers the multiple factor in the decision - making condition [4], and Quality of Service (QoS) attributes are mostly used as an important part in the process of decision making to evaluate in multiple criteria situation. In this paper, our literature review conclude problems of service selection, the used of MCDM to evaluate QoS, moreover, concentrate with Analytic Hierarchy Process (AHP) method and some other hybrid techniques of AHP with SMI, VIKOR and Simple Additive Weighting (SAW) method to solve the problem in selection the appropriate service.

The remains of this paper are organized as follows. A review of the related works on service selection methodology will be presented in section 2. In section 3, the concept of web service, service selection, QoS and service composition will be

described as it is an important context in the process of service selection. MCDM and AHP method will be discussed in section 4. Finally, the conclusion and idea for future work will be stated in section 5.

2 Related Work

There are some researched papers on service selection that applied Multi - Criteria Decision Making (MCDM) and the used of Analytic Hierarchy Process (AHP) to evaluate Quality of Service (QoS). This section will present a review of related works as follow:

Saurabh Kumar Garga et al. [5] propose A Framework for Ranking of Cloud Computing Services which consists of a structure and a method to evaluate and measure the quality as well as prioritize of cloud services. This framework generates an important impact and creates a strong competition in service selection among cloud service providers to please their Service Level Agreement (SLA) and also develops the method to measure the QoS attributes used in analysis by designing metrics to every single attribute for measuring accuracy of service for each provider. In addition, this method can encounter with the challenge of variety dimensional units of different QoS elements by providing an approach to weight up the relative order of cloud services for every QoS element.

Mojtaba Khezrian et al. [6] present A Hybrid Approach for Web Service Selection by applying Analytical Hierarchy Process (AHP) with VIKOR (VIšekriterijumsko KOmpromisno Rangiranje) algorithm to answer the problem of web service selection. AHP is used to estimate the values of each criterion instead of collect it directly from user. Then VIKOR is applied as a Multi Criteria Decision Making (MCDM) to solve the problem of identifying and ranking the appropriate candidate services. Finally, the method is verified by using four criteria of QoS and five alternative choices of services. The result states that this technique can select the finest and the most connected service candidate.

R. Dinesh Kumar et al. [7] propose A QoS Aware Quantitative Web Service Selection Model which is a model that applied Analytic Hierarchy Process for web service selection. This technique used for selecting the greatest web service instance based on the limitation of QoS. The QoS manager will acts as a middle person between service providers and clients to announce and search for available service operations. The QoS factors, used in this method are response time, throughput, reliability, availability and cost, will be determined and ordered by the AHP technique. Then the top level of service candidate will be chosen and provided to the requester for further used. As a result, this method can be refer to used as a Web services managers to select instance service and in - depth to adoption research on the web services based information system.

Dou Wanchun et al. [8] state that in the process of selecting service from non - functional properties, customers always make their own decision base on their personal preferences to impose on a candidate service. The candidates are frequently evaluated by a group of users who may possibly have different preferences or priorities. For these reasons they propose A QoS - Aware Service Evaluation Method for Co - Selecting a Shared Service which examines a service evaluation technique to promote and share service's evaluation to the group of users. This method is deployed by using AHP method to convert qualitative individual level of user's preference and priority into numeric before evaluates using SAW. Finally, the candidate services will comprehensively evaluate.

Kumar N. et al. [3] present QoS Base Cloud Service Provider Selection Framework, a framework for cloud service selection by enabling the user to choose the most appropriate cloud service provider from the cloud repository. This work uses AHP approach to come over a multi - criteria QoS decision making which accelerates processing of the selection. A heuristic is used as the algorithm to converge in polynomial time. As a result, the model is simple and the results are obtained in polynomial time and user can easily select the best option based on their personalized needs.

3 The Proposed Method

The background of web service, service selection, Quality of Service (QoS) and service composition which associated to this work are briefly described below:

3.1 Web Service

Web service is an application that is defined and described using XML for individual work and can be published, located, invoked as when required on the web and identified by a URL. [2] [9] Web services are one of evolutions and use for information exchange between the service providers in cloud by a standard format using XML. Web services can connect and exchange data each other even on difference technologies or platforms. However, a limitation of using web services is the requester sometime obtains over services that the service provider transfer overload. The requester has to gain services that unnecessary to their used. As shown in Fig. 1.

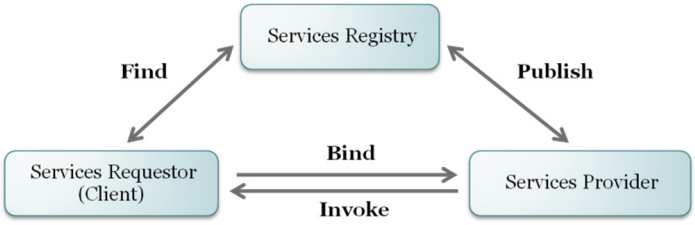

Fig. 1: Web services Model [9]

Therefore, to avoid the situation, it is essential to apply a process to handle with this problem. When there are more than one web services which match to the user's functional requirements available in the service's pool, the process of selecting web service uses some of criteria provided in the service to make a decision to choose the best candidate service [7].

3.2 Service Selection

Service selection is an approach of choosing the best service candidate from the service's pool available in cloud that appropriate to the requirement from requester or customer. Two important missions in the method of using proper services are selecting and ordering the services in which all solution of them affected directly on service's description. By describing a service, three important keys which consist of behavior, functional, and non - functional have to be considered. [10] As the similar functional services are always offered to requester, is also allows them to select the services which match to other criteria, this always referred to the non - functional attributes. The Quality of Service (QoS) which is a valuable attribute is used as criteria for selecting service process. [6] For this reason, in order to obtain the appropriate non - functional service from similar service's pool, the Multi - Criteria Decision Making (MCDM) and Quality of Service (QoS) attributes are commonly used.

3.3 Quality of Service

The Quality of Service (QoS) plays an important role to investigate and evaluate in service selection process as it is a set of valuable attribute that available in every single service. Each numeric attribute will be function in the process of weighing up then ranking therefore customer can finally obtain the most suitable service for them. Some common QoS criteria used will be defined as follow [5] [11] [12]:

- Response Time can be described as the total of time since starts until stop of the service. As well as it can refer to the efficiency of service provider. Obviously, response time is used to measure cloud service's performance and it is calculated in terms of the total time taken in responding [11]. Moreover, different type of service creates differ value of time. The less amount of time refers to the best performance as well.
- Cost/Price can be defined as one of the important criteria for services' consumption. It is the total of money that customer has to pay for their used of service. The cost/price depends on the service used as well. It also defined as an economic condition of using a service [7]. Cost is likely to

be the most quantifiable factor, however it is significant to reveal the cost/price in the characteristics which related to a particular business [5].

- Availability can be defined as the ability of service that available for customer to access. Availability plays an important role as it is the percentage of time that customer can enter to employ the service in cloud [5]. The several time user can access to execute and make use of service in cloud will improve the truth them to service provider.
- Throughput can be measured as the number of tasks completed per unit of time. The number of throughput relies on various factors that directly affect on task execution [5]. Throughput can be explained in the term of service performance as customer can accomplish their work. Each of service and cloud environment provide difference throughput.
- Reliability can be explained as the measure operation of a service. It measures how reliable a service is and how a service operates without failing for the duration of a given time and condition [7]. It is significant to the business to offer better services to their customers, for this reason, reliability is important attribute in selecting services [5].

3.4 Service Composition

Although a single service has the own value for its users, the service still has a limited service function. A single service cannot complete the consumers' requests, but it can be improved by using various services together which provide more powerful functions, to accomplish the requirements and to involve much work matched to static or atomic web service [1][13]. We called "Service Composition." A group of services can be called as a composite service to respond to customer's requirements [6]. However, the service composition concept is an aggregation of existing services available in the cloud that provide more powerful functions and match with the users' requirements rapidly. This will then offer a new value of services that are coordinate to a group of web service as a unified working unit to complete common objectives [14].

Mahboobeh [1] described the lifecycle of a typical workflow - based web service composition (WSC) into two approaches. First, the workflow - based is similar to the business process for running programs follow the workflow system [15] [16] [17]. Second, it is Artificial Intelligent (AI) planning - based technique approach. The processing of objects that have actions and constraints in each action on service selection, execution and service maintenance process for combine a new composition service. As shown the web service composition lifecycle in Fig. 2.

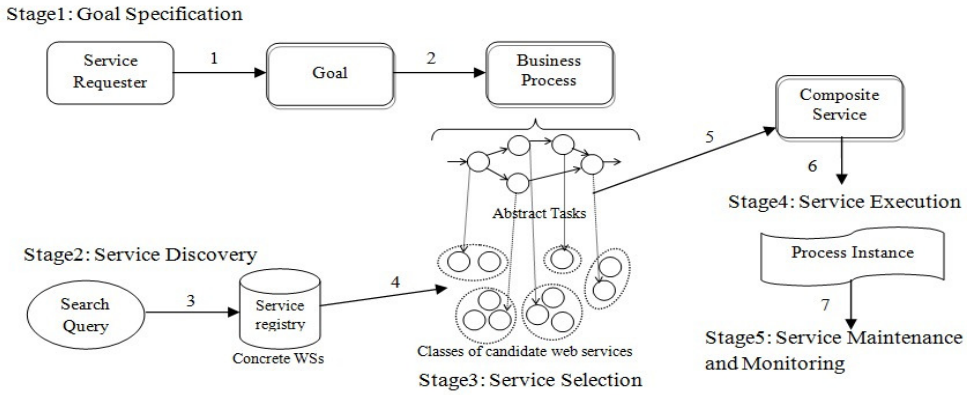

Fig. 2: Web Service Composition Lifecycle [1]

4 Results, Analysis and Discussions

4.1 Multi – Criteria Decision Making (MCDM)

Decision – Making can be explained as the evaluation and selection of thing among several similar choices provided. Normally people simply select thing base on their personal preference however in some conditions making decision to find the most suitable choice seems very difficult. For this reason, Multi – Criteria Decision Making (MCDM) is used to consider multiple and conflicting criteria in decision - making environment. Problem of MCDM commonly happens in everyday of life for example in personal situation, a price, size, style, safety and comfortable are considered in order to buy a house or a car. In business environment, MCDM are more complexity and usually of large scale. [18] The MCDM consists of several methods available to evaluate and solve the problem of decision making for functional and non – functional criteria for example Weighted Sum Model (WSM) which is a simplest MCDM and suitable for a single attribute selection problem, Weighted Product Model (WPM) that considers both single and pair comparison and Analytic Hierarchy Process (AHP) which is a pair wise comparison and provides the solution in complicated problem. The most popular used with non – functional factor is Analytic Hierarchy Process (AHP).

4.2 Analytic Hierarchy Process (AHP)

Service selection has been applied several techniques to solve the selection problem in many researches. In this review, we focus on Analytic Hierarchy Process (AHP), a pair wise comparison, which is a powerful technique to solve Multi Criteria Decision Making (MCDM) problems as compared to optimization solutions. AHP is one of generally used and the most accepted techniques to resolve MCDM problem. This method can be simply to adjusted and scalable in size to work with

decision making problems as its hierarchical structure [19]. AHP is a structured technique used to organize and analyze a problem of complex decision making based on mathematics. This technique is used widely to come over a decision making solutions for example government, business, industry, healthcare, shipbuilding and education [3].

The structure of AHP is as follow:

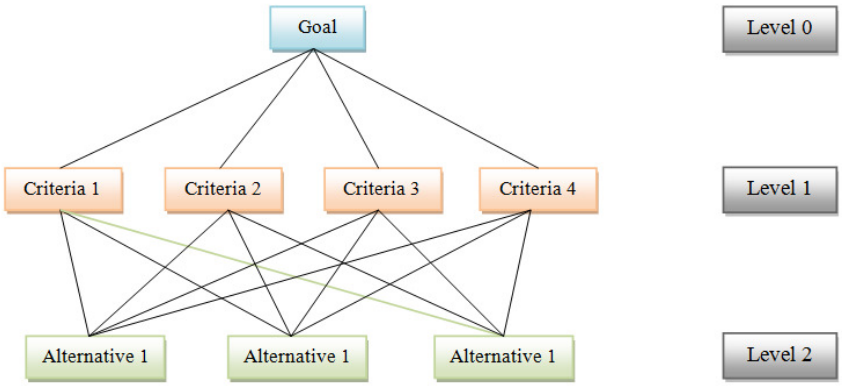

Fig. 3: Structure of AHP

From Fig. 3, the structure of AHP can be explained as follow: the purpose of analysis is assigned in the Level 0 as a topic. Level 1 consists of the multi criterion which belongs to the goal at level 0. Level 2 is a group of an alternative option after the criteria. The lines that link every level together show the relationship between goal, criteria and alternative choices. In level 1, a comparison metric matches 4 criteria to the goal as pair - wise comparison. Therefore, the metric in level 1 has a sizing of 4 by 4. Then every criterion is connected to alternative choices for a comparison, thus 3 alternatives and 4 criteria are connected together at Lever 2 [7].

Table 1: The QoS based service selection using AHP on literature reviews

Title/Author	Problem	Technique/ Approach Used	QoS Used	Description	Future Work
A QoS aware quantitative web service selection model : R. Dinesh et al. [2011]	Web service is increased, it difficult to determine the performance with the critical factor of web service quality.	AHP	6 attributes used: throughput, availability, security, cost, response time, and reliability.	To propose a web service selection model using AHP with QoS constraints.	-

A QoS - aware service evaluation method for co – selecting a shared service : Wanchun D. et al. [2011]	Users have different various priorities or preferences for selection web service then how to fulfill users' requirement.	AHP and SAW	5 attributes used: duration, reputation, successful, execution, and price.	To improve AHP to satisfy priorities and preferences for service selection with numeric weights by SAW technique.	Implement this method with real life and benchmark applications.
A hybrid approach for web service selection : Mojtaba K. et al. [2012]	With the various services on the web, the criteria for selection service are not sufficient enough.	VIKOR and AHP	4 attributes used: response time, security, cost and reliability.	To propose a hybrid approach to support selection service with the weights of criteria.	-
A framework for ranking of cloud computing services : Saurabh K. et al. [2013]	The growths of cloud service and users' demand have become difficult to determine which cloud service provider can satisfy their requirements.	Using SMI framework and AHP Hierarchy	All attributes	To propose a new framework that can compare and rank the cloud service based on user requirements with QoS attributes.	Improve ranking algorithm in QoS attributes with fuzzy sets and plan to implement and deploy the SMI framework on Amazon EC2 and Microsoft Azure.
QoS based cloud service provider selection framework : Kumar N. et al. [2014]	Increasing of services and cloud service providers, It becomes difficult and complicate for selecting web service with QoS.	AHP	5 attributes used: cost, response time, throughput, availability, and consistency	To propose a framework for cloud service selection model used analytic hierarchy with multi criteria QoS. And comparing the result with the previous research.	Apply this model with other MCDM model and implement it on the real world data set.

4.3 Discussion

From the literature reviews of several AHP and AHP with Hybrid techniques like SMI, VIKOR and SAW to solve the problem of service selection approach. Mainly problem for service selection caused by the rapidly increasing number of services available in cloud and the amount of similar properties of service that difficult to determine an appropriate service from cloud service provider to satisfy customer requirements. Moreover, the various priorities and preferences of users are complex to determine the proper service for their used as well. For this reason, the AHP

which is one of the methods in Multi Criteria Decision Making is applied to resolve the problem of MCDM as shown in Table 1.

The evaluations of service selection based on literature review are as follow: in 2011, the applied of AHP with QoS attributes was commonly used in many researches to propose new framework of web service selection and to satisfy priorities and preferences of each user. Some of technique e.g. SAW was applied with AHP to enhance the performance of selection as a result of the work, it can be a benchmark for other applications. In 2012, the used of AHP and VIKOR method with QoS can efficiency support selection service. Subsequently, in 2013, the generally used of cloud brought the new framework of AHP with all QoS attributes in order to compare and rank the candidate service among a set of services available in cloud. However, using all attribute had an impact on processing time therefore it had to improve ranking algorithm. Later, in 2014, with the applying of AHP and 5 attributes together, it can propose a framework for cloud service selection model.

The most top five QoS attributes used to analyzing and ranking in those processes are Response Time, Cost/Price, Availability, Throughput and Reliability. However, difference QoS factors are used depends on cloud environment and context as well. Even though there are some difference details on each work but the result of using AHP based stated that AHP and AHP with Hybrid techniques can work efficiency in the process of service selection and variety of QoS criteria as it can evaluate the relative ranking and select the best candidate servicer which satisfy to complete user requirement. Furthermore in the future work, these methods can be developed and implemented with real life environments moreover, can be applied with other algorithms to enhance the performance of evaluating and ranking.

5 Conclusion

This paper presents a comprehensively review the problem of non-functional service selection among the service's pool that available in cloud and discusses on AHP which is one of the method in Multi Criteria Decision Making and AHP with Hybrid techniques. We focus on process of applying the AHP, a pair wise comparison technique, with a numeric attribute that available in each service such as QoS. The result indicates that the QoS based service selection with AHP methods can efficiency support the service evaluation and selection. Moreover it can complete the difference of user's requirement for selecting the appropriate services. For future work, the service selection in cloud can be focus on other algorithms to enhance the performance and function of service selecting.

ACKNOWLEDGEMENTS
The authors first thank the anonymous reviewers for their valuable comments on our paper. We thank Suan Dusit University, Bangkok, Thailand and Universiti Teknologi Malaysia (UTM), Johor, Malaysia for their support on improving the paper as well.

References

[1] Moghaddam, Mahboobeh, and Joseph G. Davis. *Service Selection in Web Service Composition: A Comparative Review of Existing Approaches*. Web Services Foundations. Springer New York, 2011. 321– 346.

[2] Lécué, Freddy, Eduardo Silva, and Luís Ferreira Pires. *A Framework for Dynamic Web Services Composition*. Emerging Web Services Technology, Volume II. Birkhäuser Basel, 2008. 59 – 75.

[3] Kumar N. and Agarwal S. *QoS based Cloud Service Provider Selection Framework*. Research Journal of Recent Science (Res.J.Recent.Sci), 2014 Volume 3, 7 – 12.

[4]wikipedia [Online]. Accessed July 14, 2015 from https://en.wikipedia.org/wiki/Multiple-criteria_decision_analysis.

[5] Saurabh Kumar Garg, Steve Versteeg and Rajkumar. *A Framework for Ranking of Cloud Computing Services*. Future Generation Computer Systems 29, 7 – 12, 2013.

[6] Mojtaba Khezrian, Wan M. N. Wan Kadir, Suhaimi Ibrahim and Alaeddin Kalantari. *A Hybrid Approach for Web Service Selection*. International Journal of Computational Engineering Research(IJCER), Jan – Feb 2012, Volume 2, 190 – 198.

[7] R. Dinesh Kumar and Dr.G. Zayaraz. *A QoS Aware Quantitative Web Service Selection Model*. International Journal on Computer Science and Engineering (IJCSE), Apr 2011, Volume 3, No.4, 1534 – 1538.

[8] Dou Wanchun, Lv Chao, Zhang Xuyun and Jinjun Chen. *A QoS - Aware Service Evaluation Method for Co-Selecting a Shared Service*. IEEE International Conference on Web Services, 2011. 145 - 152.

[9] Mathkour Hassan, Sofien Gannouni, and Mutaz Beraka. *Web Service Composition: Models and Approaches*. Multimedia Computing and Systems (ICMCS), 2012 International Conference on. IEEE, 2012.

[10]M. Sathya, M. Swarnamugi, P. Dhavachelvan and G. Sureshkumar. *Evaluation of QoS Based Web - Service Selection Techniques for Service Composition*. International Journal of Software Engineering (IJSE), Volume 1, Issue 5, 73 – 90.

[11]Hongxia Tong, Jian Cao, ShenSheng Zhang and Yujie Mou. *A Fuzzy Evaluation System for Web Services Selection Using Extended QoS Model*. Kybernetes Volume 38, Issue 3/4, 2009, 513 – 521.

[12]Princy Bathla and Sahil Vashist. *A Sophisticated Study of QoS Ranking Frameworks in Cloud Computing*. International Journal of Advanced Research

in Computer Science and Software Engineering (IJARCSSE), 2014, Volume 4, Issue 7, 293 – 300.

[13]D'Mello, Demian Antony, V. S. Ananthanarayana, and Supriya Salian. *A Review of Dynamic Web Service Composition Techniques*. Advanced Computing. Springer Berlin Heidelberg, 2011. 85-97.

[14]El Hadad, Joyce, Maude Manouvrier, and Marta Rukoz. *TQoS: Transactional and QoS - Aware Selection Algorithm for Automatic Web Service Composition*. Services Computing, IEEE Transactions on 3.1, 2010: 73-85.

[15]Alrifai, M., Skoutas, D., & Risse, T. *Selecting Skyline Services for QoS - Based Web Service Composition*. In Proceedings of the 19th international conference on World Wide Web. 2010, 11 - 20.

[16]Sui, Qi, and Xiao - guang Hong. *An Automatic Generation Algorithm for Business Process in Workflow Management System*. 2006 10th International Conference on Computer Supported Cooperative Work in Design. 2006.

[17]Zhi - Jian, Liu Zhi - Zhong Wang, Zhou Xiao - Feng Lou Yuan - Sheng, and Shang Ling. *A New Algorithm for QoS - Aware Composite Web Services Selection*. Intelligent Systems and Applications (ISA), 2010 2nd International Workshop on, 2010.

[18]Ling Xu and Jian - Bo yang. *Introduction to Multi-Criteria Decision Making and the Evidential Reasoning Approach*. Manchester School of Management, University of Manchester Institute of Science and Technology. 2001

[19]Mark Velasquez and Patrick T. Hester. *An Analysis of Multi-Criteria Decision Making Methods*. International Journal of Operations Research Volume 10, No. 2, 2013, 55 – 66.