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Ranking of Cloud Service Providers using Multi Layered TOPSIS

Kanagaraj K

Abstract*: Cloud computing is one of the popular technological advancement in the current IT industry. The multifaceted benefits of cloud computing has attracted huge number of public and industrial customers. There are numerous cloud service providers available with variations in type and cost of resources. This makes it very difficult to select a suitable service provider. The Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS) is a popular method used of ranking service providers. However it reuires parameters that belong to a same category and rating scale. In this research we propose M-TOPSIS (Multilayer TOPSIS), a technique for ranking of service providers based on different categories with multiple parameters having different rating scales. The proposed technique applies TOPSIS for each category of input. The ranking of service provider in each category is then used to rank the available service providers, based on the overall performance. The efficiency of the proposed technique is compared with the existing models and the experimental results proved that the M-TOPSIS is able to rank service providers more accurately than the other existing models like E-FPROMTHEN.

Keywords: Service Provider, Ranking, M-TOPSIS, Cloud.

I. INTRODUCTION

Cloud computing can be considered as one of the leading-edge technological advances in the current IT industry. Cloud computing or simply cloud is attributed to the Service Oriented Architecture. Every organization is trying to utilize the benefit of cloud not only to reduce the cost overhead in infrastructure, network, hardware and software but also to provide seamless service to end users with the benefit of scalability. There are numerous cloud service providers available in the market and are rapidly changing and reorienting themselves as per market demand. In order to gain market share, the cloud service providers are trying to provide state of the art technology to the users with less cost. In this scenario, it becomes very difficult for customers to select the best service provider as per their requirement.

It also brings the challenge of selecting an appropriate deployment mode. There are several techniques proposed for selecting a suitable service provider, however there are lots of scope for improvement in selecting an appropriate service provider and deployment model. This research work mainly focus of selecting a suitable cloud service provider for the user requirements. The main user constraint is that the service provider should be able to execute the application effectively. Surprisingly, none of the existing models has solution to select a service provider based on the application. Hence in this work we propose a model that uses the application type for selecting service provider in addition to the existing parameters.

The TOPSIS a popular model for ranking cloud service providers. However, it can be used when all the parameters belong at the same category and rating scale. Hence in this research we propose the multicriteria decision making method named as M-TOPSIS is proposed to find out the best suitable service provider among the existing providers.

II. LITERATURE REVIEW

When an organization wants to migrate to the cloud environment an important problem is to choose the CSP which best fits its requirements. Since in the cloud market the CSPs number is increasing, the organization needs to be assisted by decision methods for CSPs evaluation, ranking and selection. Several approaches have been proposed to solve the CSPs ranking problem, including Multi Attribute Decision Making (MADM) methods. One of the most used MADM methods is Technique for Order Preference by Similarity to the Ideal Solution The Technique for Order Performance by Similarity to Ideal Solution was first proposed in 1981 by Hwang and Yoon [1]. Sachdeva [5] proposed a hybrid TOPSIS method combined with an intuitionistic fuzzy set in order to select an appropriate cloud solution to manage big data projects in a group decision making environment. As Cloud clients need trustworthy service providers who comply with Service Level Agreements (SLA) and do not deviate from their promises. Deng et al [2] have proposed the modified TOPSIS that alter the object weights to select an appropriate service provider. The group decision making with integarated weights was proposed by Liu et al [3]. In addition they have also made the system to use subjective as well as objective attributes. Ma et al [4] have proposed the Trust worthy cloud service provider selection technique.

The improved TOPSIS method using trust evaluation metrics was proposed by Sidhu et al [6]. A mathematical model of TOPSIS was proposed by Socorro et al[7] and the optimal resource provisioning in multiple clouds was proposed by Subramaian et al [8]. The use of TOPSIS in ranking evolutionary algorithms was proposed by Krohlinga & Pachecob [9]. Basu and Ghosh[10] has adopted TOPSIS in Fuzzy system to select the service providers.

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* Correspondence Author
Kanagaraj K*, Assistant Professor, MCA Department, MEPCO Schlenk Engineering College, Sivakasi, Tamilnadu, India. Email: kanagaraj@mepcoeng.ac.in.

III. MULTILAYERED TOPSIS METHOD

The multilayered TOPSIS method adds two more steps to the existing TOPSIS method. The existing method consists of seven steps to rank the cloud service providers based on the input parameters from a particular category. Evaluating the service providers using any one of the categories like using rating, performance metrics, application type or so on may not be accurate. An accurate rating can be obtained only if the service providers are evaluated based on all the categories. Hence the proposed M-TOPSIS is a multilayered approach in which the service providers are rated after analyzing them based on all the possible categories. The architecture of the proposed approach is shown in Figure 1.

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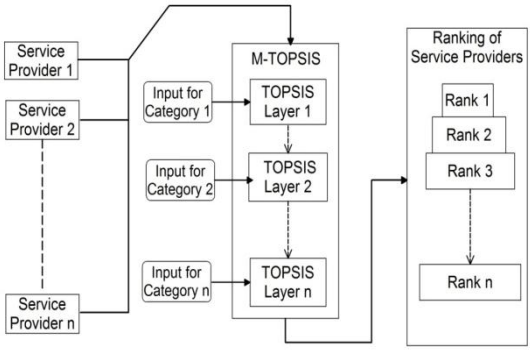

Figure 1 Ranking of Cloud Service Providers using M-TOPSIS

The proposed architecture is more generic in design such that the number of layers is not limited. This also helps us to improve the evaluation. The steps involved in the evaluation are given below.

Step 1. Evolution matrix is formed of m alternatives and n criteria, using the intersection of each alternative and criteria given as (x_{ij}) and then we have amatrix $(x_{ij})_{mxn}$

Step 2. The matrix $(x_{ij})_{mxn}$ is then normalized to form the matrix.

R = $(r_{ij})_{mxn}$ using the normalization method

$$r_{ij} = \frac{(x_{ij})}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}},\ i = 1,2,\ldots\ldots m,\ j = 1,2,\ldots,n \quad (1)$$

Step 3. Calculate the weighted normalized decision

$$t_{ij} = r_{ij}\,.w_j \quad ,\ i = 1,2,\ldots,m,\ j = 1,2\ldots\ldots,n \quad (2)$$

where $w_j = \frac{w_j}{\sum_{j=1}^{n}} \quad ,\ j = 1,2\ldots\ldots n$

Step 4. Determine the worst alternative (Aw) and the best alternative (Ab)

Step 5. Calculate the distance between the target alternative i and the worst condition

Step 6. Calculate the similarity to the worst condition

Step 7. Rank the alternative according to $s_{iw}(i = 1,2\ldots..m)$

Step 8. Repeat Step1 to Step 7 for each category of input

Step 9. Combine the output of all the categories and apply TOPSIS to rank the service providers based on the consolidated score.

The M-TOPSIS method uses the output of all the layers, each of which is rated in a different scale. The user rating will always be in a 5 point scale and the system performance will be in percentage (can be called as 100 point scale) and the ease of use may be in 10 point scale. The layered approach is helpful to combine the rating under different categories and with different points of scale.

IV. IMPLEMENTATION

The proposed method is implemented using the online tool decision radar. Decision radar is implemented in python. For implementation we have considered five cloud service providers and three different categories of rating. Table 1 shows the details of five different parameters considers for ranking the cloud service providers. All the parameters are based on a 5 point scale, in which the users rated from 1 to 5, such that 5 has the highest rating and 1 is the poor rating.

Table 1. Ratings of five service providers under 3 categories with 5 parameters each

Service Provider	Category 1: Application Specific Parameters					Category 2: Performance in Percentage					Category 3: Uses Friendliness				
	P1	P2	P3	P4	P5	P1	P2	P3	P4	P5	P1	P2	P3	P4	P5
SP1	1	1	5	2	3	90	88	94	87	98	8	5	2	8	5
SP2	5	2	4	1	4	87	97	90	79	93	5	1	4	4	4
SP3	4	3	3	5	1	92	91	88	96	94	2	8	8	3	6
SP4	2	3	2	4	5	95	79	94	92	87	1	9	9	7	9
SP5	3	4	1	3	2	92	89	99	90	94	7	6	3	9	2

Based on the values in Table 1 the TOPSIS function is applied to each category. Before processing, the values need to be normalized. The normalized values for category 1 using equation 2 is shown in Table 2.

Table 2. Normalized Values for Category 1

Service Provider	P1	P1	P3	P4	P5
SP1	0.023	0.032	0.134	0.053	0.080
SP2	0.134	0.064	0.107	0.026	0.107
SP3	0.107	0.096	0.080	0.134	0.026
SP4	0.053	0.096	0.053	0.107	0.134
SP5	0.080	0.128	0.026	0.080	0.053

Based on the Normalized values all the other values are calculated. The values calculated for category 1 are listed in Table 3.

Table 3. Different Vectors values calculated using TOPSIS for category 1

Best Answer Vector	**[0.13, 0.12, 0.13, 0.13, 0.13]**
Worst Answer Vector	**[0.026, 0.032, 0.0269, 0.0269, 0.0269]**
Choices Distance From Best Vector	**[0.17, 0.13, 0.12, 0.12, 0.15]**
Choices Distance From Worst Vector	**[0.12, 0.16, 0.15, 0.15, 0.12]**
Closeness Vector of Each Choices	**[0.41, 0.55, 0.55, 0.55, 0.44]**

Finally, based on the obtained values, the service providers are ranked as per the score obtained by them. The service provider with a score of 0.558 is ranked first and the service provider with score 0.32 is ranked last. All the other service providers are ranked between these two values.

Application Specific Ranking :

SP4(0.558)>SP3(0.554)>SP2(0.550)>SP5(0.44)>SP1(0.41)

Similar procedure is applied to all the other categories and the service providers are ranked and the obtained results are tabulated in Table 4.

Table 4 Ranking of Cloud Service Providers based on different Categories

Application Specific Ranking	SP4 > SP3 > SP2 > SP5 > SP1
Performance Specific Ranking	SP4 > SP1 > SP3 > SP5 > SP2
User Friendliness Ranking	SP5 > SP3 > SP1 > SP2 > SP4
Overall Ranking	**SP4 > SP1 > SP3 > SP5 > SP2**

The SP4 has highest ranking with respect to the application and SP1 has lowest ranking in that category. With respect to performance SP4 has highest ranking and SP2 has lowest ranking. SP5 has highest ranking with respect to user friendliness and and SP4 has lower ranking in this category.

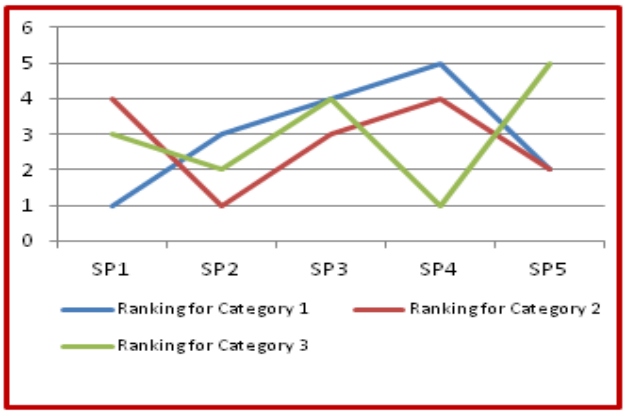

Figure 2. Ranking of Service Providers on three different Categories

From Figure 2 it is interpreted that the service provider SP4 has the highest overall ranking and it is recommended for the users.

V. COMPARISON AND ANALYSIS

To prove the efficiency of the proposed work, it is compared with E-FPROMTHENE. In E-FPROMTHENE they have compared the CSPs based on Trust Worthiness, Untrustworthiness and uncertainty values. All these parameters belong to the same performance metrics. The M-TOPSIS proposed in this work uses three different parameters like the Application Specific Ranking, Performance and User friendliness of the three cloud service providers and the experimental results proved that the proposed work is able to rank the service providers at par with the actual rankings.

Table 5 Ranking of Popular Cloud Service Providers as per M-TOPSIS

Service Provider	Application Specific	Performance	User Friendliness
Microsoft Azure	1	3	3
Amazon AWS	3	2	2
Google Cloud	2	1	1

The TOPSIS Analysis results show that Amazon AWS tops the list, followed by Microsoft Azure and the Google Cloud.

Amazon AWS (0.63) > Microsoft Azure (0.58) > Google Cloud (0.42)

The results are compared with the E-FPROMTHENE technique and the results shows that the values calculated using TOPSIS is at par with the actual ratings. Though the actual ratings are based on different criteria like Availability, Cost, Customer Support and other parameters. The M-TOPSIS is able to produce the result as close to the actual values.

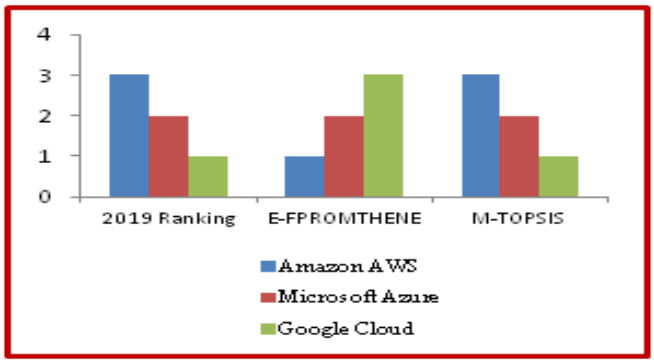

Figure 3. Comparison of M-TOPSIS with E-FPROMTHENE and 2019 Rankings

VI. CONCLUSION AND FUTURE ENHANCEMENTS

The M-TOPSIS method proposed in this research very useful to rank the service providers and select a suitable one among them. The use of multiple layers of TOPSIS is very helpful to evaluate the service provider on different categories and with different rating scales. Also the possibility to add more layers to the system is useful to select a best service provider among the availed ones. Another major advantage is that using M-TOPSIS the users can also select a service provider in any category as per their requirements. When compared with the existing approaches the M-TOPSIS is able to provide better results that are near to the actual ratings. In future this technique can be expanded considering the cost and time factors to rank the service providers.

REFERENCES

1. Hwang, C. L. & Yoon, K. S. (1981). Multiple Attribute Decision Making: Methods and Applications, Springer-Verlag Press.
2. Deng, H., Yeh, C. H., & Willis, R. J. (2000). Intercompany Comparison Using Modified TOPSIS with Objective Weights, Computers and Operations Research, 27, 963-973.
3. Liu, S., Chan, F. T. S., & Ran, W. (2016). Decision making for the selection of cloud vendor: An improved approach under group decision-making with integrated weights and objective/subjective attributes, Expert Systems with Applications, 55, 37–47.
4. Ma, H., Hu, Z., Li, K. & Zhang, H. (2016). Toward trustworthy cloud service selection: A time-aware approach using interval neutrosophic set, Journal of Parallel and Distributed Computing, 96, 75-94.
5. Sachdeva, N., Singh, O., Kapur, P. K. &Galar, D. (2016). Multi-criteria intuitionistic fuzzy group decision analysis with TOPSIS method for selecting appropriate cloud solution to manage big data projects, International Journal of
6. Sidhu, J. & Singh, S. (2017). Improved TOPSIS Method Based Trust Evaluation Framework for Determining Trustworthiness of Cloud Service Providers, Journal of Grid Computing, 15(1), 81–105.
7. Socorro, M., García-Cascales, M. &Lomita, T. (2012). On rank reversal and TOPSIS method, Mathematical and Computer Modelling, 56(5–6), 123-132.
8. Subramanian, T. &Savarimuthu N. (2016). Application based brokering algorithm for optimal resource provisioning in multiple heterogeneous clouds, Vietnam Journal of Computer Science, 3, 57–70.
9. Krohlinga A.R & Pachecob, A.G.C, (2015) , A-TOPSIS – An approach Based on TOPSIS for Ranking Evolutionary Algorithms, Procedia Computer Science 55, 308 – 317.
10. Basu, A, Ghosh,S, Implementing Fuzzy TOPSIS in Cloud Type and Service Provider Selection, Advances in Fuzzy Systems, 2018, Research Article.

AUTHORS PROFILE

Dr.K.Kanagaraj, is currently working as an Assistant Professor (Sr.G) in the MCA department of MEPCO Schlenk Engineering College, Sivakasi, Tamilnadu India. He did his MCA from M.K.Universit, Madurai, M.E from R.V.S College of Engg. Dindigul and Ph.D from Anna University Chennai during February 2020. He has Five publications in International Journals and Conferences indexed in SCI and Scopus. He completed his Summer Faculty Research Fellowship from IIT Delhi in the year 2015. He is a member of ISTE and CSI.