A Framework for Cloud Service Provider Selection using MCDM Techniques

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ABSTRACT:
Cloud Computing is a emerging technology in the specialized form of Distributed computing in which the resources (storage, processors and memory) are completely abstracted from the consumer. In rapid changing business environment, IT is a must for the survival of a company and is becoming increasingly important. The emergence of cloud computing represents a fundamental change of IT services continue to go rapidly with increasing functionality and more consumers. As a result of this growth, it is a critical issue to select the cloud service provider which meets all the business strategies and the goals of the company. This study represents a framework to choose a best cloud service provider using mcdm[1] methods for company’s users.

KEYWORDS: Cloud Service Provider, AHP, VIKOR

1. INTRODUCTION
In a rapid changing business environment, IT is a must for the survival of a company and is becoming increasingly important. The emergence of cloud computing represents a fundamental change of a IT services and cloud services continue to grow rapidly. As a result of this growth, the global and Korean major cloud service providers launched commercial and B2B and B2C cloud services such as Iaas, PaaS, and SaaS. According to company’s users of cloud services, it is critical issue to select the best cloud service provider [2] which meets all the business strategies and the goals of the company.

The study presents a Framework to choose a best cloud service provider among available providers using MCDM [3] techniques. Here, AHP (Analytic Hierarchy Process) method used for calculating relative weights and VIKOR[4] method used for Ranking the CSPS

2. RESEARCH BACKGROUND:
1. Analytic Hierarchy Process:
An AHP was first proposed by Saaty and it is one of the most commonly used methods for solving MCDM (Multi-Criteria Decision Making) problems in political, economic , scientific, social and Management Sciences[5].Using AHP, opinions and evaluations of experts can be integrated, and a complex problem can be divided into a simple hierarchy system with higher levels to lower ones and this paper AHP method is used to calculate relative weights using Eigen Vector approach. The hierarchy approach is given in fig.1

Fig 1: Architecture Hierarchy for Service Selection in Cloud
2. VlseKriterijumskaOptimizacijaIKompro

misoResenje (VIKOR) Method:

The VIKOR [10] method was
developed by Serafin Opricovic to solve multi
criteria decision problems. It determines the
compromise ranking, and accurate solution to
complex problems. The VIKOR method mainly
focuses on ranking and selecting from a number
of alternatives in the presence of criteria.

3. METHODOLOGY:
1. AHP Method

Step 1: Identify Appropriate Linguistic
Variables

Step 2: Identify the Key Criteria’s for
evaluating readiness

Step 5: Determine the Fuzzy Importance
Weights of Evolution Criteria

The weights are calculated based on formulae:

a. Sum each column of the matrix
b. Divide each element of the matrix
   with the sum of its column.
   Normalized relative weight is found
   out. The sum of each column is 1.

c. The normalized principle eigenvector
   is obtained by averaging across the
   rows.

Normalization

For a matrix of pair (m x n) matrix elements
wise

\[
\begin{pmatrix}
C_{i1} & \cdots & C_{in} \\
\vdots & \ddots & \vdots \\
C_{m1} & \cdots & C_{mn}
\end{pmatrix}
\]

a) Sum the values in each column of the
   pair-wise matrix
\[
C_0 = \sum_{i=1}^{n} C_i
\]

b) Divide each element in the matrix by
   its column total to generate a

\[
X_i = \frac{C_i}{\sum_{i=1}^{n} C_i}
\]

c) Divide the sum of the normalised
column of matrix by the number of
criteria used to generate weighted
matrix

\[
W_0 = \frac{\sum_{i=1}^{n} X_i}{n}
\]

Generated Weighted matrix

\[
\begin{pmatrix}
W_1 \\
\vdots \\
W_n
\end{pmatrix}
\]

A. Consistency analysis

Consistency vector is calculated by
multiply the pair-wise matrix by the
weights vector

\[
\begin{pmatrix}
C_{i1} & \cdots & C_{in} \\
\vdots & \ddots & \vdots \\
C_{m1} & \cdots & C_{mn}
\end{pmatrix}
\begin{pmatrix}
W_1 \\
\vdots \\
W_n
\end{pmatrix}
= \begin{pmatrix}
CV_1 \\
\vdots \\
CV_n
\end{pmatrix}
\]

Dividing the weighted sum vector with
criterion weight

\[
CV_i = \frac{1}{W_i} [C_{i1}W_1 + \ldots \ldots + C_{i1}W_n]
\]

\[
\vdots \\
\vdots
\]

\[
CV_{ni} = \frac{1}{W_{ni}} [C_{ni}W_1 + \ldots \ldots + C_{ni}W_n]
\]

Resultant weight matrix
2. Fuzzy VIKOR method
AHP weights calculation procedure are same for weights need in further process of VIKOR weights obtained in AHP

**Step 1**: Construct the Performance Rating Matrix

The Performance Rating Matrix is obtained after converting fuzzy input into BNF values

**Step 2**: Computed the values $S_j$ and $R_j$, $j=1,2,\ldots,J$ by the relations given below

Calculation of $S_j$ and $R_j$ by using the relation given in equation (A3-1.6) and (A3-1.7) respectively

$$S_j = \sum_{i=1}^{n} w_i \frac{(f'_i - f_a)}{(f'_i - f_a)}$$

$$R_j = \max_i \left[ w_i \frac{(f'_i - f_a)}{(f'_i - f_a)} \right]$$

Computed value of $S_j$ and $R_j$ is

**Step 4**: Computed the $Q_j$, $j=1,2,\ldots,J$ using the relation given below in equation (A3-1.8)

$$Q_j = \sqrt{\frac{(S_j - S^*)}{(S^* - S)}} + (1 - \nu) \frac{(R_j - R^*)}{(R^* - R)}$$

Where

$$S^* = \min_j S_j ; S^- = \max_j S_j$$

$$R^* = \min_j R_j ; R^- = \max_j R_j$$

Computed value of $Q_j$

**Step 5**: Ranking the Alternatives

Computed the values of $S$, $R$ and $Q$. Ranking of the projects based on $Q$.

### 4. Results and Discussion:

Here the case study problem takes seven choices or alternatives named as cloud service providers(CSPs) csp1, csp2, csp3, csp4, csp5, csp6, csp7 and eleven criteria's or attributes are namely Providers Name Recognition(PNR), Service Price(SP), Service Availability(SA),Performance, Scalability(PS), Security(SEC), Support(SUP), Quality, Flexibility(FX), Storage Space(SS), Previous User Rating(PUR).The Proposed framework helps the user to choose best service provider among those available service provider.

Take all the Alternatives and decision maker rating taken on scale 1 to 9 and form the alternative matrix.

**Table 1**: Alternatives Input

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>PNR</th>
<th>SP</th>
<th>SA</th>
<th>PF</th>
<th>SC</th>
<th>SEC</th>
<th>SUP</th>
<th>QUALITY</th>
<th>FX</th>
<th>SS</th>
<th>PUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSP1</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>CSP2</td>
<td>5</td>
<td>4</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>CSP3</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>8</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>CSP4</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>CSP5</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>CSP6</td>
<td>8</td>
<td>7</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>8</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>CSP7</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>

In this study using AHP to found normalized weight of each attribute and the VIKOR method was used for ranking the cloud service providers to select best cloud service provider the accurate results are obtained based on the VIKOR method. The results are given in Table 1.

**Table 2**: Table For Rankings [15]

<table>
<thead>
<tr>
<th>CSPS</th>
<th>VIKOR</th>
<th>RANKING</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSP1</td>
<td>0.419</td>
<td>5</td>
</tr>
<tr>
<td>CSP2</td>
<td>0.387</td>
<td>4</td>
</tr>
<tr>
<td>CSP3</td>
<td>0.006</td>
<td>2</td>
</tr>
<tr>
<td>CSP4</td>
<td>0.824</td>
<td>6</td>
</tr>
<tr>
<td>CSP5</td>
<td>0.128</td>
<td>3</td>
</tr>
<tr>
<td>CSP6</td>
<td>0.000</td>
<td>1</td>
</tr>
<tr>
<td>CSP7</td>
<td>1.000</td>
<td>7</td>
</tr>
</tbody>
</table>
This ranking can be used to decide the user to take CSP6 is the best among all available CSPS.

5. Conclusion:
In this study, we focus on the cloud service provider selection in cloud computing using MCDM methods and we assure that the tool proposed by us is efficient and practical in terms of real time. In the future we will extend our ranking algorithm to fuzzy sets even the expert not having the numerical value but now we only taking numerical scale on the expert opinion later we are taking fuzzy values non crisp values also taken and ranking the clouds. We will assure that our framework is used to select the best cloud service provider.

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References:
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