Selection of Mobile Network Operator Based on Multi-Criteria Decision Making Model Using Analytic Hierarchy Process

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ABSTRACT

Background: Mobile network operators have gone a long way providing good services of various means to their valued customers. In Malaysia, Maxis, DiGi, Celcom and U Mobile are the most mobile network operators subscribed by Malaysians. The government has also given the control to Long Term Evolution to these service providers so as to further improve their quality of services and to increase their revenue over time. These mobile service providers promote a variety of call, text and even internet packages to attract and maintain customer loyalty. This causes difficulties for consumers in selecting the suitable mobile network operator based on multi criteria such as monthly bill charges, data services, network coverage and so on. Objective: The objective of this paper is to solve the multi-criteria decision making problem in choosing the most preferred mobile service provider among Maxis, DiGi, Celcom and U Mobile using Analytic Hierarchy Process model. Besides that, this paper aims to identify the priority of the decision criteria such as network coverage, monthly bill charges and commitment, data services, rewards, value-added services, influence and customer after-sales services in decision making process. Results: Maxis is the most preferred mobile network operator followed by DiGi, U Mobile and Celcom. Besides that, the monthly bill charges and commitment is the most significant factor in the multi-criteria decision making process followed by data services, influence, network covergae, customer after-sales services, rewards and value-added services. Conclusion: Maxis is found to be the most preferred mobile network operator while monthly bill charges and commitment is the most essential criteria in the multi-criteria decision making process. The significant of this paper is to identify the most preferred mobile network operator in Malaysia as well as the most important criteria in decision making process.

INTRODUCTION

Mobile service provider (MPS) or mobile network operator is a telephony company that offers network communication services to the users of telecommunication devices. A miniature card called the subscriber identity module (SIM) will be given by the respective MPS personnel to their customers. In Malaysia, there are a total of 8 mobile service providers to cater for the 30 million users countrywide. As of 2014, the companies that provide telecommunication services to Malaysians are Maxis, Celcom, DiGi, U Mobile, XOX COM, P1, RedTone Mobile and last but not least, Merchantrade. A lot of similar studies have been done to address issues regarding mobile networks. These mobile service providers promote a variety of call, text and even internet packages to attract and maintain customer loyalty. This causes difficulties for consumers in selecting the most suitable mobile network operator based on multi criteria such as monthly bill charges, data services, network coverage and so on. The objective of this paper is to solve the multi-criteria decision making problem in choosing the most preferred mobile network operator among Maxis, DiGi, Celcom and U Mobile using Analytic Hierarchy Process (AHP) model. Besides that, this paper aims to identify the weights and priority of the decision criteria such as network coverage, monthly bill charges and commitment, data services, rewards, value-
added services, influence and customer after-sales services in decision making process. The rest of the paper is organized as follow. The next section discusses about the literature review. Section 3 describes the data and methodology. Section 4 discusses about the empirical results of this study. Section 5 concludes the paper.

Literature review:

The concept of Analytic Hierarchy Process (AHP) is introduced by Thomas Saaty [1]. According to Merkin [2] and Saaty [3, 4], AHP is formed based on the distinct mathematical constitution of undeviating matrices and their related right-eigenvector’s capabilities to generate estimated or true weights. Alam et al. [5] conducted a survey to yield the preferences of consumers in selecting their telecom operators in Bangladesh using AHP. Besides that, Ajay et al. [6] managed to develop a framework to identify the factors affecting the preference of mobile service providers and the choice of telecom operators among the consumers in India by utilizing a hybrid fuzzy AHP method. Hassan et al. [7] studied on the selection of mobile network operator using AHP and found out that consumers prefer monthly commitment the most, monthly charges the second, followed by rewards and value-added services. In the past studies, the network coverage, monthly charges and commitment, data services, rewards, value-added services, influence and customer after sales services have been identified as the decision criteria in the selection of mobile network operator. Quality of service assists to develop the essential competitive advantage by becoming the effective factor or decision criterion for differentiation [8]. Wal et al. [9] denoted that service quality was an important contributing factor to maintain competitive advantage. Competitive advantage means an advantage a firm gains over its competitors by offering its customers greater value-for-money services either by lowering the price of goods and services or offering additional rewards [10]. Consequently, Lai et al. [11] concluded that one of the important aspects that affect the customers’ view of mobile network service quality was network coverage.

The monthly bill charges and commitment play an important role in the telecommunication industry [12]. The success of any telecommunication company relied on suitable pricing policies besides continuous usage from its customers. As the price competition between mobile services providers heated up, Trebing [13] noted that there are only three major sets of pricing tactics which were setting low prices to attract customers with high purchasing power, setting high entry charges for second movers and writing off standardized investment against customers. Rewards are things offered to customers by a service provider in recognition of their loyalty and achievements. Kahneman and Tversky [14] predicted that people are often afraid of risks and tend to prefer rewards with a definite extent compared to an indefinite one. However, there were also some possibilities that consumers have a higher tendency towards a reward of indefinite extent [15-17]. Shen et al. [18] proposed that the motivation towards a reward of uncertain extent is higher than a reward of known extent. In this research, motivation was defined as the funding of money, time and effort by consumers to gain a specific reward [19].

The family influence, peer pressure and media coverage are identified decision criteria in the past studies. Since young adults refer to their families as a reliable source of information and reference, the family automatically plays a vital role in influencing the decision making process [20, 21]. Aside from the strong family influence on buying behavior, peer groups seems to have even a more significant impact than the role of blood-related members [22]. Fatima [23] also concluded that peer pressure has great influence on the purchasing power of consumers. The media also contributed fairly in the selection of mobile networks. Samson et al. [24] also conducted a study on media influence and found that online digital communications has a positive impact on the buying decision of consumers.

Data and methodology:

Data:

In this research, the preference of mobile network operator among Universiti Tunku Abdul Rahman (UTAR) Perak Campus’ students will be identified. The seven decision criteria identified in this study are network coverage, monthly bill charges and commitment, data services, rewards, value-added services, influence and customer after-sales service. AHP was utilized and applied in finding the weights and priority of the decision criteria as well as mobile network operator. The mobile network operators used were Maxis, DiGi, Celcom and U Mobile while others do not play a significant figure in the Malaysian mobile network industry. Questionnaires were distributed to 300 students and the mean for each entry in the pair-wise comparison matrices was obtained. Expert Choice™ software was used to analyze the data.

Analytic Hierarchy Process Model:

A few factors are considered in this particular sampling. Firstly, respondents who are using more than one mobile network operators are to select the best one among them regardless of it being a prepaid or postpaid package. Secondly, respondents must have understood the content of the services offered by mobile service providers to be able to make a reliable pair-wise comparison. The AHP model is a hierarchy structure that consists of three levels which are the goals, decision criteria and decision alternatives. Figure 1 shows the general hierarchy structure in AHP model.
Fig. 1: General hierarchy structure in AHP model.

Table 1 shows the goal, decision criteria and decision alternatives identified in this study.

Table 1: Goal, decision criteria and decision alternatives in the selection of mobile network operator.

<table>
<thead>
<tr>
<th>Level 1: Goal Definition</th>
<th>Selection of Mobile Network Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 2: Decision Criteria</td>
<td></td>
</tr>
<tr>
<td>1. Network Coverage</td>
<td></td>
</tr>
<tr>
<td>2. Monthly Charges and Commitment</td>
<td></td>
</tr>
<tr>
<td>3. Data Services</td>
<td></td>
</tr>
<tr>
<td>4. Rewards</td>
<td></td>
</tr>
<tr>
<td>5. Value-Added Services</td>
<td></td>
</tr>
<tr>
<td>6. Influence</td>
<td></td>
</tr>
<tr>
<td>7. Customer/After Sales Services</td>
<td></td>
</tr>
<tr>
<td>Level 3: Decision Alternatives</td>
<td></td>
</tr>
<tr>
<td>1. Maxis</td>
<td></td>
</tr>
<tr>
<td>2. DiGi</td>
<td></td>
</tr>
<tr>
<td>3. Celcom</td>
<td></td>
</tr>
<tr>
<td>4. U Mobile</td>
<td></td>
</tr>
<tr>
<td>5. Others</td>
<td></td>
</tr>
</tbody>
</table>

Data analysis in the AHP model can be divided into five steps.

Step 1: State the goal or objective and distinguish the decision criteria and alternatives to build the hierarchy.

Step 2: Develop pair-wise comparison matrices for the identified decision criteria and alternatives. The elements are compared in pairwise to obtain their relative importance to the problem. Table 2 shows the scale used for the pairwise comparison in AHP model.

Table 2: Scale used for pairwise comparison in AHP model.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Two elements have the same level of importance</td>
</tr>
<tr>
<td>3</td>
<td>One element has a slightly higher importance than the other</td>
</tr>
<tr>
<td>5</td>
<td>One element has a stronger level of importance compared to the other</td>
</tr>
<tr>
<td>7</td>
<td>One element has a slightly higher dominance to the other</td>
</tr>
<tr>
<td>9</td>
<td>The highest and most extreme dominance of an element</td>
</tr>
<tr>
<td>2, 4, 6, 8</td>
<td>Intermediate ratings, when compromise is required</td>
</tr>
</tbody>
</table>

For $n$ number of decision criteria or decision alternatives, the number of pairwise comparison matrix can be obtained by using the formula $(0.5)n(n - 1)$. The matrix constructed will be as follows.

\[
C = \begin{bmatrix}
    c_{11} & c_{12} & \ldots & c_{1n} \\
    c_{21} & c_{22} & \ldots & c_{2n} \\
    \vdots & \vdots & \ddots & \vdots \\
    c_{n1} & c_{n2} & \ldots & c_{nn}
\end{bmatrix}
\]

where $C = (c_{ij})$, $c_{ij} > 0$ and $c_{ji} = 1/c_{ij}$.
Step 3: Identify the weights that control the decision criteria and Local weights of the alternatives from the matrices above by utilizing the Normalization Method. To determine the criteria and local weight of decision alternatives, calculate the total of the data of each row, \( \tau_i = \sum_{j=1}^{n} c_{ij} \), \( i = 1, 2, 3, \ldots, n \) and normalizing the local weight \( \tau_i = \frac{\sum_{j=1}^{n} c_{ij}}{\sum_{j=1}^{n} c_{ij}} \), \( i = 1, 2, 3, \ldots, n \). The results of the normalized vector of the local weight is \( y = [\tau_1, \tau_2, \ldots, \tau_n]^T \).

Step 4: Identify the Global weights of the decision alternatives by the local weights priority synthesis.

\[
A \times V = \begin{bmatrix}
a_{11} & a_{12} & \cdots & a_{1n} \\
a_{21} & a_{22} & \cdots & a_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
\vdots & \vdots & \ddots & \vdots \\
a_{n1} & a_{n2} & \cdots & a_{nn}
\end{bmatrix} \times \begin{bmatrix}
v_1 \\
v_2 \\
\vdots \\
\vdots \\
v_n
\end{bmatrix}
\]

Matrix \( A \) denotes the local weights attained by the decision alternatives and each column denotes the local weight obtained by each factor. The \( V \) matrix denotes the transpose of the local weight attained by the criteria. Therefore, global weight can be obtained by having matrix \( A \) multiply with matrix \( V \).

Step 5: Checking for consistency:
In pairwise comparisons, consistency is always an issue. A small consistency ratio (CR) is always preferred. Therefore, repetition of the pairwise comparisons is encouraged until the CR attains the value 0.10 or lower [1]. CR is obtained in terms of the consistency index (CI) and random index (RI) as shown below.

\[
CI = \frac{\lambda_{\max} - n}{n - 1}
\]

\[
CR = \frac{CI}{RI}
\]

where \( \lambda_{\max} \) assumed to be the maximum eigenvalue, and the RI values calculated by Saaty [1] as shown in Table 3.

<table>
<thead>
<tr>
<th>( n )</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI</td>
<td>0.00</td>
<td>0.58</td>
<td>0.90</td>
<td>1.00</td>
<td>1.24</td>
<td>1.32</td>
<td>1.41</td>
<td>1.45</td>
<td>1.51</td>
</tr>
</tbody>
</table>

Empirical results:
Figure 2 shows the model sensitivity analysis which displays the priority or preference of the mobile network operator for each decision criteria.

Fig. 2: Model sensitivity analysis.
As shown in Figure 2, the line shows the current weights or priority of the mobile network operator for each decision criteria. The bar chart at the bottom of the sensitivity analysis graph shows the priority of the decision criteria among UTAR students. In this case, monthly bill charges and commitment is of the most concern among them followed by data services, influence, network coverage, customer after-sales service, rewards and value-added services. The coloured lines symbolize the performance of each mobile network based on all the seven factors. Maxis is represented by the blue line while DiGi is represented by the red followed by brown for U Mobile, green for Celcom and yellow for Others. It can be deduced that the competition between Maxis and DiGi is very stiff as the blue and red lines are very near to one another. Maxis overpowered DiGi in terms of network coverage, data services, rewards and influence while DiGi excelled in terms of monthly bill charges and commitment as well as customer after-sales service. However, the both of them are of equal comparison in the value-added services factor. On the other one hand, U Mobile surpassed both of these giant competitors in terms of data services. Although the presence of U Mobile rivalled on par with the two major ones, Celcom seemed to have outweighed U Mobile in the areas of network coverage and customer after-sales service. Other mobile network operators did not seem to affect much on the students’ choice as they did not prove to have a big market share in the mobile networks industry.

Figure 3 displays the weights and priority of all decision criteria in the selection of mobile network operator.

![Fig. 3: Weights and priority of all decision criteria in the selection of mobile network operator.](image)

Based on Figure 3, UTAR Kampar students preferred monthly bill charges and commitment with the highest weights (0.245) followed by data services (0.216), influence (0.197), network coverage (0.195), customer/after-sales service (0.071), rewards (0.042) and value-added services (0.034). Table 4 shows the consistency ratio for each decision criteria.

<table>
<thead>
<tr>
<th>Decision Criteria</th>
<th>Consistency Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly Bill Charges and Commitment</td>
<td>0.05</td>
</tr>
<tr>
<td>Data Services</td>
<td>0.07</td>
</tr>
<tr>
<td>Influence</td>
<td>0.07</td>
</tr>
<tr>
<td>Network Coverage</td>
<td>0.07</td>
</tr>
<tr>
<td>Customer/After-Sales Service</td>
<td>0.07</td>
</tr>
<tr>
<td>Rewards</td>
<td>0.07</td>
</tr>
<tr>
<td>Value-Added Services</td>
<td>0.07</td>
</tr>
</tbody>
</table>

The consistency ratio for each decision criteria in this study is less than 0.10. This implies that the pairwise comparison matrix does not exhibit any serious and significant inconsistency. Therefore, the judgments made by the students on the weights and priority of decision criteria in the selection of mobile network operator are reliable and acceptable.

Finally, Figure 4 presents the overall weights and priority of mobile network operators.

![Fig. 4: Overall weights and priority of mobile network operators.](image)
As shown in Figure 4, the result shows that the students have chosen Maxis (0.333) as their most preferred mobile network operator with respect to all seven decision criteria which are the network coverage, monthly bill charges and commitment, data services, rewards, value-added services, influence and customer after-sales service. The priority or preference of the mobile network operator is followed by Digi (0.317), U Mobile (0.170), Celcom (0.132) and others (0.047). The overall consistency ratio is 0.05 which is well below 0.10. This implies that the pairwise comparison matrix does not exhibit any serious and significant inconsistency. Therefore, the best decision of selecting Maxis as the most preferred mobile network operator using AHP model is acceptable.

Conclusion:

In this study, Maxis is found to be the most preferred mobile network operator followed by Digi, U Mobile, and Celcom using AHP model. In this multi-criteria decision making process, the monthly bill charges and commitment is the most essential decision criteria in the selection of mobile network operator. The priority of the decision criteria is followed by data services, influence, network coverage, customer after-sales service, rewards and finally value-added services. Other mobile network operators are recommended to improve the monthly bill charges and commitment as well as data services which have been identified as the most important decision criteria by the users in this study. The significant of this paper is to identify the most preferred mobile network operator in Malaysia as well as the most important criteria in decision making process.

REFERENCES