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ORIGINAL ARTICLE

Selection of Mobile Network Operator Using Analytic Hierarchy Process (AHP)

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ABSTRACT

In Malaysia, Celcom, Maxis and DiGi are the most familiar mobile network operator subscribed by Malaysian. These three operators promote a variety of packages to attract mobile users. In this paper an Analytic Hierarchy Process model is built up to solve the multi-criteria decision making problem in selecting the most suitable mobile network operator. Four criteria associated with mobile network operator were considered and questionnaires regarding selection of mobile network operators were distributed. Celcom is found to be the most preferable mobile network operator while monthly commitment becomes the most important criteria in the selection process followed by monthly charges, rewards and value added services.

***Key words*:** analytic hierarchy process, mobile operator, multi-criteria decision making

Introduction

Mobile network operator (MNO) is a telephone company that provides network services for mobile phone users. The operator will give a small card recognized as SIM card to their customer to be inserted into mobile phone in order to gain access to the service provided. Currently, there are thousands of active mobile network operators. The world largest mobile network operator is China Mobile Limited which was incorporated in Hong Kong on 3rd September 1997 with 667 million subscribers and awarded the world's largest mobile network operator in January 2012. The company provides services not only in Mainland China and Hong Kong but also Mount Everest (Hennock, 2003)and Spratly Islands(Mansfield, 2011).

Issues on mobile network operators are not new.Kuo and Chen (2006) studied on the selection of mobile value added of mobile phone operators in Taiwan using fuzzy synthetic evaluation method in order to provide an analytical tool to select the best mobile value-added service firm.Keramati and Ardabili (2011) focused on factors that most influence Iranians on their decision to remain or churn in their current mobile network operator. Kim & Yoon (2004) identified the determinants of subscriber churn and customer loyalty in Korea while Liao and Lin (2011) analyzed the efficiency of six major mobile network operators in Japan and Korea between the year 2002 till 2006 including factors that influence efficiency.

In this paper, we will identify the most preferable mobile network operator among students in the School of Mathematical Sciences of Universiti Kebangsaan Malaysia (UKM). The four criteria used are monthly commitment, charges, rewards and value added services. The priority weights of mobile network operator based on user's preferences was built using Analytical Hierarchy Process. The mobile network operators included are Celcom, Maxis and DiGi since these operators are the most subscribed by students.

Methodology:

In a rapidly changing environment nowadays, decision making process becomes more challenging as it is hard to select the best decision alternatives when there are multiple objectives to choose from. Hassan et al. (2010a, 2010b) and Hassan and Tabar (2011) dealt with decision making of multiobjective resource allocation problems. Hassan and Mohammad Basir (2009), Hassanand Sahrin (2012),Hassan and Loon (2012),Hassan and Ayop (2012) and Hassan et al. (2012a, 2012b) used goal programming for decision making in various applications.Saaty (1980) solved this problem by developing the analytic hierarchy process (AHP) in the 70s. The AHP is an instinctively simple technique, which formulates and analyzes decisions by simplifying a multifaceted multi-criteria decision problem. This study adopted the AHP technique to analyze consumer's preferences in selecting mobile network operator.

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AHP includes three phases, which are decomposition, comparative judgment and priority synthesis (Saaty, 1980). The AHP model for our study is illustrated in Figure 1.

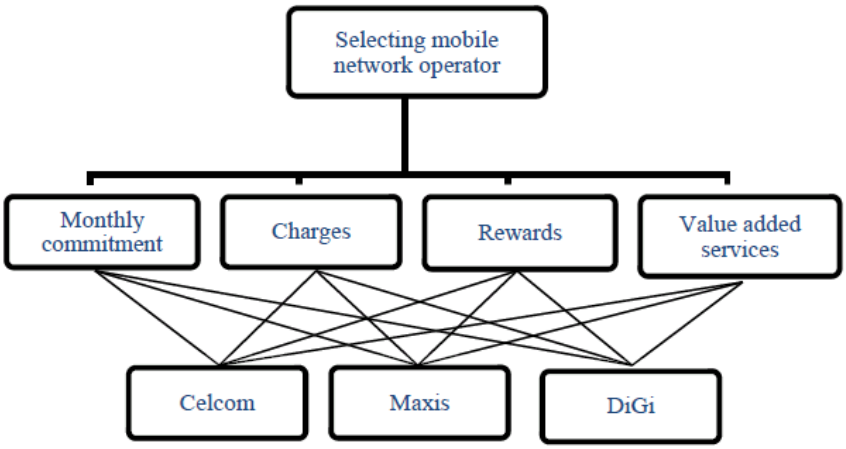

Fig. 1: The AHP model

Decomposition phase:

In the decomposition phase, the hierarchical structure is constructed such that the top level represents the overall objective and the lower level indicates the main evaluation criteria and alternatives.

Comparative judgment phase:

In the comparative judgment phase, a comparison matrix at each level is constructed based on the user's preference from the numerical ratings of pairwise comparison. In this phase, the AHP questionnaire was designed in accordance with analytic hierarchy structure. All criterion and alternatives were compared pairwise extracting numerical scale 1 (equally important) to 9 (very important) ratings to obtain their relative importance to the problem.

If there are *n* decision criteria or decision alternatives, then there will be $(0.5)n(n-1)$ pairwise comparisons in square matrices. A pairwise comparison matrix C, for *n* decision criteria is in the form

$$C = \begin{bmatrix} 1 & a_{12} & a_{13} & \dots & a_{1n} \\ 1/a_{12} & 1 & a_{23} & \dots & a_{2n} \\ 1/a_{13} & 1/a_{23} & 1 & \dots & a_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1/a_{1n} & 1/a_{2n} & 1/a_{3n} & \dots & 1 \end{bmatrix}$$

A pairwise comparison matrix for decision alternatives with respect to each of the criteria uses the same form as the matrix above.

Priority synthesis phase:

The priority synthesis phase calculates a composite weight for each alternative based on the preferences obtained from the comparison matrix. In this study, the technique used for the priority or weight determination is the eigenvector method. The right principle eigenvectors are estimated corresponding to the maximal eigenvalue λ_{max} of the pairwise comparison. The resulting composite weights produce a relative ranking of the alternatives with the top rank indicates an optimal alternative.

Consistency checking:

In making paired comparisons, people often do not have the logical ability to always be consistent. It is preferable to have a small consistency ratio(CR). Saaty (1980) suggested repeating the pairwise comparisons until the CR reaches 0.1 or lower.CR is the ratio of consistency index (CI) to random index (RI), which is given by $CR = CI/RI$, where

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$$CI = \frac{\lambda_{max} - n}{n - 1}$$

with λ_{max} being the maximal eigenvalue, and the standardized RI values are those calculated by Saaty (1977) as shown in Table 1.

Table 1: Random indices

n	2	3	4	5	6	7	8	9	10
RI	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

Modelling:

The AHP model illustrated in this paper uses the four decision criteria of monthly commitment, charges, rewards and value added services. Monthly commitment refers to the monthly fees that users need to pay based on their mobile network usage monthly. Charges include single call and messaging charges offered by the mobile operator networks. Rewards refer to special benefits during particular periods such as birthdays or anniversary rewards. Value added services include extra services provided to mobile users such as call forwarding, voice mail and missed call notification. The three mobile network considered are Celcom, Maxis and DiGi since these three are the most popular networks subscribed by students.

Results and Discussions

The questionnaires were collected from 36 respondents and the average of each entry in the comparison matrices was calculated. Respondents were among students of the age of 20-29 with the experience of using more than one mobile network operator. Data analysis was done using Expert Choice (EC) software.Table 2 is the questionnaire to compare the relative importance between decision criteria with respect to goals.

Table 2: Questionnaire

Evaluation criteria	Numerical scale																	Evaluation criteria
Monthly commitment	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Charges
Monthly commitment	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Rewards
Monthly commitment	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Value added services
Charges	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Rewards
Charges	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Value added services
Rewards	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Value added services

The resulting priorities or weights were calculated at each level adopting the eigenvector method using Expert Choice software. The synthesis output with respect to goals is illustrated in Figure 2. Celcom was found to be the most favorable mobile network operator with the highest weight 0.416 followed by Maxis and DiGi with weights 0.354 and 0.230 respectively. The overall consistency ratio is 0.06 which is acceptable for AHP implementation.

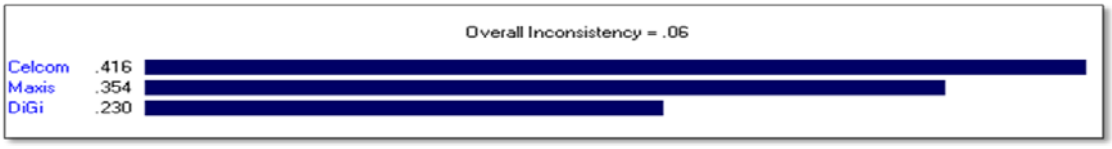

Fig. 2: Synthesis output with respect to goals

From the results tabulated in Table 3, respondents prioritize monthly commitment criteria in selecting mobile network operators with the highest weight 0.419 followed by charges (0.381), rewards (0.143) and value added services (0.057)with a consistency ratio CR of 0.09. This implies that student users want to know how much they have to pay for their monthly usage as an indicator in selecting mobile network operator, most probably because they have limited allowance.

Table 3: Synthesized priorities and ranks for criteria with respect to goals

Decision criteria	Priority	Rank
Monthly commitment	0.419	1
Charges	0.381	2
Rewards	0.143	3
Value added services	0.057	4

Table 4 shows the synthesized priorities and ranks with respect to decision criteria with the acceptable CR value for each criterion. Celcom obtained the highest priorities or ranks in selecting a mobile network operator for every criterion. This implies that respondents prefer Celcom to other mobile network operator relating to all four decision criteria.

Table 4: Synthesized priorities and ranks with respect to decision criteria

Decision Criteria	Celcom	Maxis	DiGi	CR
Monthly commitment	0.390 (1)	0.354 (2)	0.254 (3)	0.00669
Charges	0.430 (1)	0.332 (2)	0.238 (3)	0.00001
Rewards	0.457 (1)	0.417 (2)	0.127 (3)	0.00768
Value added services	0.439 (1)	0.349 (2)	0.212 (3)	0.00106

Conclusions:

Our paper presented a decision-making method for selecting the best mobile network operator through AHP method among students in a department of a public university. It illustrates the use of AHP satisfying as many criteria based on the students' preferences. Celcom was found to be most popular among the three mobile network providers followed by Maxis and DiGi based on monthly commitment followed by charges, rewards and value added services in descending order of decision criteria.

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