Analytic Hierarchy Process (AHP) in Multi Criteria Decision Making: A case of Locating The Operations of Low Cost Carrier In Malaysia

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Abstract. Decision making is an important rule for an individual or a group in an organization. However, decision making can sometime take a long time to be realized. The objective of this paper is to investigate if a different approach that is the Analytic Hierarchy Process (AHP) model is applicable in facilitating decision making particularly for decision makers who were faced with multiple criteria problem. In this paper, a group of decision makers (judgement sampling were used) were tasked to determine the location for the operation of low cost carrier comprising sites of which include the KLIA, Subang Airport and the Low Cost Terminal. The AHP was used as a decision making approach to investigate if it is applicable in addressing the multiple criteria decision making problem. The criteria that are taken into consideration in this study include the benefit and cost of each selected locations in term of economy, social and environment. The AHP allows decision to be constructed as hierarchies and each criterion can be assigned with a preference scale that is determined by the decision makers. The findings indicate that the approach facilitate decision making in a shorter period of time. In general, based on the preference scale assigned by decision makers to the identified criteria the Low Cost Terminal is highly preferred with an economic ratio benefit of 0.447 and social ratio benefit of 0.437. However, in term of environmental benefits with a ratio of 0.508, the KLIA was preferred by the decision makers over Subang Airport and the Low Cost Terminal. Overall the Low Cost Terminal is highly preferred with a ratio of 0.719, 0.488 and 0.454 for each criterion.

Keywords: Low cost carrier,AHP,multiple criteria,decision making,economic,social and environmental benefits

1. Introduction

The divergent needs of the airlines have impacted service providers and policy makers. Although a new location has been agreed by the Malaysian government for the operations pf the low cost carrier, this study is an attempt to investigate if the Analytic Hierarchy Process (AHP) model is applicable as an approach for multiple criteria decision making problem. The growth in the aviation industry has over the years contributed positively towards economic growth in term of tourism receipts, facilitate the movement of people and goods and enable the creation of new businesses. With the increasing propensity to travel the aviation industry have somewhat evolved more markedly in the last few years with the increasing emergence of low cost carriers notably in Europe and Asia compared to the traditional full service airlines. The increase in passenger numbers provide the opportunity for market segmentation for the different group of travellers those that require full airline services and the group of people that willingly sacrifice travel comfort for lesser air fares.

The International Civil Aviation Organization (ICAO) on the Regulation describes a full service airline model as one that operates on a myriad of hub-and-spoke networks which allow the airlines to operate more frequent services including inter-connection through co-operation with other airlines in code-sharing, block spacing or franchising agreement. The airlines provide add-on services for passengers such as in-flight services, on ground facilities and personal ticketing. On the other hand the business model of low cost airlines are characterized by its focus on short-haul routes with the extension on long-haul routes, concentrating on point-to-point services, high frequencies, simple low fare structures, high-density single class, simple in-flight services, staffing flexibility and minimal overheads with the intensive use of electronic commerce for marketing and distribution. According to Dennis (2000) another notable feature of the low-cost airlines is the preference of low-cost carriers to

locate their operations in secondary airport where a multi-airport system is in place. The growth of the low-cost carrier has spanned over three decades when Southwest Airlines the airline that has been credited as the most successful start-up for the low-cost model flies out of Texas in the 1970s. When the aviation industry was deregulated in the United States, the model was adopted by airlines in Europe such as Ireland's Ryanair which began operations in 1991 and EasyJet which was formed in 1995. Most of the new low-cost entrants try to emulate the Southwest business model. While there have been successes there have been numerous reported failures too. Binggeli and Pompeo (2002) pointed out with the exception of the three airlines (Southwest, Ryanair and EasyJet) all other players in the low-cost segment have accumulated losses of almost USD 1 billion in the period from 1996 to 2001 leading to bankruptcies for ValuJet, Carnical Air, Kiwi, PAnAM II, Western Pacific, Midway and Sun country airlines in the United States and losses of USD 300 million by low-cost carries in Europe leading to the demise of Colorair, Debonair and AB airlines.

Nonetheless, by 2004 low-cost carriers were edging into Australasia, led by Malaysia's Air Asia and Australia's Virgin Blue with Singapore introducing Valuair and Tiger airways while Thailand launched One-Two-Go and Nok Air. According to Bieger, Doring and Laesser (2003) low-cost carrier will continue to grow as the airline business is based on a different structure of airports systems and practices as well as entirely different price logic. However, it has remained that the presence of low-cost carriers has brought about many changes to the general outlook of the aviation industry.

Initially air transport needs in Malaysia were provided by full service airlines. These include Malaysia's national carrier Malaysia Airline System (MAS), Transmile Air, Pelangi Air and Air Asia. MAS focus on providing extensive international and regional air services whereas most of the other airlines concentrated on serving the domestic air services. However due to the ever increasing cost of domestic air services some of the airline operation had ceased their operation. They are Transmile Air and Pelangi Air. Transmile Air had nowadays focus on air cargo services.

Air Asia begins its operation as a full service airline. It was formed in 1996 when the government agreed to the establishment of a second national airline to provide complimentary air services to the national carrier. However by the late 1990s the airline had incurred heavy losses due to its high operating costs. In December 2001, in the midst of the airline's financial crisis, Tune Air Sdn. Bhd. Acquires from the DRB-Hicom group 99.25 percent equity of the airline shares. This acquisition had brought about a management revamp to Air Asia which sees the airline turned into Asia's first low-cost carrier modelled after the famous low-cost airlines such as Southwest Airlines and Ryanair . Since its inception as a low-cost carrier Air Asia have steadily gained momentum with increased in passenger numbers and more new destination introduced. In November 2004, Air Asia was listed as a public company on the KL Stock Exchange.

2. Objective

The objective of this paper is to investigate if a different approach that is the Analytic Hierarchy Process (AHP) model is applicable in facilitating decision making particularly for decision makers who are faced with multiple criteria problem as in the choice of location for low-cost carrier operations.

3. LITERATURE REVIEW

What is a secondary airport and why does secondary airport plays an important role for the low-cost carrier? A general description of an airport is an area on land or water that is used for the arrival, departure and surface movement of aircraft and the primary objective of airports is to provide safe, secure, efficient and economical services to users (ICAO, 2000). The secondary airport phenomenon was first realized in the United States. With major airports reaching their maximum capacity and become congested, existing airports that are less congested at the periphery of major airports which is known as the secondary airport often located within 50 or 70 miles from the major airport offer viable alternatives for accessing metropolitan area (Bonefoy &Hansman, 2004). Later those less congested airports were used by the low-cost carriers in the United States as these airports provide the airline with greater efficiency and lower operating cost. By limiting services on point-to-point and using less congested airports, lower operating cost per passenger can be achieved by the carriers. As it does not offer network services, no inter-connectivity services were provided. In addition, using less congested airport means faster turnaround time, high punctuality, less idle time and savings on airport related cost thus maintaining the low cost structure.

Decision making is a daily occurrence in the life of individuals or group of people and it could be trivial or important, repetitive or novel, expected or unforeseen (Cook & Slack, 1991). While most people would like to see decision making as a means of optimizing choice, the truth is individual often fail to do so in their daily life because of the psychological constraints and the inherent incapability of individuals to make rational decision on complex matters that require optimality choice (Janis & Mann, 1979).Instead, decision maker "satisfies" by seeking the best of the satisfactory options to be the best solution to the problems (Simon, 1993). However, failure to make effective decision leads to poor, ineffectual and wrong decisions (Drucker, 2001). With respect to the importance of decision making and the effects that it has by allowing ourselves the opportunity to investigate the applicability of an alternative decision solving model as in the Analytical Hierarchy Process (AHP) it will provide a platform to address complex problem in a more systematic and effective way.

On the other hand to simplify the complexity of trade-off between alternatives and for decision that relates to public policy decision making, most decision maker applies the cost-benefit analysis to make inform decision as the cost-benefit analysis has always been recognized as a legitimate mean to improve efficiency and equity when associated with a particular project or policy (Weimer & Vining, 1989). Nonetheless, when using the cost-benefit analysis it is not always possible to put a value to all alternatives or criteria under considerations. Sometimes decision makers find difficulty assigning value to the criteria they have to assess. How do decision makers assign value to intangible criteria? To solve the problem the weights of the criteria must be determined because criteria are not equally important. By determining the weight of the criteria a value can thus be assigned to the criteria to indicate its importance relative to the other criteria under consideration. The larger the weight the more the important or preferred the criterion. Decision makers will then be able to identify the "best" alternative and order the alternatives in rank of preference. According to Taylor (2004) there are several ways of assigning weights to criteria, that is, by ranking, rating or by developing pair wise comparison. As for that matter the application of the Analytic Hierarchy Process (AHP) is a viable tool to assist in decision making.

AHP was developed by Professor Thomas Saaty of the Wharton Business School in 1977. It was based primarily on the pair wise comparison matrices that decision maker use to establish preferences between alternatives for different criteria and the rating methods (Saaty,1980; Saaty,1994). Since its introduction the AHP has been applied widely in various fields. It has been utilized in a lot of specific application and areas such as economics and planning, energy, health, conflict resolution and arms control, material handling and purchasing, manufacturing system, manpower selection and performance measurements, project and portfolio selection, marketing, budget allocation, education, politics, sociology and the environment (Saaty, 1980; Saaty & Vargas, 1982; Zabedi, 1986).

A notable study on the application of AHP as an aid in decision making in determining the location for an ice hockey stadium was undertaken by Carlson anD Walden (1995). In the study with the help of the AHP the most suitable site that addressed the concerns of the decision makers was

identified by the group. In the field of academia with the help of the AHP a more transparent process of awarding faculty's members for their excellence of performance in term of research, teaching and service to the university and community was introduced (Badri & Abdulla, 2004). A similar study regarding the use of the AHP was related to an earlier research in the selection of high-ranked personnel in the academia (Taylor, Ketcham & Hottman, 1989). Soon (2004) had also conducted a study on the application of the AHP in relations to job selection for fresh economic graduates in one of the local university.

Apart from its application in the field of academia the AHP is also widely used in the manufacturing and production field. Pineda-Henson, Culaba and Mendoza (2002) used the AHP to asses the environmental performance of manufacturing process particularly in the pulp and manufacturing industry. Other than that it was also used to draw out the most suitable plant layout that maximize flexibility, increase production volume and reduce manufacturing costs (Abdul Hamid, Kochar & Khan, 1999).

In determining the best production planning and material procurement systems the applicability of the AHP was also tested (Razmi, Rahnejat & Khan, 1998). Chan and Abhary (1996) investigate the suitability of various flexible manufacturing systems and cellular manufacturing configuration system with the help of the AHP. A study on manufacturing managers was also conducted to determine the administration of technologies selection with the use of the AHP (Weber, 1993).

Therefore it is apparent since its introduction, the AHP has been widely used and its versatility is applicable in various fields. Other than the education and manufacturing related fields mentioned above the AHP technique is also applicable in other diverse areas of study. These include among other studies in benchmarking (Gilleard & Wong, 2004; Portovi, 2001), outsourcing (Udo,2000), supplier selection (Bhutta & Huq, 2002; Handfield, Walton, Sroufe & Melynk, 2002), product development (Muller & Fairlie-Clarke, 2001), banking (Huu & Kar, 2000), software selection (Davis & Williams, 1994), marketing (Davies, 2001) and project evaluation (Liang, 2003).

4. METHODOLOGY

This research had adopted a qualitative approached by using focus group method for the data collection. The sampling procedure was judgment sampling. The focus group is made up of ten individuals whose inputs and judgment formed the basis of this study. The ten individuals were representing the Ministry of Transport (MOT), the Department of Civil Aviation (DCA), Malaysia Airport Holdings Berhad (MAHB), Penerbangan Malaysia Berhad (PMB) and the Board of Airline Representatives (BAR). The focus group adequately represent a diverse range of players within the industry which include the administrators (MOT), regulators (DCA), airport operator (MAHB), major international airlines (BAR) and the domestic air services operator (PMB). To facilitate the process of managing the focus group one of the senior administrator was chosen to lead the discussions. This allows the group to discuss freely and enables to elicit maximum information and to observe the group interactions. In total, two meetings with the group were held at the Ministry of Transport to sufficiently obtain data for the construction of AHP.

In general, the group agreed that in selecting a particular project which in this case refers to the location for low cost carrier operations the benefits from such project need to be taken into consideration. As such the group had decided the impact of the project should include some economic, social and environmental evaluations. These decision criteria are summarized in a questionnaire and administered to the group so that their order of preference can be ranked and to enable the construction of the pair wise comparisons matrices. The input variables were the economic, social and environment criteria while the output variables include the possible alternatives (location) for the operation of low cost carrier operations. By identifying the input and output variables it helps in the construction of the hierarchies of goal, criteria and alternatives as required in the AHP.

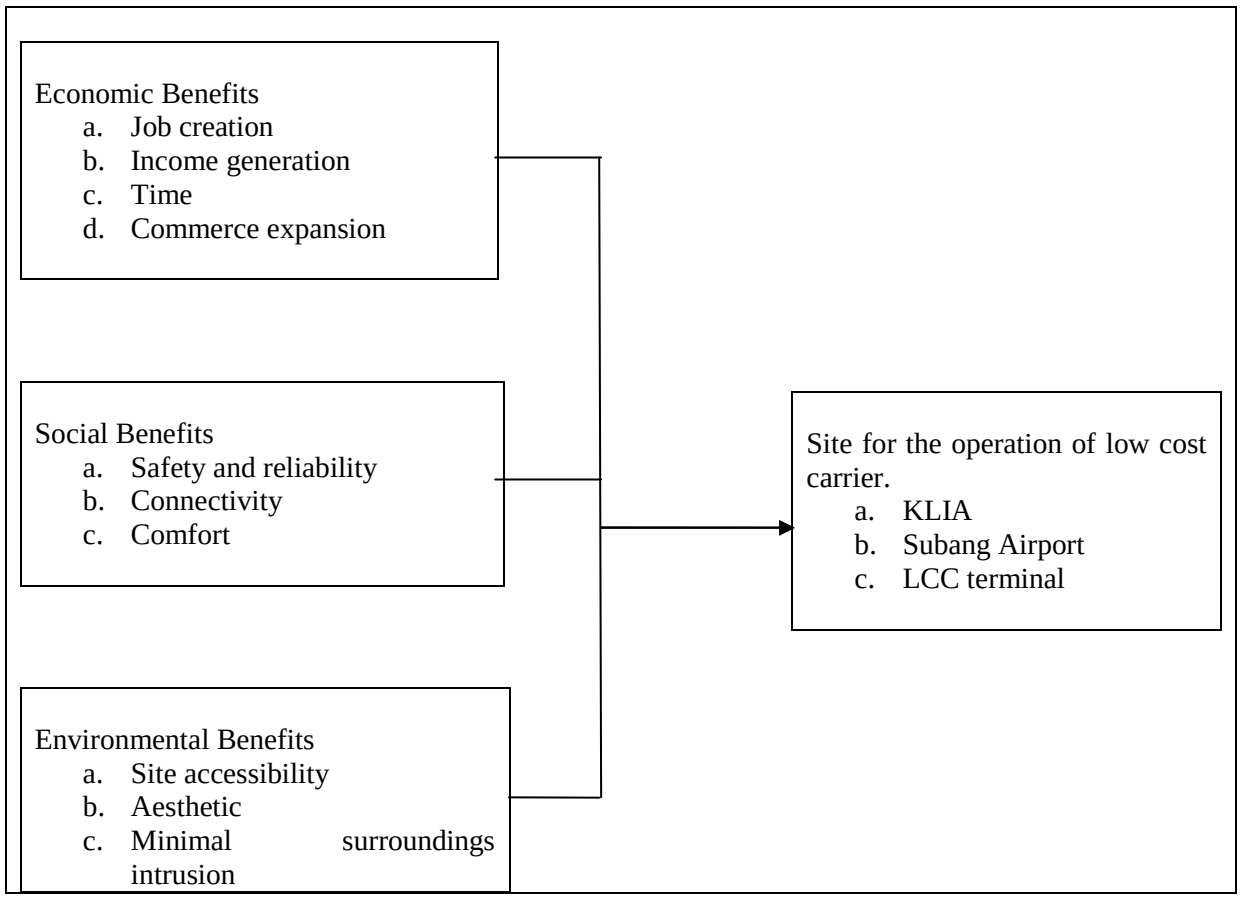


Figure 1.0 : A schematic diagram showing the input and output variables

The reasons for forming the focus group was because (a) the members possess the necessary information that is relevant to the questions at hand, (b) the member are expert in their own role to sufficiently represent the view of their organization, (c) most members play the managerial role of being decision maker in their own organization, and (d) fairly dependable data can be obtained within a short time frame. In short the focus group has sufficient expertise and managerial clout to be source of reference for the study. Most of the managers have more than 10 years working experience and were well versed with major problem in the aviation industry.

5. FINDINGS

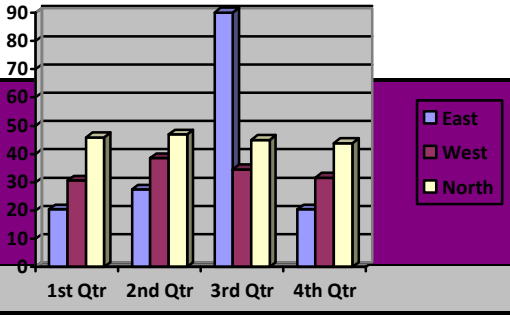
Findings had shown the results from the pair wise comparisons matrices that were constructed based on the criteria selected by the focus group. The data is presented in the following manner (a) the benefits pair wise comparisons matrices which include the economic, social, and environmental criteria, (b) the individual sites benefits pair wise comparisons matrices (site A: KLIA; site B: Subang Airport; site C: LCCT) (c) the overall sites' benefit ranking.

5.1 Benefit Pair Wise Comparisons Matrices

5.1.1 Economic Benefits

Table 5.1 answers to the question of the economic criteria which is the most important?

Table 5.1: Economic benefits



	Priorities
Time	0.054
Commerce	0.217
Income	0.269
Job creation	0.460
	1.000

$\lambda = 4.553$, CI = 0.184, CR = 0.046

Job creation at a ratio of 0.460 is important to the decision makers.

5.1.2 Social Benefits

Table 5.2 answers to the question of the social criteria which is the most important?

Table 5.2: Social benefits

	Priorities
Safety and reliability	0.138
Connectivity	0.239
Comfort	0.623
	1.000

$\lambda = 3.306$, CI = 0.153, CR = 0.051

Comfort at a ratio of 0.623 is highly important to the decision makers.

5.1.3 Environmental Benefits

Table 5.3 answer to the question of the environmental criteria which is the most important?

Table 5.3: Environmental benefits

	Priorities
Accessibility	0.175
Minimal intrusion to surroundings	0.475
Aesthetic	0.350
	1.000

$\lambda = 3.431$, CI = 0.216, CR = 0. 072

Minimal intrusion to the surroundings at a ratio of 0.475 is important to the decision makers.

5.2 Site's Benefit Pair Wise Comparison Matrices

5.2.1 Time

Table 5.4 answers to the question of the site which provides timely services?

Table 5.4 : Time

	Site A	Site B	Site C	Priorities
Site A	0.125	0.077	0.158	0.120
Site B	0.272	0.231	0.211	0.272
Site C	0.608	0.692	0.632	0.608

λ = 3.074, CI = 0.037, CR= 0.012

Timely services are likely to be provided by using Site C at a ratio of 0.608.

5.2.2 Commerce

Table 5.5 answers to the question of the site which will likely create opportunity for commercial activities?

Table 5.5: Commerce

	Site A	Site B	Site C	Priorities
Site A	0.122	0.385	0.111	0.206
Site B	0.024	0.077	0.111	0.071
Site C	0.854	0.538	0.778	0.723

λ = 3.313, CI = 0.157, CR= 0.017

More opportunity for commercial activities can be created in Site C at a ratio of 0.723.

5.2.3 Income

Table 5.6 answers to the question of the site which will generate higher income?

Table 5.6: Income

	Site A	Site B	Site C	Priorities
Site A	0.140	0.400	0.129	0.223
Site B	0.023	0.067	0.097	0.062
Site C	0.837	0.533	0.774	0.715

λ = 3.270, CI = 0.135, CR= 0.045

Site C offers opportunity for higher income at a ratio of 0.715.

5.2.4 Job Creation

Table 5.7 answers to the question of the site which will create job opportunity?

Table 5.7: Job creation

	Site A	Site B	Site C	Priorities
Site A	0.600	0.692	0.429	0.574
Site B	0.200	0.231	0.429	0.286
Site C	0.200	0.077	0.143	0.140

λ = 3.137, CI = 0.069, CR= 0.023

Site A create more job opportunity at a ratio of 0.574.

5.2.5 Safety and Reliability

Table 5.8 answers to the question of the site which will provide safe and reliable operations for air travel?

Table 5.8: Safety and reliability

	Site A	Site B	Site C	Priorities
Site A	0.139	0.122	0.455	0.238
Site B	0.833	0.732	0.455	0.673
Site C	0.028	0.146	0.091	0.088

λ = 3.389, CI = 0.195, CR= 0.065

Site B provides better safety and reliability for air travel at a ratio of 0.673.

5.2.6 Connectivity

Table 5.9 answer to the question which site provide good / better connectivity?

Table 5.9: Connectivity

	Site A	Site B	Site C	Priorities
Site A	0.462	0.429	0.467	0.452
Site B	0.077	0.071	0.067	0.072
Site C	0.462	0.500	0.467	0.476

λ = 3.003, CI = 0.001, CR= 0.000

Site C offer better connectivity at a ratio of 0.476.

5.2.7 Comfort

Table 5.10 answer to the question which of the site providers most comfort (number of people per square feet of space) to the users?

Table 5.10: Comfort

	Site A	Site B	Site C	Priorities
Site A	0.455	0.357	0.471	0.427
Site B	0.091	0.071	0.059	0.074
Site C	0.455	0.571	0.471	0.499

λ = 3.025, CI = 0.012, CR= 0.004

Site C offers better comfort for users at a ratio of 0.4 99.

5.2.8 Accessibility

Table 5.11 answers to the question, which of the site will be the most accessible?

Table 5.11: Accessibility

	Site A	Site B	Site C	Priorities
Site A	0.652	0.789	0.429	0.623
Site B	0.130	0.158	0.429	0.239
Site C	0.217	0.053	0.143	0.138

λ = 3.306, CI = 0.153, CR= 0.051

Site A is more accessible to users at a ratio of 0.623

5.2.9 Intrusion to surroundings

Table 5.12 answers to the question which of the site will cause minimal intrusion to its surroundings?

Table 5.12: Intrusion to surroundings

	Site A	Site B	Site C	Priorities
Site A	0.677	0.840	0.429	0.649
Site B	0.097	0.120	0.429	0.215
Site C	0.226	0.040	0.143	0.136

λ = 3.465, CI = 0.233, CR= 0.078

Site A minimally intrude on its surroundings at a ratio of 0.649.

5.2.10 Aesthetic

Table 5.13 answer to the question which of the site is aesthetically pleasing for the users?

Table 5.13: Aesthetic

	Site A	Site B	Site C	Priorities
Site A	0.231	0.333	0.217	0.260
Site B	0.077	0.111	0.130	0.106
Site C	0.692	0.556	0.652	0.633

λ = 3.039, CI = 0.019, CR= 0.006

Site C is found to be more aesthetically pleasing to its user at a ratio of 0.633

5.3 Overall Sites' Benefits Ranking

The following table 5.14 indicates the overall sites' benefits ranking for the economic, social and environmental criteria

Table 5.14 : Site overall criteria ranking

	Economic	Social	Environment

KLIA	0.371	0.407	**0.508**
SUBANG	0.719	0.156	0.181
LCC Terminal	**0.447**	**0.437**	0.310

LCC Terminal is highly preferred in term of economic benefits at a ratio of 0.447. LCC Terminal is also highly preferred in term of social benefits at a ratio of 0.437. KLIA is however, highly preferred in term of environmental benefits at a ratio of 0.508.

6. DISCUSSION

The applicability of the Analytic Hierarchy Process as an approach to aid decision making for multi criteria problem had indicated that the decision achieved in this study is highly similar to the decision that has made by the government to locate the low cost carrier operation in the new Low Cost Carrier (LCC) Terminal. In fact with the use of the AHP a timely decision was obtained within two meetings with focus group. The group had agreed that with the help of the AHP model had contributed towards a decision making process that is more precise in that; (a) it allows decision to be arranged in a morphological way (agreed structure); (b) permits decision makers to use judgment and observations to surmise relations to make prediction of most likely outcome; (c) allow values and influences to be incorporated and traded off with greater accuracy and (d) include the judgment that result from intuition and emotion. In relation to other studies the outcome of this study is highly similar to earlier findings that decision making is about selection that is, the selection of outcomes from alternative courses of action that involve the group of people in a setting (Mintzberg,et al., (1976); Noorderhaven, (1995).

The results had indicated that for economic and social benefits the Low Cost Carrier Terminal is highly preferred than the Subang airport. With a ratio of 0.477 it is higher than KLIA at 0.371 and Subang at 0.179. The group had also agreed that job creation is the highest important criterion to be considered for economic benefits. This finding is in tandem with the study conducted by the ATAG (2002). With a ratio of 0.460 it is ranked higher than commercial opportunities at 0.217 and 0.269 respectively. Higher job creation can however be found in the KLIA. A low cost carrier will optimize manpower usage and thus may not offer high opportunity for job creation as compared to the KLIA and Subang. The group was found to be consistent in their decision making. At the end of the deliberation, a lower ratio of 0.140 was assigned to the LCC Terminal.

For the same economic benefits, the results indicate that “time” has the lowest priority between income generation and commercial opportunities at 0.054. The group identifies that higher income and opportunities for more commercial activities can be derived if the chosen site is the LCC Terminal. Higher income here refers to activities that are not the direct result f aeronautical aqctivities rather more on the commercial activities. The result had showed that a ratio of 0.723 for commerce and 0.715 for income generation being assigned to the LCC Terminal.

In term of social benefits “comfort” is the highest preference of the criteria. A ratio of 0.623 was assigned to comfort as compared to 0.239 for connectivity and 0.138 for safety and reliability. The facilities at the LCC Terminal were able to accommodate the type of services that requires fast turnaround. As for Subang although the airport is perceived to be suitable as a “secondary” airport for short haul flights, the growing numbers of passengers carried by low cost carrier may exceed the airport’s carrying capacities sooner than expected. Based on the conflicting scenarios, the LCCT was finally assigned the highest ranking. Results also showed that better “connectivity” can be achieved at the LCCT. Although Subang is preferable in term of its nearness to the city center but the LCCT is located near to the KLIA that has well developed facilities and connections to other mode of transportation. The Subang airport does not have any dedicated link to either site, making it less attractive to air traveler as well as incurring additional expenses for travel purpose.

As for environmental benefits, concerned for “minimal intrusion to surrounding” is highly important to the decision makers. With a ratio of 0.475 it is higher that aesthetic at 0.350 and 0.175 for accessibility. The result had indicated that the least intrusion is to be realized if the KLIA is chosen.

Discussion reveals that KLIA was built with the considerations for long term expansion while the Subang airport is severely limited for any major expansion programmed undertakings.

7. CONCLUSION

The results had revealed that the LCCT Terminal provides the highest economic and social benefits. However, in term of environmental benefits the highest was obtained if KLIA is chosen. Between the three criteria, economic and social benefits favor the LCCT while environmental benefits can be derived by locating the operations of low cost carriers in the KLIA.

Result also showed that by using the analytic hierarchy process, decision maker were more able to analyze complex problem in making multi criteria decision. It provides a way to determine which criteria outweighs another, both in the near and long terms. Because it is concerned with real life problem it allows for consensus building and compromise when logic and intuition failed to help decision maker.

By representing the strengths and judgments numerically and agreeing on a value, decision making group do not need to participate in prolonged arguments. In dealing with complexity, the analytical approach provided by the AHP helps rationalize decision making. There are other tools that facilitate decision making such as the economic methods based on cost and benefits analysis. Although it is widely used particularly in project development evaluation it has its limitation in that not all decision criteria can be assigned to monetary value. However, such criteria which are intangible are equally important in that people have equity to that development (Weimer & Vining, 1989). With the help of the AHP, decision maker can utilized it as an alternative to compliment complex decision making. By considering the combined usage of AHP and other methods the decision making process will be more systematic and coherent. At the same time it will also help decision makers to make more effective decision (Drucker, 2001).

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