DEVELOPING A POLICY DECISION TOOL FOR A DOMESTIC AIRLINE COMPANY: A CASE OF INDONESIA

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Abstract: The Indonesian government has started to liberalize airline market in 1991 by granting private airlines the rights to operate internationally and in 1997 by easing new airline companies to operate. Developing a cost database, empirical cost calculation formulas and using Visual Basic and Visual C++ programming language, the a computer assisted planning tool **MERPATI** enables an automation of cost estimation based on the aircraft types, market segments and aircraft age. The current software is based on a simple network connecting two airports as well as a multi-legs route allowing aircraft to land to 5 consecutive airports. It reduces planning time and costs as well providing various simulations exercise for airline managers and decision makers to deal with a fast-changing business environment. Further research should be directed to improve the cost structure based on the theoretical formulation and to develop a network-based software allowing aircraft and airline-crews to be modelled separately.

Keyword: Air transport, Indonesia, cost model, software

1. INTRODUCTION

According to the World Tourism Organization (WTO), world tourism is growing at the rate of 4% per year. The organization estimated that in 1991, the number of tourists were around 450 Million, with East Asia and the Pacific enjoyed the highest growth of 8,9%. This region is expected to be visited by more than 100 million tourists or more than 15% of world tourists and growing to approaching 200 million or 20% in ten years time. There are also a significant change in the demand from mass market to various niche markets and from organized travel to individual leisure and business trips, characterized by high demand for quality of services.

Between 1979 to 1991, the number of visitors to Indonesia has increased five times from 501,430 to 2,269,870 with the average growth of 15%. In 1997, this number became

5,185,243 and as the result of an economic-turn-political crisis, the number of visitors dropped to 3,510,033 and now steadily growing to bounce back to the 1997 level in 2002.

The capacities of the airline companies operating to and within Indonesia to cater the growing demand for international as well as domestic tourists are certainly the key factor in promoting tourism industry. At the moment the capacity of the international segment are able to respond to the demand in a flexible manner. With the current 15 million seats in 1997, the industry should cater 5.2 million passengers.

In 1991, the Indonesian government has started liberalizing its domestic airline market, by allowing new and private airline companies to operate in international as well as domestic routes. The liberalization process can be summarized in the following table.

Table 1. Change in the Airline Market Liberalization

No	Year	Air transport policies
1	1990	Under the pressure of tourism sector, the Indonesian government allow chartered operator to import jet-engine aircraft and compete in the domestic market. Control was made through fare and licensing requirement for airline companies.
2	1991	Private airline companies were allowed to operate on international segments
3	1996	The Indonesian government considered allowing more liberal policy for particular companies from other countries to serve domestic segment. This policy was never implemented.
4	1996	Policy for corporatization and mainstreaming GARUDA Indonesia Airline – a largest state-owned airline company
5	1996	GARUDA Indonesia and MERPATI Airlines – a second state-owned company, become a separate business entity.
6	1997-1998	Airline companies operating in a domestic market experienced a difficult time because of the astronomical change in the foreign exchange rate due to the economic crisis.
7	1999	Growing domestic travel, liberalization policy on the establishment of an airline companies (Gov. Decree 44/1999) has encouraged more than 20 new private airline companies. This was also due to the abundant international supply of leased aircrafts, allowing new airline companies to be established without a requirement for owning aircrafts.
8	2000	Government and INACA (Indonesian Air Carriers Association) deregulated the airfare allowing companies to set their own economy-class fare within upper and lower boundary. This has created a neck-to-neck price competition within the industry and between air transport and rail/sea transport

Source: Hooper, 1997, and added with more recent data

MERPATI Airline is a largest airline companies operating in the domestic market. It serves 32 domestic routes and 5 international routes and carrying 1.5 million passengers annually – a sharp decline from around 4.5 million before economic crisis (1997). It's aircrafts take-off and land at 68 airports in Indonesia (Merpati, 2000). It holds 32.5% share of all air transport market and 16.7% of the competing market. Figure 1 shows that MERPATI Airline (airline company code: MZ) has a significant number of routes operating in a monopolistic situation – mainly serving Indonesian eastern region. With the growing number of new operators, the monopolistic market has received a serious threat and the company ought to seek ways to cut costs and increasing service quality.

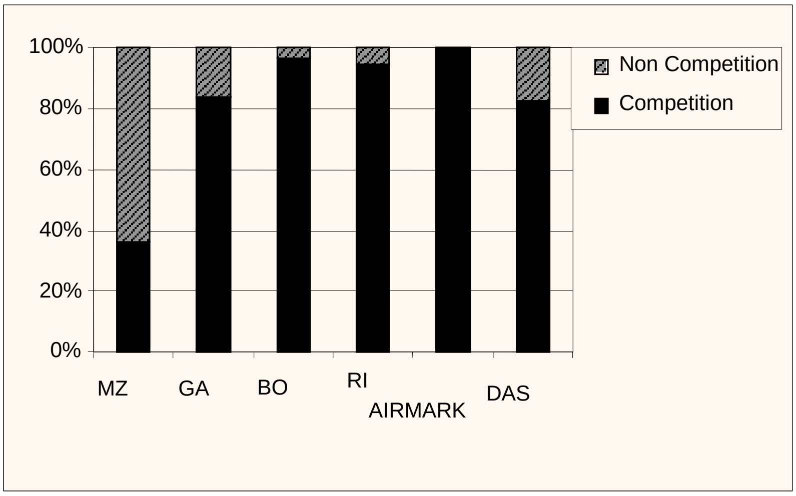

Figure 1. Market Share of Each Airline Company in Competitive and Monopoly Markets, Year data 2000
(source: Merpati Airlines Ltd, 2000)

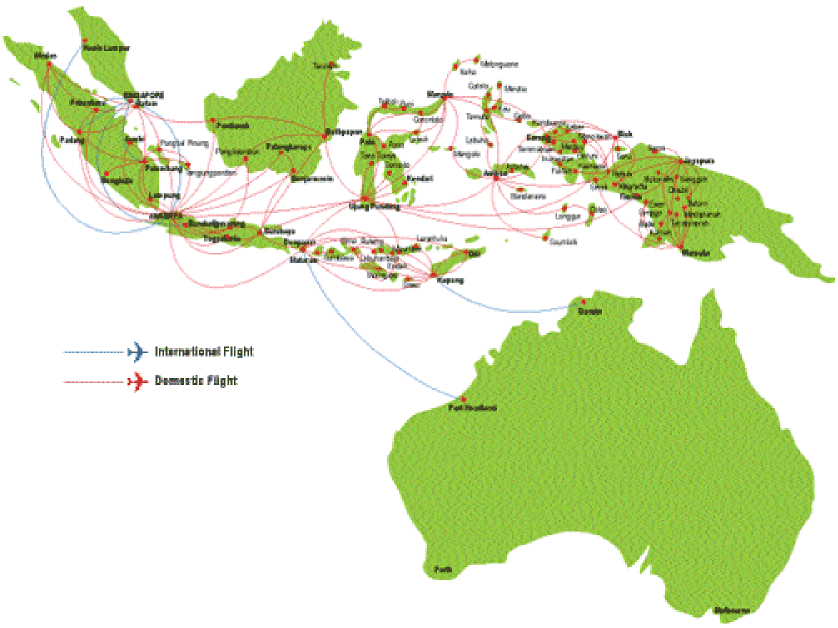

Figure 2. MERPATI Domestic and international network
(source: Merpati Airlines Ltd, 2000)

The current airline tariff deregulation and the presence of new operators are certainly seen as a threat to company's business. Figure 3 below shows the decline of the passenger even with the "bouncing-back" Load factor, which is mainly attributed to the decreased fleet number. The figure also clearly indicates the result of a double-attack hitting Merpati Ltd., the economic crisis and the emergence of new companies. This situation is of course triggered the need for an improved strategies and policies in delivering the air transport services.

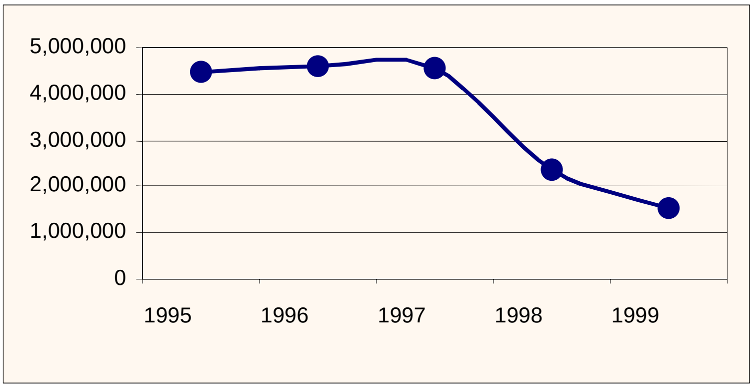

Figure 3. The Trend in the Number of MERPATI Passengers, 1995-1999

The company has responded the tight competition by improving a in-flight service and using a fleet of jet-engine aircrafts and reducing the number of propeller-engine aircrafts. The jet-engine aircraft is estimated to have higher captivity in comparison with the propeller-engine aircrafts. This situation is somehow different with the strategies adapted elsewhere, especially in Europe where some companies tried to cut costs by using modern propeller-engine aircrafts, i.e. advanced turbo-prop (ATP) aircraft.

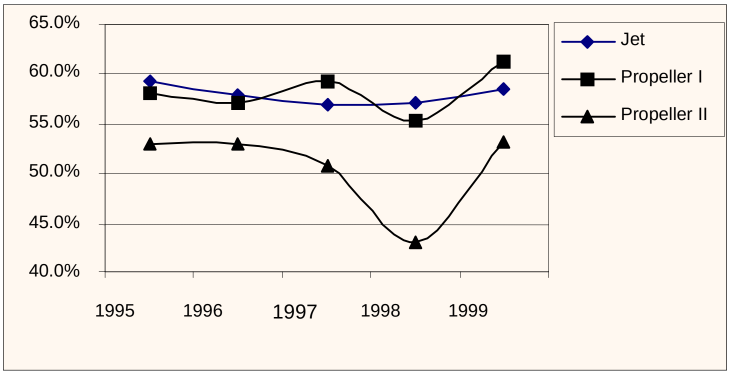

Figure 4. Load Factor Change by A/C types, 1995-1999

The current planning system at many airline companies in Indonesia, including Merpati was still based on a manual calculation undertaken by various division. This situation is seen inappropriate in a fast-changing business environment. Day-to-day strategies and tactics need to be addressed timely and precisely within the airline company. Understanding cost structure and the effect of various demand level on the choice of aircraft will help airline managers and planners to provide alternative solutions to the top executives. The purpose of this study is to develop a computer-based decision tool to enable the airline managers and planner to test various demand and supply options, i.e. aircraft types. By introducing such a simulation procedure, airline company can try various scenario without actually testing it on the field. The computer-based decision tool is expected to reduce the time required for planning and designing the routes and associated costs for testing the decision using real aircraft. Thus it will improve airline's ability to compete with other airlines and bring the consumer costs down.

2. THEORETICAL FOUNDATION IN MODEL DEVELOPMENT

2.1. Airline Network

In general, there are three types of airline networks normally operating in a country serving domestic passengers, namely grid, hub-and-spoke and line, each of which has its own characteristics. Grid system is largely used and adopted by private operator having a limited number of aircraft whereas hub-and-spoke system is usually becoming a choice of a large operator having various types of aircrafts and having a complicated connecting schedule. Company serving a simple commuting travel uses line system, which is less popular one.

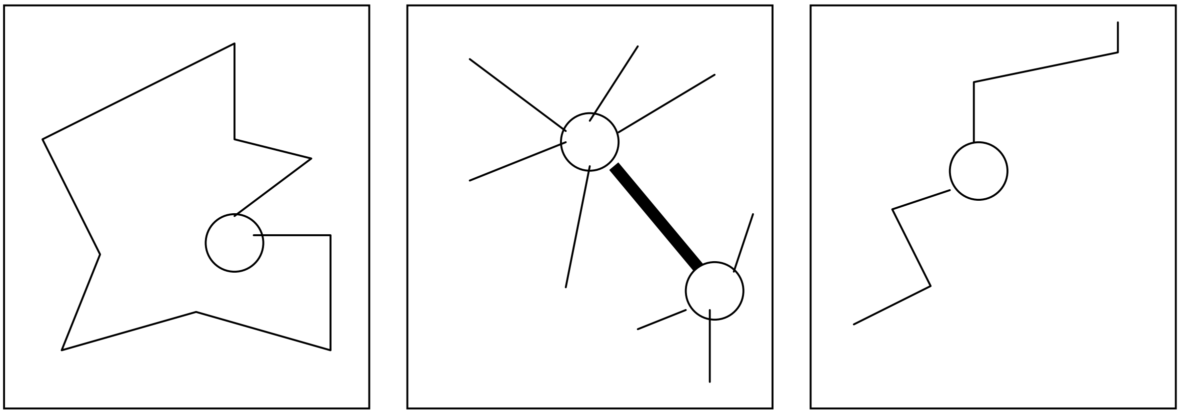

Figure 5. Types of Airline Operation.

Despite the fact that hub and spoke system has the possibility for exploiting the economies of density, the system has disadvantage when operating under a tight competitive regime. In such condition, private operators are required to meet the demand for a direct flight by sacrificing the opportunity to adjust the low level of demand with smaller aircraft. On the contrary, under monopoly market, such system will provide enormous chance for incumbent operator to provide a (financially) cost-efficient service and transferring the cost of transfer or transit to the consumer. For many travelers, especially business travelers, this condition is becoming unacceptable since the transfer costs has a higher value than in-aircraft travel costs.

2.2. Cost Model

Since many airlines apply cost-based pricing in determining their fare, it important for the companies to identify components and the structure of the airline operating costs. Seristo and Vepasalainen (1997) identified that cost reduction potential for Finnair can be described in the following table.

Table 2. Cost Reduction Potentials

Cost item	**Cost drivers**		
	Route network	Fleet composition	Company policies
Aircraft crew costs	+++	+++	+++
Engineering overheads	+	+++	
Direct Engineering	+	+++	+
Marketing	+++		+
Aircraft standing	+++	+	
Station and ground	+		+
Passenger services	+		+

General and administration	+		+
Fuel		+	
Airport and en-route charges	+		
Direct passenger service			+

+++ : there is significant cost reduction potential
+ : there are relevant costs implications
source : Seristo and Vepasalainen, 1997, pp. 21

Taking out the marketing costs and with a-priori assumption that airline costs consist of flight costs and service costs, the total operating costs can mathematically be written as follows (CTRD, 2001):

$$OC = \sum_{n} (FC_n + SC_n)$$
$$OC = \sum C_{ccn} + C_{fn} + C_{ni} + C_{rn} + C_{rcn} + C_{tcn} + C_{fon} + C_{can} + C_{ctn} + C_{dcn} + C_{cpn} + C_{son} \quad (1)$$

With :

FC : Flight cost
SC : Passenger service cost
C_{cc} : Cockpit crew cost
C_f : Fuel, Oil, Water Methanol cost
C_i : Insurance
C_r : Aircraft rent
C_{rc} : RON Crew cost
C_{tc} : Crew on Transit cost
C_{fo} : other flight costs
C_{ca} : Cabin attendant cost
C_{ct} : Catering cost
C_{dt} : Passenger transit and delay cost
C_{cp} : Claim passenger dan freight cost
C_{so} : other passenger service costs
n : flight segment

Profit for the airline company (Π) is defined as the difference between total revenue, i.e., passenger (D) times fare (P) minus airline costs (C). N represent the flight segment and p reflects the airline market:

$$\Pi = \sum_{n,p} D_n^p P_n^p - \sum_{n,p} C_n^p \quad (2)$$

Profit maximizing scheme can be obtained through differentiating the above equation with respect to D, P and C.

In a competitive-market condition, airline companies require a robust and coherent strategy to serve preferred market segment. This requires knowledge in understanding the "model of competition" in the airline industry. Park (1997) has developed a mathematical model for describing the competition situation in the airline industry. Imagine three hypothetical airports represented by A, B and E in the Figure 6 below, served by three companies. Company 1 serves all possible routes whereas company 2 and 3 operate in segment AE and BE.

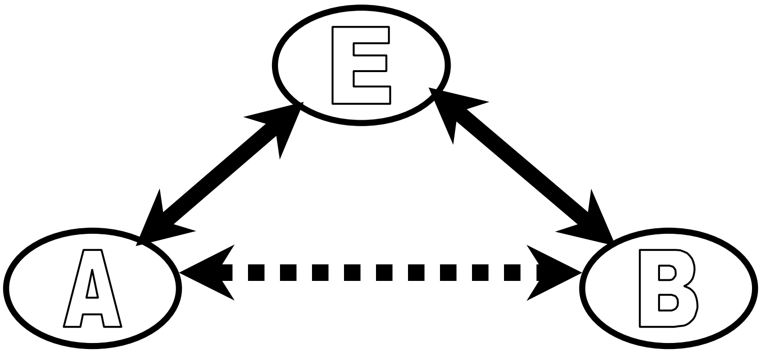

Figure 6. Hypothetical Airline Network

Since all companies are profit-making entities, profit function can be written as follows:

$$\Pi^1 = Q^1_{AE} D(Q^1_{AE} + Q^2_{AE}) + Q^1_{BE} D(Q^1_{BE} + Q^3_{BE}) + Q^1_{AB} D(Q^1_{AB}) - C(Q^1_{AE} + Q^1_{AB}) - C(Q^1_{BE} + Q^1_{AB}) \quad (3)$$

$$\Pi^2 = Q^2_{AE} D(Q^1_{AE} + Q^2_{AE}) - C(Q^2_{AE}) \quad (4)$$

$$\Pi^3 = Q^3_{BE} D(Q^1_{BE} + Q^3_{BE}) - C(Q^3_{BE}) \quad (5)$$

$$D(Q) = \alpha - Q \quad (7)$$

$\alpha > 0$

$$C'(Q) = 1 - \theta Q \quad (8)$$

$\theta > 0$

With :

Π	: profit
D(Qi)	: demand function for route i (AB, AE, BE)
Qi	: number of passengers in two-ways
C(Qi)	: cost function; this function represent the economies of density with C(Q) fulfill the requirement for C'(Q)>0 and Q"<0. To simplify the case, all companies have similar cost functions and serving homogenous demand
α	: demand level
θ	: measurement reflecting the air traffic density.

Assuming that the three companies are competing in the Cournot system (see Brander and Zhang ,1990 and Oum et.al., 1993, quoted in Park, 1997), profit maximizing scheme for company 1 can be illustrated as follows:

$$\alpha - 2Q^1_{AE} - Q^2_{AE} = 1 - \theta(Q^1_{AE} + Q^1_{AB}) \quad (9)$$

$$\alpha - 2Q^1_{BE} - Q^3_{BE} = 1 - \theta(Q^1_{BE} + Q^1_{AB}) \quad (10)$$

$$\alpha - 2Q^1_{AE} = [1-\theta(Q^1_{AE} + Q^1_{AB})] + [1-\theta(Q^1_{BE} + Q^1_{AB})] \quad (11)$$

Using a similar method, the scheme for company 2 and 3 are:

$$\alpha - 2Q^1_{AE} - Q^2_{AE} = 1-\theta(Q^2_{AE}) \quad (12)$$

$$\alpha - 2Q^1_{BE} - Q^3_{BE} = 1-\theta(Q^3_{BE}) \quad (13)$$

The left hand equation represent the marginal revenue for every market is set equal to the marginal cost in serving the passenger for that particular market. By setting $Q^1_{AE}=Q^1_{BE}$ and $Q^2_{AE}=Q^3_{BE}$ and solving equation (9)-(13) will yield the following solution.

$$Q^1_{AE} = Q^1_{BE} = \frac{(\theta^2 - 2\theta + 2)\alpha - 2}{2(3\theta^2 - 7\theta + 3)} \quad (14)$$

$$Q^1_{AB} = \frac{(1-\theta)[(3+\theta)\alpha - 6]}{2(3\theta^2 - 7\theta - 7\theta + 3)} \quad (15)$$

$$Q^2_{AE} = Q^3_{BE} = \frac{(2-5\theta)\alpha - 2(1-3\theta)}{2(3\theta^2 - 7\theta + 3)} \quad (16)$$

It can be proved that second derivation of each company in profit maximizing scheme will decrease until $\theta<2/3$. Since the output and marginal revenue should be positive than α should be limited to the condition where $6/(\theta+3)<\alpha<[6(1-\theta)]/[\theta(5-4\theta)]$ for $0<\theta<2/5$. It should also be noted that no limit for existing α is necessary for $2/5<\theta<2/5$.

3. MERPATI SOFTWARE

The development of cost model for Merpati Ltd., was carried out in the form of software MERPATI (Modelling Airline Network to Improve Its Competitiveness). The model is based on the existing database of the airline costs and estimated costs from previous years. The software was developed using DSS (Decision Support System) principles because of the following modelling issues:

1) it operates in unstable economic conditions
2) difficulties in tracking the business operation – thus requires a quick response
3) existing operating system is not flexible in responding with the change in demand and market preference
4) business analysis is not built-in into the existing system

The software, programmed using Visual C++ was written through Evolutionary Prototyping Approach, which has the characteristics as follows:

1) focussing on important sub problems, small but important elements
2) it has the capacity of continuous improvement and
3) has the principle of: refine, expand and modify system in cycles

The advantage of such approach in comparison with other programming approach is that the software can serve as data management system, model management, communication tool, and knowledge management by creating a knowledge portal.

There are basically two types of data, namely static/secondary and dynamic/primary data. Static data represent data that need longer updating period, i.e. infrastructure data. Dynamic data reveal the data that needs to be updated in a shorter period of time. The example of the latter data is the aircraft actual costs for previous years used to validate the current year's formulae. The dynamic data is also a primary data since it is collected through a series of survey and data collection exercise whereas the static data are obtained from secondary sources.

The most important element in the model and software development is the data structure and the data hierarchy. Figure 7 below illustrates information is classified as data module and container module – showing aircraft data: costs at the flight sector/segment and costs at the airport. When the number of airport visited by the preferred aircraft increases, the database should also add the information of that particular airport, i.e. aircraft-specific airport costs.

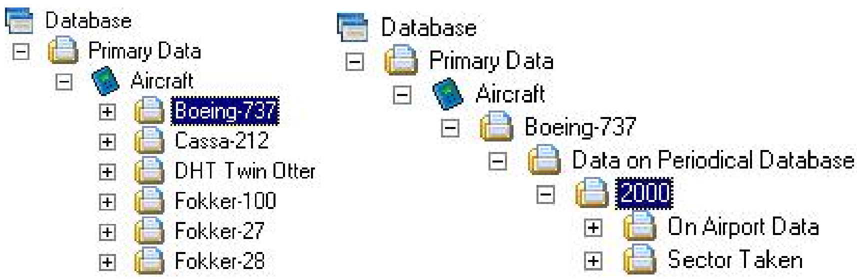

Figure 7. Data Module (left) and Container Module (right)

With 86 airport visited by the airline company, the database must provide specific airport costs for each aircraft type. Figure 8 below depicts the example of a hierarchical view of airport data for Fokker 28 aircraft.

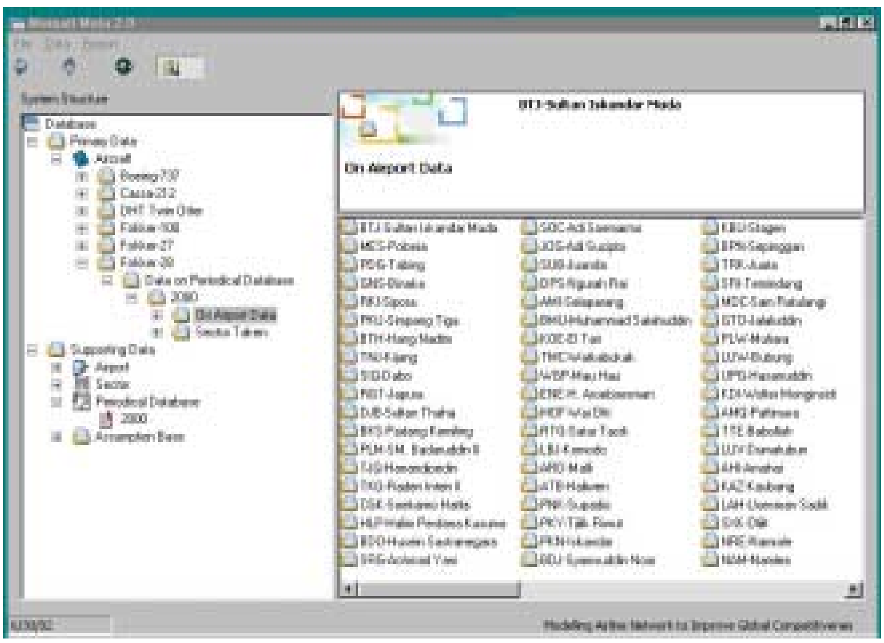

Figure 8. Merpati Meta 2.0 in Modus Hierarchical View

The software also develop an inquiry form allowing an easy access to the user to input, add or alter the cost data. The combination of an empirical data and theoretical formula was used to generate the detailed information about the cost associated with each individual aircraft. This is a rigorous process since it has to differentiate unit costs of various aircraft types. Even for similar aircraft, the cost will be different depending on the year of manufacture and delivery, owneship scheme (own, hire/rent, lease) and maintainance history.

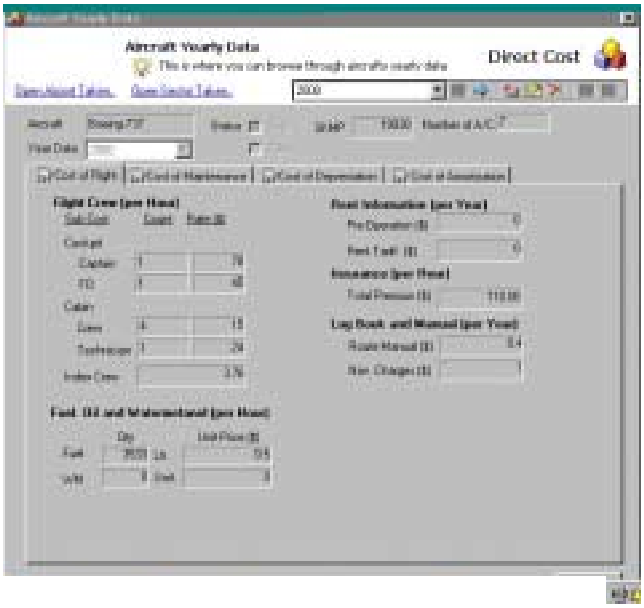

Figure 9. Entry Form for Aircraft Data

4. EMPIRICAL FINDINGS

4.1. Aircraft Cost Structure

The proportion of total operating costs reveals the components of costs that should be carefully looked at. The below table shows the aggregate (average) cost structure of the aircraft. It demonstrates that fuel and spare parts have the highest proportion, and they account for by 19.51% and 26.59% respectively. The aircraft depreciation costs is also an important contributor since it reflects the ability of the company to change its fleet. In some new airline companies, however the depreciation costs and spare part costs are avoidable costs since they often use hired/chartered aircrafts and hence transfer the risk for high costs to the aircraft rental companies.

Table 3. Percentage of the Aircraft Operating Costs

	Cost category		Cost components	Proportion of Total Operating Costs
A	Flight costs	1	Cockpit crew	2.99
		2	Fuel, Oil, Water Methanol	19.51
		3	Insurance	1.91
		4	Aircraft lease/rent	0.13
		5	RON Crew	0.29
		6	Crew on Transit	0.00
		7	Other flight costs	0.32
B	Aircraft maintenance costs	1	Engineering Staffs	1.33
		2	Spare parts	26.59

		3	Spare part transport	0.64
		4	Overhaul	7.26
		5	Other maintenance costs	0.37
C	Depreciation and amortization	1	Aircraft Depreciation	13.88
		2	Depreciation of Ground Properties & Equipment	0.43
D	Station costs	1	Station staff	1.97
		2	Landing costs	0.66
		3	Ground Handling	0.42
		4	Station Insurance	0.04
		5	Station Maintenance	2.17
		6	Station Rent	-
E	Passenger service costs	1	Cabin Attendant	0.14
		2	Catering	4.59
		3	Pac Transit and Delayed	0.20
		4	Pax Claim & Freight	0.02
		5	Biaya Pelayanan Pax lain	0.58
F	Sales costs	1	Marketing/Sales staffs	0.79
		2	Documents	0.32
		3	Commission and Discount	3.10
		4	Promotion	0.69
		5	Reservation	1.37
		6	Other sales costs	0.14
F	Administration and general costs	1	Administration staffs	1.29
		2	General costs	5.86
TOTAL				**100%**

Source: CTRD, 2001

It is also essential to recognize that catering costs has also a high proportion of costs – reflecting the high demand for passenger to receive in-flight service and on the other hand also increasing a possibility for cutting the fare down by providing less-than-standard economy class service and increasing the number of passenger. Some companies like Garuda Indonesia has successfully adapting this strategy by combining non-meal service and the use of older fleets (which has lower or zero depreciation costs).

The costs for travel agent through commission and providing a discount fare are accounted for by 3% of the total costs. Airline companies, including Merpati, Ltd., have responded to reduce such component by introducing a direct purchasing or through on-line booking.

4.2. Examples of an Aircraft Cost Calculation

The model/software is able to calculate the aircraft cost in several modules, namely (1) simple model, and (2) multi leg model. Simple model refers to an aircraft cost model for two connecting airports and multi leg model estimate the costs for aircraft to visit maximum of 5 (five) airports in one day. It is worth noting that current practice/regulation of aircraft operation allows maximum 5 times take-offs and landings in a day for a similar cockpit/cabin crew.

Following figure illustrates the output of the cost calculation for a simple route between Jakarta and Ujung Pandang, the capital city of South Sulawesi. This sector is a highly competitive segment. Basically there are three output boxes: simulation condition, summary result, and detailed costs.

Simulation condition describes the types of aircraft tested for a particular sector. It also identified the year data used for this simulation. This information is essential since, as described above, each aircraft operated has a specific condition that affects its costs. Year data also represent the year at which all infrastructure data, e.g., airport data: runway length, capacity, taxiway, are obtained. If the aircraft cannot land at Ujung Pandang because of the runway length, the software will reject the request for estimating the costs.

Figure 10. Simulation Result: Jakarta – Ujung Pandang Sector for Boeing-737

Summary table is perhaps the most important aspect for the airline top executives. It summarizes the cost/sector, cost/sector/seat, cost/mile and cost/mile/seat. The information is necessary to determine the base airfare, level of discounted fare and the commission to the travel agent. It is important to note that the airfare can not be determined solely based on the cost/seat on a particular sector since the company's pricing policy may be based on various factors and marketing strategies. Tight competition in the Indonesian airline market has forced the airline companies to generate more revenue on the more captive market or at places with less-competition and lowering the profit margin for the competitive sector. In a multi-leg or multi-sector cost calculation, the airfare policy may opt to internally (within the route) create mechanism for a cross-subsidy.

The third table reveals detailed costs for that particular sector. It shows the combination of direct and indirect costs and is broken down to its cost category: flight cost, cost of maintenance, cost of depreciation, and cost of amortization (for direct costs) and cost of station, cost of administration, cost of passenger service and cost of sales. The above sector using Boeing 737 shows that the cost of fuel and cockpit crew dominates the direct cost for operating the aircraft for Jakarta-Ujung Pandang sector. The two cost category far exceed other direct cost components significantly. While it might be difficult to reduce the fuel cost (although some other airline try to do this by more discipline take-off/landing procedure, cruising speed and flight altitude), the biggest challenge is to create an efficient costing system for the cockpit crew. For the indirect costs components, empirical data show that cost of catering and reservation are unusually high. They can be reduced substantially by providing more competitive catering service and using a direct marketing or on-line marketing more aggressively.

The model also allows the cost calculation for various sectors using similar aircraft or alternatively a similar sector using various aircraft types. Since an aircraft is developed to suit a particular flight condition, e.g. travel distance, the calculation of cost differentials among various available aircraft in the fleet will provide airline top managers to choose appropriate aircraft.

Figure 11. Cost Comparison between Two Sectors for Boeing 737

The above figure depicts the cost comparison between AMI-SUB sector (left bar) and AMQ-UPG (right bar) sectors using Boeing 737 aircraft. Exercising various sectors with different block time or flight time help airline managers and planners to understand the non-linearity of the cost curve. This information is essential when choosing the appropriate aircraft for a specific sector or a route. In practice however, the managers may not choose the cheapest aircraft serving a particular/set of sector, as this will depend on the captivity/sensitivity of the passenger with the aircraft types. In Indonesia for example, consumers are sensitive to aircraft types, for example even in a short distance trip the consumers see that propeller-engine aircraft is a backward technology although it can substantially reduce the cost of flight.

5. REMARKS FOR FUTURE WORKS

The research has provided an improved and systematic approach to determine the aircraft and airline operating costs. It can simulate various market situation and costs policy faced by airline companies in a tight competition. The use of software enables airline companies to reduce the high costs of implementing a series of policy-package by simulating them, instead of experimenting them. Development of MERPATI as a decision support system has also reduced the planning costs substantially; the research has estimated that the planning time for a single route scenario can be reduced from 36 person-hours to 3 person-hours.

Future improvement of the model and software includes:

a. Improvement in the costs formula by combining the empirical formula used in this research and theoretical formula developed elsewhere.
b. The ability to incorporate various and new financing mechanism to provide advice on the provision of aircraft – since at the moment all aircrafts are assumed to be owned by the companies. Future costs formula should include the possibility of aircraft's hire, lease, rent, charter and purchase.
c. Cost calculation for the whole network or all airline operation is also recommended during the course of model/software development. This however would be the trade off between highly complicated modelling and programming effort and the response time required by the management in dealing with day-to-day competition. With the advancement of computer technology and more importantly the capacity of the airline planning staffs to operate and maintain the software, this possibility can be explored further.
d. Airline operation involves a complex system incorporating the scheduling of aircrafts, cockpit crews, cabin crews and maintenance – each in itself a complex system. In the future, each scheduling algorithm and costs associated with such scheduling should possible to model/programme. The airline costs model/software will then consist of various sub modules/suites and consolidated into an integrated costs model/software.

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