05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

MEASURING EFFICIENCY OF STATIONS IN AN AIRLINE NETWORK: AN APPLICATION OF DATA ENVELOPMENT ANALYSIS

MAD ITHNIN SALLEH
MOHD ISA YEOP

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

MASTER OF SCIENCE (QUANTITATIVE SCIENCES)
FACULTY OF INFORMATION TECHNOLOGY & QUANTITATIVE SCIENCES
UNIVERSITI TEKNOLOGI MARA

APRIL 2005

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

Universiti Teknologi MARA

Measuring Efficiency of Stations in an Airline Network: An Application of Data Envelopment Analysis

Mad Ithnin Salleh (2003307445)
Mohd Isa Yeop (2003213729)

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

Project submitted in partial fulfillment of the requirements

for the degree of

Master of Science (Quantitative Sciences)
Faculty of Information Technology & Quantitative Sciences

APRIL 2005

Master of Science (Quantitative Sciences)

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

ACKNOWLEDGEMENT

Special appreciation to our project supervisors:

Internal –Associate Professor Hasni Hashim, MARA University of Technology, Faculty of Information Technology and Quantitative Sciences

External –En. Mohamed Amirudin Jumaat, Operation Research Manager, Malaysia Airlines, Complex A-ABO103, Sultan Abdul Aziz Airport, 47200 Subang, Selangor Darul Ehsan

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

TABLE OF CONTENTS

		page
Acknowledgements		i
Table of Contents		ii
List of Tables		v
List of Figures		vi
List of Appendices		vii
Abstract		viii
CHAPTER 1	**INTRODUCTION**	
	1.1 Background of Organization	1
	1.2 Problem Statement	2
	1.3 Problem Definition	3
	1.4 Research Questions	3
	1.5 Research Objectives	4
	1.6 Significance of the Project	4
	1.7 Scope and Limitations of Project	4
	1.8 Layout of Project Report	5
CHAPTER 2	**LITERATURE REVIEW**	
	2.1 Introduction	6
	2.2 Data Envelopment Analysis (DEA)	11

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

CHAPTER 3	**RESEARCH METHODOLOGY**	
	3.1 Introduction	15
	3.2 Study Assumption	15
	3.3 Research Data	15
	3.4 Analysis of Data	17
	3.5 Performance Measurement Using Data Envelopment Analysis (DEA)	17
	3.6 The Analytic Hierarchy Process	21
	3.6.1 Developing the Hierarchy	21
	3.6.2 Pairwise Comparison	22
	3.6.3 The Pairwise Comparison Matrix	25
	3.6.4 Synthesization	26
	3.6.5 Consistency	27
	3.6.6 Other Pairwise Comparisons for the Best Station Problem	28
	3.6.7 Using AHP to Develop Overall Priority Ranking	32
CHAPTER 4	**ANALYSIS AND RESULT**	
	4.1 First Analysis	33
	4.1.1 Determining the Relative Efficiency	33
	4.1.2 The Station's Ranking on Overall Performance	36
	4.1.3 Identifying Potential Transformation for Achieving Efficiency	37
	4.2 Second Analysis	38
	4.2.1 Synthesization	38
	4.2.2 Consistency	40

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

	4.2.3	Discussion for Other Pairwise Comparison for the Station Selection Problem	43
	4.2.4	Overall Priority Ranking	44
CHAPTER 5	**CONCLUSION**		
	5.1	Introduction	46
	5.2	Research Summary	46
	5.3	Conclusions	47
REFERENCES			
APPENDIX 1	The Project Schedule		
APPENDIX 2	Input and Output Data		
APPENDIX 3	Data Envelopment Analysis (DEA)-Data Table		
APPENDIX 4	Data Envelopment Analysis(DEA)-Solution List		

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

LIST OF TABLES

		Page
Table 1 :	Input and Output Factor Used in This Study	11
Table 2 :	The Participating Units: The Airline Stations in Selected Continent	16
Table 3 :	The Input and Output Factors	16
Table 4 :	Comparison Scale for the Importance of Criteria Using AHP	24
Table 5 :	Summary Pairwise Comparison of Six Criteria for the Best Station in Selected Continent	25
Table 6 :	The Pairwise Comparison Matrix	26
Table 7 :	Pairwise Comparison Matrices Showing Preference for the Station Using Each Criterion	29
Table 8 :	Overall Stations Performance for the First Half of Year 2004	35
Table 9 :	Overall Stations Performance for the Second Half of Year 2004	35
Table 10:	Overall Performance Ranking	36
Table 11:	Suggested Output Augmentation	37
Table 12:	Priorities for Each Station Using Each Criterion	43

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

LIST OF FIGURES

		Page
Figure 1:	A Model for Measuring Station Performance	20
Figure 2:	Performance Indicator	20
Figure 3:	Hierarchy for the Best Station Problem	22

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

LIST OF APPENDICES

Appendix 1: The Project Schedule
Appendix 2: Input and Output Data
Appendix 3: Data Envelopment Analysis (DEA) – Data Table
Appendix 4: Data Envelopment Analysis (DEA) – Solution List

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

ABSTRACT

This study attempts to provide a mechanism in measuring relative efficiency of selected five airline stations for the year 2004.The objective is achieved by establishing a set of efficiency indicator particularly in the aspect of relative efficiency covering both input and output factor of the stations. In this context, the relative efficiency of five stations in selected continent involved in the study were using non-parametric technique called Data Envelopment Analysis (DEA). The results of using this method to asses the relative efficiencies of all selected five airline stations are then reported. Outcomes are obtained from seven different specifications of output and input. For overall relative efficiency result, three out of five stations were found to be efficient or productive. These three stations can serve as efficient reference set for the relatively inefficient station for potential improvement.

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

CHAPTER 1

INTRODUCTION

1.1 Background of Organization

This study is based on a hypothetical problem in a major networked airline operating in a global environment. The organization chosen is one of the leading carrier airlines company. It is previously a government agency that was later privatized. It embarked on a system of corporate governance that would ensure the fulfillment of its role not only as a major carrier but also as a corporate citizen centered on being responsible to its shareholders. However, this change in business practice did not change the company's focus on being customers-driven.

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

It is the mission of the airline, as a corporation, to provide a transport service that ranks among the best in terms of safety, comfort and punctuality, distinguished and loved for its personal touch and warmth. The airline aim to set new world standards continuously with enhanced in-flight services, reliable ground support and excellent infrastructure as well as to respond to consumer demand for worldwide coverage.

In this new age of technology, the airline company is committed to being a carrier as well as a responsible corporate citizen in the global economy. The airline also ventures into a diversified operation that is the human resource development, training, catering, property consultancy and technical ground support for aircrafts. The airline also provides world-class cargo management facilities to meet the needs of their partners.

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

1.2 Problem Statement

As the competitive nature of an airline intensifies, the ability of the firm within the industry to withstand extended periods of productive inefficiency diminishes. These firms are no longer able to set the price freely, and the ability to achieve monopoly rent reduces. As a result, these firms have limited cushion before economic losses incurred. As a perfectly competitive emerges, pricing control is agreed to the market and trend towards the marginal cost of the most efficient producer in this industry.

The competitive nature of the airlines industry has become more intense in recent years. The economic recession and industry turmoil resulting from September 11 attack shifted demand downward and reduced it's near term growth rate. There has been highlighted that the tendency for rivalry to increase between firm in an industry when growth in demand slows or slack off all together. The rivalry between firms is further intensified in those situations where inventory is perishable and production costs are highly fixed, both characteristics of the airlines industry.

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

Economic theory clearly establishes the importance of measuring efficiency in the airline industry. In the face of weak demand, both pricing level and profitability have deteriorated. Those firms with lower level of efficiency are likely to feel the impact of this dynamics more severely. Those without a strong financial base with which to absorb the lost in profitability may, in fact, not survive.

The main focus in this study is to discuss the performance assessment particularly on the aspect of relative efficiency to measure the level of productivity via indicator. We are actually comparing the efficiency among several units of assessment. The concept of efficiency here is the capability of a unit in utilizing input to produce output. In the context of the airline, the units assessed are stations, where they set up their sales office and airport operations. In general the unit of assessment can be defined as the entity proposed to compare its performance with other entities of it kind. The unit of

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

assessment uses a set of limited resources referred to as input factors to be transformed into a set of outcome referred to as output factor.

As a proactive action to face this kind of stiff competition, the airline tries to evaluate the efficiency of selected stations. This kind of performance measurement will play a role as a management decision-making tool to the management. This performance measurement may help the airline to survive and make profit in the airlines industry.

1.3 Problem Definition

As the competition in the airlines industry become stiffer, an operation research technique shall be applied to help the airline faces this situation. In the current situation the airline tries to assess the performance of it stations the selected continent in terms of relative efficiency measures. This is a hypothetical study using a set of data based on an actual environment.

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

1.4 Research Questions

The research questions involved in this project including:

1. How data envelopment analysis enables the airline to calculate the relative efficiency of it's five stations?
2. Which stations comprise the reference sets for the inefficient stations?
3. Which station can serve as a reference center for improvement to other station?

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

1.5 Research Objectives

The objectives of this research are:

1. To compute the relative efficiency of the airline's five selected stations.
2. To identify the efficiency reference set for the relatively inefficient station for potential improvements.

1.6 Significance of the Project

There should be numerous benefits that the airline can be achieved from this project. Some of them are:

1. To gain better insight into the performance of each station.
2. To identify efficient operating practices in which can be disseminate to all other station so that they will improve their performances.
3. To generate potential improvements for inefficient units and re-allocate limited resources to improve productivity.
4. To provide an intellectual advantage to managers who may be involved in relative efficiency analysis in the other problem.

1.7 Scope and Limitations of the Project

For the purpose of adequate data, this study will take into consideration only the selected five stations namely Station A, Station B, Station C, Station D and Station E. This study will cover only on the selected stations. There are some reasons why the selected stations were chosen in this study. One of the reasons is to strengthen the airline's market presence at the selected stations location.

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

Another reason for choosing the selected station for this study is because it is expected that the chosen ones are the airline's engine of growth for the next few years to complement and support company long-haul flights whereby identifying and exploiting new areas of growth is a central pillar of company business plan.

Besides that, the demand for airfreight is expected to grow strongly where, the forecasted world average cargo traffic annual growth is 5.5% with Asia to lead the growth in airfreight demand. On this basis, the airline's freighter services will further build on its strength in the named stations, with emphasis on the selected markets to improve yield and overall revenue with the main trade lanes from the named and Far East into Europe and Australia in which is also another reason to choose the selected stations in this study.

From the schedule shown in APPENDIX 1, it takes about four months from the project proposal submission to the final project presentation. The scope in this study shall be reasonably restricted by the time constraint.

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

Since this project applies actual historical data from the airlines business, it is important to realize that restricted information is accessible and some information may not be revealed.

1.8 Layout of the Project

In chapter 1 the problem statement, research questions, research objectives, significance of the project, scope and limitations of the project are discussed. In the chapter 2 the literature reviews from the previous research is done are given. Where as in chapter 3 the methodology used in research shall be explained. While in chapter 4 the results of the study shall be discussed. Overall conclusion of the study shall be discussed in last chapter.

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi