OPERATIONAL PERFORMANCE MEASURMENT OF WORLD MAJOR AIRLINES WITH A PARTICULAR EMPHASIS OF ETHIOPIAN AIRLINES: AN INTEGRATED COMPARATIVE APPROACH

by

ABEYI ABEBE BELAY

submitted in accordance with the requirements
for the degree of

DOCTOR OF BUSINESS LEADERSHIP

at the

UNIVERSITY OF SOUTH AFRICA

SUPERVISOR: DR G A IMIRU

NOVEMEBR 2017

I. Abstract

Organizations specifically the airlines industry are increasingly facing the Challenges of operational efficiency measurement. During the last years enormous attention has been given to the assessment and improvement of the performance of productive systems. However, literatures show that there are limitations of the existing models to measure efficiency uniformly and exhaustively across the airlines. The problems are due to lack of the technical efficiency measuring model which unifies and integrates different measuring models into a single model. Therefore, this thesis investigates assessment of the operational performance of world major airlines by employing integrated comparative models to address the above the problems. In this study, technical efficiency is addressed among many performance issues by using three types of modes of performance measurement: a non parametric one, represented by Data Envelopment Analysis (DEA) and; a parametric one, represented by Stochastic Frontier Analysis (SFA) and the Balance Scorecard (BSC) which is a strategic management tools.

Unlike most of the previous studies, this study integrates the BSC concepts into DEA and SFA model. To evaluate technical efficiency of major international airlines, the study use panel of unbalanced data for the year 2007-2014 to make integrated comparative analysis. The research project incorporates seven leading variables and four lagging variables taken from BSC concept to implement into the DEA and SFA. All the three models of performance measurements have their own strength and limitation if they are used alone. But if the three models are integrated and combined together, they would yield better comparative and quality of efficiency assessment. Therefore, the study primarily developed of a model beginning from the theoretical framework assumption into building of a unified comparative model of integrated comparative operational efficiency assessment of airlines.

The research design and methodology uses secondary data collection i.e. annual reports and business reports of airlines which are collected from the airlines own website. The huge amount of financial and operational data cannot be collected by using primary data collection method as it would make it practically impossible and expensive. So by employing secondary data collection method saves time, money and a panel data can be accessed and generated easily.

Hence, from 100 world major airlines population which are ranked by revenue, simple random sampling is used to select 80 samples airlines for this study. First, the BSC identifies the input and output variables. Next, the DEA model ranks the efficiency measurement, identifies the slack variables and benchmarks the airlines. Third, the SFA model identifies technical efficiency, the random error and technical inefficiency. Finally, the technical efficiency estimates obtained from the two techniques are analyzed comparatively. The research makes further analysis of particular case of the Ethiopian Airlines in relation to the most efficient and inefficient airlines and in comparison of the regional analysis.

After extensive tests have been conducted, 'Balanced Frontier Envelopment' model is developed. According to this model, it is a paramount to measure efficiency with combining the strength of three models together and gives better results than the previous one or two combined models. The developed and integrated strategic model enhances measuring of the operating technical efficiency of airlines. This model benefit the airlines industry in many ways such as minimizing the cost and maximizing profit through managing technical efficiency which lead into the success of the airlines.

From the model perspective, therefore, result of DEA model is much higher than the result of SFA model. DEA model is easy to manipulate than the SFA model because the former does not need the functional form while the later requires a functional form. Furthermore, according to the efficiency finding of the study, first, the European regional airlines are relatively more efficient than the rest of regions in the worlds. Second, the North America regional airlines are the second more efficient regional airlines in the world. Third, the Ethiopian airlines are the most efficient in Africa when we compare among Egyptair, Kenyan Airways and South African Airways. Fourth, high revenue does not necessarily leads to the technical efficiency of the firm.

II. Summary of Key Terms

Operational Performance; Technical Efficiency; Balanced Scorecard; Data Envelopment Analysis; Stochastic Frontier Analysis; Efficiency Estimate; Financial Performance; World airlines and Ethiopian Airlines.

III. Acknowledgements

First of all, I would like to thank the almighty God for his unyielding support through his son lord Jesus for continuous divine guidance, leading and awakening the giant inside me by the Holy Spirit. Without the Devin help, I would not be able to this or that.

Next, my heart warm thank goes to my mother and my sister for their constant prayer, support, care and love. Their presence, advice and prayer beside me make me happy and strong.

Third, I would like to thank my supervisor DR. Getie Andualem for his kind and unbending supervision. Without him the paper would not come to an end. So thank you from the bottom of my heart.

Fourth, I should acknowledge thanking my friends. They have made a lot of contribution to the successful completion of the paper. I could not list all of their names but my special thanks go to two of them who made a great support during my study. Thank you my friend Mr. Mengistu Geberemesekel for sharing his view and encouragement and Mr. Banti Addis for editing the paper, sharing his view, forwarding feedback and comments.

Finally, I am very thankful to Arsi University and Ministry of Education for financing and facilitating my education. At last, my deepest gratitude goes to the University of South Africa for offering of doctor of business leadership research opportunity and their academia for their kind and thoughtful support.

IV. Declaration

Name: ABEYI ABEBE BELAY

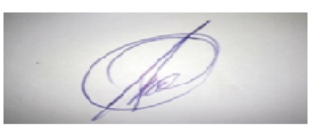
Student number: 7846-312-2

Degree: DBL

Exact wording of the title of the thesis as appearing on the copies submitted for examination:

OPERATIONAL PERFORMANCE MEASURMENT OF WORLD MAJOR AIRLINES WITH A PARTICULAR EMPHASIS OF ETHIOPIAN AIRLINES: AN INTEGRATED COMPARATIVE APPROACH

I declare that the above thesis is my own work and that all the sources that used or quoted have been indicated and acknowledged by means of complete reference.



10-09-2018

------------------------------------- -------------------------------

SIGNATURE DATE

V. Dedication

To My Mom

VI. Table of Contents

I. Abstract ii
II. Summary of Key Terms iii
III. Acknowledgements iv
IV. Declaration v
V. Dedication vi
VI. Table of Contents vii
VII. List of Tables x
VIII. List of Figures xiii
IX. Abbreviations xiii
Chapter: 1 Introduction 16
1.1 General Overview of the Thesis 16
1.1.1 Operational Performance Measurement 16
1.1.2 Existing Models 17
1.1.3 A Need for New Model 18
1.2 Background: The Airline Industry 19
1.2.1 Contribution 19
1.2.2 Growth 19
1.2.3 Challenges 20
1.3 Problem Statement 21
1.4 Research Objectives 22
1.4.1 The General Objectives of the Study 22
1.4.2 The Specific Objectives of the Study 23
1.4.3 Research Questions 23
1.5 Rationale 23
1.6 Delineation of Study 25
1.7 The scope of the Study 27
1.8 Significance of the Study 28
1.9 Glossary: Parameters and Definition of Terminology 34

1.10 Organization of the Thesis 40
Chapter: 2 Literature Review 42
2.1 Introduction 42
2.2 Theoretical Model Review 42
2.2.1 The Balanced Scorecard 45
3.2.3. Stochastic Frontier Analysis 53
2.2.4 The General Comparison among the Three Models: BSC-DEA-SFA 56
2.3 Empirical Reviews 59
3.4 The Research Gap 71
2.5 Conceptual Framework 73
Chapter: 3 Research Design 76
3.1 Introduction 76
3.2 Research Process 76
3.2.1 Step 1 – Identify Research Question 77
3.2.2 Step 2 – Establish Research Objectives 77
3.2.3 Step 3 – Literature Review 78
3.2.4 Step 4 – Research Plan 79
3.2.5 Step 5 – Gather the Data 81
3.2.6 Step 6 – Analyse and Interpret the Data 81
3.2.7 Step 7 – Prepare and Present the Findings 81
3.3 Research Approach 82
3.4 Research Type 82
3.5 Research Design 82
3.6 Sampling Design 83
3.6.1 Population of the Study 83
3.6.2 Sampling Technique 83
3.6.3 Sample size 84
3.7 Research Models Specifications 85
3.7.1 DEA Model Specifications 86
3.7.2 SFA Model Specification 91
3.8 Data Collection Method 96
3.8.1 Data Source 97

3.8.2 Data Types ... 97
3.9 Research Variables and Measures ... 98
3.10 Data Analysis Method ... 100
3.11 Validity and Reliability ... 103
3.11.1 Validity ... 104
3.11.2 Reliability ... 107
3.12 Ethical Issues ... 109
Chapter 4: Result of the Study ... 110
4.1 DEA Result ... 112
4.1.1 Descriptive Statistics for Each Year ... 112
4.1.2 Characteristic of Sample Airlines Each Year ... 118
4.1.3 DEA Efficiency and Benchmark Peer of Each DMUs for the Sample Airlines ... 134
4.1.4 Summary of Output Slacks for Eight Airlines ... 150
4.1.5 Summary of Input Slacks for Each Airlines ... 158
4.1.6 Percent of Potential Improvement for Pure Technically Inefficient Airlines ... 166
4.1.7 Frequency Distributions and Descriptive Statistics of Technical and Scale efficient scores ... 177
4.1.8 Canonical Correlation ... 185
4.2 Stochastic Frontier Analysis Results ... 208
4.2.1 SFA and OLS Result of the Study for the Year 2014 ... 208
4.2.2 SFA and OLS Result of the Study for the Year 2013 ... 211
4.2.3 SFA and OLS Result of the Study for the Year 2012 ... 214
4.2.4 SFA and OLS Result of the Study for the Year 2011 ... 217
4.2.5 SFA and OLS Result of the Study for the Year 2010 ... 220
4.2.6 SFA and OLS Result of the Study for the Year 2009 ... 223
4.2.7 SFA and OLS Result of the Study for the Year 2008 ... 226
4.2.8 SFA and OLS Result of the Study for the Year 2007 ... 229
4.3 Comparative Results of DEA and SFA ... 232
Chapter: 5 Discussion, Conclusions and Recommendations ... 252
5 .1 Discussion of the Study ... 252
5.2 Conclusion of the Study ... 262
5. 3 Recommendation of the Study ... 269
References ... 276

Appendix 1: Ethical Approval Letter....316
Appendix 2: Annual Financial and Traffic Report for Year 2007....318
Appendix 3: Annual Financial and Traffic Report for Year 2008....319
Appendix 4: Annual Financial and Traffic Report for Year 2009....320
Appendix 5: Annual Financial and Traffic Report for Year 2010....321
Appendix 6: Annual Financial and Traffic Report for Year 2011....322
Appendix 7: Annual Financial and Traffic Report for Year 2012....323
Appendix 8: Annual Financial and Traffic Report for Year 2013....325
Appendix 9: Annual Financial and Traffic Report for Year 2014....327
Appendix 9: Foreign Currency Transaction into US Dollars (2007-2014)....328
Appendix 10: Negative Net Income Airlines Excluded from the Sample Airlines Year 2014....331
Appendix 11: Negative Net Income Airlines Excluded from the Sample Airlines Year 2013....332
Appendix 12: Negative Net Income Airlines Excluded from the Sample Airlines Year 2012....333
Appendix 13: Negative Net Income Airlines Excluded from the Sample Airlines Year 2011....334
Appendix 14: Negative Net Income Airlines Excluded from the Sample Airlines 2010....335
Appendix 15: Negative Net Income Airlines Excluded from the Sample Airlines Year 2009....336
Appendix 16: Negative Net Income Airlines Excluded from the Sample Airlines Year 2008....337
Appendix 17: Negative Net Income Airlines Excluded from the Sample Airlines Year 2007....337
Appendix I8: World Airline Ranking Financial....338

VII. List of Tables

Table 1 Detail Comparison of the Three Models (BSC, DEA and SFA)....58
Table 2 Empirical Litature Review....61
Table 3-Summarises Number of DMU between the Year 2007 and 2014....85
Table 4-Indicates the other Related Study's Sample....85
Table 5-Summary DEA Models....91
Table 6-The Measurement of Research Construct Adopted from Wu and Laio (2014)....100
Table 7-Descriptive Statistics of Samples for the Year 2014....112
Table 8-Descriptive Statistics on Sample Airlines for the Year 2013....113
Table 9-Descriptive Statistics of Sample Airlines for the Year 2012....113
Table 10 Descriptive Statistics of Sample Airlines for the Year 2011....114
Table 11 Descriptive Statistics of 40 Sample Airlines for the Year 2010....114
Table 12 Descriptive Statistics of 29 Sample Airlines for the Year 2009....115
Table 13 Descriptive Statistics of 29 Sample Airlines for the Year 2008....116

Table 14 Descriptive Statistics of 43 Sample Airlines for the Year 2007 ... 117
Table 15 Characteristics of the Sample Airlines 2014 ... 118
Table 16 Characteristics of the Sample Airlines 2013 ... 120
Table 17 Characteristics of the Sample Airlines 2012 ... 122
Table 18 Characteristics of the Sample Airlines 2011 ... 124
Table 19 Characteristics of the Sample Airlines 2010 ... 126
Table 20 Characteristics of the Sample Airlines 2009 ... 128
Table 21 Characteristics of the Sample Airlines 2008 ... 130
Table 22 Characteristics of the Sample Airlines 2007 ... 132
Table 23 DEA Efficiency and Benchmark Peer of Each DMU for the Sample Airlines of Year 2014 ... 134
Table 24 DEA Efficiency and Benchmark Peer of Each DMU for the Sample Airlines of Year 2013 ... 136
Table 25 DEA Efficiency and Benchmark Peer of Each DMU for the Sample Airlines of Year 2012 ... 138
Table 26 DEA Efficiency and Benchmark Peer of Each DMU for the Sample Airlines of Year 2011 ... 140
Table 27 DEA Efficiency and Benchmark Peer of Each DMU for the Sample Airlines of Year 2010 ... 142
Table 28 DEA Efficiency and Benchmark Peer of Each DMU for the Sample Airlines of Year 2009 ... 144
Table 29 Table DEA Efficiency and Benchmark Peer of Each DMU for the Sample of Airlines 2008 .. 146
Table 30 DEA Efficiency and Benchmark Peer of Each DMU for the Sample Airlines of 2007 ... 148
Table 31 Summary of the Output Slacks for the Year 2014 ... 150
Table 32 Summary of the Output Slacks for the Year 2013: ... 151
Table 33 Summary of Output Slacks for the Year 2012: ... 152
Table 34 Summary of Output Slacks for the Year 2011: ... 153
Table 35 Summary of Output Slacks for the Year 2010: ... 154
Table 36 Summary of Output Slacks for the Year 2009: ... 155
Table 37 Summary of Output Slacks for the Year 2008: ... 156
Table 38 Summary of Output Slacks for the Year 2007: ... 157
Table 39 Summary of Input Slacks for the Year 2014 ... 158
Table 40 Summary of Input Slacks for the Year 2013: ... 159
Table 41 Summary of Input Slacks for the Year 2012: ... 160
Table 42 Summary of Input Slacks for the Year 2011: ... 161
Table 43 Summary of Input Slacks for the Year 2010 ... 162
Table 44 Summary of Input Slacks for the Year 2009: ... 163
Table 45 Summary of Input Slacks for the Year 2008: ... 164
Table 46 Summary of Input Slacks for the Year 2007: ... 165
Table 47 Percent Potential Improvement for 13 Pure Technically Inefficient Airlines 2014 ... 167
Table 48 Percent potential Improvement for 11 Pure Technically Inefficient Airlines 2013 ... 168
Table 49 Percent Potential Improvement for 8 Pure Technically Inefficient Airlines 2012 ... 169
Table 50 Percent Potential Improvement for 3 Pure Technically Inefficient Airlines 2011 ... 170
Table 51 Percent Potential Improvement for 5 Pure Technically Inefficient Airlines 2010 ... 171
Table 52 Percent Potential Improvement for 3 Pure Technically Inefficient Airlines 2009 ... 172
Table 53 Percent Potential Improvement for 12 Pure Technically Inefficient Airlines 2008 ... 173
Table 54 Percent Potential Improvement for 23 Pure Technically Inefficient Airlines 2007 ... 175
Table 55 Frequency Distributions and Descriptive Statistics of Technical Efficiency of Year 2014 ... 177

Table 56 Frequency Distributions and Descriptive Statistics for Technical Efficiency of Year 2013 178
Table 57 Frequency Distributions and Descriptive Statistics for Technical Efficiency of Year 2012 179
Table 58 Frequency Distributions and Descriptive Statistics for Technical Efficiency of Year 2011 180
Table 59 Frequency Distributions and Descriptive Statistics for Technical Efficiency of Year 2010 181
Table 60 Frequency Distributions and Descriptive Statistics for Technical Efficiency of Year 2009 182
Table 61 Frequency Distributions and Descriptive Statistics for Technical Efficiency of Year 2008 183
Table 62 Frequency Distributions and Descriptive Statistics for Technical Efficiency of Year 2007 184
Table 63 Canonical Loading of the Year 2014 185
Table 64 Canonical Loading of the Year 2013 188
Table 65 Canonical Loading of the Year 2012 191
Table 66 Canonical Loading of the Year 2011 194
Table 67 Canonical Loading of the Year 2010 197
Table 68 Canonical Loading of the Year 2009 200
Table 69 Canonical Loading of the Year 2008 203
Table 70 Canonical Loading of the Year 2007 206
Table 71 Summary of the OLS Estimates for 2013 209
Table 72 Technical Efficiency Estimation of SFA for the Year 2014 210
Table 73 Summary of the OLS Estimates for 2013 211
Table 74 Technical Efficiency Estimation of SFA for the Year 2013 213
Table 75 Summary of the OLS Estimate for the Year 2012 214
Table 76 Technical Efficiency Estimation of SFA for the Year 2012 216
Table 77-The OLS Estimates for the Year 2011 217
Table 78 Summary Technical Efficiency Estimation of SFA for the Year 2011 219
Table 79 Summary of the OLS Estimate for the Year 2010 220
Table 80 Summary Technical Efficiency Estimation of SFA for the Year 2010 222
Table 81 Summary of the OLS Estimate for the Year 2009 223
Table 82 Summary Technical Efficiency Estimation of SFA for the Year 2009 225
Table 83 Summary of the OLS Estimates for the Year 2008 226
Table 84 Summary Technical Efficiency Estimation of SFA for the Year 2008 228
Table 85 Summary of OLS Estimate for the Year 2007 229
Table 86 Technical Efficiency Estimation of SFA for the Year 2007 231
Table 87 Comparative Results of DEA and SFA for the Year 2014 232
Table 88 Comparative Results of DEA & SFA for the Year 2013 234
Table 89 Comparative Results of DEA & SFA for the Year 2012 236
Table 90 Comparative Results of DEA & SFA for the Year 2011 238
Table 91 Comparative Results of DEA & SFA for the Year 2010 240
Table 92 Comparative Results of DEA & SFA for the Year 2009 242
Table 93 Comparative Results of DEA & SFA for the Year 2008 244
Table 94 Comparative Results of DEA & SFA for the Year 2007 247
Table 95-Summary of DEA Variable Return of Scale Technical Efficiency 249
Table 96- Regional Analysis of DEA results for 100%Efficient No. of DMU 250
Table 97-Regional Analysis of SFA results for (0.8-0.99) Efficient No. of DMU 250

Table 98 Summarizes the Particular Case of Ethiopian Airlines 259

VIII. List of Figures

Figure 1Taxonomy of Efficiency Measurement Techniques 44
Figure 2 Demonstrates the Details of the Financial and Non-Financial Parameters. 46
Figure 3 Conceptual Framework of the Study 73
Figure 4 Indicates the Canonical Correlation of Input and Outputs Fixtures 105
Figure 5 Integrated Comparative Model 263

IX. Abbreviations

AE- Allocative Efficiency

ASEAN-Association of Southeast Asian Nations'

ASK-Available seat kilometres

ASKs-available seat kilometres;

ASMs-available seat miles;

ATK-Available tonne kilometres

ATKs- available ton kilometres;

BSC- Balanced Score Card

CE-Cost Efficiency

CLMM-MCMC-the generalized linear mixed models – Markov Chain Monte Carlo generalized linear mixed models

CRS NDEA Constant Return Scale -Network Data Envelopment Analysis models

Crste-constant returns of scale technical efficiency

CTK- Cargo tonne kilometres

CVA -Cash value added

DDEA-Dynamic Data Envelopment Analysis models

DEA-Data Envelopment Analysis

DNDEA- Dynamic Data Envelopment Analysis models with network structure

DRS- decreasing return of scale

DSBM-DEA –virtual frontier dynamic slacks based measure model – data envelopment analysis

EACC-Earnings after Cost of Capital

EBIT - Earnings before interest and taxes.

EBITDA -Earnings before interest, taxes, depreciation and amortisation.

EBITDAR-Operating profit before depreciation, amortisation and rental charges

EFF.-EST. - efficiency estimate

EPS -Earnings per share

ET (Ethiopian) – Ethiopia Airlines

FTE- full-time employees

IAG- International Airlines Group

IATA International Air Transport Association

ICAO-international Civil Aviation Organization

IRS- increasing returns of scale

JAL- Japan Airlines

LCC-Low-cost carrier

MRO -Short for maintenance, repair and overhaul of aircraft

OC- operating cost

SCs-sales costs

OLS- Ordinary Least Square

OprRevenue-Operating Revenue

OR, operating revenue

R & D- Research and Development

ROA- Return to Asset

RoCE -Return on capital employed

ROI- Return to Asset

RPK-Revenue Passenger Kilometre

RPKs-revenue passenger kilometres;

RPMs, revenue passenger miles;

RTK -A Revenue tonne-kilometre

ATK -Available Ton Kilometres

RTKs, revenue ton kilometres;

SBM-NDEA (slacks based measure model network data envelopment analysis

SBM-Slacks Based Measure

SFA- Stochastic Frontier Analysis

TBI- total business income;

TFP index (total factor productivity index

TE- Technical Efficiency

TKO-An offered tonne-kilometre

TOPSIS- technique for order preference by Similarity to the Ideal Solution

VDRAM-DEA- virtual frontier dynamic range Adjusted Model – Data Envelopment Analysis

VFB-DEA- virtual frontier benevolent – data envelopment analysis

Vrste-variable returns of scale technical efficiency

WACC -Weighted Average Cost of Capital

Chapter: 1 Introduction

1.1 General Overview of the Thesis

1.1.1 Operational Performance Measurement

Decision makers are keen on seeking practical and feasible ways to improve the efficiency of their firms. As a result, Yang and Morita (2013) indicate that efficiency improvement has been widely studied in operational performance measurement application as well as in academic research. Over the last few decades, the issue of performance evaluation has created a significant attention. The economy indicators that researchers usually considered in evaluating the overall performance of airlines could be obtained from either operational measures or financial measures (Merkert and Morrell, 2012; Tsai et al., 2012; Hung and Chen, 2013).

Particular, efficient operation is often regarded as one objective of organization administration, which implies that one organization gains a good deal of outputs by consuming low levels of inputs. The efficiency analysis literature was originally developed towards ranking the economic producers with respect to their technical efficiency scores rather than explaining the differences in the performances of the analyzed units. It is as important that efficiency in relation to airlines operations should be particularly studied since the economic performance of an airline depends critically upon the achievement of the highest degree of operational efficiency.

For the pursuit of better operational performance and profitability, organizations are looking for strategies to improve their operational performance and boost their profitability. As competition intensifies due to changes in the industry structure and the emergence of new technologies, organizations are determined to reduce their operational cost while enhance their profitability. This holds true for the airline industry as well.

Currently, Merkert and Hensher (2011) state airlines have suffered from high levels of competition and economic pressure, with high volatility in fuel and foreign exchange rates adding to their financial woes. As global air transport industries becomes an increasingly competitive, Bjelicic (2012) point that most operating airlines feel pressured and have to respond quickly in order to survive in the industry. To the researcher’s view, the only way to lead in this industry is to improve airlines efficiency. Assessment of relative overall performance both from year-to-year and in relation to another airline is a need to employ operational efficiency improvement.

1.1.2 Existing Models

Any business organization's goal is to improve its operational performance. Through the employment of various types of performance measures models, firms can assess the efficiency measurement and the implementation of their business process vis-a-vis their strategic objectives. Furthermore, Chen and Chen (2006) proposes performance measurement model can help businesses in evaluating their resource allocation processes in order to determine how resources can be better managed and distributed to the appropriate channels.

Traditionally, many performance measures schemes have been basing around financial aspects only, omitting important non-financial aspects. The evaluation of the performance of airlines, for example, usually employs financial indices, providing a simple description about the airline's financial performance in comparison to previous periods. Focusing only on financial aspects, however, Hsu (2009) says it not enough for management to deal with the changing business environment.

For example, Kaplan and Norton (1996) introduced the concept of a "Balanced scorecard (BSC)" as a basis for a strategic management system. This approach not only included financial and non-financial aspects but also blended business strategies into management systems. But it is not numerically applicable to measure the quantitative data.

Additionally, Charnes et al. (1978) adopted the data envelopment analysis (DEA) models a non-parametric approach as a main measurement performance approach based on mathematical planning, not only to improve on "traditional" approaches, but also to expand the role of mathematical techniques from original planning to measurement and control. Unlike the BSC approach which is based on strategic performance management, the DEA approach develops one efficiency result under the operational environment of multi-input and multi-output. Even though, DEA is better than the BSC model in its advancement of measuring the efficiency, still the DEA has limitation since it cannot separate identify the technical inefficiency from the statistical noise and the inefficiency. For this reason, another model is essential to supplement the DEA model. Stochastic frontier analysis (SFA) is used to complement the result of the DEA model to separate the technical inefficiency and statistical noise. In this study, so we propose a new technique for incorporating technical inefficiency and statistical noise into a producer performance evaluation based on data envelopment analysis (DEA) and Stochastic Frontier Analysis.

1.1.3 A Need for New Model

Despite critical need to address issues in airline's performance, to our knowledge there is absence of paper examining specific topic related to airlines both operational and financial performance measurement and comparative analysis using data envelopment analysis (DEA), balanced Scorecard (BSC) and Stochastic Frontier Analysis (SFA) models as an instrument for assessing the technical and financial efficiency of major world airlines using operational and financial data. Hence, this paper contributes to the literature on airline efficiency by undertaking an international comparison of major world airline technical performance.

Our proposed model not only reflect the efficiency standing of major world airlines in light of all the recent market challenges but also determine those factors that explain the sources of efficiency variations between airlines using inputs and outputs. It performs analysis on the comparative efficiency of major world airlines in this new market context looking at a large sample of airlines and using three different methods of measuring performance efficiency. Additionally, this empirical study investigates the possible driving factors that may account for higher of operational efficiencies of world airlines and proposes a new integrated comparative model which enhances strategic operating efficiencies measurement.

The remainder of this paper is organized as follows. Chapter 1 discusses background of the study, statement of the problem, research objectives, rationale of the study, significance of the study, scope of the study and limitation of the study. The rest of chapters are organized as follow; chapter 2 presents the literature review; chapter 3 describes the research design of the study; chapter 4 illustrates the result of the Study and finally, chapter 5 presents the discussion, conclusion and recommendation of the study.

1.2 Background: The Airline Industry

1.2.1 Contribution

The global airline industry provides a service to virtually every country in the world, and has played an integral role in the creation of a global economy. The airline industry itself is a major economic force, in terms of both its own operations and its impacts on related industries. The airlines industry contributed 2.4 trillion USD to global economic; it supports 58 million jobs globally (IATA, 2015); supports up to 3.5% of global GDP; carried 35% value of world trade; carried 3 billion passengers worldwide per year by aviation industry and scheduled worldwide passenger traffic forecast to grow at 4.4% per year (ICA0, 2014). The airline industry's net post tax profit for 2014 was $16.4 billion, a 2.2% margin on revenues according to IATA's report (2015).

1.2.2 Growth

The global air transport network has doubled in size every 15 years since 1977 and, between now and 2030 (ICAO, 2012); it is poised to double again. Scheduled commercial international and domestic operations accounted for approximately 3.2 billion passengers in 2014 (ICA0, 2015) and are expected to grow to over six billion by 2030, and the number of departures is forecast to grow from 31 million in 2012 to some 60 million in 2030 (Cir 333).

The aviation industry is complex and growing network of about 1,500 airlines that offered scheduled services connecting 3,850 commercial airports worldwide in 2011. They link both major and minor city pairs, facilitating the movement of people, goods, and services (ICAO, 2013). There was also an increase in aircraft deliveries in 2014 to 1,627 new aircraft. The in-service fleet rose to 26,051 aircraft from 25,187 in 2013(IATA, 2014; ICAO, 2014).

In terms of passenger-kilometres performed, international and domestic services combined, Asia/Pacific remains the largest Region with 30 per cent of the world traffic, posting a 6.4 per cent growth (ICAO, 2012). The report further sates both Europe and North America represent 27 per cent of the world traffic; the Middle East represents 8 per cent of the world traffic, the Latin America/Caribbean Region accounts for 5 per cent of the world traffic and the rest of the world including African Region traffic (2 per cent) in 2012.

1.2.3 Challenges

Since the deregulation of US airlines in 1978, the air transport market has undergone considerable change which has led to a significantly increased competition and the pressure on governments to reduce their involvement in the economics of airline competition has spread to most of the rest of the world (ATA, 2008). Also, adjustments following the events of September 11, 2001 have affected the environment in which air services are provided. The large-scale market entry of low-cost carriers (LCCs) has increased competition and affected the fares charged by incumbent airlines. As a consequence of these and other developments, it is probable that the relative efficiency of the world's airlines has changed. Successful new entrant and low-fare airlines had a great impact both on airline pricing practices and on the public's expectations of low-priced air travel. While the desirability of LCC strategy from the cost efficiency perspective as already documented by other studies in the literature (Barros and Peypoch, 2009; Merkert and Hensher, 2011), it also raises questions about there being more to the LCC strategy than just low cost benefits.

The focus of scholarly works since the deregulation of the U.S. airline industry in 1978 has constantly aimed at benchmarking airlines from the aspects of efficiency and productivity. Since then, dozens of research in airlines are cantered on how airlines promote efficiency and productivity amidst the rising competition sparked by moves for liberalization in the air transport industry in both the United States and the European Union.

Airlines are currently fighting the perception that they are a major source of greenhouse gases by listing all the ways they have reduced jet fuel usage over the past 10 years: modernizing their fleets to more fuel-efficient planes, efforts to control fuel use, and modifications to existing planes to increase fuel efficiency, to name a few. Though the airlines may have undertaken these initiatives to cut costs in the wake of high oil prices, they are using their accomplishments as a way to ease environmental concerns. Global recession is hurting this industry more than anything else due to decline in business and leisure travel and as a result. Since the terrorist strikes in 2001, a number of federally mandated security measures have been put into effect – both to reassure the flying public and to prevent future occurrences. Airlines are now required to either screen all bags for explosives or make sure each bag is matched to a passenger seated on that flight – time-consuming and expensive initiatives. High crude oil prices continue to remain a concern for the airline industry and a source of concern and losses.

These important challenges – sustaining airline profitability, ensuring safety and security, and developing adequate air transportation infrastructure – are not confined to any single country. Airlines around the world are encountering a growing wave of liberalization, if not outright deregulation, and as a result are facing competitive pressures, both from new entrant low-cost airlines and restructured legacy carriers. The rapid growth of the global airline industry and the continued threat of terrorist attacks make safety and security issues critical to every airline and every airline passenger. And due to all the above and other reasons, the need for aviation industry to be technically efficient in performance measurement is of particular importance to economies of the aviation world where much greater rates of demand growth are forecast for air transportation.

1.3 Problem Statement

Currently, airlines have suffered from high levels of competition and economic pressure, with high volatility in fuel and foreign exchange rates (Merkert and Hensher, 2011); shrinking fuelled by consolidation and bankruptcies; mergers, capacity cuts, bankruptcy filings, large- scale losses, and high debt levels (Rahmi, 2012); huge losses during the 2008—2009 global economic recession (IATA, 2015); skyrocketing oil prices, long global recessions, falling demands, fierce price-cutting, collapsing yields revenue per mile and shattering consumer confidence (Sundaram and Abdulrahman, 2011) and technologically driven innovations influences with rising fuel prices, environmental concerns, terrorist attacks, and small margins-airline(Maik, 2013).

Most organizations –irrespective of their size, age, or industry- are increasingly faced with challenge of continuous and dynamic change (Ireland and Webb, 2007) which need technical efficiency measurement tools. One of the means that firms can supposedly use to cope with rapid and continuous environments, financial or operational challenges is to enhance strategic technical efficiency.

Over the last few decades, the problem of performance evaluation has attracted significant attention which led to variety of methods that seek to develop measures to assess the performance of organizations by systematically obtaining and integrating both subjective and objective data (Ouellette et al., 2010; Lu et al., 2012; Gramani, 2012; Lee et al., 2013). Currently, various performance measurement methods have been devised and employed to airline industry to deal with the performance measurement techniques. Despite many efforts have been taken; there also exists of a number of drawbacks associated with the various models of measuring of operational performance especially technical efficiency of the airlines.

As with every performance measurement technique has its own advantages, there are some issues with every performance measurement techniques used. These issues may range from simple screening procedures to sophisticated mathematical procedures according to the methods used. However, literatures show that there are gaps in the performance measurement techniques to measure with a unified model by avoiding the prevailing limitations. These problems mostly arise from the limitations of the technical assessment model itself.

Hence, as global air transport industry becomes increasingly competitive, most operating airlines feel pressured and have to respond quickly in order to survive in the industry. The only way to lead in this industry is to improve airlines efficiency (Bjelicic, 2012). These improvements can come by employing of the better performance measuring models. Assessment and evaluation of relative technical efficiency both from year-to-year and in relation to another airline is a need to utilize better operational efficiency improvement model. Therefore, the study develops a unified integrated comparative model to measure better operational technical efficiency.

1.4 Research Objectives

1.4.1 The General Objectives of the Study

The primary objective of this study is to develop an integrated comparative technical efficiency measurement model which enhances strategic operating efficiency.

1.4.2 The Specific Objectives of the Study

SO1: To measure the operational performance of world major airlines after constructing of an integrated comparative model.

S23: To assess the comparative efficiency of world major airlines with a particular emphasis of Ethiopian Airlines through the comparative analysis of the model.

SO3: To identify the potential percentage of efficiency improvement for inefficient airlines that determines the driving factor for source of efficiency by using the new model

SO4: To determine the significant correlation among variables of inputs and outputs of newly designed model

1.4.3 Research Questions

- ✓ Does the newly constructed integrated comparative model properly measure the operational performance of world major airlines
- ✓ Can the new model asses the comparative efficiency of world major airlines in relation to the particular case of Ethiopian Airlines?
- ✓ Can the new model successfully identify the potential percentage of efficiency improvement for inefficient airlines that determines the driving factor for source of efficiency?
- ✓ Are there significant correlations among input and output variable by using of the new model?

1.5 Rationale

The researcher is trying to justify the need for undertaking the research as it has numerous treasons and that something has to be done about the problem; and this research informs the necessary directions, policies, solutions and strategies and also give recommendation to the airline industry as to what should be done to use technical efficiency measurement model which can enhance the strategic operational performance efficiency measurement.

The economic impacts of the airline industry range from its direct effects on airline employment, company profitability and net worth to the less direct but very important effects on the aircraft manufacturing industry, airports and tourism industries, not to mention the economic impact on virtually every other industry that the ability to travel by air generates. Why is the researcher interested in the development of efficiency measurement model for the airline industry? The motivation for this study stems from different reasons in the mind of researcher.

First, different events have taken place in the global airline industry in recent years which draw the curiosity of the researcher. The onset of the economic crisis in 2008 and the associated oil price increases resulted in some airlines slumping back into difficulties. Again, this period witnessed the emergence of low-cost carriers (LCCs) for example Southwest airlines in USA and Ryanair in Europe as genuine competitors in terms of lower airfares, suggesting the presence of lower cost structures and higher levels of efficiency and productivity. On the top of that, this period is also associated with a phase of intense market volatility in financial data, reflecting the problems the airlines faced which can be averted using the efficiency measurement model so that the future strategic direction can be sought. On the contrary, the Ethiopian Airlines are announcing the consecutive higher revenue and elevated profit despite these challenges. This left the researcher in wonder the possibility of the success. Hence, it is advisable to see different alternative models of efficiency measurement.

Secondly, productivity and efficiency issues in the airlines sector have drawn the attention of the researcher due to increased competition facing the industry particularly in the context of international market segment. Currently, airlines have suffered from high levels of competition and economic pressure, with high volatility in fuel and foreign exchange rates (Merkert and Hensher, 2011); shrinking fuelled by consolidation and bankruptcies; mergers, capacity cuts, bankruptcy filings, large- scale losses, and high debt levels (Rahmi, 2012); huge losses during the 2008—2009 global economic recession (IATA, 2015); skyrocketing oil prices, long global recessions, falling demands, fierce price-cutting, collapsing yields revenue per mile and shattering consumer confidence (Sundaram and Abdulrahman, 2011) and technologically driven innovations influences with rising fuel prices, environmental concerns, terrorist attacks, and small margins-airline(Maik, 2013). Most organizations –irrespective of their size, age, or industry- are increasingly faced with challenge of continuous and dynamic change (Ireland and Webb, 2007) which need technical efficiency measurement tools. One of the means that firms can purportedly use to cope with rapid and continuous environments, financial or operational challenges is to enhance strategic technical efficiency.

Thirdly, the researcher's wider investigation and deep understanding of airlines in relation with his personal interest of the topic related to Ethiopian airlines and other curiosity of the dynamic growth of world airlines are the reason why he chose the topic. During this time, the researcher found the research gap where he can contribute original significant contribution to the airline indisutry. Due to the above and other reasons, various performance measurement methods have been employed to airline industry performance studies. There are also a number of drawbacks associated with the various models of measuring of operational performance especially technical efficiency of the airlines to alleviate the above problems. As with every performance measurement technique, there are some issues with every performance measurement techniques.

Finally, integration of BSC's concept into DEA & SFA models is the major motivation of the research. All the three models of performance measurements have their limitation if they are used alone. But if they are integrated and combined together, they would yield better comparative and quality of efficiency assessment. This leads the researcher into the development of an integration and comparative operational efficiency assessment of airlines that provides the closest observation data with a wide range of Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) models. The dilemma of model choice depends on the trade off between minimal specification which favours DEA and allowing for stochastic error in measuring company efficiency which favours SFA.

Therefore, it is justifiable for the researcher to undertaking the research to contribute in the context and presents an updated clear view of the extent of efficiency of major world airlines and complementing earlier research in this field through developing of a unified model. Furthermore, the researcher informs the necessary directions, policies, solutions, strategies and also gives recommendation by compares the results obtained from the two alternative integrated DEA and SFA models to benchmark technical efficiency airlines which can enhance the strategic operational performance efficiency measurement model.

1.6 Delineation of Study

This section explains the limit of our study in things that a reader might reasonably expect the researcher to do but that the researcher, for clearly explained reasons, has decided not to do in terms of subject, objectives of the study, data collection method, time frame of the study, the issues, sample size, geographical location what information or subjects is being analysed and the issues to which the research is focused.

First, the study does not centre all aspect of performance evaluate such as financial performance, economic efficiency, allocative efficiency and technical efficiency measurement of world airlines. The efficiency measurement doe not uses the all operational and financial data to make such efficiency measurement or performance evaluation methods for it is unrealistic.

Second, the study does not covers all of world airlines in aviation industry which are registered by the International Aviation Transport Association (IATA) because it is not economical and time wasting plus it is not the objective of the research to deal with the whole population of the study. As there are more than one thousand and five hundred airlines exist in the world, it is important to focus on the top hundred major airlines in the world as a population.

Third, the study does not integrate all models of performance evaluation since it is not practical to deal with different models such as Malmquist Productivity index; Bayesian Stochastic Production Frontier; Total Factor Productivity Index; B-Convex DEA Model; Technique for Order Preference by Similarity to Ideal Solution; Virtual Frontier Dynamic Slacks Based Model-DEA and DEA Double Bootstrap; For this reason, three models (DEA, SFA and BSC) are only selected which boosts the strategic operating efficiency measurement.

Fourth, study does not cover all years of time frame of data where all of changes happened in the worlds especially the airline industry. If the time frame is wide it is impossible to conduct the research at least at this level. Hence, a time frame was chosen for investigation from the time period (2007-2014) and it is chosen because of less economic and political stability especially the recession of 2008 and 2009.

Fifth, it is impossible for this paper to take all 80 samples which are selected by using random sampling technique. It is necessary to exclude the samples that have net income negative (-NI) as they are already inefficient or in loss; and the cargo only airlines as they have different measuring variables than the passenger airlines or the passenger and the cargo airlines.

Sixth, the all variables cannot be constructed using balanced score card: all outs and all inputs cannot be used for the study project. It is unwise to deal with a number of variables like Cargo Revenue; Aircraft Departures; seat capacity; Selling Mode; Available Seat Kilometres; Available Ton Kilometres; Average Yields; Block Hours; Code-Share; Passenger Load Factor and etc.

Finally, qualitative data collection method is not employed in this research project for the objectives of the study do not use such type of collecting data to generate huge amount of operating and financial data.

1.7 The scope of the Study

The researcher is obligated to inform the reader about the scope of study research paper. The following section explains the scope of the study in terms of subject, objectives of the study, data collection method, time frame of the study, the issues, sample size, geographical location what information or subjects is being analysed and the issues to which the research is focused.

First, this study focuses on one aspect of performance evaluate i.e. technical efficiency measurement of world airlines. The efficiency measurement uses the operational and financial data to make such efficiency measurement.

Second, the study fortunately covers all regions of the world major airlines industry which is listed as top 100 airlines ranked by Flight Global Insight Data in term of highest rank of revenues for the year of 2014. As there are more than one thousand and five hundred airlines exist in the world, it is important to focus on the top hundred airlines in the world. These world major airlines can literally represent all contents of the world i.e. Europe, North and Latin America, Middle East, Africa and Australia regions.

Third, the study consists of the integration three models i.e. Data Envelopment Analysis (DEA), Stochastic Frontier Analysis (SFA) and Balanced Scorecard (BSC). These models are comprised from the statistical model, econometric model and strategic management model. The BSC concept is integrated into Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) models with seven input variables and four output variables.

Fourth, study covers eight years of time frame starting from year 2007 to year 2014 where a number of significant changes happened in the worlds especially the airline industry. This time is a time economic recession, many anilines hosts financial loses and became bankrupt; skyrocketing of fuel price; a terrorist attack happened during this time etc. All these and other causes affect the airline world. Hence, the stated time frame was chosen for investigation. The time period (2007-2014) is chosen because of less economic and political stability especially the recession of 2008 and 2009.

Fifth, 80 samples are selected by using random sampling technique in this study. The sample size varies across the time frame of the study. For the sample, in 2007 the sample size is 43; in 2010 are 40 and in 2014 are 33. The actual sample size varies because of the net income negative (-NI) and the cargo only airlines are excluded from the sample. The researcher would like to remind the reader about the inconsistence of the sample size across years has nothing to do with using of random sampling techniques which will not affect or bias the result.

Sixth, the eleven variables are constructed using balanced score card: four outs and seven inputs are used for the study project. Operation revenue, net income, return to asset and return to investment are identified as an output while Capital cost, energy cost, labour cost, material cost, number of passengers, revenue passenger kilometres and other cost are used as input for the study.

Finally, the quantitative data collection method is employed by collecting financial and operation numerical data. These data ate collected from the annual and business report of the airlines. The reports are collected from the airline's website.

1.8 Significance of the Study

Generally, our study makes a number of key contributions. To the best of our knowledge, this is the first comprehensive empirical investigation of technical efficiency for world major airlines by employing a strategic integrated comparative model which enhances operating performance of airlines. It provides an original and detailed empirical application of developed model. It measures the operational performance of the airline industry by integrating the three models a DEA-SFA-BSC model. Benchmark learning airlines, business executives and managers of Ethiopian airlines and other airlines use the DEA-SFA-BSC model and the results to improve their business strategies operational and finical performance. In doing so, this study contributes to informing and clarifying the debate in the operational performance of technical efficiency measurement area relating to circumstances in which firms deploy technical efficiency model in aviation industry. The specific detailed significance of the study is presented in sub-sections as follow:

A. The practical significance for Managers

This study has a number of practical implications for managers who are seeking to identify their strategic direction for implementing strategic operational management model. A good understanding of both strategic direction of operational and financial management is important in this regard. Airlines managers need to better identify, establish and combine their firm's strategic technical efficiency in response to varying internal and external contingencies of international expansion. In focusing on this, we are able generate greater nuance and provide stronger empirical clarification to an issue that has only been partially addressed in the literature so far.

First, this study provides guidance to managers on how technical efficiency measurement would be most efficacious using the strategic integrated comparative developed model. From theoretical perspectives, it better informs and refines the strategic choice firms make, thus advancing the state of knowledge on how firms best maximize the opportunities and compete on the basis of their strategic directions.

Second, managers may drive guidance in their planning by applying the integrated strategic comparative model and the findings in their deliberations for better measurement of both operational and financial performance. The study provides theoretical framework and an empirical illustration the effect of strategic measurement of technical efficiency on operational performance measurement. This is a unique contribution to the literature itself.

Third, the managerial applicability of our approach illustrates the ability of the approach to build on the empirical results based on actual data collected from each airline. In addition to validating the approach for realistic scenarios, the methodology we illustrate can be extremely useful for managers to more fully understand the decisions to be technically efficient such as global scenario.

Fourth, managers can also use the proposed model to understand the role of different model parameters for different scenarios. For example, will the role of efficiency measurement model apply for international expansion? Will the role of efficiency measurement model be different if the degree of competition in the foreign market is high? By visualizing the empirical results and global facts, managers can visualize the impact of these different situations to fine-tune foreign market expansion decisions by using efficiency measurement model.

Fifth, the results help managers assess their decisions and make better strategic direction for future improvement technical performance efficiency. The study also contributes to ongoing strategic management and international marketing strategy by examining the interplay between the strategic direction and international performance measurement model. It shows that strategic direction of international expansion needs to be acknowledged to understand the antecedents of technical efficiency measurement model. In addition, the extent of strategic direction activities contributes to the implementation of effective international operational performance measurement model.

Finally, the study also provides insights into when firms trade-off or accumulate capabilities. A good understanding of asset and operating frontiers is important in this regard. Managers need to better identify, establish and combine their firms' resources in response to varying internal and external contingencies. The results could also be very useful for the executives of airline companies to allocate their resources for further improvement of their technical performance.

B. The practical Application for Ethiopian Airlines

The paper observes a missing link in the transition from strategic direction to growth to international expansion using the strategic operating performance measurement model, which has implications for ET's effort towards itself as a *spirit of Africa*. The result will suggest that managers of ET need to involve personal in strategic performance planning to increase technical efficiency.

First, the findings of this study provide an insight into the future of ET's role in the international arena and increase awareness of managers' views on the strategic performance measurement models and choices. The paper provides a model for strategically managing the performance of an aspiring firm, even though the majority of the airlines in the industry are facing distressing circumstances.

Next, the framework is helpful for business practice for the Ethiopian Airlines to identify the right streams for strategic performance measurement of firms to drives international expansion strategies. Hence, for managers of the ET, the framework may help to succeed in business practices, as well as individually selecting fields of activity giving the chance for a positive future career. As an example for the use in business practice, the framework can be useful for strategic planning. Strategic management department and strategic planning practitioner of the airline can find it very useful. For them, the right allocation of resources and the right fields to invest in, how to follow the right trends and be successful with business strategy in long term will be shown.

Third, the competitive strategies – such as operational strategies, generic strategies, intensive strategies, and diversification strategies – can be helpful for the Ethiopian Airlines to gain a competitive advantage over their rivals by using this integrated comparative approach model. Also, the ability to leverage, innovate, and pioneer new ideas, as well as a visionary management team of the company, are essential for using strategic performance measurement of an organization.

Importantly, this paper also makes an empirical contribution by evaluating the Ethiopian airlines cases to determine the level and scope of technical efficiency of the Ethiopian airlines as compared to the other regional airlines analysis. The question regarding the right kind of strategic direction on measuring operational technical efficiency is a perennial one for managers of the firm, and thus examining the factors that determine such involvement is useful for both researchers and managers of the Ethiopian Airlines.

Finally, by empirically demonstrating the role of strategic technical efficiency measurement on the level of firm's performance measurement tools, our work contributes to operational efficiency and strategic management theory using the practical case of the Ethiopian Airlines. This further emphasizes the need to look at the complex relationship between different airlines, different variables, and different models. By discussing and empirically testing such complex interactions, our study helps to further enrich the theory on strategic measurement models beyond the particular scenario case. Academics, students and practitioners from the region and beyond will find this case study interesting and useful the particular insight of the Ethiopian Airlines.

C. The practical Significance for Researchers

The study makes a novel contribution to the literature, as there has been very limited research on this area. Since none of previous studies have integrated BSC; DEA and SFA to assess the operational efficiency of the airline industry, the results of this study could serve as a baseline for further academic validations. Previous studies also never investigate the interrelationship among the indices of the four dimensions of BSC for the airline industry by measuring technical efficiency using alternative models (i.e. DEA and SFA). The four dimensions of BSC will be used as the input or output factors of DEA and SFA to ensure the comprehensiveness of the input-output data. Therefore, this research fills the gap of the previous research limitations.

The pervious researches' findings on the role of measuring technical efficiency are inconsistent. The inconsistency might be due to several factors, including lack of experience and knowledge about the operational performance measurement, poor design of strategic efficiency measurement, using incompetent of measuring model efficiency etc.

The new developed model and the discussion of future areas of examination may help other researcher to identify future paths of strategic operational management research which are worth focusing on, as some of them can also be found in many studies. These areas are, especially in the field of strategic management, performance management, marketing management, international business research.

D. The practical Application for Airline industry

The result of this research may be useful for healthy rival airline to prepare and take advantage of that eventuality being efficient in operational and financial aspect using better performance measurement. For instance, managers of rival firms can make concerted efforts to plan on adding aircraft, increasing prices, or expanding routes, decisions with regard to hiring additional personnel and increased emphasis on being technically efficient that can be valuable tactics in light of impeding bankruptcies in the industry. The research hopes this study acts as a springboard for future investigation into these and other related effects of strategic direction on operational performance measurement of airline industries and other industries such as banking that are undergoing traumatic stress in the present economy. An airline industry wanting to implement an effective technical efficiency measurement strategy needs to pay attention to the links between the performance measurement strategy of the industry and the extent of the effect the implementation. So the approach can provides starting point to simultaneously determine the decisions with the partial emphasis to maximize or minimize the international expansion.

Even though this study is developed and applied in Ethiopian context, the study is also useful for any airline in route planning, international expansion and in formulating major policy decisions to enhance strategic operating performance measurement. Others benefits include effective fleet scheduling, strategic alliances, decisions on aircraft and fuel purchases, and developing optimal fare polices. This paper adds to the existing literature by developing strategic integrated model of airlines.

The study contributes to knowledge in the area of international expansion and strategic management of companies from developing countries by providing evidence on how on company has achieved world position in a highly competitive position that is available in each of its chosen market. In particular, it contributes to the limited empirical evidence on the efficient benchmark airlines at the present time.

E. The Practical Application for Other Organizations

The study findings imply that an industrial firm that wants to implement its operational performance strategy efficiently needs to pay attention to the links between the operational performance strategy and the extent of its strategic performance an activity. Here, the CEO's of other organization involvement, engagement, communication, and commitment are crucial. Management from different sectors might be advised to evaluate the advantages of applying an integrated comparative model to measure technical efficiency of their organization which leads to high performance indices.

For example, it is also useful for tourism industry professionals. Since airline transportation is a major and the most important way of transportation of international travel, the results of this study provide important insights to practitioners and the tourism ministry about how performance strategies can be designed to manage operational and financial performance and how airline industry can be the performance measurement concept to formulate better efficiency strategies and implement effectively.

F. The Practical Application for Policy makers

It is possible that our research may provide some assistance both to individual companies and to national policy makers in future of enhancing strategic efficiency of the operational and financial performance of aviation industry. The level of involvement is among the most important decisions in determining international operational performance and our research will show the roles of technical efficiency measurement using a unified model to better guide the future direction as an important input for strategic decision.

1.9 Glossary: Parameters and Definition of Terminology

The flowing are the parameters and definitions of aviation and financial terminology used in this study. These are the clarification and the constructs of the research project. This section is divided into two: the aviation and the financial section.

A. Aviation Terminology:

A Revenue Passenger-kilometre (RPK) denotes one paying passenger transported for one kilometre.

A Revenue tonne-kilometre (RTK) -denotes one tonne of load (passengers and/or cargo) transported one kilometre.

Aircraft utilization – The average number of block hours operated per day per aircraft for the total fleet of aircraft.

An offered tonne-kilometre (TKO) -denotes the offered capacity equivalent of one tonne of load (passengers and/or cargo) for one kilometre;

ASK (Available Seat Kilometres) Passenger seat capacity measured in seats available multiplied by distance flown

ATK (Available Ton Kilometres) -Overall capacity measured in tones available for carriage of passengers and cargo load multiplied by the distance flown.

Available Seat kilometres (ASK)-The number of seats available for sale multiplied by the distance flown

Available seat miles – The number of seats available for passengers multiplied by the number of miles the seats are flown.

Available tonne kilometres (ATK) -The number of tonnes of capacity available for the carriage of load (passenger and cargo) multiplied by the distance flown Cargo revenue per CTK Cargo revenue divided by CTK

Average yields -Average revenue earned per unit of output; normally based on total passenger-kilometres or tonne-kilometres sold, but they can also be calculated per unit of traffic volume, e.g. per passenger carried or per kilometre flown.

Average fare – The average one-way fare paid per flight segment by a revenue passenger.

Average fuel cost per gallon – Total aircraft fuel costs, including fuel taxes and effective portion of fuel hedging, divided by the total number of fuel gallons consumed.

Average stage length – The average number of miles flown per flight.

Block hours -The time from the moment an aircraft leaves its parking position ("off-blocks time") to taxi to the runway for take-off until it comes to a complete standstill at its final parking position at the destination airport ("on blocks").

Code-share -A code-share is a flight segment that is sold under the flight number of one airline, while being operated either partly or entirely by another airline. Both companies maintain their own independent profile on the market.

Hub- In air traffic a hub refers to an airline's transfer airport, a central connecting point for different routes. Passengers and goods are transported from the original starting point to the airport's hub. From there they are carried to their destination by a second flight alongside passengers and goods from other departure points.

Breakeven Load Factor -The load factor at which revenue will be equal to operating costs.

Cargo tonne kilometres (CTK) The number of tonnes of cargo that generate revenue (freight and mail) carried multiplied by the distance flown.

ICAO-international Civil Aviation Organization

International Air Transport Association (IATA) – the international trade association for the airline industry.

Load factor – The percentage of aircraft seating capacity actually utilized, calculated by dividing revenue passenger miles by available seat miles.

Low-cost carrier Low-cost carrier is airlines which offer largely low ticket prices but with reduced service levels and sometimes additional charges on board and on the ground. Flights are mostly from secondary airports outside the major cities.

MRO -Short for maintenance, repair and overhaul of aircraft

Network carrier -In contrast to low-cost carriers these airlines offer a wide-ranging, normally global route network via one or more hubs, with synchronised connecting flights.

Passenger-kilometre/tonne-kilometre -Standard output units for air transport.

Operating expense per available seat mile – Operating expenses divided by available seat miles.

Operating expense per available seat mile, excluding fuel – Operating expenses, less aircraft fuel, divided by available seat miles.

Operating expense per available seat mile, excluding fuel and profit sharing – Operating expenses, less aircraft fuel and profit sharing, divided by available seat miles.

Operating Margin -Operating profit expressed as a percentage of operating
revenue.

Operating margin Operating profit/(loss) as a percentage of total revenue

Operating revenue per available seat mile – Operating revenues divided by available seat miles.

Overall Load Factor RTK divided by ATK.

Overall load factor -RTK expressed as a percentage of ATK

Passenger load factor -RPK expressed as a percentage of ASK

Passenger load factor/cargo load factor Measure of capacity utilisation in per cent. The cargo load factor expresses the ratio of capacity sold to available capacity. The passenger load factor refers to passenger transportation and the cargo load factor to freight transport or total traffic.

Passenger revenue per available seat mile – Passenger revenue divided by available seat miles.

Passenger revenue per RPK (yield) - Passenger revenue divided by RPK

Passenger Seat Factor -RPK divided by ASK.

Passenger unit revenue per ASK- Passenger revenue divided by ASK

Regularity id the percentage of flights completed to flights scheduled, excluding flights cancelled for commercial reasons

Revenue passenger kilometres (RPK) is the number of passengers that generate revenue carried multiplied by the distance flown

Revenue passenger miles – The number of miles flown by revenue passengers.

Revenue passengers – The total number of paying passengers flown on all flight segments.

RTK (Revenue Ton Kilometres) Actual traffic load (passenger and cargo) carried in terms of tons multiplied by the distance flown. The revenue load in tonnes multiplied by the distance flown

Unit Cost (cents per ATK) - Transport operating costs incurred per ATK.

Unit costs/unit revenues -Key performance indicator for air transport. Unit costs (CASK) denote the operating expenses divided by offered seat kilometres. Unit revenue (RASK) denotes the traffic revenue divided by offered seat kilometres.

Yield (cents per RTK) - Transport Revenue earned per RTK.

Yield per passenger mile – The average amount one passenger pays to fly one mile.

B. Financial Terminology

Adjusted EBIT is main earnings metric for the Company's forecast. This relates to EBIT adjusted for asset valuations and disposals and for the measurement of pension provisions.

Cash flow is a measure of a company's financial and earnings potential. It is calculated as the difference between the inflow and outflow of cash and cash equivalents generated from ongoing business activities during the financial year

Cash value added (CVA) is a parameter for measuring performance of value creation. When the cash flow generated in a period ($EBITDA^{plus}$) is greater than the minimum cash flow required to cover the cost of capital, the CVA is positive and value is created.

Deferred taxes are a balance sheet item used to show taxable and deductible temporary differences. Deferred taxes reflect the temporary differences between assets and liabilities recognised for financial reporting purposes and such amounts recognised for income tax purposes.

Dividend yield is an Indicator for assessing the profitability of an investment in shares. It is determined by dividing the dividend by the share price at the close of the reporting year and then multiplying it by 100.

Debt repayment ratio is a financial indicator. It represents the ratio of adjusted cash flow from operating activities to net indebtedness and pensions, The rating agencies' comparable criteria for an investment grade rating are met if a target of at least 60 per cent is achieved sustainably.

Dividend cover -The number of times profit for the year covers the dividends paid and proposed

Earnings After Cost of Capital (EACC) is the main indicator of value creation. This is calculated from EBIT plus interest income on liquidity less taxes of 25 per cent and costs of capital. A positive EACC means that the Company has created value in a given financial year;

Earnings per share (EPS) are earnings are based on result after tax, adjusted for earnings attributable to equity holders for interest on the 5.8 per cent convertible bonds. Shares are based on the weighted average number of ordinary shares adjusted for assumed conversion of the bonds and the dilutive impact of employee share-based payments outstanding

EBIT is a financial indicator denoting earnings before interest and taxes. From financial year 2015: main earnings indicator. This is calculated from total operating income less operating expenses plus the result from equity investments.

EBITDA is a financial indicator denoting earnings before interest, taxes, depreciation and amortisation. Depreciation relates to items of property, plant and equipment and amortisation to intangible assets – both terms apply equally to non-current and current assets. The figure also includes impairment losses on equity investments accounted for under the equity method and on assets held for sale.

EBITDA^{plus-} refers to the operating result adjusted for non-cash items. It includes all cash-relevant items over which management has an influence.

EBITDAR Operating profit before depreciation, amortisation and rental charges

Equity method Accounting method for measuring income derived from a company's investments in associated companies and joint ventures. Under this method, investment income equals a share of net income proportional to the size of the equity investment.

Equity ratio is a financial indicator expressing the ratio of shareholders' equity to total assets.

Free cash flow is a financial indicator expressing the cash from operating activities remaining in the reporting period after deducting net cash used for investing activities.

Group of consolidated companies are group of subsidiaries included in a company's consolidated financial statements.

Impairment is losses recognised on the carrying amount of assets. Impairment charges are recognised when an asset's "recoverable value" (the higher of fair value less costs to sell and value in use) is below its carrying amount. By contrast, depreciation or amortisation is the systematic allocation of the depreciable amount of an asset over its useful life.

Internal financing ratio is a financial indicator expressing the degree to which capital expenditure was financed from the cash flow generated.

Net indebtedness/net liquidity is a financial indicator denoting non-current borrowing less cash, cash equivalents and current securities.

Operating result is an earnings measure. The operating result is calculated as the profit from operating activities, adjusted for book gains and losses, write-backs of provisions, impairment losses, results of financial investments and the measurement of financial liabilities at the end of the period

Interest cover is the number of times profit before taxation and net interest expense and interest income covers the net interest expense and interest income

Manpower equivalent is number of employees adjusted for part-time workers, overtime and contractors

Net Profit Margin is net profit divided by operating revenue.

Current ratio is total current assets divided by total current liabilities.

Quick ratio is total current assets minus inventory divided by total current liabilities.

Net Working Capital is total current assets minus total current liabilities.

Total debt to total asset ratio is total debt divided by total assets.

Debt/Equity ratio is Long term debt plus current maturity of long term debt divided by equity.

Times interest cover ratio is net income before interest and tax divided by interest expense.

Rating is a standardised measure used on international financial markets to judge and categorise a company's creditworthiness. A rating can enable conclusions to be drawn about whether an issuer is capable of meeting in full its obligations under the terms of the issue.

Registered shares with transfer restrictions are registered shares that may only be transferred with the approval of the company.

Retention of earnings is transfer of a company's profit to equity. It strengthens the company's financial position.

Return on equity is financial indicator expressing the ratio of net profit to shareholders' equity.

Return on capital employed (RoCE) is profit or loss before exceptional items, adjusted for aircraft leases, multiplied by 1 minus the Group standard tax rate, divided by tangible fixed assets on and off balance sheet plus working capital – excluding cash and cash equivalents and any current portion of non-current interest-bearing borrowings. Earnings before interest and taxes divided by equity plus long term loan.

Return on sales is a financial indicator expressing the net profit before taxes in relation to sales revenue.

Total capital is total equity plus net debt

Total group revenue per ASK is total group revenue divided by ASK

Total operating expenditure per ASK is total operating expenditure divided by ASK

Total shareholder return is a financial indicator expressing the overall return that an investor earns from the increase in the market capitalisation or share price, plus the dividend payment. The total shareholder return is calculated from the share price at the close of the reporting year plus the dividend paid in respect of the previous year, multiplied by 100 and divided by the share price at the close of the previous year.

Traffic revenue is revenue generated solely from flight operations. It comprises revenue from transporting passengers and cargo as well as related ancillary services.

Total traffic revenue per ATK is revenue from total traffic (passenger and cargo) divided by ATK

Weighted Average Cost of Capital (WACC) is the average return required on the capital employed at a company. It is the return on for both debt and equity.

Working capital is a financial indicator for assessing a company's liquidity, measured as the difference between its current assets and its current liabilities.

1.10 Organization of the Thesis

Chapter one introduced the subject matter and basis for the dissertation. It provides an overview background development of the airline industry from its inception with the research objectives, rational of the study, scope of the study, limitation of the study and the significance of the study. The remainder of the thesis is structured as follows. Chapter two presents a literature review. The current state of the literature around various performance measurement techniques and technical efficiency of the airlines industry are presented. This forms the basis for this dissertation. The literature concerning about the issues of performance measurement, airline performance measurement and several specific performance measurement techniques are reviewed. It introduces theoretical foundation of the study. An outline of the performance measurement models and theoretical frame work are also introduced. Chapter three provides the methodological approach taken in the design and execution of this study. This includes data identification & gathering, sample selection, software selection & validation and data analysis. Chapter four presents the result of DEA and SFA efficiency scores to examine the two alternative models for each of the airlines. The best and worst performing airlines are then tabulated by means of a comparative analysis. The input and output targets that are required in order for each airline to achieve pare to optimal efficiency are also provided. Chapter five provides the discussion, conclusion and recommendation the study of research. The developed new model is presented and explained to its full detail in this chapter.

Chapter: 2 Literature Review

2.1 Introduction

This chapter presents a review of the literature surrounding performance measurement both theoretical foundation and empirical pertaining specifically to airlines industry. Theoretically, an over view taxonomy of the three performance measurement techniques: the Balanced Scorecard, Data Envelopment Analysis and Stochastic Frontier Analysis with application, historical development, usages, benefits, limitation and the general comparison of these models are discussed. Empirically, a thematic of the current state of the airlines performance literature is presented. The discussion of methodology is given a special emphasis since the major objective of the study is developing a model. Hence, this section briefly discusses the models used, the sample size, the focus of the study, the inputs and output selection, the major findings, the critique, and the research gaps of different researchers. This review draws from the general fields of strategy and operations management of performance evaluation to specifically technical efficiency models and measurement. In doing so it seeks to influence not only each of these fields individually, but also as a result of focusing these fields through an airlines lens to have an impact in the sphere of airlines performance management. Therefore, the literature is primarily sourced from academic journals and is discussing about the theoretical and the empirical study with the finding and limitation overall performance measurement of technical efficiency.

2.2 Theoretical Model Review

In this section, we briefly introduce the basic three models of the research undertaken. These three models are called Balanced Scorecard (BSC), Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). The study proposes the integration the three models together to measure the technical efficiency of the airlines.

In general, there are many different performance measurement techniques available to the researcher wishing to investigate company performance in airlines. These range from simple screening procedures like the less common cash flow and service quality type analyses to sophisticated mathematical procedures like the productive use of Frontier type analyses. All of these techniques are valid research tools and this validity is not dependent on prolificacy of usage. In business organization, performance measurement has historically been based almost exclusively on financial performance. Specifically, profit was generally considered to be the primary metric when measuring the performance of a business. At the most basic level this is a reasonable assumption. However, comparing performance across airlines is difficult due to the complexity of their structure. While an airlines core business activity is always the same, the elements which make up the airline itself are often vastly different.

Direct performance comparisons can be useful when assessing a firms' technical efficiency position. For example, Mason and Morrison (2008) addresses the issues when attempting to compare the financial and operating performances of airlines a difficulty arises when trying to take account of their differing business models. However, fleet type and size, route network and structure, staff numbers, airports served and even the regulatory environment in which they operate are all factors that must be considered making direct comparison difficult. Another issue is the availability of data. This issue gives rise to a trend in the literature whereby when airline performance is being measured or compared there is a clear tendency towards publicly available financial only measures such as Potter (2011) is typical examples of studies that use publicly available financial measures. Otherwise, the availability is limited.

In an attempt to identify a process that considers both financial and non financial measures in an airline context the following three methods of performance measurement are chosen for review primarily because they are relatively well known and widely used both in academia and in industry and also used in this study. Hence, this research is concerned specifically with airline performance measurement applying the integrated three models and the comparative approach that require the identification of a suitability of the newly developed technique. This results in a sufficient body of literature from which to make decisions regarding suitability and practicality the new model of this research. The three performance evaluation techniques applied in this study are:

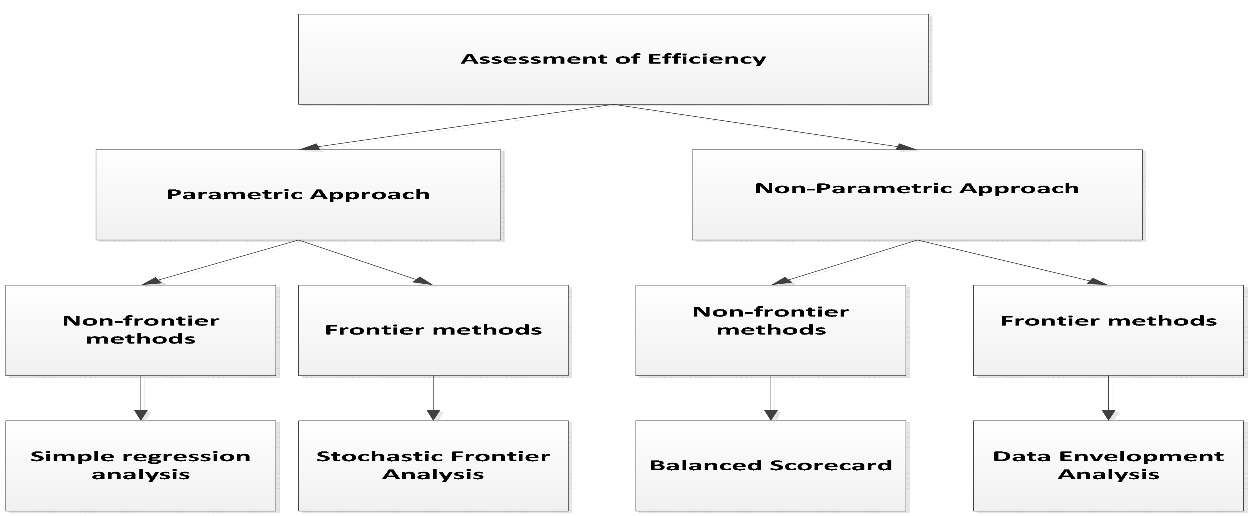
1) The Balanced Scorecard – is well established method for identifying financial and operational measures of a company using four perspectives. The inputs and the outputs of the decision making units (DMU) are extracted by using Balanced Scorecard (BSC).

2) Data Envelopment Analysis is non-parametric linear statistical approach and after the identification of the inputs and the outputs, they are measured by using of the non-parametric programming approach –data envelopment analysis (DEA).

3) Stochastic Frontier Analysis is Parametric approaches not only specify functional form, but also take account of the residual term in the analysis. The second alternative parametric programming approach of stochastic frontier analysis (SFA) models will be evaluated to get comparative efficiency against the DEA.

The researcher therefore believes that by integrating BSC model, into DEA and SFA models, the study utilize three future perspectives indices for the growth and the importance of DMU capacities to take effective steps of technical efficiency measurement tool which has more capability of measurement.

Figure 1Taxonomy of Efficiency Measurement Techniques



Source: this research

The above figure summarises the difference between parametric and non-parametric approach how to deal with assessment of efficiency. The two major approaches use different methods of efficiency measurement. Both parametric and non-parametric approach has frontier and non-frontier methods. While the parametric approach uses simple regression analysis for non-frontier methods and stochastic frontier analysis for frontier methods, the non-parametric approach uses balance card for non-frontier methods and data envelopment analysis for frontier of the non-parametric method. So this research integrates both the parametric methods of stochastic frontier analysis and the non-parametric methods of both balanced scorecard and data envelopments analysis. The researcher believes that this integration gives better results of efficiency measurement than each individual or two combinations of the models such as BSC and DEA (Wu and Laio, 2014) and avoids the limitation if each of the models is used alone.

Generally, the increased level of competitiveness is one of the characteristics of the new world and organizations which aim to improve their market share, profitability and as a result sustainability in current complex environments needs to adapt with environmental situation and change. In order to achieve such a goal organizations need to apply modern tools and scientific techniques. Having summarised the taxonomy of each efficiency assessment now let us discusses a little further each model of assessment.

2.2.1 The Balanced Scorecard

Balanced Scorecard (BSC) is one of the three models used in this study. It is another popular method of performance evaluation and it is a management tool which helps managers to examine their activities from different views. Najafi, et al., (2010) identifies the four perspectives including financial, customer, internal processes, and learning and growth perspectives and tries to make a balance between financial goals and the other remained perspectives. The Balanced Scorecard considers a company from four important perspectives;

1) The Customer perspective – How do customers see us?

2) The Internal Perspective – What must we excel at?

3) The Innovation and Learning Perspective – Can we continue to improve and create value?

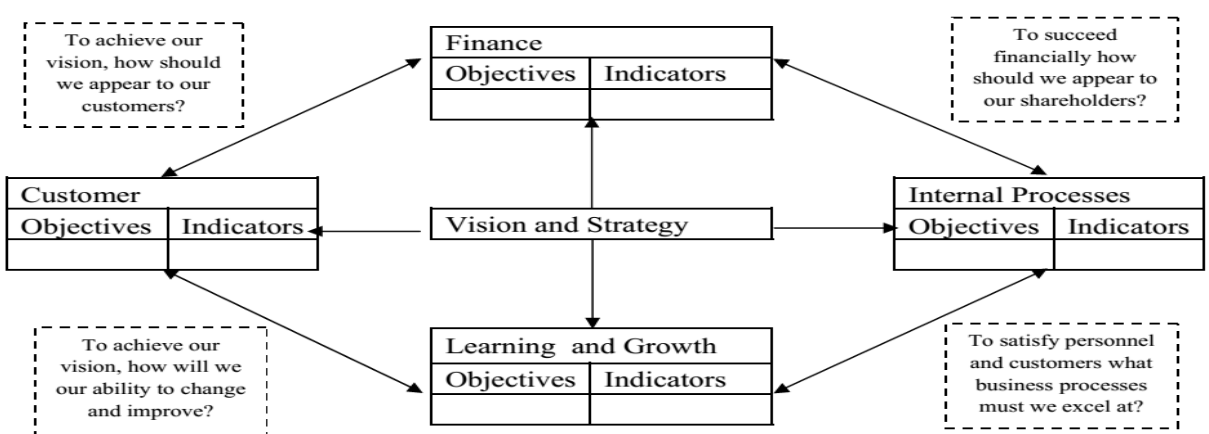
4) The Financial Perspective - How do we look to shareholders?

The idea of the BSC was created by Kaplan and Norton (1996) who advocated the emphasis of both financial indicators (lagging indicators) and non-financial indicators (leading indicators) specifically in regard to aspects related to maintaining customer satisfaction, continuing internal process improvement, and investing in employee learning and growth). The idea of BSC is to focus on non-financial items affecting the efficiency of an organization. BSC developed the indices toward four outlooks of growth and learning, internal processes, customer and finance and intends to balance financial goals as the result of past performance (past view indices) and three other indices (future view indices).

Kaplan and Norton (2007) emphasized that executives of firms should not only try to achieve the financial measures referenced above but should also try to arrange organizational alignment in terms of customers, internal business processes, and learning and growth. The BSC particularly identifies the cause-and-effect relationship among leading indicators and lagging indicators (Eilat et. al., 2008). Fletcher and Smith (2004) argued that learning and growth perspectives were the leading indicators of internal business processes which were also the leading indicators of customer satisfaction. The three aspects of leading indicators were all influence financial indicators in the long run.

Therefore, the BSC provides a very clear picture for executives that current good financial performance does not ensure that future financial performance will be good also; However, current good performance related to customer satisfaction, internal business processes, and employee's learning and growth will ensure that future financial performance will be good (Lee, 2008). Based on the above statements, it is important to create an appropriate working environment for the employees and encourage them to emphasize creativity, learning, and development in the firm (Huang, 2009).

Figure 2 Demonstrates the Details of the Financial and Non-Financial Parameters.



Source: this research

Kaplan and Norton (2007) emphasized that executives of firms should not only try to achieve the financial measures referenced above but should also try to arrange organizational alignment in terms of customers, internal business processes, and learning and growth. The BSC particularly identifies the cause-and-effect relationship among leading indicators and lagging indicators (Eilat et al., 2008). The three aspects of leading indicators were all influence financial indicators in the long run.

Therefore, the BSC provides a very clear picture for executives that current good financial performance does not ensure that future financial performance will be good also; However, current good performance related to customer satisfaction, internal business processes, and employee's learning and growth will ensure that future financial performance will be good (Lee, 2008). Based on the above statements, it is important to create an appropriate working environment for the employees and encourage them to emphasize creativity, learning, and development in the firm (Huang, 2009).

Companies that are formal users of the BSC believe it brings many paybacks. An important element of the Balanced Scorecard is limiting the number of measures examined from each perspective. The BSC can help streamline highly diversified companies whose various business units need to be realigned with one unifying corporate strategy. This forces managers to focus on the measures that are most critical.

Another important element is that it forces managers to consider all operational measures no matter how dissimilar, allowing them to identify if improvements in one area are coming about at the expense of standards in another area. There are other positives for companies that use the BSC. Chen & Jones (2009) found that these companies are more likely to link strategic objectives to long term targets, thus avoiding short term-ism. They also tend to be more flexible and open to restructuring working environments if required. Employees see an attitude that is less resistant to change and individual business units have the autonomy to make adjustments in organisational procedures which may facilitate any changes required.

Moreover, the balanced scorecard facilitates decision making using a variety of accounting measures from different entity perspectives; traditionally, these perspectives are labeled financial, customer, internal business process, and learning and growth (Hank et al., 2015).

Scorecard measures are specifically selected to assess whether strategic objectives are being achieved (Cheng & Humphreys, 2012; Humphreys & Trotman, 2011; Kaplan, Petersen, & Samuels, 2012; Libby, Malina et al., 2007). Scorecard proponents reason that financial measures cannot adequately capture all useful performance indicators when assessing achievement of strategic objectives, and thus a more "balanced" approach of evaluating both financial and nonfinancial measures from financial and nonfinancial entity perspectives will lead to more informed decisions that create greater entity value. Scorecards can become complex (Hank et al., 2015).

There is also evidence to suggest that the BSC is positively correlated to managers' levels of job satisfaction. Burney & Swanson (2010) found that managers whose emphasis was on the Financial, Customer and Innovation & Learning perspectives had higher levels of job satisfaction than those whose emphasis was on the Internal Business perspective, although no reason is given as to why this may be the case. Also, Gonzalez-Padron et al. (2010) found a positive correlation between a focus on the customer perspective and financial performance but found no such correlation for the other perspectives. Overall BSC usage has remained reasonably consistent to improve operating performance and to be associated with flexibility, openness to change and increased job satisfaction.

As with every performance measurement technique there are some issues with the BSC model. This is a crucial principle of the Balanced Scorecard – a failure to convert improved operational performance into improved financial performance and requires re-examination of the failed process. It is believed to be complex and costly to develop and implement it. It relies on an assumption that a company adopting it is open, honest and willing to embrace it from the top down. It is not really suitable for small companies. Dyball et al., (2011) points out that there still appears to be a bias towards financial measurements by managers.

First, Banchieri et al. (2011) identified three areas of concern in the BSC model – perspectives, indicators and cause & effect relationships. Essentially the BSC views an organisation from a mechanistic perspective; it does not consider any outside influence and reduces the complexity of the company to a simplistic cause and effect relationship. Kune (2008) underlines this issues that the BSC does not consider the time lag factor and views the cause and effect relationship as simultaneous. The lag in the cause and effect relationship must be monitored closely as the entire

BSC concept is about harmonisation and it is pointless improving, for example, quality at the expense of volume or productivity (Norreklit et al. 2008).

Another major issue with the BSC is the tendency towards financial measures that managers may pay insufficient attention to leading and non-financial measures. This brings to the failure of the purpose of the Balanced Scorecard. Neumann, Roberts & Cauvin (2010) found that managers preferred financial measures over non-financial measures at a rate of two to one. A study by Herath et al. (2010) also identified the fact that assumption is usually the financial measures against performance bonuses for managers are set to primarily focus the financial measure. This was also confirmed by Chen & Jones (2009) who reported that the employees in BSC companies indicated that the company pays more attention to the financial measures. The manner in which the metrics themselves are developed can also be problematic. The goals and metrics are constructed by senior management and then filtered down through the company. There are several challenges with this process. Top management may not have a complete view of the area for which they are setting the benchmarks. These challenges may be overcome if management are fully open, honest and not resistant to change.

Third, the Balanced Scorecard is about strategy not individual control. Goals are established and it is assumed that management and staff will do whatever is necessary to achieve them. These goals are strategic and apply to the company as a whole. As a result no one goal may be achieved to the detriment of individual sections of the company. It is this understanding of interdependent relationships that promotes strategic thinking which keeps companies moving forward.

In Short, the Balanced Scorecard has been successfully implemented across a wide number of industries and geographical locations. Organisations must foster involvement, consistency and adaptability in order to achieve measurable results from the implementation of a BSC (Deem, et al., 2010). This would imply that company culture also plays a large part in the usefulness of the Balanced Scorecard (Chavan, 2009). BSC usage only leads to higher performance if managers understand the cause and effect relationships that link drivers with future financial performance (Capelo & Dias, 2009) and that a BSC which focuses purely on measurement and not strategy.

2.2.2 Data Envelopment Analysis (DEA)

Data Envelopment Analysis (DEA) is a non-parametric frontier method and originated from a study in operations research, and was first proposed by Charnes, Cooper and Banker (1978). DEA uses linear programming to construct a piecewise linear "efficient frontier" that envelops Decision-Making Units (DMUs) or firms based on outputs and input quantities. Efficiency indices are then calculated relative to this frontier. It had the ability to evaluate the efficiency using multiple inputs and outputs. Data envelopment analysis measures the efficiency of decision-making departments of organization regarding the various inputs and outputs. Later, Charnes et al. (1978) proposed a model which had an input orientation and assumed constant return to scale (CRS). Subsequent papers have considered alternative sets of assumptions, such as Banker, Charnes and Cooper (1984) who proposed a variable returns to scale (VRS) model. It had the ability to evaluate the efficiency using multiple inputs and outputs. This model called Data Envelopment Analysis.

Nowadays, DEA is a well-known operations research (OR) technique for evaluating the relative efficiency of a set of homogeneous decision making units (DMU). The method is able to compare the efficiency of multiple decision-making units which by using multiple inputs and multiple outputs deliver similar services (Koskal and Aksu, 2007). It has also become one of the most important techniques on measuring the relative efficiency of different units (Wu et al. 2010; Pulina et. al. 2010). In DEA, DMUs can be measured on the basis of multiple inputs and outputs, even if the production function is unknown (Amirteimoori and Kordrostami, 2010). Relative efficiency of a DMU is measuring by dividing weighted outputs to weighted in puts and compares with the efficiency score of other DMUs. The DMU which achieve 100% of efficiency considers as efficient DMU and the others with scores lower than 100% consider as inefficient DMUs (Lee et al., 2008).

Among several techniques, Data Envelopment Analysis (DEA is one of the accurate one in evaluating the organizations performance (Masoumzadeh, 2010). DEA measures the relative efficiency of a group of decision making units (DMUs) which use multiple inputs to produce multiple outputs. Its production frontier plotted using linear programming and each firm is compared to the frontier and assigned an efficiency score (Hussey et al., 2009). It provides a methodology whereby within a set of comparable (DMUs), those exhibiting best practice could be identified and would form an efficient Frontier" (Cook & Seiford, 2009).

It is important to get clarity understanding concerning the issues of efficiency. The definition and the classification of efficiency vary. Farrell (1957) defines *technical efficiency* as the ability of a firm to obtain maximum output from a given set of inputs and *allocative efficiency* as the ability of a firm to use the inputs in optimal proportion, given their respective prices. These two measures are then combined to provide a measure of total *economic efficiency*. In this paper the technical relative efficiency are only disused and the allocative efficiency are omitted. Relative efficiency of a DMU is measuring by dividing weighted outputs to weighted in puts and compares with the efficiency score of other DMUs. The DMU which achieve 100% of efficiency considers as efficient DMU and the others with scores lower than 100% consider as inefficient DMUs (Lee et al., 2008).

DEA imposes no assumptions about the parameters of the underlying distribution of inefficiency- "nonparametric". It assumes that all firms lying distant from the frontier are inefficient. each DMU in DEA method is allowed to select the most favourable weights, or multipliers, for calculating efficiency, which is represented as a ratio of weighted outputs to weighted inputs. Since DMUs treat an input/output factor with varying degrees of importance, the method only distinguishes efficient and inefficient DMUs.

The methods implemented in the program for DEA are based upon the works of Rolf Fare, Shawna Grosskopf and Lovell (1994) for the calculation of technical and scale efficiencies by using the standard of CRS and VRS DEA models. Basically, DEA involves the use of linear programming methods to construct a non-parametric piecewise surface over the data, so as to be able to calculate efficiencies relative to this surface. The computer program considers a standard CRS and VRS DEA models that involve the calculation of technical and scale efficiencies. The method applied in the study is an input orientation with the output from the program includes technical, scale and residual slacks.

Because of its easy and successful application and case studies, DEA has gained too much attention and widespread use by business and academy researchers such as evaluation of data warehouse operations (Mannino et al., 2008), selection of flexible manufacturing system

(Mini and Seema, 2016; Roma and Sebastian, 2014; Liu, 2008), analyzing firm's financial statements (Edirisinghe and Zhang, 2007; Pran Krishansing, 2012). It is a widely recognized technique for evaluating the efficiencies of decision making units (DMUs) in identifying and benchmarking of the airline industry (Zhu, 2011; Barros and Peypoch, 2009; Roghanian and Foroghi, 2010; Merkert & Morrell, 2012) and etc are studied using DEA model in various areas. DEA can also accommodate both financial and operational data (Martin & Roman, 2008). There is no need to know a pre-assumption of production function and there is no limitation in inputs and outputs amounts.

Despite its wide application, it has some issues related with the model. The first issue is that the lack of definition of DMU is also highlighted by Charnes et al. (1978) in their original paper so clearly this is a long-running issue as DEA provides relative efficiency scores meaning that efficiency is not ranked in absolute terms. This should be borne in mind when using DEA as a DMU may score number one (100 per cent) for efficiency but this is only relative to the other DMU's examined and still may fall far short of true optimal efficiency. This gives rise to another issue. One of the assumptions of DEA is that all DMU's of interest are observed and all relevant inputs and outputs have been measured (Gajewski et al., 2009). This leaves the DEA process open to manipulation by vested interests, for example a management team may wish to exclude or manipulate measurements from a particular underperforming DMU. This can lead to some DEA results being nonsensical (Liu, 2009). This issue was specifically identified by Martin & Roman (2008). In their study of Spanish airports managers influenced their efficiency scores by manipulating the inputs i.e. runways, terminal buildings etc. in a particular manner to produce the desired results.

Second, DEA is also very permissive of what actually constitutes a DMU and an input or output. No guidance is provided for analysts and choosing the parameters (Parkin & Hollingsworth, 1997). Additionally, DEA also suffers from methodological difficulties such as: producing many different DMU's since managerially problematic as the efficient DMU's cannot be ranked if several are positioned on the production frontier; multiple projections and multiple reference sets; it is conventional and it cannot provide an industry wide evaluation. Efficiency can only be compared from within the reference set; DEA cannot provide statistical inferences, (Sueyoshi & Goto, 2012)

Third, the issue of data integrity was also highlighted by Kuo & Lin (2012) who suggested that data should be homogenised into values within the same value range which would ensure that the weight range of evaluation indicators is meaningful. It was also suggested that the number of DMU's should be at least two to three times larger than the sum of the number of inputs + outputs. This places an operational limitation on the use of DEA. As DEA is nonparametric no statistical inferences can be made (Chakraborty et al., 2011; Assaf & Matawie, 2010). This also places a limitation on sample size and comes with an associated lack of inferential power when compared to parametric methods.

Fourth, the main disadvantage of DEA method is that there is no provision for statistical noise or measurement error in the model. Hussey et al. (2009) states the limitation of DEA as it assumes no measurement error or random variation and it is sensitive to number of input and output variables. Standard statistical tests to find the significance of the variables or hypothesis testing can also not be applied in this non-parametric technique. Measure of efficiency is relative to members of sample. Use of efficiency score in a regression may violate statistical assumptions.

In general, DEA is a relatively straightforward yet comprehensive non-parametric statistical linear method of efficiency measurement by assuming all relevant inputs and outputs of DMUs. A greater and ongoing issue is the lack of clear definition of what constitutes a DMU and an input or output. Despite the fact that DEA is widely used across many industries and multi-purpose it does require open and honest engagement by managers in reporting their figures. Beyond that, a prudent and systematic application of the process should yield useful and, perhaps even more importantly, actionable information regarding a firms efficiency.

3.2.3. Stochastic Frontier Analysis

Stochastic frontier analysis (SFA) is an econometric method that captures the efficiency with which inputs are converted into an output. The technique is used to study production efficiency, cost and profit frontiers, and economic efficiency. The model as it appears in the current literature was originally developed by Aigner et al. (1977). It allows for measurement error and random variation. Its interest is in the residuals and Error term is decomposed into "random noise" and "measure of inefficiency". SFA must guess the statistical distribution of the inefficiencies in advance. SFA allows a potential shock to its ability to produce care.

Contrarily to the non-parametric methodologies, parametric approaches not only specify functional form, but also take account of the residual term in the analysis. In other words, it provides not only a measurement of efficiency, but can also be used as an “explanation” for inefficiency. The so-called Stochastic Frontier Approach (SFA) requires a functional form in order to estimate the frontier production function and it is based on the idea that the data are contaminated with

In its traditional applications, SFA was applied to assess the production frontier representing the maximum output that can be potentially produced from a given level of inputs Zhao bin et al. (2016). If actual output is operated at the frontier level, the production process is considered fully efficient. Otherwise, the production process is considered technically inefficient, implying the scope for improved production performance. The error term is separated into two components, including a non-negative term and a more conventional symmetric error term. The former captures production inefficiencies, while the latter captures random disturbances.

Stochastic Frontier Analysis method involves regression and analysis of error term. There are various standards against which firm-level efficiency could be implemented under SFA, namely, production, cost, revenue or profit frontier depending on the direction of the research, data availability or decision to impose behavioural objectives in the study (Syed and Dietrich, 2014). A SFA method uses cost function and production function as more. The common independent variables are input prices, outputs and provider characteristics for cost function (Hussey et al., 2009). The researcher must decide whether to use total cost or average cost; he/she must choose functional form and must assume distribution for error term.

For calculating efficiency, Syed and Dietrich (2014) points out the superiority of the SFA model to other alternative parametric and non-parametric methods in a number of respects. Under the deterministic frontier specification, random external events or error in the model specification or measurement of the component variables could also translate into increased inefficiency measures. But stochastic frontier is randomly placed by the whole collection of stochastic elements that might enter the model outside the control of the firm. Due to this attractive feature along with the internal consistency and ease of implementation, stochastic frontier is being considered as the standard and most widely accepted econometric technique for efficiency analysis (Bhaumik et al., 2012; Greene, 2008; Kumbhakar et al., 2012).

Additionally, Kumbhakar et al., (2012) briefly points that the main three important advantage of the econometric frontier are it can investigate the validity of the model specification; it can identify the irrelevant variables and it can permit the decomposition of deviations from efficient levels between “noise” (or stochastic shocks) and pure inefficiency.

The other advantage of SFA that it is a parametric method that uses maximum likelihood estimation and has certain econometric methodological advantages that make it conducive to international marketing research. Matthew and Ryan **(**2015) claims that SFA is better suited for certain types of data sets than other methods because it is useful with both small and large data sets that require researcher assumptions and probability distributions; it can accommodate different types of data as inputs and outputs and it is well-suited for panel data, and in particular unbalanced panel data.

Many varieties of the stochastic frontier model have appeared in the literature. The stochastic frontier model is used in a large literature of studies of production, cost, revenue, profit and other models of goal attainment. There is a growing literature in which the stochastic frontier approach is used to estimate performance. Here are some of the major empirical studies using stochastic frontier analysis.

SFA is applied in bank (Lensink and Meesters, 2012; Aysan et al., 2011) and Salma and Younes, 2015) in airline efficiency (Assaf, 2009); in stock-price volatility (Adjasi, 2009) and (Osamah et al., 2010); in efficient governance (Wided et al., 2007); in technical efficiency change (Rumki, 2010); in economic growth and sustainability (Selin and Jean-Pascal, 2011); in airport efficiency (Héctor and Augusto, 2014); in technical efficiency and meta-technology ratios **(**Mohammad et al., 2014); in foreign direct index (Zhaobin et al., 2016); in corporate efficiencies (Syed and Michael (2014); in manufacturing small and medium enterprises (Muhammet and Ali, 2014); and in human capital development **(**Catarina and Geetha, 2015**)**.

However, it is not without issues that SFA uses many inputs and outputs relative to number of observations and its results is sensitive to assumptions about functional form, error term decomposition, and choice between total and average cost (Hussey et al., 2009). Unlike the DEA, the SFA impose functional form on the data (Carlos, 2005). SFA was again subject to criticism, as it requires a pre-specification of the functional form in the estimation of cost or production frontier technologies. SFA also requires larger sample size than DEA.

2.2.4 The General Comparison among the Three Models: BSC-DEA-SFA

Generally, critique says about both SFA and DEA lack of consideration of quality of products and inadequate case-mix control. Both need for strong but un-testable assumptions. Too few observations require aggregation of inputs and outputs. These methods used by academic researchers not by providers or practitioners. Two scientific methods to estimate the efficient frontier are the econometric frontier and data envelope analysis (DEA). Both have their advantages and drawbacks. According to Carlos (2005), unlike the econometric stochastic frontier approach, the DEA permits the use of multiple inputs and outputs, but does not impose any functional form on the data; neither does it make distributional assumptions for the inefficiency term. Both methods assume that the production function of the fully efficient decision unit is known. In practice, this is not the case and the efficient isoquant must be estimated from the sample data. In these conditions, the frontier is relative to the sample considered in the analysis

Table 1 summarizes the major similarity and difference of each three models. Each model has its own unique advantage and disadvantage and strength and weakness. First, the way of comparison for BSC is an ideal virtual unit whereas is applied against efficiency frontier for DEA and SFA.

Another difference is the use or applicability of variables. While BSC applies the leading and lagging factors, DEA and SFA models uses input and output. The same is true in strong mathematical ranking of DEA and SFA but weak for BSC. The BSC is a widely used means of assessing company performance and does allow for the inclusion of financial and non financial data. However, many aspects of it are largely subjective which results in large amounts of quantitative data which makes direct comparison difficult. Confidentiality and data availability are also issues for an outside researcher seeking to create multiple balanced scorecards for comparison purposes.

Third, DEA and SFA has similarity in high accuracy, in ability of ranking, in benchmarking measurement, inability of future viewing; and strong in applying a mathematical ranking and the reverse is true for BSC. Empirically, two approaches have been developed for use in measuring efficiency: parametric that uses econometric approach and non-parametric that has been traditionally assimilated into data envelopment analysis (DEA), a mathematical programming model. With respect to the parametric approach, this can be subdivided into deterministic and stochastic frontier analysis (SFA) models. Econometricians' criticism of DEA is based on the fact that DEA cannot differentiate between the random variations in productivity and variation in efficiency (Kolawole, 2010)

Finally, the BSC and DEA have similarity as both are non-parametric method; inability to test Hypotheses, both cannot form specify functional form and both does not accommodate statistical noise and both can accommodate output and input while SFA is a parametric method can test hypotheses, need specification of functional form, has econometric estimation and accommodation of statistical noise. Unlike DEA, which uses observed data to construct production frontiers as well as the calculus of efficiency scores relative to those constructed frontiers, SFA assumed that departures from the best practices frontier may be stochastic (i.e. random shocks) or deterministic (i.e. inefficiency). Again, the novelty of this model in comparison to ordinary least squares (OLS) regression lies in the decomposition of observational error into two unobservable stochastic components viz, uncontrollable error representing statistical noise and controllable error representing inefficiency error (Kolawole, 2010).

Table 1 Detail Comparison of the Three Models (BSC, DEA and SFA)

Compatibility	BSC	DEA	SFA
Way of comparison	Compared with an ideal virtual unit	Compared with the efficiency frontiers	Compared with the efficiency frontiers
Variables for review	Leading factors/ lagging factors	Input/out	Input/out
Mathematical ranking	Weak	Strong	Strong
Applicable of measurement	Management by objectives (self management)	Management by benchmarking	Management by benchmarking
Accuracy of measurement	Moderate	High	High
Ranking	Does not support	Has	Has
Future view	Dealing factors	Does not have	Does not have
Improvement focus	Both leading & lagging factors	Only output factors	Only output factors
Regarding organization strategy	Emphasis on improving leading factors	Emphasis to improving productivity (output/input ratio)	
Method	Non-parametric method	Non-parametric method	parametric method
Hypotheses test	Can not	Can not	Can
Functional form	not specified	not specified	needs to be specified
Programming	-	Mathematical	econometric estimation
Accommodate noise	Does not	Does not	Specifies noise
Accommodate multiple outputs and multiple inputs	Can accommodate multiple outputs and multiple inputs	Can accommodate multiple outputs and multiple inputs	Typically can only accommodate single output with multiple outputs

Source: This study, Wu and Liao (2014) and Aryanezhad et al. (2011)

2.3 Empirical Reviews

These section discuses the empirical study of different researchers concerning operational performance measurement of the airlines industry. Primarily, this research is concerned with examining the performance measurements of various airlines including the models used for the study. It particularly focuses on the technical efficiency measurements issues with their objectives specially the model selections, the ample size and regional focus of the study, the data type, qualitative and quantitative the research methods with the research gap, their major finding and the critiques.

Performance measurement has been used evaluating different purposes. The applications of performance measurement evidences are presented as follow in detail. It is applied in different organizations and in different sectors such in service industry such as banking (Dexiang and Desheng, 2010; Ryan et al., 2015 and Thanh and David, 2016) and in health sectors (Vedran et. al., 2012; Aki et al., 2012; Peter and Artie, 2012 and Siddhant et al., (2016); in manufacturing companies (Ruzita et al.; 20108; Abhijeet et al., 2013; Supannika and Deepak, 2011;Luqman et al., 2015); in academic research sectors (Andrey and Mike, 2011); in environmental performance management(Jie et al., 2012; Jose et al., 2012; Maria et al., 2012; Manik et al., 2015 and Andreia et al., 2016) and in supply chain management(Adrien et al., 2009; Omkarprasad and Manoj, 2013; Saurabh et al., 2016; Anup et al., 2015 and Kazi and Nazmul, 2014). Over the last few decades, the problem of performance evaluation has attracted significant attention which led to variety of methods that seek to develop measures to assess the performance of organizations by systematically obtaining and integrating both subjective and objective data (Lu et al., 2012; Ouellette et al., 2010; Gramani, 2012; Lee et al., 2013).

The airline industry is part of the world transportation system. While it shares many things in commonalities with other modes of transportation, it has its own unique features. First, the airline industry is more capitally intensive because of using the advanced technology and sophisticated equipment (Budd, 2012; Chen and Chen, 2012; Liou, 2012).

Second, the demand for air travel is very high price elasticity for leisure travel (Holloway, 2008; Belobaba et al., 2009; Assaf, 2009; Badra, 2009). In addition, O'Connor (2011) describes modern aircraft service have concentrated their promotional activities in order to differentiate their product.

Finally, Petrick (2010) argues that the airline industry is particularly sensitive to business cycles with very high fixed costs and operating leverage that struggles very difficult to survive in time of demand drops. He additionally noted that the use of capital-intensive structure and the practice of using fares and service schedules to gain a competitive edge seem to favour big firms, which eventually form an oligopolistic type of industry structure (Petrick, 2010). Because the airline industry still faces pressure related to brutal competition from airlines from different countries, capitally-intensive, technology-driven, has requirements for wages, gas, and infrastructural investments, an effective performance measurement could be very important for an airline to survive and prosper in the world's competitive airline markets.

Table 2 Empirical Litature Review

Author(s)	Sample size and focus	Method(s) used	Input variables	Output variables
Barbot et al.(2008)	47 worldwide airlines, 2005	BCC-DEA and TFP index (total factor productivity index) and regression analysis	Number of employees; the airline's fleet; fuel; other operating inputs	Passenger revenue; cargo revenue; other revenue
Greer (2008)	8 US passenger airlines, 2000-2004	Malmquist productivity index – input oriented distance function	Employees; fuel; seat capacity	ASMs (ASKs)
Assaf (2009)	12 major US airlines, 2002-2007	Bayesian stochastic production frontier	Labour cost; total oil and fuel expenses; total of other operational costs; number of aircraft; load factor (the ratio of performed ton-kilometres to ATKs)	Operating Revenue (OR)
Barros and Peypoch (2009)	12 European airlines, 2000-2005	Efficiency with CCRDEA models and bootstrapped truncated regression, explaining efficiency in a two-stage approach	Employees; OC; aircraft	RPKs; EBIT
Greer (2009)	18 US airlines, 1999-2008	Input-oriented DEA and A Tobit regression model in a two-stage approach	Labour; fuel; seat capacity	ASMs (ASKs)
Chow (2010)	Chinese airlines, 2003-2007	Efficiency analyzed with DEA and productivity analysis – a Malmquist index based upon output oriented distance function	Full-time employees; aircraft fuel used; seat capacity	RPKs; RTKs
Ouellette et al. (2010)	7 Canadian Airlines, 1960-1999	Input-oriented DEA – technical efficiency and allocative efficiency	Capital; investment (sales of capital at market price; purchases at market price); labour; energy; materials	Unit toll (adding freight output to passenger output converted into ton-kilometres); charter flights (converted into ton-kilometres)
Merkert and Hensher (2011)	58 of the largest passenger airlines, 2008-2009	Input-oriented function DEA model and smoothing homogenous bootstrap approach in a two-stage approach	ATKs as a proxy for capital; staff proxied by ATK price (determined by dividing the sum of all operating costs by average staff cost, as the price for one unit of labour)	RPKs; RTKs

Table 2 Empirical Literature Review (Continued)

Author(s)	Sample size and focus	Method(s) used	Input variables	Output variables
Sjöogren and Söoderberg (2011)	50 major international airliners,1890-2003	A stochastic frontier methodology – input distance function	Producing model: labour; fuel; aircraft capacity; aircraft departures; selling model: ASKs; aircraft departures Total model: labour; fuel; aircraft capacity; aircraft departures	Producing model: aircraft departures Selling model: ASKs; passengers carried; freight carried
Hu et al (2017)	15 ASEAN Airlines, 2010-2014	DEA Return to scale and Quality of mean efficiency	RPKs and total Revenue	Aircraft number, operating cost and ASK
Wu and Liao (2014)	38 major world airlines	Integrated DEA-BSC model and CRS	RPK, Number of passengers, Energy (fuel) cost, Capital cost, Material cost, Labour cost and Other operating expense per employee	Operating revenue (OR) Return on investment (ROI) Return on assets (ROA) Net income (NI)
Barros and Couto (2013)	23 European airlines, 2000-2011	Malmquist and Luenberger productivity measures	Employee; OC; ASKs	RPKs; RTKs
Barros et al. (2013)	11 US airlines, 1998-2010	B-Convex DEA model	Total cost; number of employees; number of gallons	Total revenue; RPMs; passenger load factor
Wu et al. (2013)	12 airlines, 2006-2010	Efficiency with input oriented CCR, BCC-DEA models and bootstrapped truncated regression explaining efficiency in a two-stage approach	Number of full-time employees, OC; number of aircraft	RPKs; Operating Revenue (OR)
Lee and Worthington (2014)	Several airlines, 2006	A bootstrap in output oriented VRS SBM-NDEA (slacks based measure model network data envelopment analysis) and events analysis truncated regression in a two-stage approach	Kilometres flown; number of employees; total assets	ATKs
Lee and Worthington (2014)	Several airlines, 2006	A bootstrap in output oriented VRS SBM-NDEA (slacks based measure model network data envelopment analysis) and events analysis truncated regression in a two-stage approach	Kilometres flown; number of employees; total assets	ATKs

Table 2 Empirical Literature Review (Continued)

Author(s)	Sample size and focus	Method(s) used	Input variables	Output variables
Tavassoli et al. (2014)	11 domestic airlines in Iran, 2010	SBM-NDEA (slacks based measure model – network data envelopment analysis) in two stages: technical efficiency; service effectiveness	First stage of inputs: number of passenger planes; number of employees; number of cargo planes	First stage of outputs: ASKs; ATKs; Second stage of inputs: ASKs; ATKs
Barros and Wanke (2015)	29 African airlines, 2010-2013	TOPSIS (technique for order preference by Similarity to the Ideal Solution) and neural networks in a two-stage approach	Number of employees; total number of aircraft; OC	RPKs; RTKs
Cui and Li (2015b)	11 international airlines, 2008-2012	VFB-DEA (virtual frontier benevolent – DEA) cross efficiency model	Number of employees; capital stock; ATKs	RPKs; RTKs; TBI; CO_2 emission volume
Cui and Li (2015a)	10 Chinese airlines 2008-2012	DEA, Malmquist index and Panel regression model	Labour; capital; fund; technology inputs	The percent of the passenger turnover volume without accidents or incidents to total passenger turnover volume; net profit rate
Li et al. (2015)	22 international world airlines, 2008-2012	VDSBM-DEA (virtual frontier dynamic slacks based measure model – data envelopment analysis) in three stages	Input of first stage: number of employees; aviation kerosene	Output of first stage: ASKs; ATKs; Input of second stage: ASKs; ATKs; fleet size
Mallikarjun (2015)	27 US and European airlines, 2012	Three-stage un-oriented network DEA	First stage of inputs: operating expenses First stage of outputs: ASKs; Second stage of inputs: ASKs; fleet size; destinations	Second stage of outputs: RPMs Third stage of inputs: RPMs

Table 2 Empirical Literature Review (Continued)

Author(s)	Sample size and focus	Method(s) used	Input variables	Output variables
Merkert and Pearson (2015)	Top 150 airlines worldwide by total revenue, 2011- 2012	DEA model and truncated regressions in a two-stage approach	Pre-stage OLS regression variables: operating margin of the ith airline First stage of inputs: ASKs; full-time employees (FTEs)	Pre-stage OLS regression variables: customer ranking score; average fare paid by passenger (passenger revenue/ RPKs); load factor (RPKs/ASKs) First stage of outputs: CUSTOM_RANK, MARGIN; RPKs
Wanke et al. (2015)	35 Asian airlines, 2006-2012	TOPSIS (technique for order preference by similarity to the ideal solution) and CLMM-MCMC (the generalized linear mixed models – Markov Chain Monte Carlo generalized linear mixed models) in a two-stage approach	Main factors represent the airlines inputs: Factor 1 – cost and assets: operational cost; depreciation; salary; total assets Factor 2 – human and physical resources: employees; planes	Main factors represent the airlines outputs Factor 1 – revenue generating drivers: revenue; RPK; passenger Factor 2 – profitability; EBIT
Cui et al. (2016)	21 airlines for which the number of revenue passengers ranked in the top worldwide in 2012, 2008- 2012	VDSBM-DEA (virtual frontier dynamic slacks-based measure model – data envelopment analysis) and Robust regression in a two-stage approach	Number of employees; aviation kerosene dynamic factors: capital stock	RPKs; RTKs; TBI
Li et al. (2016)	22 International airlines from 2008-2012	SBM-DEA (slacks-based measure model – data envelopment analysis); Two models: network SBM with weak disposability and network SBM with strong disposability in a three-stage approach	Input of first stage: number of employees; aviation kerosene	Output of first stage: ASKs; ATKs; Input of second stage: ASKs; ATKs; fleet size

Table 2 Empirical Literature Review (Continued)

Author(s)	Sample size and focus	Method(s) used	Input variables	Output variables
Omrani and Soltanzadeh (2016)	8 Iranian airlines, 2010-2012	Input-oriented CRS NDEA (Network DEA models), DDEA (dynamic DEA models), DNDEA (dynamic DEA with network structure) in two stage	Input of first stage: number of employees Carry over flow among periods: number of fleet's seats	Outputs of first stage: ASKs; number of scheduled flights Inputs of second stage: ASKs; ATKs; number of scheduled flights
Saranga and Nagpal (2016)	13 Indian airlines, 2005-2012	Input oriented VRS-DEA (two type) and a two-way random effects (GLS regression and also a Tobit model) in a two-stage approach	Technical efficiency: staff strength; ASKs; operating expense less employee expenditure/ASKs Cost efficiency: employee expenditure/staff strength	Technical efficiency: RPKs; Cost efficiency: OR/ASKs
Wanke et al. (2016)	19 Latin American airlines, 2010-2014	VDRAM-DEA (virtual frontier dynamic range Adjusted Model – Data Envelopment Analysis) and Simple regression in a two-stage approach	Number of employees; number of aircraft (dynamic factor) Number of domestic flights; number of Latin and Caribbean flights; number of international flights	15 contextual variables: contextual and business-related characteristics of the airline: age, ownership type and RPK average growth; the network size of the airline; and the fleet mix of the airline
Yu et al. (2016)	13 LCC airlines, 2010	Non-radial input-oriented SBM-DEA (slacks-based measure model – data envelopment analysis) model	Number of employee; gallons; number of seats; number of destinations	ASKs
Assaf and Josiassen (2009)	15 major UK airlines, 2002-2007	DEA double bootstrap	labour expenses, aircraft fuel expenses and aircraft value	TKA or tonne kilometres available and total operational revenues

Notes: ASMs, available seat miles; ASKs, available seat kilometres; ATKs, available ton kilometres; RPKs, revenue passenger kilometres; RTKs, revenue ton kilometres; OC, operating cost; SCs, sales costs; TBI, total business income; RPMs, revenue passenger miles; OR, operating revenue.

A number of performance measurement models have been applied for measuring airlines performance. The above Table 2 summarizes the study, the sample size and the focus of the study, the models used and the input and output selections. These contemporary models are DEA-BCC, DEA-VRS, B-Convex DEA Model and TFP index; DEA and productivity analyzed with Malmquist index; Malmquist index; DEA Stochastic Bayesian production frontier and TOPSIS model. We have presented some of these models in the following manner by starting from the most common model to the other models.

Airline performance studies consist of the majority of aviation industry research for different purposes with numerous methods. Various methods have been employed to airlines performance studies. Even if their objectives of the study of most of the researchers have similarity in measuring the operational performance of technical efficiency, still they have some difference in their objectives.

Generally, they have assessed the performance of the airlines in different ways. For example, Assaf and Josiassen (2011) and Barbot et al. (2008) investigated the efficiency and productivity of the airlines; Saranga and Nagpal (2016) identified critical drivers of performance; Chow and Kong (2010) and Barros and Couto (2012) evaluated productivity change; slightly differ the study of Lee et al. (2015) in measuring productivity growth and the study of Anton Brits (2010) in determining changes of total-factor productivity measure; again Barros et al. (2015), Wu et al. (2014) and Barros and Peypoch (2009) assessed airlines performance; Joo and Min (2015) evaluated efficiency by adding strategic alliances and managerial impact; Molhotra (2012) and Fowler and Joo (2014) analysed benchmark and operating efficiency; Assaf et al. (2013) analysed and evaluated airlines performance; Karlaftis et al. (2009), Lee and Worthington (2014) and Barros and Wanke (2015) estimated technical efficiency; Arjomandi and Seufert (2014) examined both environmental and technical efficiency of airlines; Lee et al. (2011); Yank and Zhu (2015) and Barros et al. (2013) have measured technical efficiency of the airlines.

Again, as table 2 shows that the selections of the models for measuring technical efficiency vary from one to other. The use of the model for the measurement of the operational performance of the airlines differ one from the other but most of the study apply DEA in different specifications ways to measure efficiency. DEA is one of the most prolific performance measurement methods used in airline performance studies. With airlines performance studies various models of DEA are used by researchers investigating the airline industry.

First application of DEA model has been applied in the following studies. Barbot et al. (2008) used DEA with total productivity Factor; Saranga and Nagpal (2016) used two sage DEA; Chow and Kong (2010) applied Constant Return of Scale(CRS)- DEA but on the contrary Joo and Min (2015) used the opposite Variable Return of Scale (VRS)-DEA output oriented; and again Fowler and Joo (2014) mixed DEA with Tobit Regression analysis; Wu and Liao (2014) integrated BSC and DEA; Rashim Molhotra (2012) used simple DEA; Barros and Peypoch (2009) applied the two stage DEA-CCR index model; Arjomandi et al. (2014) used Bootstrap DEA model under VRS; Lee et al. (2011) applied two sage bootstrap DEA and Lee and Worthington (2014) used two stage DEA-VRS output oriented, bootstrap DEA and Truncated regression analysis. Lin (2012) used DEA model but gave no indication of which model was used, i.e. BCC, CCR or pure scale.

In other studies, only one model has been used by Arjomandi & Seutert (2014); Zhu (2011); Assaf & Jesiassen (2011); Lu, Wang, Hung & Lu (2012); and Lee & Worthington (2014). More inclusive results are accomplished by studies that apply to two or more DEA methodologies (Merkert & Morrell, 2012; Joo & Fowler, 2014). While Merket & Williams (2013) used all three models (BCC, CCR and Pure Scale) only technical efficiency was reported but the rest of results for pure scale and pure technical efficiency are not available. Again, data were drawn from both primary and secondary a source which gives rise to the previously documented issues.

Second, Stochastic Frontier Analysis (SFA) model has been applied next to the DEA in assessing the operational performance of the airlines. Karlaftis et al. (2009) used SFA; Assaf and Josiassen (2011) used Bayesian Distance Frontier Model; Lee et al. (2013) specified an environmental technology and Yank and Zhun (2015) used Cobb-Duglas production function regression model.

Third, the other researcher applied TOPSIS Model. These are Barros et al. (2015) who used TOPSIS Model and Barros and Wanke (2015) who applied TOPSIS model and added Neural Network model. Fourth, other methods have been used sporadically in airline performance measurement. Zuidberg (2014) used econometric analysis to identify the influence of airline characteristics on average operating cost per aircraft movement. Barros & Couto (2013) and

Jentabadi & Ismail (2014) used the Luenberger Productivity Indicators and Structural Equation Modelling respectively to evaluate productivity and overall airline performance. Both of these studies used financial and operational data. Barros and Couto (2012) applied Malmquist Index and Luenberger indicator Anton Brits (2010) used Total Factor productivity (TFP) index and econometric approach; Asraf et al. (2013) critically reviewed airlines performance; and Barros et al. (2013) used B-convex model.

The sample size and the focus of the study are the other area of discussion in this study as table 2 indicates. Assaf and Alexander (2011) measured the efficiency of UK airlines in light of all the recent industry challenges; The sample size and the focus of the study vary from study to study however most of technical efficiency assessments focus on the world airlines, and Asian, US and European are the third, fourth and fifth respectively.

First, major studies of technical efficiency measurement focus regions are observed on the world airlines. Table summarize sample size and focus of study. The Merkert and Pearson (2015) has studied the highest number of top 150 airlines worldwide for the year 2011- 2012and next Merkert and Hensher (2011) 58 of the largest passenger airlines from the year 2008-2009 though Sjöogren and Söoderberg (2011) 50 major international airliners they seems to use relatively older data than the rest of the study 1890-2003; Barbot et al. (2008) 47 worldwide airlines for the year of 2005 and Cui and Li (2015b) studied the least number of 11 international airlines from the 2008 to 2012.

Second highest study focus on the Asian regions. These studies include Wanke et al. (2015) examined 35 Asian airlines for the year 2006-2012; Chow (2010) studied Chinese airlines from 2003-200; Hu et al (2017) observed 15 ASEAN Airlines from 2010- 2014and Cui and Li (2015a) inspected 10 Chinese airlines from 2008- 2012.

The third major focus of study is US regional airlines. These include Mallikarjun (2015) observed 27 US and European airlines from 2012; Barros et al. (2013) studied 11 US airlines, 1998-2010; Greer (2008)and Greer (2009) investigated 8 US passenger airlines 2000-2004 and 18 US airlines from 1999-2008 respectively and Assaf (2009) studied 12 major US airline from2002-2007.

The fourth focus of study is European regional airlines. These are studied by Barros and Peypoch (2009) who investigated 12 European airlines from 2000-2005; Barros and Couto (2013) studied 23 European airlines 2000-2011 and Assaf and Josiassen (2009) inspected 15 major UK airlines for the year 2002-2007.

Finally, the last and the least regional focus of study are noticed African and Latin American airlines. For example, Barros and Wanke (2015) dealt with 29 African airlines from 2010-2013 and Wanke et al. (2016) examined 19 Latin American airlines in the years between 2010 and 2014.

There are a number of issues related to selection of inputs and outputs. Table 2 lists some examples of input and output variables found in the literature. Do airlines have clearly defined and quantifiable outputs and inputs? The answer is undoubtedly NO. Consequently, various measures of outputs and inputs have been defined and used in airline technical efficiency studies, often based on data availability. Operating Revenue is employed in (Barbot et al., 2008; Assaf, 2009; Wu and Liao, 2014; Barros et al., 2013; Wu et al., 2013; and Merkert and Pearson, 2015).

Revenue Passenger Kilometres (RPK) are applied by (Barros and Peypoch,2009; Chow, 2010; Merkert and Hensher, 2011; Hu et al., 2017; Barros and Couto, 2013); Barros et al., 2013; Wu et al.,2013; Barros and Wanke, 2015; Cui and Li,2015b; Merkert and Pearson, 2015) are the common output measures for scheduled passenger services however in this study RPK is used as an input based on the study of Wu and Liao (2014). RPK is the product of the number of paying passengers and the number of kilometres they travelled (Barros and Peypoch, 2009).

Number of passenger of passenger is applied in study of (Sjöogren and Söoderberg, 2011 and Wu and Liao, 2014), labour cost used in the study of (Assaf, 2009; Greer, 2009; Sjöogren and Söoderberg, 2011; Wu and Liao, 2014; Cui and Li, 2015a); energy cost is employed in Barbot et al., (2008); Greer (2008); Greer (2009); Chow (2010); Ouellette et al. (2010); Sjöogren and Söoderberg (2011) and Wu and Liao (2014)

Importantly, capital cost and material cost are commonly utilized in the following study of Ouellette et al. (2010) and Wu and Liao (2014) and Cui and Li (2015a) as an input. The other cost as an input is used by Barbot et al., (2008); Assaf (2009) and Wu and Liao (2014).

However, Net Income (NI), Return on Asset (ROA) and Return on investment (ROI) are the least output variables used by Wu and Liao (2014).

Finally, there are some similarity and contradicting findings among the performance measurement of technical efficiency of the airlines though most of the studies are not directly related. Barbot et al., (2008) found out that LCC are in general more efficient than full service carrier; Lee et al (2013) concluded that a pollution abatement activity of airlines lowers productivity growth; Barros and Peypoch (2009) remarked that operational efficiency is in a growing trend; Fowler and Joo (2014) claimed that European airlines are the lowest efficient airlines among the airlines.

Wu and Liao (2014) found that excellent efficiency frontier performing airlines perform better in energy, capital and other operating costs; Molhotra (2012) found DEA brings out the high and poor performing airlines; Barros et al. (2015) refuted that efficiency level were stagnated over the period of analyzed implying inexistence of a learning curve; Chow and Kong (2010) proved that non state-owned airlines are performing better than state-owned airlines; Bhadra (2009) noted that airlines productivity appears to be converging overtime and all LCCs have been found to perform efficiently within compared within their own peers.

Barros et al. (2013) supported that Us airlines display a reasonable level of efficiency with some airlines maintaining a remarkable level of efficiency in all years while the other airlines present inefficiency in some years; Barros and Couto (2012) found that most European airlines did not experience productivity growth between 2001 and 2011; Joo and Min (2015) rejected that airlines alliances did not necessarily improve the participating airlines comparative operating official despite it cost saving potential due to share resources; Assaf et al. (2013) assumed that airlines performance have been sprawling around multifaceted topics including management, institution and organizational structure.

Lee and Worthington (2014) asserted that non-US and non-European international airlines do perform at efficient levels which provides a benchmarking for poorly performing airlines in US; Barros and Wanke (2015) observed that network size-related variables are the most important variables of efficiency level; Assaf and Josiassen (2011) supported that European airlines have slightly higher efficiency and productivity growth that US airlines; Arjomandi and Seufert

(2014) proved that many of the most technically efficient airlines are from china and North Asia while many of the best environmental performers are from European; lee and Worthington (2011) asserted that non-US and no-European international airlines do perform at efficient levels which provides a benchmarking for poorly performing airlines.

Yank and Zhu (2015) claimed that large airlines have higher technical efficiency but less Increasing Return of Scale technical efficiency that the small one and the trend of technical of airlines in china is growing up every year; Karlaftis et al. (2009) supported that airlines experience constant returns to scale while technical efficiency ranges between 50% and 97% approximately and Nagpal and Saranga (2016) claimed that while some of structural and regulatory factors have an undesirable impact on airlines performance, lowest carriers in India have managed to achieve significant operational efficiency

Therefore, this study argues that there are research gaps in terms of selection of models and selections of research variables and measure. The study further noted that the selection of recent data and the series of the panel of data and focus of the study will be bridged by this study.

3.4 The Research Gap

From this brief review of theoretical and empirical study we find that although numerous studies have attempted to assess airlines efficiency in the world, the in-depth literature review indicates that there exists a limitation of study in focusing on measuring efficiency using integrating the BSC-DEA-SFA models together. Hence, the study fills the gap and yields original significant contributions to the literature of performance measurement theory through comparing results between SFA and DEA to explore the efficiency of different inputs and outputs using the newly developed integrated models. Moreover, the study tries to make a particular and a detailed analysis of Ethiopian airlines in relation with the world major airlines using regional analysis of airlines so as the new model enhances a strategic operating efficiency of Ethiopian airlines and the rest of all the airlines.

Specifically, the four dimensions of BSC are used as the input or output factors of DEA and SFA to ensure the comprehensiveness of the input-output data. Particularly the important contributions of this study fill the previous gaps which include:

(1) The gaps of incorporating the lagging and leading factors of BSC for the input/output variables of DEA and SFA;

(2) The gaps of implementing significant canonical correlation analysis to verify the interrelationship among four factors of BSC; and

(3) The gaps of integrating input and output efficiency to address managerial implications to decision making to set up improvement strategies

(4) The gaps of assessing the relative efficiency of the airlines by using the alternative efficiency measurement DEA and SFA models.

(5) More importantly, the gaps of developing an integrated DEA-SFA-BSC model to measure the operating efficiency of the airline industry;

The study makes a novel contribution to the literature, as there has been a limited research area. As it offers an integrated model that incorporated the concepts of BSC; DEA and SFA, the leading and lagging factors of BSC were adopted to the evaluation of operational performance of international airlines along with DEA and SFA. Therefore, BSC has served as the compliment of DEA and SFA. Using the DEA-SFA-BSC results, such as the efficiency frontiers, the amount of slacks, and benchmark learning partners, business executives could develop their improvement strategies.

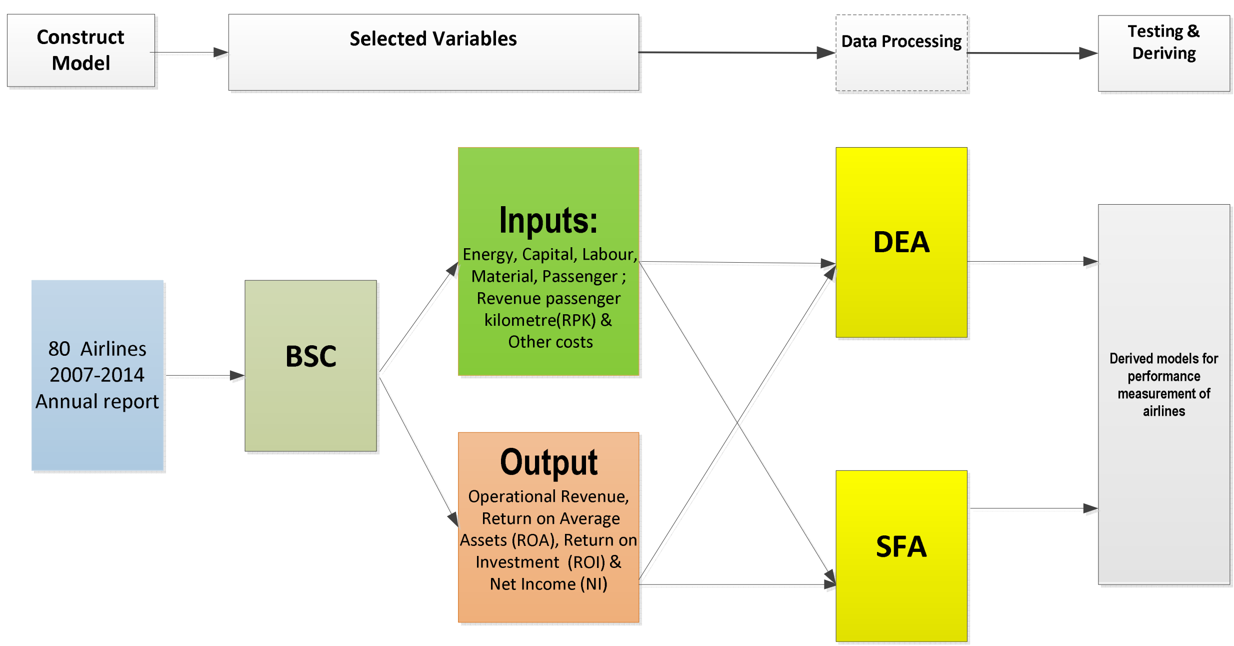
Since previous studies have neglected to integrate BSC; DEA and SFA to assess the operational efficiency of the airline industry, the results of this study could serve as a baseline for further academic validations; the results could also be very useful for the executives of airline companies to allocate their resources for further improvement. Thus, it provides insights into when firms trade-off or accumulate capabilities. A good understanding of asset and operating frontiers is important in this regard. Managers need to better identify, establish and combine their firms' resources in response to varying internal and external contingencies.

Therefore, the researcher claims that this study fills the pervious gap and provides an original and detailed empirical validation of BSC-DEA-SFA integrated model. In doing so, this study contributes to informing and clarifying the debate in the strategic performance measurement area relating to the circumstances in which firms trade-off and/or accumulate efficiency.

2.5 Conceptual Framework

Based on the above three models, the study proposes the following conceptual framework to be investigated. Figure 3 summarizes the conceptual framework of the study. Generally, the research project constructs model and selects variables; process the data and finally produces a model after meticulous test. Specifically, inputs and outputs are identified using the BSC concepts. Next, sample of eight years data are taken using simple random sampling technique. The inputs and outputs are integrated into the two alternative methods: DEA and SFA. Finally, a unified comprehensive integrated model is developed. This model is believed to measure relative technical efficiency of airlines industry and other organizations better.

Figure 3 Conceptual Framework of the Study



Source: this research

An Integrated BSC- DEA- SFA Model

Since DEA, SFA and BSC have several limitations as stated above, an integrated BSC-DEA-SFA approach has been developed to evaluate the performance of the airline industry. The integration of these models as presented in this study is more advanced than the capabilities of DEA, SFA and BSC alone.

Although an integration of DEA and BSC has been adopted in a few studies (Chen et al., 2008; Garcı´a-Valderrama et al., 2009; Asosheh et al., 2010 and Wu et al.2012), none of them has been adopted in the airline industry to integrate BSC, DEA, and SFA . Since DEA, SFA and BSC have several limitations as stated above, an integrated DEA-BSC approach has been developed to evaluate the performance of the airline industry. The integration of these models as presented in this study is more advanced than the capabilities of DEA, SFA and BSC alone.

On one hand, BSC is a widely acceptable performance measurement system. The leading and lagging factors of BSC are adopted by incorporating both the lagging and leading factors of BSC for the input/output variables of DEA and SFA to evaluate the relative performance of airlines. In other words, the BSC structure is embedded into DEA and SFA model through a balanced consideration. This integrated model not only can minimize information overload by limiting the number of measures used (Kaplan and Norton, 1996), but the scorecard also can be developed by linkage to key success factors. On the other hand, DEA can set a benchmark for companies based on their inputs and outputs and can also transform performance measures into managerial information.

This conceptual framework tends to use different variables to represent customer orientation, internal process improvement, and financial performance. However, none of the previous BSC-DEA-SFA model has been adopted for the airline industry. So this study aims to measure the operating performance of the airline industry by developing DEA-SFA-BSC model. Specifically, to create a systematic relationship between DEA, SFA and the BSC, the conceptual framework asserts that the integrated DEA-SFA-BSC model could improve the overall capabilities of three models and it also reduces the faults of each one.

In addition, in order to evaluate the competitive position of airline companies, managers can apply the integrated BSC-DEA-SFA model to identify the efficiency frontier, benchmarking partners, and inefficient slacks for each of the airlines. It is important for each airline company to understand its relative position in term of productivity and efficiency. The results of this study are intended to provide competitive information and learning partners which are essential for firms to design their long term strategies and objectives.

Chapter: 3 Research Design

3.1 Introduction

This chapter introduces the research designs and methodology including research tool selection and validation; data availability and collection; and sampling techniques. Empiricism is an approach taken in the pursuit of knowledge that asserts that only when that knowledge is gained through experience and the senses can it be considered sound.

The methodology used in this study presents a novel contribution to the Ethiopian Airlines and to the world airline literature and other organizations. In contrast to most previous studies in the literature that failed to incorporate the theoretical regularity conditions (i.e. the BSC, DEA and SFA integrated comparative approach) in the estimation of the efficiency, our model is estimated subject to full theoretical regularity as none of them has been adopted in the airline industry to integrate BSC, DEA, and SFA

This chapter is organized as follows. First, it discuses research process, research approaches, research type, research design, sampling techniques of the study, data collection method, data analysis method, Validity and reliability of the study.

3.2 Research Process

This framework provides an excellent overview and starting point when considering a research project. It gives insight into not only the thought process but also into what is required procedurally in order to execute a research project.

Saunders et al. (2007) presented a more detailed and formal approach to research with their Research Onion diagram. The research onion identifies and examines each major step in the research process and provides the researcher with an overview of each step.

Overall, the research onion provides a comprehensive six step approach to research. The research presents a similar but more detailed approach to research:

Step 1 – Identify Research Question

Step 2 – Establish Research Objectives

Step 3 – Select Research Strategy

Step 4 – Prepare a Research Plan

Step 5 – Review the Literature

Step 6 – Gather the Data

Step 7 – Analyse and Interpret the Data

Step 8 – Prepare and Present the Findings

In terms of describing the research process used in this study with reference to reliability, replicability and validity of the scientific philosophies are used as underlying guiding principles. Each piece of research is, by its very nature, a unique process and as such may not fit a pre prescribed structure. With this in mind the following describes the steps taken by the researcher in carrying out this study.

3.2.1 Step 1 – Identify Research Question

At the beginning of the study after exhaustive efforts, the researcher has been searching for a topic associated with strategic vision of the Ethiopian airlines and interrelated issues for the selection of topic since then he has been familiar with a number of articles related concerning the airlines and much of the study were done on the performance evaluation of airlines. Then, he has gained an interest and developed a deep understanding of the airlines industry with the issues of technical efficiency assessment. He has found the research gap from what he has witnessed on the massive changes that have taken place across the international industry as a result of the arrival of the low cost carriers, financial recession, 9/11, SARS, raising fuel price, to the marketplace. During this time many companies tried and failed to successfully emulate the low cost model including attempted moves to low cost carrier model by legacy carriers. This would suggest that emulating the low cost model is not as straightforward as it might appear, nor is it a guarantee of success. Thus the research question becomes 'What elements constitute highest efficiency of the airlines?'

3.2.2 Step 2 – Establish Research Objectives

Fundamentally, this research sets out to examine world major airlines in an attempt to identify those who are leading the field in terms of airlines performance. In addition, it is intended to benchmark the airlines examined and investigate their financial, operational and strategic activities in an attempt to identify best practices or common characteristics that may be followed by the poorer performing airlines with a particular emphasis of Ethiopian airlines. Above all, the major objective of the study is to develop an integrated comparative model which is a unified comprehensive model to measure technical efficiency.

3.2.3 Step 3 – Literature Review

A review of the relevant literature is carried out. This review covered two main areas performance measurement techniques and the current literature surrounding performance measurement in airline. Chapter 3 looked specifically at performance measurement techniques. The goal is to identify a suitable technique that would measure financial and operational performance. It is necessary that publicly available data could be used as the researcher has no access to proprietary data. The Balanced Scorecard, Data Envelopment Analysis and Stochastic Frontier Analysis are all reviewed. The reviews are conducted in both a general context and more specifically within the context of airline performance measurement.

Chapter 3 also reviews the literature specific to performance measurement from an airlines perspective. This is carried out with a view to identifying a gap in the literature. From this review DEA was identified as one of the most commonly used analysis techniques with regard to assessing company performance in airlines. This highlights DEAs and SFA suitability for performance analysis in the airlines sector above that of other methods. None of the studies integrated using of BSC- DEA and SFA to its full potential together. DEA consists of three different methodologies for assessing efficiency, but in the majority of the studies reviewed only one or two methodology was employed. In this study, all three DEA models Variable Return of Scale (VRS) and Pure Scale methodologies will be used and applied in comparative with SFA. In the majority of the studies data sources were either not provided or the data were obtained from a mix of third party agencies i.e. International Civil Aviation Organization (ICAO) or International Air Transport association (IATA) and some cases included data that were taken from the airlines themselves.

Although DEA is a frequently used method for assessing company performance in an airlines context, to date the structure of the majority of the empirical work appears to be; investigate general data availability (i.e. investigate what data has been collected and made available by a third party such as IATA, ICAO or www.wikinvest.com) → apply DEA → report result. This approach ultimately results in a study of DEA and SFA using airline data. This researcher proposes the opposite, a study of airlines using DEA & SFA , by adopting the input and output using the BSC concept and following structure, select target group for investigation (airlines) → investigate specific data availability directly from target group → apply DEA & SFA model → report result → further analysis. This approach not only allows for more targeted results i.e. a DEA & SFA study on a group of specifically selected airlines as opposed to a "group of airlines" but gives a deeper insight into how these airlines are performing, why they appear where they do when ranked alongside their peers and then provides specific, actionable targets in order to improve performance. The further analysis aspect of the study consisted of case studies of high, medium and low performing airlines as identified from the Data Envelopment Analysis and Stochastic Frontier Analysis. This allowed for the identification of best practice across a range of financial and non financial headings.

The result of the review is the identification of Data Envelopment Analysis and Stochastic Frontier Analysis as a suitable technique for the purpose of the study. DEA and SFA are chosen as they are the best methods of those reviewed that could handle operational and financial data combined, only SFA did require specialised knowledge or "insider" information and could cope with variables of differing units. This specialized knowledge gap would be filled using the expert's assistance.

3.2.4 Step 4 – Research Plan

Research strategy is primarily concerned with the quantitative strategy. Bryman & Bell (2007) describe the quantitative research strategies thus: Quantitative research is deductive, tests theories. Initially it was intended that research strategy for this study was supposed to be qualitative one and make use of interviews with senior airline managers. It was envisaged that through cross referencing of pre-defined questions in conjunction with open ended questioning a pattern would emerge pointing to various "best practices" which could then be recommended for application to varying degrees across the industry. This course of action proved to be unrealistic very early in the process for various reasons including access to the relevant personnel, time constraints and commercial sensitivities. Therefore, the researcher finally used quantitative research strategy which is the best and the ultimate research strategy for this type of research.

3.2.4.1 DEA and SFA Model Parameter Selection

With respect to data availability this study uses labour costs, fuel costs, material cost, capital cost, RPK (Revenue passenger Kilometre), number of passengers as input and other operating expense per employee and it is insignificant. The outputs used for this study are operating revenue, net income (NI), return on asset (ROA), and return on investment (ROI). Tonne KMs is not used as this study did not include cargo figures. Regarding the availability of data an effort is made to align these chosen variables with the most commonly used BSC's variables as input and output. It should be noted that there is a certain level of distortion when using inputs/outputs such as number of employees and EBIT. In the case of number of employees this distortion arises through the use of outsourcing. Contract workers are not counted as employees but do contribute to input. EBIT may also be distorted depending on whether or not an airline owns or leases some or all of its fleet. It should also be noted however that in the cases of those airlines that do carry cargo the resources utilised to deliver this service are included in all of the inputs used for this study but only one of the outputs (EBIT).

There is no agreement on the number of DMUs that should be used in a data envelopment analysis. There is a general consensus that the minimum number of DMUs should be twice total number of inputs plus total number of outputs, which in this case would give six DMUs. A DMU may constitute another airline within the group to be examined i.e. revenue passenger miles flown or it may constitute values from the same airline but from different time periods i.e. revenue passenger miles flown in each quarter. It is accepted that the more DMUs included the more accurate the results will be. There are obvious limitations to this approach and many studies use a rule of thumb which suggests: total number of inputs plus total number of outputs times two as the minimum number of DMUs used Wu et al, (2012). Using this rule of thumb gives seven inputs + four outputs × two which results in a recommended minimum of 22 DMUs. This study uses 22 DMU's which is greater than the recommended minimum.

DEA & SFA may be input or output oriented. In the case of an input oriented DEA & SFA the focus is on making changes to the input variables in order to achieve efficiencies. For example, an airline may achieve an efficiency score of 80 per cent in an input oriented DEA meaning that it needs to reduce its inputs while maintaining output values in order to achieve a higher efficiency score. Conversely, an airline may achieve an efficiency score of 80 per cent in an output oriented DEA meaning that it needs to increase its outputs while maintaining input levels in order to improve efficiency.

This study uses an input-oriented model as this provides an indication of capacity shortfall and encourages a more strategic approach to improving efficiency as opposed to the often “blunt instrument” approach of reducing inputs.

3.2.5 Step 5 – Gather the Data

The date is gathered from Cargo only airlines will be excluded as one of the input variables selected are total number of passengers. Mixed cargo/passenger airlines are accepted. It might be more correct to define these airlines as passenger carriers who also carry cargo. There is no difference among airline business model airline follows or the ownership of the airlines or the strategic alliance of the airline for consideration of selection of samples. The time period selected for the data collection was the year 2007-2014. Data collection takes into consideration from 2007 to 2014. The year 2014 is the latest period and 2007 is the oldest for which annual reports are available. A random sampling technique is essentially approach taken to the data collection from each airlines annual report. As a result of this process and simple random sampling technique, 80 samples of airlines reports are selected for further attention. This will be further refined based on the inputs/outputs identified above, of the original 100 airlines investigated 80 are checked for provision of enough commonality of data to be used in this study.

Each report will be read and if a particular report is felt to be providing sufficient data, it will be put aside for closer investigation. If the annual reports are not available in English, it would be discounted so are others quite brief documents with little substance or usable data.

3.2.6 Step 6 – Analyse and Interpret the Data

Once the various elements of the proposed Data Envelopment Analysis and Stochastic Frontier Analysis model are established (i.e. inputs/outputs and number of DMUs) the analysis is performed.

3.2.7 Step 7 – Prepare and Present the Findings

This study consists of Data Envelopment Analysis and Stochastic Frontier Analysis of world major airlines. All three DEA models (CCR, VRS and Pure Scale) and SFA model are performed and further analysis, primarily in the form of a comparative case study, are carried out based on the results. An evaluation of the robustness of each efficient airlines efficiency score are also carried out in order to ascertain which airlines are suitable role models for the less efficient airlines. The data is taken solely from secondary sources i.e. annual reports and business reports. The basic DEA & SFA model results and findings are presented primarily in tabular and graphical format as this provides a clear and concise overview of the model outputs. Finally, the researcher made a conclusion and forwarded a recommendation to be made.

3.3 Research Approach

Quantitative research approach is employed for this study purpose because the nature of the research which is appropriate for this study. These practical considerations give rise to the decision to use publicly available, accessible data which necessitated a quantitative approach. A quantitative approach by definition is concerned with measurement through the collection of numerical data. This allows for reliability of measure and makes the research easier to replicate.

As a quantitative type research, this study is concerned with causality relationships between variables. This study deals with the identification of the best performing airlines and then it identifies common characteristics that they may share. This in turn requires the identification of a performance measurement technique that could make valid use of such data. Finally, the availability of the data required investigation. Several techniques are considered but given the constraints of data availability and the lack of requirement for "industry expert" input and its flexibility Data Envelopment Analysis and Stochastic Frontier Analysis are chosen.

3.4 Research Type

The research is explanatory type. As a quantitative type research, this study is concerned with causality relationships between variables. An exploratory research project is an attempt to lay the groundwork that leads to future studies, or to determine if what is being observed might be explained by a currently existing theory. Most often, exploratory research lays the initial groundwork for future research.

3.5 Research Design

This study uses an in-depth case study based airline industry of world major airlines with a particular emphasis of Ethiopian Airlines by using of secondary data since case study is preferably used to explore in detail and in depth through a panel of data. Case study understands the intricate complexity and idiosyncrasy of one particular case. Its goal is to understand and report the uniqueness of individual cases (both commonalities and differences and it is usually no attempt to represent case by single or multiple “scores”. An empirical study is employed using cross-sectional research design with a panel of unbalanced data from 2007-2014. Empiricism in this study is an approach taken in the pursuit of knowledge that asserts that only when that knowledge is gained through experience and the senses can it be considered sound.

3.6 Sampling Design

3.6.1 Population of the Study

The population for this study is world major airlines which are currently operational in the world including Ethiopian airline. In order to “define” a population, it is decided to limit the study to major world airlines which are listed as 100 top performing airlines in term of revenue by global financial insight analysis. The top 100 airlines are selected merely by their highest financial performance (top Revenue). The researcher uses the top financial performance evaluation as a method of screening the airlines population. Next, the availability and content of each airlines annual report are investigated. The 100 annual reports are accessed online through the relevant airlines website. The authenticity of data of airlines is crossed checked against International Civil Aviation Organization (ICAO) and International Air Transport Association (IATA). Any reports not available in English will be discarded. The remaining reports are read in their entirety.

3.6.2 Sampling Technique

Simple random sampling is used for this study. The of the availability data and the commonality of data are identified through the systematic reading of each available annual report and recording potential inputs and outputs using the concept of BSC is the reason for using the Simple random sampling technique.

Simple random sampling is the basic sampling technique where we select a number of airlines for study from a population of airlines. Each individual airline is chosen entirely by chance and each member of the population has an equal chance of being included in the sample. Every possible sample of a given size has the same chance of selection.

An unbiased random selection of airlines is important so that if a large number of airlines samples are drawn, the average sample will accurately represent the population. However, this does not guarantee that a particular sample airline is a perfect representation of the whole airlines industry. Simple random sampling merely allows one to draw externally valid conclusions about the entire population based on the sample.

Conceptually, simple random sampling is the simplest of the probability sampling techniques. It requires a complete sampling frame, which may not be available or feasible to construct for large populations. Advantages are that it is free of classification error, and it requires minimum advance knowledge of the population other than the frame. Its simplicity also makes it relatively easy to interpret data collected in this manner. For these reasons, simple random sampling best suits situations where not much information is available about the population and data collection can be efficiently conducted on randomly distributed items, or where the cost of sampling is small enough to make efficiency less important than simplicity.

3.6.3 Sample size

Sample size is determined by using Slovin's Formula analysis. Of the 100 airlines population, only 80 airlines will be selected to perform a Data Envelopment Analysis and SFA by taking a confidence level of 95 percent (which will give us a margin of error of 0.05).

$$n = \frac{N}{1 + Ne^2}$$

Where n=sample size;

N =population size and

e = margin error or deviation from sample.

n=100/(1+100(0.0025)

n=80

Wu et al. (2012) and Roll et al. (1989) established rule of thumb to determine the size of sample. Minimum requirement for limiting the sample size is the number of units (DMUs) for DEA should be at least twice the number of inputs and outputs considered (Wu et al., 2012).

Sample airlines

Table 3-Summarises Number of DMU between the Year 2007 and 2014

	2014	2013	2012	2011	2010	2009	2008	2007
Number of DMU	33	39	39	36	40	29	29	43
Cargo	6	6	5	6	4	6	3	6
NI(-)	20	14	17	18	16	22	22	3
Incomplete	21	21	19	20	20	23	26	28
Total	80	80	80	80	80	80	80	80

The above table 3 indicates the number of DMU from the year 2007 to 2014. The 80 total size of sample of airlines are selected randomly for each year. However, due to some reasons (i.e. cargo, NI and incomplete data) the number of DMU varies from year to year. Therefore, in 2014, the number of DMU is 33; in 2010 number of DMU is 40 and in 2007 the number of DMU is 43. The highest number of DMU is 43 in year 2007 and the lowest number of DMU is 29 in year 2008 and 2009.

Other Related Study's sample

Table 4-Indicates the other Related Study's Sample

Author	**Sample size**
• Wu et al. (2012)	• 38 world major airlines
• Arjomandi et al. (2014)	• 48 of the world' s major airlines
• Barros et al. (2013)	• 11 USA Airlines
• Barros and Couto (2013)	• 23 European Airlines
• Merkert and Hensher (2011)	• 15 US Airlines
• SjÖogren and SÖderberg (2011)	• 18 Major UK Airlines
• Ouellette et al. (2010)	• 50 Largest Airlines
• Barros and Peypoch (2009)	• 12 US Airlines

3.7 Research Models Specifications

The following are the research models specifications which are used for the study.

1. Data Envelopment Analysis (DEA)- Charnes et al. (1978) and
2. Stochastic Frontier Analysis (SFA)-Aigner et al. (1976)

3.7.1 DEA Model Specifications

The DEA methodology measures the performance efficiency of organizations units called DMUs. This technique aims to measure how efficiently a DMU uses the resources available to generate a set of outputs. The performance of DMUs is assessed in DEA using the concept of efficiency or productivity defined a ratio of outputs to total inputs. Efficiencies estimated using DEA are relative, that is, relative to best performing DMU or DMUs (if multiple DMUs are the most efficient). The most efficient DMU is assigned an efficiency score of unity or 100%, and the performance of other DMUs is vary between 0 and 100% relative to the best performance.

Consider a set of n observations on the DMUs. Let us define the following:

$j = 1,2,\ldots\ldots,n$ DMU

i=1,2,……m inputs

r=1,2,……s outputs

Each observation, DMU_j, j=1, 2,……, n, uses:

x_{ij} - amount of input i for unit j, i =1,2,……,m and j = 1,2,……,n

y_{ij} - amount of output r for unit j, r =1,2,……,s and j = 1,2,……n

u_r - weight assigned to output r, r = 1,2,…… ,s.

y_i - weight assigned to input i, i = 1,2,……,m.

The DEA methodology gives a measure of efficiency that is defined as the ratio of weighted outputs to weighted inputs. The most important issue in this method is the assessment of weights. Charnes et al. define the efficiency measure by assigning to each unit the most favourable weights. In general, the weights will not the same for different units. Further, if a unit happens to be inefficient, relative to others, when most favourable weights are chosen, then it is inefficient, independent of those of weights.

Given these weights, the efficiency of a DMU in converting the inputs to outputs can be defined as the ratio weighted sum of output to weighted sum of inputs.

$$\text{Efficiency} = \frac{\sum_{r=1}^{x} u_r y_{ij}}{\sum_{i=1}^{m} v_r x_{ij}} \qquad (1)$$

The weights for DMU are determined using mathematical programming as those that will maximize the efficiency of a DMU subject to the condition that the efficiency of other DMUs (calculated using the same set of weights) is restricted to values between 0 and 1. The weights are chosen that only most efficient units will reach the upper bound of the efficiency measure, chosen as 1. Let us take one of the DMUs, say the *o*th DMU as the reference DMU under evaluation whose efficiency (E_o) is to be maximized. Therefore, to compute the DEA efficiency measure for the *o*th DMU, we have to solve the following fractional linear programming model:

$$\max E_o = \frac{\sum_{r=1}^{x} u_r y_{ij}}{\sum_{i=1}^{m} v_r x_{ij}} \qquad (2)$$

subject to

$$\frac{\sum_{r=1}^{x} u_r y_{ij}}{\sum_{i=1}^{m} v_r x_{ij}} \leq 1, \quad j=1,\ldots,n \qquad (3)$$

$$u_r \geq \varepsilon, \quad r=1,\ldots,s$$

$$v_i \geq \varepsilon, \quad i=1,\ldots,m$$

Where ε is an infinitesimal or non-Archimedean constant that prevents the weights from vanishing (Charnes, Cooper, Seiford, 1994). When we solve the above mathematical program, we get the optimal objective function (2) that presents the efficiency of DMU of DMU_o. If the efficiency is unity, then the firm is said to be efficient, and will lie on the efficiency frontier. Otherwise, the firm is said to be relatively inefficient. To find the efficiency measures of other DMUs, we have to solve the above mathematical program by considering each of the DMUs as the reference DMU. Therefore, we obtain a Pareto efficiency measure where the efficient units lie on the efficiency (Thanassoulis, 1999). To simplify them, we should convert them to a linear program format. The fractional program (2), (3) can be conveniently converted into an equivalent linear program by normalizing the denominator using the constraint max $\sum_{i=1}^{m} v_i x_o$ =1. As the weighted sum of inputs is constrained to be unity and the objective function is the weighted sum of outputs that has to be maximized.

$$\max \sum_{r=1}^{s} u_r y_{ro} \qquad (4)$$

subject to $\sum_{r=1}^{m} v_{\mathrm{i}} x_{io}$ (5)

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{r=1}^{m} v_{\mathrm{i}} x_{io} \leq 0, \ \mathrm{j}=1,\ldots,\mathrm{n}$$

$$u_r \geq \varepsilon, \quad r = 1,\ldots,s$$

$$v_i \geq \varepsilon, \quad i=1,\ldots,m$$

This model is the CCR (Charnes, Cooper, and Rhodes) model. Similarly a general input minimization CCR model can be represented as

$$\min \sum_{i=1}^{m} v'_i x_{io} \qquad (6)$$

subject to

$$\sum_{r=1}^{x} u'_r y_{ro}$$

$$\sum_{\mathrm{r}=1}^{\mathrm{s}} \mathrm{u'}_{\mathrm{r}} \mathrm{y}_{\mathrm{rj}} - \sum_{\mathrm{r}=1}^{\mathrm{m}} \mathrm{v'}_{\mathrm{i}} \mathrm{x}_{\mathrm{ro}=1}$$

$$\sum_{r=1}^{s} u'_r y_{rj} - \sum_{r=1}^{m} v'_{\mathrm{i}} x_{ij} \leq 0, \ j=1,\ldots,\mathrm{n}$$

$$u_r \geq \varepsilon, \quad r = 1,\ldots,s$$

$$v_i \geq \varepsilon, \quad i=1,\ldots,m$$

According to the basic linear programming, every programming problem (usually called the primal problem) has another closely related linear program, called its dual. Therefore, the dual of the output maximizing DEA program is as follows,

$$\theta^{*}=\min \theta \qquad (8)$$

subject to

$$\sum_{r=1}^{s} \lambda_j x_{ij} \leq \theta x_{io}, \; i=1,\ldots, m$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{ro}, \; r=1,\ldots, s \qquad (9)$$

$$\lambda_j \geq 0$$

θ unrestricted.

If $\theta^{*}=1$, then the current input levels cannot be reduced, indicating that DMU_o is on the frontier. Otherwise, if $\theta^{*}<1$, then DMU_o is dominated by the frontier. θ^{*} represent the input-oriented efficiency score of DMU_o. The individual input reduction is called slack. In fact, both input and output slack values may exist in model (8)

$$S_i^{-}=\theta^{*}x_{io}- \sum_{j=1}^{n} \lambda_j x_{ij} \quad i=1,\ldots, m$$

$$S_r^{+}=\sum_{j=1}^{n} \lambda_j x_{rj} - y_{ro} \quad r=1,\ldots, s \qquad (10)$$

To determine the possible nonzero sacks after solving the linear program (8), we should solve the following linear program:

$$\text{Max} \sum_{i=1}^{m} S_i^- + \sum_{j=1}^{n} S_r^+$$

subject to

$$\sum_{j=1}^{n} \lambda_j x_{ij} + S_i^- = \Theta^* x_{io} - \quad i=1,\ldots, m$$

$$\sum_{j=1}^{n} \lambda_j x_{rj} - S_r^+ = y_{ro}, \quad r=1,\ldots, s \qquad (11)$$

$$\lambda_j \geq 0,$$

Θ unrestricted.

DMU$_o$ is efficient if and only if Θ^*=1 and S_r^{-*} =S_r^{+*}=0 for all i and r. DMU$_o$ is weakly efficient if and only if $\Theta^{*=}$1 and S_r^{-*}≠0 and (or) S_r^{+*}≠0 for some I and r. in fact models (8) and (9) represents a two stage DEA process that can be summarized in the following DEA model:

$$\min \theta - \varepsilon \left(\sum_{i=1}^{m} S_i^- + \sum_{j=1}^{s} S_r^+\right)$$

subject to

$$\sum_{j=1}^{n} \lambda_j x_{ij} + S_i^- = \Theta^* x_{io} - \quad i=1,\ldots, m$$

$$\sum_{j=1}^{n} \lambda_j x_{rj} - S_r^+ = y_{ro}, \quad r=1,\ldots, s \qquad (12)$$

$$\lambda_j \geq 0,$$

θ unrestricted.

Where s are the slack variables; x represents input variables; y represent output variables; λ is a scalar factor; and $\theta$and $\emptyset$ represent efficiency score of a DMU.

Table 5-Summary DEA Models

Frontier type	Input-oriented	Output-oriented
	min $\theta - \varepsilon\ (\sum_{i=1}^{m} S_i^- + \sum_{j=1}^{s} S_r^+)$	max $\emptyset - \varepsilon\ (\sum_{i=1}^{m} S_i^- + \sum_{j=1}^{s} S_r^+)$
Subject to	$\sum_{j=1}^{n} \lambda_j x_{ij} + S_i^- = \theta^* x_{io} - i=1,\ldots,m$	$\sum_{j=1}^{n} \lambda_j x_{ij} + S_i^- = x_{io} - i=1,\ldots,m$
CRS	$\sum_{j=1}^{n} \lambda_j x_{rj} - S_r^+ = y_{ro}, \quad r=1,\ldots,s$	$\sum_{j=1}^{n} \lambda_j y_{rj} \geq \emptyset\ y_{ro}, \ r=1,\ldots,s$
	$\lambda_j \geq 0 \quad j=1,2,\ldots,n$	$\lambda_j \geq 0 \quad j=1,2,\ldots,n$
VRS: add $\sum_{j=1}^{n} \lambda_j = 1$;NIRS: add $\sum_{j=1}^{n} \lambda_j \leq 1$, NDRS: add $\sum_{j=1}^{n} \lambda_j \geq 1$		

Table 5 summarizes the DEA model under the Constant Variable Scale (CRS) and Variable Return of Scale (VRS) for input and output oriented.

3.7.2 SFA Model Specification

The parametric stochastic frontier analysis (SFA) was developed by Aigner et al (1977). The SFA model is a parametric econometric model which is used to analyze the frontier efficiency. The key advantage of SFA is its stochastic treatment of residuals, decomposed into a non-negative inefficiency term and an idiosyncratic error term that accounts for measurement errors and other random noise. However, SFA builds on the parametric regression techniques, which requires a rigid ex ante specification of the functional form. Since the economic theory does not justify a particular functional form, the flexible functional forms, such as the translog or generalized McFadden, are frequently used in the SFA literature. The problem with the flexible functional forms is that the estimated frontiers often violate the monotonicity, concavity/convexity and homogeneity axioms.

A production unit is considered technically efficient if, using the given technology; it produces the maximum output using a given level of inputs. Developed independently by Aigner *et al.* (1977) and Meeussen and Van Den Broeck (1977), SFA specifies a production frontier wherein the error term is comprised of producer specific inefficiency and random error. The original specification involved a production function specified for cross- sectional data which had an error term which had two components, one to account for random effects and another to account for technical inefficiency. The model can be expressed in the following form:

(1) $\mathbf{Y_i = x_i\beta + (V_i - U_i)}$, **i=1,...,N,**

where $\mathbf{Y_i}$ is the production (or the logarithm of the production) of the *i*-th firm;

$\mathbf{x}_i$ is a kx1 vector of (transformations of the) input quantities of the *i*-th firm;

$\boldsymbol{\beta}$ is an vector of unknown parameters;

the $\mathbf{V}_i$ are random variables which are assumed to be iid. N (0, σv2), and independent of the

$\mathbf{U}_i$ which are non-negative random variables which are assumed to account for technical inefficiency in production and are often assumed to be iid.

$| N (0,\sigma v^2)|$

This original specification has been used in a vast number of empirical applications over the past two decades. The specification has been altered and extended in a number of ways. These extensions include the specification of more general distributional assumptions for $\mathbf{U_i}$, such as the truncated normal or two-parameter gamma distributions; the consideration of panel of data and time-varying technical efficiencies.

The above model defined by equation1is called a s*tochastic* frontier production function because the output values are bounded from the above by the stochastic (i.e. random) variable exp (x_i`+$v_i$). The random error $v_i$ can be positive or negative and so the stochastic frontier outputs vary about the deterministic part of the model, exp **($\mathbf{x_i}$`β).**

A cob-Douglas stochastic frontier model takes the form that produce the output Y_i using only one input, x_i.

(2) $Y_i = \beta_o + \beta_1 \text{In } x_i + v_i - u_i$ or

(3) $Y_i = \exp(\beta_o + \beta_1 \text{In } x_i + v_i - u_i)$ or

(4) $Y_i = \exp(\beta_o + \beta_1 \text{In } x_i)$ x exp (v_i) x exp (- u_i)

{Deterministic component} {Noise} {Inefficiency}

Much of the stochastic frontier analysis is directed towards the prediction of the inefficiency effects. The most common output oriented measure of technical efficiency is the ratio of observed output to the corresponding stochastic frontier output:

(5) $TE_i = Y_i \div \exp(x`_i \beta + v_{i)} = \frac{\exp(x`i\ \beta + vi - ui)}{\exp\ (x`i\ \beta + vi)} = \exp\ (u_i)$

This measure of technical efficiency takes a value between zero and one. It measures the output of the i-th firm relative to the output that could be produced by a full-efficient firm using the same input vector.

Aigner, Lovell and Schmidt (1977) obtained maximum likelihood (ML) estimates the assumptions

(6) $v_i \sim iidN(0,\sigma_v^2)$ and

(7) $u_i \sim iidN^+(0,\sigma_u^2)$

Assumption 6 says the v_i s are independently and identically distributional random variables with zero means and variance σ_v^2. Assumption 7 says the u_is are independently and identically half-normal random variables with scale parameter σ_u^2. That is, the probability density function (pdf0 of each u_i is a truncated version of a normal variable having zero mean and variance σ_u^2. Aigner, Lovell and Schmidt (1977) parameterised the log-likelihood function for this so-called half-normal model in terms of $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\lambda^2 = \sigma_u^2 / \sigma_v^2 \geq 0$. If $\lambda = 0$ there are no technical inefficiency effects and all deviations from the frontier are due to noise. Using this parameterization, the log-likelihood function is

(8) $\text{In L}(y|\ \beta, \sigma, \lambda) = -\frac{I}{2}\text{In}(\frac{\pi\sigma^2}{2}) + \sum_{i=1}^{I} \text{In } \Phi(-\frac{\varepsilon_{i\lambda}}{\sigma}) - \frac{1}{2\sigma^2}\sum_{i=2}^{I} \varepsilon_i^2$

Where y is a vector of log-outputs; $\varepsilon_i = v_i - u_i = \text{In } y_i - x_i'\beta$ is a composite error term; and $\Phi(x)$ is the cumulative distribution function (cdf) of the standard normal random variable evaluated at x.

As we know, maximizing a log-likelihood function usually involves taking first-derivatives with respect to the unknown parameters and setting them to zero. Unfortunately, in the case of equation 8 these first-order conditions are highly nonlinear and cannot be solved analytically for β, σ and λ. Thus, we must maximize the likelihood function 8 using an iterative optimization procedure. This involves selecting starting values for the unknown parameters and systematically updating them until the values that maximize the log-likelihood functions are found.

SFA with Multiple Inputs and Multiple Outputs

The Stochastic Frontier Analysis permits evaluating the technical efficiency scores for the input variables ($x_1, x_2, ..., x_k$) with output y_1 and to obtain a measure of the Technical Efficiency (TE_1) that can be called TE (y_1) i.e. a technical efficiency that is a function of y_1. We suggest performing multiple SFA with the same group of input variables ($x_1, x_2, ...,x_k$) but with different output variables (y_j) (j=2, …,k). For each i-th SFA we have the corresponding TE (y_i) with continuous values in [0,1]. Each indicator of efficiency TE (y_i) obtained by each SFA, can be transformed into values on an ordinal scale. You obtain k rankings each due to a specific input variable used (y_j). It becomes, therefore, a problem of ordering multivariate data of an ordinal type. In a lot of applications we are interested in a unified ranking of the DMU rather than in values of the single Technical Efficiency. In order to obtain a single DMU, we can use a Principal Component Analysis in considering the TE (y_i) (j=1,2, …,k) as variables. We may grade the DMU according to the score on the first axis, we you obtain a ranking that is dependent on the first eigenvalue.

After verifying the hypothesis of asymmetry present in the residuals of the OLS and after trying several models with different dependent variables, the first model of SFA (SFA1) is:

$$(9) \quad In\ (y_{1i}) = \beta_0 + \beta_1 x_{i1} + \beta_2 + \beta_2 x_{i2} + \beta_3 + \beta_3 x_{i3} + \beta_4 + \beta_4 x_{i4} + \beta_5 + \beta_5 x_{i5} + \beta_6 + \beta_6 x_{i6} + \beta_7 + \beta_7 x_{i7}$$

where i refers to the i-th DMU, y_{i1} is operating revenue of the airlines, x_{i1} is the number of passenger travelled within a year, x_{i2} is the revenue passenger kilometre (RPK , x_{i3} is the energy cost, x_{i4} is capital cost, x_{i5} is labour cost, x_{i6} is material cost and x_{i7} is other cost . Variables v_i and u_i are defined as described earlier.

The function (10), the third model (11) and the fourth model, SFA2, SFA3 and SFA4 respectively, differ from (9) only for the output variable (y_{2i}, y_{3i} y_{4i})) :

(10) $In\ (y_{2i}) = \beta_0 + \beta_1 x_{i1} + \beta_2 + \beta_2 x_{i2} + \beta_3 + \beta_3 x_{i3} + \beta_4 + \beta_4 x_{i4} + \beta_5 + \beta_5 x_{i5} + \beta_6 + \beta_6 x_{i6} + \beta_7 + \beta_7 x_{i7}$

(11) $In\ (y_{3i}) = \beta_0 + \beta_1 x_{i1} + \beta_2 + \beta_2 x_{i2} + \beta_3 + \beta_3 x_{i3} + \beta_4 + \beta_4 x_{i4} + \beta_5 + \beta_5 x_{i5} + \beta 6 + \beta_6 x_{i6} + \beta_7 + \beta_7 x_{i7}$

(12) $In\ (y_{4i}) = \beta_0 + \beta_1 x_{i1} + \beta_2 + \beta_2 x_{i2} + \beta_3 + \beta_3 x_{i3} + \beta_4 + \beta_4 x_{i4} + \beta_5 + \beta_5 x_{i5} + \beta 6 + \beta_6 x_{i6} + \beta_7 + \beta_7 x_{i7}$

Where, in (6) y_{2i} the net income (NI), in (7), y_{3i} represents Return on Asset (ROA) and y_{4i} is Return on Income (ROI).

3.8 Data Collection Method

Data collection method for the study employed the secondary data such as statistical data concerning operational, financial and strategic performance data. Secondary data is data which has been collected by individuals or agencies for purposes other than those of our particular research study. These secondary data is available which are entirely appropriate and wholly adequate to draw conclusions and answer the question or solve the problem. For this study, primary data collection simply is not necessary. It is far cheaper to collect secondary data than to obtain primary data. For the same level of research budget a thorough examination of secondary sources yields a great deal more information than can be had through a primary data collection exercise. The time involved in searching secondary sources is much less than that needed to complete primary data collection. Secondary sources of information can yield more accurate data than that obtained through primary research.

The advantage of the secondary data is less expansive in terms of cost and it is time saving. Comparative study is possible through secondary data. Huge amount of financial and operational data can be access and generated easily than the primary data. It can result also in unforeseen discoveries through data reanalyzes. It is relatively permanent and available at any time.

It should not be forgotten that secondary data can play a substantial role in the exploratory phase of the research when the task at hand is to define the research problem and to generate hypotheses. The assembly and analysis of secondary data almost invariably improves the researcher's understanding of the marketing problem, the various lines of inquiry that could or should be followed and the alternative courses of action which might be pursued.

While secondary research is often valuable, it also has drawbacks that include: not Specific to researcher's needs; inefficient spending for Information; incomplete information; not timely and not proprietary information. The main disadvantage of secondary data is that there is no real control for data quality. It may be collected for a purpose that does not match to the need. Thirdly, access may be difficult or costly when the data is collected for commercial reason. Sometimes aggregations processes and definitions may be unsuitable. Finally, initial purpose may dictate how data are presented e.g. published company reports presented different from unpublished reports. It is unobtrusive data collection methods for that data don't collect information directly from evualuees.

3.8.1 Data Source

Secondary data can be acquired for research purposes from archives, libraries, museums, repositories and databases accessible online. A great deal of potentially useful secondary information already exists within enterprises. Typically useful information would be that relating to sales, finance, production, operation and transportation.

The type of secondary data used in this study is quantitative data which can be classified underwritten documents. This document uses the organization's record of annual and business reports by collecting from organization's website. The documentary sources of the organization records for this research is available on each organization's website as data archive which is accessible to the general public. The choice of data collection approach for this study depends on the situation. The technique is more appropriate for this specific situation than other.

3.8.2 Data Types

A panel of unbalanced data are collected from years 2007 to 2014. The term panel data refers to multi-dimensional data frequently involving measurements over time. Panel data contain observations of multiple phenomena obtained over multiple time periods for the same firms.

A panel dataset have data on *80* number of DMU, over *8 years* time periods, for a total of 80×8 observations. Data like this is said to be in long form. In some cases the data may come in what is called the wide form, with only one observation per case and variables for each different value at each different time period.

3.9 Research Variables and Measures

Although an integration of DEA , SFA and BSC has been adopted in a few studies (Chen et al., 2008; Garcı ´a-Valderrama et al., 2009; Asosheh et al., 2010), none of them has been adopted in the airline industry using the three models. This study selected measurements indicators based on Kaplan and Norton (1996) to include both leading factors and lagging factors. Specifically, this study identified financial performance as the lagging factors, and customer orientation, internal process improvement, and learning and growth as the leading factors. Basically, technical efficiency measures are based on Wu and Liao (2014) and are used to estimate all the variables relevant to this study. These measures are conventionally used in the industry and reported extensively in secondary sources. Several measures for technical efficiency variables have been used in this study. A list of variables along with their definition within the airline industry has been provided as follows:

Seven inputs are used in this study as lagging factor based on the concept of BSC perspectives applied in the study of Wu and Liao (2014). These input variables are RPK, Number of passenger, Labour Cost, Energy cost, Capital Cost, Material Cost and Other Cost. Four variables are employed in this study as outputs. These are Operating Revenue, Net income (NI), Return on Asset (ROA) and Return on Investment (ROI).

In terms of the financial perspective, the first indicator is operating revenue that recognizes passenger and cargo sales when transportation is provided. Moreover, return on average assets (ROA) is the second indicator since ROA is used internally by companies to track asset-use over time, to monitor company performance, and to look at different operations of divisions by comparing them one to the other (Wu and Liao, 2014) . Return on Asset (ROA): Joo, Nixon and Stoeberl (2011) suggests a novel framework based on return on assets (ROA) which is popular and user-friendly to managers, and demonstrate it by use of an example. Joo et al, (2011) further states ROA as the most popular measure of profitability in finance and is frequently defined by net income after tax divided by total assets. ROA is a comparative measure and does not provide an absolute value. It is recommended for comparing a company's ROA to its previous ROA or similar companies' ROA. It is an indicator of how profitable a company is relative to its total assets. ROA gives an idea as to how efficient management is at using its assets to generate earnings. Calculated by dividing a company's annual earnings by its total assets and ROA is displayed as a percentage. And the second is ROI. Return on Investment (ROI): there are many definitions of the ROI but Meng and. Berger (2012) defines ROI as a financial ratio that expresses profit in direct relation to investment. The ROI is simply the net profits (or savings) expected from a given investment, algebraically expressed as a percentage of the investment: [ROI = net profits (or savings) / investment]. ROI measures the gain or loss generated on an investment relative to the amount of money invested. ROI is usually expressed as a percentage and is typically used for personal financial decisions, to compare a company's profitability or to compare the efficiency of different investments. The third is Net Income. Net income under IFRS includes some gains and losses from changes in fair value, and accruals from the application of the revenue recognition and matching principles (Kabir and Laswad, 2011). NI is a company's total earnings (or profit); net income is calculated by taking revenues and subtracting the costs of doing business such as depreciation, interest, taxes and other expenses (Wu and Liao, 2014). Hence, NI is a better predictor of future cash flows and net income (Kanagaretnam, Mathieuand and Shehata, 2009). Net Income (NI), Return on Asset (ROA) and Return on investment (ROI) are the least output variables used by Wu and Liao (2014).

For the customer orientation perspective, the major indicator is the market share which reflects the competitive position of an airline company. (Barros and Peypoch, 2009) described RPK is the product of the number of paying passengers and the number of kilometres they travelled the world airline market share in terms of passenger traffic revenue passenger kilometre. One RPK is defined as one paying passenger transported 1 km. In terms of the internal process improvement perspective, the indicators include fuel cost, capital cost, and material cost because airlines are considered to evaluate the internal operating processes critical to success (Kimmel et al., 2010). Capital cost and material cost are commonly utilized in the following study of Ouellette et al. (2010) and Wu and Liao (2014) and Cui and Li (2015a) as an input. Thus, these three indicators are the most likely to be associated with this objective. Due to the fact that many airline services provide undifferentiated products, if airlines can obtain better cost efficiency, they will attain a competitive advantage among other airlines.

In terms of the learning and growth perspective, the indicator is the operating expenses per employee. Since the other (Barbot et al., 2008; Assaf, 2009 and Wu and Liao, 2014) expenditures include a variety of things, such as those airport-related expenditures (that is, landing fees, gate agents, and baggage handlers) and in-flight catering expenditures (Vasigh et al., 2008). If airlines begin to offer more elaborate services, other operating expenses should be expected to increase. Being easy areas for immediate cost-cutting, other operating expenses have shown dramatic reductions, particularly catering. Moreover, within a service company, particularly the airline industry, the improvement of production efficiency depends on the quality of employees. Therefore, employees need to be highly trained to ensure high quality service, which leads to the enhancement of customer satisfaction (Yilmaz, 2009). Thus, in analyzing the learning and growth perspective, this study also includes the labor cost as one of the indicators. The measures of all research variables that adopted in this study are based on Wu and Laio (2014). The measures of all research variables that adopted from Wu and Laio (2014) in this study are shown in Table 6.

Table 6-The Measurement of Research Construct Adopted from Wu and Laio (2014)

Construct	Indicator
Airline output measurement	
Financial perspective (1)	Operating revenue (OR) Return on investment (ROI) Return on assets (ROA) Net income (NI)
Airline input measurement	
Customer perspective (2)	Revenue passenger kilometre (RPK) Number of passengers RTK (Revenue Ton Kilometre),
Internal business perspective (3)	Energy (fuel) cost Capital cost
Learning and growth perspective (4)	Labour cost Other operating expense per employee

3.10 Data Analysis Method

Analysis of data in this study is a process of inspecting, cleaning, transforming, and modelling secondary operational and financial data of airlines with the goal of discovering useful information, suggesting conclusions, and supporting decision-making. The data analysis has multiple facets and approaches, encompassing DEA and SFA techniques. The analysis refers to breaking whole documents into its separate components for individual examination. The data analysis is a process for obtaining raw data from the airlines annual report and converting it into information useful for decision-making by users. The data is collected and analyzed to answer research questions, research objectives.

Hence, the study uses quantitative data analysis using statistical non-parametric model (DEA) analysis and econometrics parametric (SFA) analysis method. A quantitative data analysis for a panel of data from 2007 to 2014 is conducted. Quantitative operation efficiency analysis technique compares a firm's performance against its peer in the industry as well as against the historical performance.

Data Analysis Software

Once the various elements of the proposed Data Envelopment Analysis and Stochastic Frontier Analysis model are established (i.e. inputs/outputs and number of DMUs) the analysis will be performed. There are several DEA & SFA software packages available. Many of these are available on a "free trial" basis, but offer extremely limited usage, i.e. the number of DMUs and inputs/outputs are limited as are, in some cases, the type of model allowed (e.g. constant returns to scale or variable returns to scale). DEA Version 2.1 and FRONTIER 4.1 are standard software package which can measure DEA and SFA are used for the study consecutively. Once the data is imported it is then a matter of selecting the desired model (CRS, VRS, and Pure Scale).

DEA requires that all variable values be positive. Those airlines which have record losses it is necessary to apply three DEA model runs will be then performed using this data.

1) A Constant Returns to Scale Model (CRS) which provides overall efficiency scores

2) A Varying Returns to Scale Model (VRS) which provides technical efficiency scores

3) CRS/VRS which provides pure scale efficiency scores

A robustness score is determined for each of the efficient airlines as identified in each of the three DEA models. Robustness is a measure of how suitable an airline is for emulation. We achieved robustness by determining how often an efficient airline appeared in a reference set. Based on these scores the efficient airlines are categorised as highly robust, moderately robust and not robust.

The DEAP and FRONTIER software provide input and output targets as a by product of a model run. These targets are the values that would result in a 100 per cent efficiency score if they are the actual input and output values of each airline. In order to validate the software these target values are substituted for the actual values with the expectation that each airline would then score 100 per cent. On completion of the software validation, a one-at-a-time sensitivity analysis is carried out in order to assess the models sensitivity to input and out variable changes. This is covered in detail in chapter six.

In general, the study used DEAP version 2.1, Frontier Version 4.1, XLSTAT and Shazam to analyses the DEA results, the SFA Results, Descriptive Statistics and Canonical Correlation respectively. The DEAP version 2.1computer program is used for this study to measure DEA efficiency. The program involves a simple batch file system where the user creates a data file and a small file containing instructions. The user then starts the program by typing "DEAP" at the DOS prompt and is then prompted for the same of the instruction file. The program then executes these instructions and produces an output file which can be read using a text editor, such as NOTEPAD, EDIT. The execution of DEAP Version 2.0 generally involves five files: the executable file DEAP.EXE; the start-up file DEAP.000; a data file; an instruction file and an output file. The program requires that the data be listed in a text file and expects the data appear in a particular order. The instruction file is a text file which is usually constructed using a text editor or a word processor. Output file is a text file which is produced by DEAP when an instruction file is executed.

The FRONTIER Version 4.1 computer program assumes a linear functional form and thus if you wish to estimate Cobb-Douglas production function, we must log all of your input and output data before creating the data file for the program to use. The execution of FRONTIER VERSION 4.1generally involves five files; the executable file FRONT41.EXE; the start-up file FRONT41.000; a data file (for example, called TEST.DTA); an instruction file (for example, called TEST.INS) and an output file (for example, called TEST.OUT) The start-up file, FRONTE41.000, contains value for a number of key variables such as the convergence criterion, printing flags and so on. This text file may be edited if the user wishes to alter any values. The output file is crested by FONTIER during execution

The program will follow a three-step procedure in estimating the maximum likelihood of the parameters of a stochastic frontier production function. The three steps are: (1) Ordinary Least Squares (OLS) estimates of the function are obtained with all β estimators with the exception of the intercept will be unbiased; (2) a tow-phase grid search of γ is conducted, with β parameters (excepting β_0) set to OLS vales and the β_0 and σ^2 parameters adjusted according to the corrected ordinary least squares formula presented in Coelli (1995). Any other parameters (μ, η or δ's) are set to zero in this grid search and (3) the values selected in the grid search are used as starting values in an iterative procedures (using the Davidon-Fletcher-Powell Quasi-Newton method) to Obtain the final maximum likelihood estimates.

Finally the XLSTAT is used to conduct the Canonical correlation test of the data. The trial version is employed which is freely available and is effective to test the canonical correlation

3.11 Validity and Reliability

We approached with emphasises the need for an idea to be subject to rigorous testing before being accepted as knowledge. The methods and procedures used in this testing are based on measurable and observable evidence.

We conducted research to adhere to three important principles: reliability, replication and validity (Bryman & Bell, 2007). We checked the reliability refers to the question of whether or not the measures that are devised for business and management concepts. This study uses stable measures such as operating revenue, capital, labour and fuel costs. These are "concrete" values and so are reliable and make replication possible.

We also examined the replication or replicability is a measure of how easy it is to repeat research work (Bryman & Bell, 2007).There are various reasons for replicating other researchers' findings such as confirming the results are correct or conducting the research again in light of new or updated theories. In order for this replication to be possible, the study describes the processes and procedures in detail. We ensured the consistency of the dataset by verifying the data from many sources. Both validity and reliability of the study are assessed in many ways to check the quality of the study. The processes and procedures utilized for this study are presented as follows**.**

3.11.1 Validity

We made the certainty of the validity of the study by measuring what it is intended to measure and by apprehension with the integrity of the results and conclusions of a research work. Our empirical evidence of airlines measure the domains of interest allows strong inferences regarding validity. Establishing validity in this context involves examining the logical relationships that should exist between assessment measures of technical efficiency for airlines. The various types of validity we presented as flows:

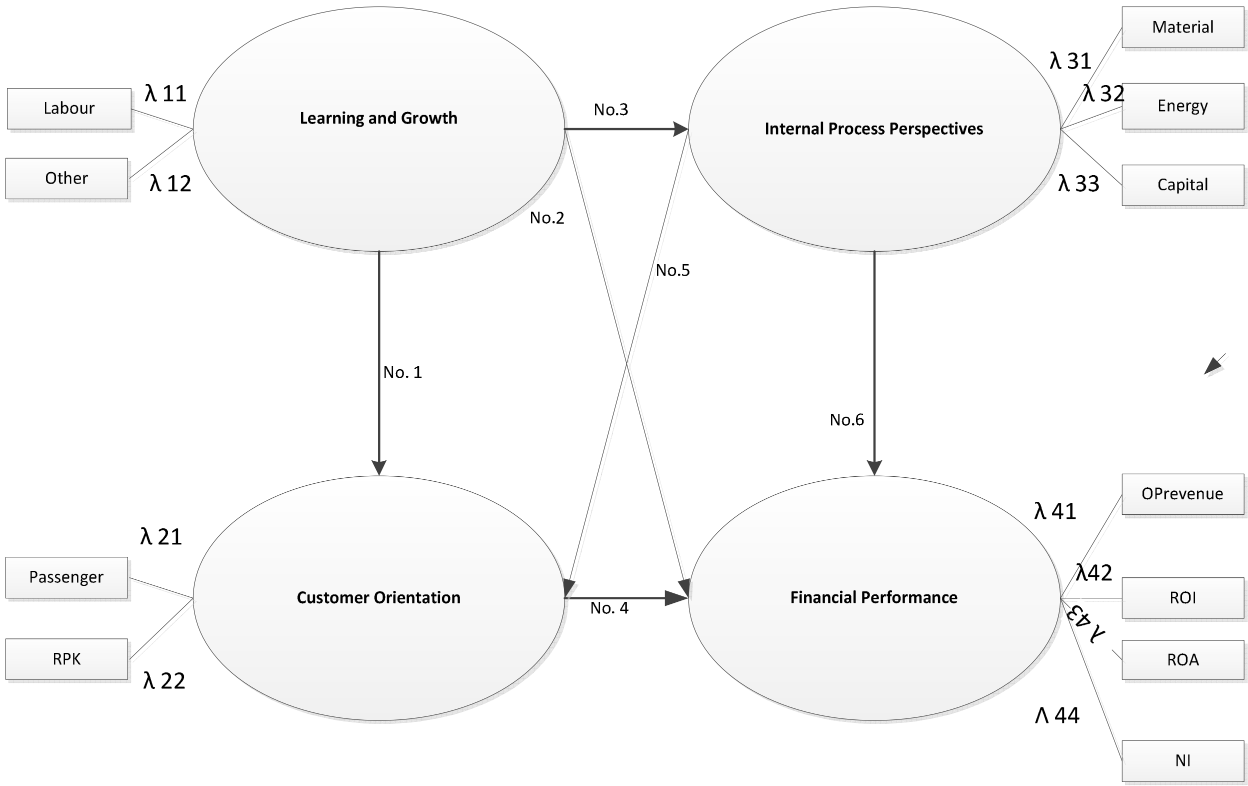
3.11.1.1 Measurement or Construct Validity

The study tried to answer question of whether or not a measure is actually a measure of the concept that is under examination. For example, in the context of this study the variables used; number of employees, capital cost, material cost, fuel costs, staff costs, operating revenue, and passengers carried are all reliable measures of their constructs. Similarly with performance measurement techniques, several were investigated and ultimately identified as valid measures of their respective constructs and have been widely used in research studies.

3.11.1.2 Internal Validity

The study is concerned primarily with causality to questions whether or not a conclusion that supposes a causal relationship between two or more variables is valid. This study assumes causal relationships although such relationships are identifiable through various means such as canonical correlation analysis. Such relationships are included in the scope of this study but are undoubtedly grounds for further research.

Figure 4 Indicates the Canonical Correlation of Input and Outputs Fixtures



The above figure 4 shows that the interrelation of inputs and outputs using the four perspectives of the BSC concept. As the detailed information for the canonical results indicates in the above figure, there are about six interrelationships exist in each yearly canonical loading.

The first correlation is the interrelation between the learning and growth perspective with the customer orientation perspectives. Labour and other cost are selected from the learning and growth perspective while number of passenger and revenue passenger kilometre (RPK) is selected from the customer perspectives.

The second correlation is between learning and growth perspective and the financial performance perspective. Two variables are selected from the learning and growth perspectives and four variables are selected from the financial perspectives. Labour and other costs belong to learning and growth category while operating revenue, return on income (ROI), return on asset (ROA) and net income (NI) belong to financial performance category.

The third correlation group is, the interrelationship between learning and growth perspective with the internal process perspectives. The learning and growth perspective has labour and other costs indexes while the internal process perspective has material, energy and capital costs indexes.

The fourth group of interrelationship is made between customer orientation and financial performance. From customer orientation, number of passenger and revenue passenger kilometre are selected whereas from financial performance, operating revenue, return on asset (ROA), return on investment (ROI) and net income (NI).

The fifth interrelationship is among internal process perspectives and the customer orientation perspectives. From internal process perspectives, material, energy and capital costs are selected and from the customer perspectives, the number of passenger and the revenue passenger kilometres are selected for this correlation.

The sixth and the last interrelationship is the correlation between the internal process perspectives and the financial performance perspectives. Material, energy and capital costs are selected from the internal process perspectives. Operating revenue, the return on asset (ROA), the return on investment (ROI) and the net income (NI) are selected for the financial performance variables.

3.11.1.3 External Validity

The study is primarily to ask whether the results of a study can be generalized beyond a specific context. As this study necessarily uses simple random sampling technique generalisations and inferences about the entire population can be made hence external validity is very high. Again, this is an area for further research as there is possible value in replicating this research using random sampling and hence providing inferences.

These principles are important as they allow for a considered and structured research strategy. This in turn allows for clear communication between researchers and allows for easy replication of work. The empirical work for this study is carried out in three phases: firstly, a total of 100 annual reports of world airlines are examined; out of top 100 by revenue ranked airlines, 80 are selected because simple random sampling technique and of the availability of data. Secondly, a formal DEA and SFA models are built and the performance of 80 airlines to examine in detail using these models; thirdly, then Ethiopian airlines is further examined with benchmark airlines as mini-case studies. The benefits of this structured approach are protection against errors and the provision of groundwork for future research.

3.11.1.4 Content Validity

The study checked to what extent an empirical measurement reflects a specific domain of content of the study.

3.11.2 Reliability

The reliability of this research instrument is concerned to what extent the instrument yields the same results on repeated trials. Although unreliability is always present to a certain extent, there is generally a good deal of consistency in the results of a quality instrument gathered at different times as the study deals with the numerical values of financial and operational statistics eight years data of the airlines. As the study follows the scientific research, accuracy in measurement is of great importance. Our scientific research approach normally measures financial and operational attributes of the airlines which can easily be assigned a precise value. The consistency of a set of measurements or measuring instrument is studied quantitatively and Test-retest reliability is conducted.

3.11.2.1 Retest Method

Stability – the researcher repeated the administration to obtain the same result and the same test tools are used on the same sample size more than once, and it provides reliability co-efficient as an indication of how reliable the tool is.

The study determined the reliability of empirical measurements by the retest method in which the same test is given to the same data after a period of time. The reliability of the test (instrument) is estimated by examining the consistency of the results between the two tests.

The researcher obtains the same results on the two administrations of the instrument, and then the reliability coefficient is 1.00. Normally, the correlation of measurements across time is less than perfect due to different experiences and attitudes that researcher have encountered from the time of the first test. The test-retest method is a simple, clear cut way to determine reliability cheap and practical.

3.11.2.2 Internal Consistency Method

Homogeneity –this study measured using the most popular internal consistency reliability estimate -Cronbach's alpha to measure the reliability of a tool to check internal consistency of the scales and provide a unique estimate of reliability for the given test administration by using multiple administrations of instruments.

3.11.2.3 Alternative Form Method

This research conducted this method by two testing with the same people. Each of the two tests is designed to measure the same thing and should not differ in any systematic way. One way is used use random procedures to select items for the different tests.

Evaluating secondary data sources**:** During the research, secondary data sources are reviewed with caution to be sure that: this enable to answer the research question and meet the objectives; their benefits greater than their cost and the researcher is allowed access to the data.

Overall suitability

Measurement validity**:** we measured he validity measured in relation to the data ability to answer the research problem and meet the objectives.

Coverage and unmeasured variables: The researcher made sure that the data cover the population, covers the time period of study and covers the research variables.

Precise suitability

Reliability and validity: To measure these criterions, the researcher looks at the source of data. Source of data from airlines are cross-checked by using ICAO, IATA and Centre for Aviation are likely to be reliable for authenticity of the data. The researcher considered the accuracy and consistency of the data. The methods the data are collected with, and researcher is responsible for data collection is important to evaluate the reliability and validity.

Cost and benefits: Comparing the cost of acquiring the data with benefits the study brings minimum cost compared with the other way of collecting the data. One of the advantages of collecting the secondary data for this research is the financial and time costs of obtaining these data is less expansive. The data has been collected and entered into the computer. Generally, data benefit overweight the data cost**.**

Overall suitability of secondary data: Measurement criteria are evaluated against the following questions whether data set contain the information required or whether the measures used match those required or whether the data set a proxy for the data really needed or whether it cover the population or whether data about population be separated from unwanted data or whether the data sufficiently up to date or whether the data covering all the variables needed.

Precise suitability: Precise suitability is evaluated using the following questions: how reliable the data is? Or how credible are the data sources? Is the methodology clearly described? (Is the sampling accurate? Who is responsible for collecting and recording the data? Is the researcher cleared how the data were analyzed and compiled? Are the data likely to contain measurement bias? And Are we happy that that the data have been recorded accurately?

Generally, the researcher's design properly applied the methods to cross-check and guarantee if same data and methods give same conclusions (objectivity); conclusions are correct i.e. mistakes are eventually found or at least one has good idea how trustworthy the conclusions are (statistics); the results can be independently verified or reproduced by the scientific community; the assumptions we have made are correct (e.g. the object of our research exists or can be explained within the scope of our research); we are measuring what we think we are measuring; the setting does not change (e.g. with time, place, culture); the research methods and the sample we have chosen are good for the purpose of our research (e.g. not biased); our calculations are correct; we are not overlooking something important and the interpretation of the results is correct.

3.12 Ethical Issues

The undertaken research proposal is subjected to an ethical approval process that is completed. A completed ethical clearance from was filled and submitted for the approval and then the ethical clearance approval letter was approved to collect data. Since the researcher uses public accessed secondary data that participants are not put at any risk by the research project.

Chapter 4: Result of the Study

This chapter presents the results of the study using Data Envelopment Analyses (DEA) and Stochastic Frontier Analysis (SFA) efficiency measurement models. The study employed a panel research design to analyze the sample. The data was collected and analysed from annual report of airlines for the year 2007-2014 as our sample. The results of each model are presented in the following format:

4.1 DEA result

- 4.1.1 Descriptive statistics for each year
- 4.1.2 Characteristic of sample airlines each year
- 4.1.3 DEA efficiency and benchmark peer of each DMUs for the sample airlines
- 4.1.4 Summary of output slacks for eight airlines
- 4.1.5 Summary of input slacks for each airlines
- 4.1.6 Percent of potential improvement for pure technically inefficient airlines
- 4.1.7 Frequency distributions and descriptive statistics for technical and scale efficient scores for each year
- 4.1.8 Result of canonical correlation

4.2 SFA result

- 4.2.1 OLS result
- 4.2.2 Technical efficiency of SFA results

4.3 Comparative results of the two alternative model DEA and SFA result

In general, the study used DEAP version 2.1, Frontier Version 4.1, XLSTAT (trail version) and Shazam (trail version) software to analyses the DEA results and the SFA Results, Descriptive Statistics and Canonical Correlation of the results respectively.

The DEAP version 2.1computer program is used for this study to measure DEA efficiency. The program involves a simple batch file system where the user creates a data file and a small file containing instructions. The user then starts the program by typing “DEAP” at the DOS prompt and is then prompted for the same of the instruction file. The program then executes these instructions and produces an output file which can be read using a text editor, such as NOTEPAD, EDIT. The execution of DEAP Version 2.0 generally involves five files: the executable file DEAP.EXE; the start-up file DEAP.000; a data file; an instruction file and an output file. The program requires that the data be listed in a text file and expects the data appear in a particular order. The instruction file is a text file which is usually constructed using a text editor or a word processor. Output file is a text file which is produced by DEAP when an instruction file is executed.

The FRONTIER Version 4.1 computer program assumes a linear functional form and thus if you wish to estimate Cobb-Douglas production function, we must log all of your input and output data before creating the data file for the program to use. The program is developed by Tim Coelli (1996) and the program is freely download from the program involves a simple batch file system where the user creates a data file and a small file containing instructions. The execution of FRONTIER VERSION 4.1generally involves five files; the executable file FRONT41.EXE; the start-up file FRONT41.000; a data file (for example, called TEST.DTA); an instruction file (for example, called TEST.INS) and an output file (for example, called TEST.OUT) The start-up file, FRONTE41.000, contains value for a number of key variables such as the convergence criterion, printing flags and so on. This text file may be edited if the user wishes to alter any values. The output file is crested by FONTIER during execution.

Both programs i.e. DEAP version 2.1 and Frontier Version 4.1 are developed by Tim Coelli (1996) and the programs are freely downloaded from the web site of University of New England at http://www.une.edu.au/econometrics/cepawp.httm

The program will follow a three-step procedure in estimating the maximum likelihood of the parameters of a stochastic frontier production function. The three steps are: (1) Ordinary Least Squares (OLS) estimates of the function are obtained with all β estimators with the exception of the intercept will be unbiased; (2) a tow-phase grid search of γ is conducted, with β parameters (excepting β_0) set to OLS vales and the β_0 and σ^2 parameters adjusted according to the corrected ordinary least squares formula presented in Coelli (1995). Any other parameters (μ, η or δ's) are set to zero in this grid search and (3) the values selected in the grid search are used as starting values in an iterative procedures (using the Davidon-Fletcher-Powell Quasi-Newton method) to Obtain the final maximum likelihood estimates.

Finally the XLSTAT is used to conduct the Canonical correlation test of the data. The trial version is employed which is freely available and is effective to test the canonical correlation

4.1 DEA Result

4.1.1 Descriptive Statistics for Each Year

Table 7-Descriptive Statistics of Samples for the Year 2014

NAME	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
OprRevenue US%	13743	12616	159150000	1137	40362
NI (US$)	554.9	603.73	364490	19.223	2882
ROA (%)	4.6894	3.9214	15.377	0.361	15.43
ROI (%)	5.3888	3.9597	15.679	0.17	16.23
Passenger	52.568	45.581	2077.6	6.908	197.34
RPK	87698	87210	7605600000	7826	330740
Energy (US$)	3790.2	3437.1	11814000	22.4	11675
Capital (US$)	3316.7	5842.4	34133000	170.4	32489
Labor (US$)	2537.1	3030.2	9182400	78.7	11225
Material (US$)	1662.4	2342.7	5488300	45.652	11428
Other (US$)	2388.5	2078.5	4320300	176.1	8790

Table 7 supplies descriptive statistics of the feasible used in the DEA model for 33 sample airlines relative to the year 2014, including mean values, standard deviations, variance, minimum values and maximum values. The sample airlines perform average annual operational revenue US$ 13,743 million, ROA of 46.89 percent, ROI of 53.89 percent and net income US$ 554.5 million. The highest two inputs are the annual RVK (US$ 330740 million) and the annual operating revenue (US$ 40,362 million).

Table 8-Descriptive Statistics on Sample Airlines for the Year 2013

NAME	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
OprRevenue	10509	10692	114330000	966.12	39874
NI	573.49	1668.4	2783700	9.708	10540
ROA (%)	4.3577	4.9664	24.665	0.11	20.17
ROI (%)	5.4226	7.0453	49.637	0.08	38.7
Passenger	41.941	35.109	1232.6	4.418	139.21
RPK	73497	77318	5978000000	7129.4	330110
Energy	3083.3	3015.6	9093900	46.4	12345
Capital	2389	5111.9	26132000	141.45	31883
Labor	1970.7	2592.5	6720800	64.305	11159
Material	1497.3	2041.6	4168200	44.011	9869.3
Other	1857.8	1775.9	3153600	142.98	8675

Table 8 provides descriptive statistics of the viable used in the DEA model for 39 sample airlines relative to the year 2014, including mean values, standard deviations, minimum values and maximum values. The sample airlines perform average annual operational revenue US$ 10,509 million, ROA of 43.58 percent, ROI of 54.22 percent and net income US$ 573.49 million. The highest two inputs are the annual RVK (US$ 330,110 million) and the annual operating revenue (US$ 39,874 million).

Table 9-Descriptive Statistics of Sample Airlines for the Year 2012

NAME	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
OprRevenue	8876.2	8862.8	78550000	898.15	38719
NI	317.09	422.69	178670	8.754	2150.1
ROA (%)	3.7697	3.84	14.746	0.05	16.98
ROI (%)	5.6856	9.0156	81.281	0.1	49.56
Passenger	36.859	30.55	933.33	3.644	119.15
RPK	59330	58681	3443400000	6514.1	310500
Energy	2745.2	2575.8	6634700	161.4	10150
Capital	2303.3	5233.7	27392000	99.213	29536
Labor	1578	2070.8	4288000	72.084	10397
Material	1355.6	1894.2	3588100	36.403	8785.7
Other	2187.1	3172.9	10067000	1.698	17468

Table 9 provides descriptive statistics of the viable used in the DEA model for 39 sample airlines relative to the year 2013, including mean values, standard deviations, minimum values and maximum values. The sample airlines perform average annual operational revenue US$

8876.2 million, ROA of 37.70 percent, ROI of 56.86 percent and net income US$ 317.09 million. The highest two inputs are the annual RVK (US$ 310500 million) and the annual operating revenue (US$ 38719 million).

Table 10 Descriptive Statistics of Sample Airlines for the Year 2011

NAME	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
OprRevenue	9828.3	10569	111700000	779.12	39973
NI	410.05	476.44	226990	2.086	1975
ROA (%)	4.725	3.8641	14.931	0.02	20.42
ROI (%)	5.8772	5.9028	34.844	0.01	28.85
Passenger	38.434	35.61	1268	3.137	141.8
RPK	69770	76588	5865700000	5640.6	333920
Energy	2929.8	3045.2	9273300	260.73	12375
Capital	2498.8	5477.4	30002000	93.791	31925
Labor	1849.1	2502.7	6263400	56.845	10737
Material	1950700	11696000	1.3679E+14	28.346	70177
Other	1809.4	2133.6	4552100	114.28	10008

Table 10 provides descriptive statistics of the viable used in the DEA model for 36 sample airlines relative to the year 2012, including mean values, standard deviations, minimum values and maximum values. The sample airlines perform average annual operational revenue US$ 9828.3 million, ROA of 47.25 percent, ROI of 58.77 percent and net income US$ 410.05 million. The highest two inputs are the annual RVK (US$ 33, 3920 million) and the annual Material cost (US$ 70177 million).

Table 11 Descriptive Statistics of 40 Sample Airlines for the Year 2010

NAME	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
OprRevenue	6876.9	8480.3	71916000	4.391	36195
NI	360.24	544.14	296090	19.537	2217
ROA (%)	5.5444	5.3882	29.033	0.55	27.25
ROI (%)	7.093	7.8727	61.979	0.68	38.89
Passenger	28.991	29.653	879.28	2.89	119.27
RPK	51824	63194	3993500000	5230.6	310810
Energy	2090.6	2501	6255000	147.18	11327
Capital	1993.1	4715.5	22236000	52.041	28580
Labor	1365.7	2082.7	4337500	43.513	10048
Material	1040.2	1592.3	2535300	28.189	6869.7
Other	1238	1266	1602700	94.898	5389

Table 11 provides descriptive statistics of the viable used in the DEA model for 40 sample airlines relative to the year 2010, including mean values, standard deviations, minimum values and maximum values. The sample airlines perform average annual operational revenue US$ 6876.9 million, ROA of 55.44 percent, ROI of 70.93 percent and net income US$ 360.24million. The highest two inputs are the annual RVK (US$ 310,810 million) and the annual Operating revenue (US$ 36195 million).

Table 12 Descriptive Statistics of 29 Sample Airlines for the Year 2009

NAME	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
OprRevenue	3868.3	3419.9	11695000	3.519	11780
NI	174.68	203.02	41219	0.001	788.6
ROA (%)	4.399	4.076	16.614	0	15.28
ROI (%)	5.9693	5.7528	33.094	0	24.71
Passenger	19.784	17.861	319.01	2.81	86.31
RPK	32127	28114	790410000	4597.3	101760
Energy	1135.6	1164.7	1356400	109.66	4406.7
Capital	790.97	715.38	511770	53.1	2551.7
Labor	702.26	797.93	636690	27.096	3468
Material	827.24	1302.7	1696900	52.938	6036.4
Other	814.97	710.52	504840	75.433	2142.7

Table 12 provides descriptive statistics of the viable used in the DEA model for 29 sample airlines relative to the year 2009, including mean values, standard deviations, minimum values and maximum values. The sample airlines perform average annual operational revenue US$ 3868.3 million, ROA of 43.99 percent, ROI of 59.69 percent and net income US$ 174.68 million. The highest two inputs are the annual RVK (US$ 101760 million) and the annual Operating revenue (US$ 11,780million).

Table 13 Descriptive Statistics of 29 Sample Airlines for the Year 2008

NAME	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
OprRevenue	8052.7	9736.8	94805000	4.14	36368
NI	386.44	465.46	216650	0.699	1527.8
ROA (%)	5.4887	5.2396	27.454	0.08	26.88
ROI (%)	6.6276	7.417	55.012	0.07	35.96
Passenger	26.078	23.693	561.38	2.505	88.529
RPK	43327	45593	2078700000	3863.5	207230
Energy	1904	1919	3682400	216.55	7871.8
Capital	1932.4	5190.5	26941000	46.745	28177
Labor	1514.1	2568	6594700	57.479	10274
Material	1045.4	1666.8	2778300	41.465	7928.9
Other	1862.2	3156.7	9964700	74.757	14376

Table 13 provides descriptive statistics of the viable used in the DEA model for 29 sample airlines relative to the year 2008, including mean values, standard deviations, minimum values and maximum values. The sample airlines perform average annual operational revenue US$ 8052.7 million, ROA of 38.64 percent, ROI of 66.27 percent and net income US$ 386.44 million. The highest two inputs are the annual RVK (US$ 207,230 million) and the annual Operating revenue (US$ 36,368million).

Table 14 Descriptive Statistics of 43 Sample Airlines for the Year 2007

NAME	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
OprRevenue	7988.1	9316.5	86798000	360.57	40155
NI	321.04	434.57	188850	6.589	2408.4
ROA (%)	4.4966	3.7195	13.835	0.07	18.7
ROI (%)	5.424	4.9311	24.316	0.13	24.18
Passenger	39.698	63.375	4016.4	2.096	372.3
RPK	50666	62523	3909100000	3140.9	310690
Energy	1651.7	1632.3	2664400	131.21	6011
Capital	1673.6	3712.7	13784000	31.547	23919
Labor	1472.9	2149.8	4621700	48.232	9153.2
Material	993.38	1481.9	2196000	25.764	8358.1
Other	1435.2	1892.2	3580300	1.248	8608.1

Table 14 provides descriptive statistics of the viable used in the DEA model for 29 sample airlines relative to the year 2007, including mean values, standard deviations, minimum values and maximum values. The sample airlines perform average annual operational revenue US$ 7988.1million, ROA of 44.97 percent, ROI of 54.24 percent and net income US$ 321.04 million. The highest two inputs are the annual RVK (US$ 310,690 million) and the annual Operating revenue (US$ 40,155 million).

4.1.2 Characteristic of Sample Airlines Each Year

Table 15 Characteristics of the Sample Airlines 2014

Item	Description	Frequency	Percent
Age of the airline	less than 20 years old	9	27.3
	21-40 years old	5	15.2
	41-60 years old	7	21.2
	more than 61 years old	12	36.4
Region	Asia	9	27.3
	Europe	9	27.3
	North America	10	30.3
	Australia & Oceania	1	3
	Africa	1	3
	Latin America	2	6.1
	Middle East	1	3
Employee Size	less than 10,000 employees	12	36.4
	10,000-20,000 employees	5	15.2
	20,001-30,000 employees	4	12.1
	30,000-40,000 employees	3	9.1
	more than 40,001 employees	9	27.3
Fleet size	less than 100 carriers	8	24.2
	100-200 carriers	6	18.2
	201-300 carriers	9	27.3
	more than 301 carriers	10	30.3
Number of passenger (per year)	less than 15 millions	7	21.2
	15-30 millions	7	21.2
	31-45 millions	6	18.2
	more than 46 millions	13	39.4

Table 15 discuses the characteristics of sample airlines for the year 2014. It present the age of the airlines; the region of the airlines; employee size; fleet size and the number of the airlines per for the year of 2014. 36.4 percent of the sample airlines have more than 61 years old, 27.3 percent of sample airlines have less than 20 years old and 21.2 percent of the sample airlines have between 40 and 60 years old.

Concerning the regions of sample airlines, 30.3 percent of the sample airlines belong to the North America and is the highest percent in 2014. Asia and Europe have the same percentage of regional representation of the samples and it is 27.3 percent (the second highest). Latin America has 6.1 percentages of the regions.

The table 15 shows the employee size of the sample airlines and it is subdivided into four groups: a group less than 10,000 employees has 36.4 percent; a second grope from 10,000 to 20,000 employees has 15.2 percent; a third group is an employee size between 30,000 and 40,000 employees has 9.1 percent and the last group is an employee size more than 40,001 employees has 27.3 employees.

When we look at the fleet size of the sample airline, 30.3 percent has more than 301 carriers; 27.3 percent has between 201 and 300 carriers; 24.2 percent has less than 100 carriers and 18.2 percent has between 100 and 200.

The number of the passenger indicates another characteristic of sample airlines and it has four groups. 39.4 percent of the sample airlines have more than 46 millions of passenger flown per year; 21.2 percent of the sample airlines have the same number of passenger flown for a group less than 15 million and another group between 15 and 30 millions of the passengers. Finally, 18.2 percent of the sample airlines have between 31 and 45 millions of passenger per year.

Table 16 Characteristics of the Sample Airlines 2013

Item	Description	frequency	Percent
Age of the airline	less than 20 years old	10	25.6
	20-40 years old	6	15.4
	41-60 years old	7	18
	more than 61 years old	16	41
Region	Asia	9	23.1
	Europe	12	30.8
	North America	10	25.6
	Australia & Oceania	2	5.1
	Africa	1	2.6
	Latin America	3	7.7
	Middle East	2	5.1
Employee Size	less than 10,000 employees	17	43.6
	10,000-20,000 employees	7	18
	20,001-30,000 employees	3	7.7
	30,000-40,000 employees	4	12.1
	more than 40,001 employees	8	20.1
Fleet size	less than 100 carriers	12	30.8
	100-200 carriers	8	20.1
	201-300 carriers	7	18
	more than 301 carriers	12	30.8
Number of passenger (per year)	less than 15 millions	11	28.2
	15-30 millions	9	23.1
	31-45 millions	5	18.8
	more than 46 millions	14	35.9

Table 16 discuses the characteristics of sample airlines for the year 2013. It present the age of the airlines; the region of the airlines; employee size; fleet size and the number of the airlines per for the year. 41 percent of the sample airlines have more than 61 years old, 25.6 percent of sample airlines have less than 20 years old and 18.0 percent of the sample airlines have between 41 and 60 years old and 15.4 percent of the sample airlines have between 20 and 40 years of old. Concerning the regions of sample airlines, 30.8 percent of the sample airlines belong to the Europe and is the highest percent in 2014; North America has 25.6 percent; Asia has 23.1 and Latin America has 7.7 percentages of the regions.

The table 16 shows the employee size of the sample airlines and it is subdivided into four groups: a group less than 10,000 employees has the highest percentage of 43.6 percent; a second group from 10,000 to 20,000 employees has 18 percent; a third group is an employee size between 30,000 and 40,000 employees has 12.1 percent and the last group is an employee size more than 40,001 employees has 20.1 employees.

When we look at the fleet size of the sample airline, two groups have the same 30.38 percent (a group of more than 301 carriers and a group less than 100 carriers); 18.0 percent has between 201 and 300 carriers; and 20.1 percent has between 100 and 200.

The number of the passenger indicates another characteristic of sample airlines and it has four groups. 35.9 percent of the sample airlines have more than 46 millions of passenger flown per year; 28.2 percent of the sample airlines have a number of passengers flown for a group less than 15 million and 23.1 percent have another group between 15 and 30 millions of the passengers. Finally, 18.8 percent of the sample airlines have between 31 and 45 millions of passenger per year.

Table 17 Characteristics of the Sample Airlines 2012

Item	Description	Frequency	Percent
Age of the airline	less than 20 years old	10	25.6
	20-40 years old	8	20.5
	41-60 years old	7	18
	more than 61 years old	14	35.9
Region	Asia	10	25.6
	Europe	10	25.6
	North America	10	25.6
	Australia & Oceania	2	5.1
	Africa	2	5.1
	Latin America	4	10.3
	Middle East	1	2.6
Employee Size	less than 10,000 employees	6	15.4
	10,000-20,000 employees	9	23.1
	20,001-30,000 employees	7	18
	30,000-40,000 employees	6	15.4
	more than 40,001 employees	11	28.2
Fleet size	less than 100 carriers	11	28.2
	100-200 carriers	11	28.2
	201-300 carriers	8	20.5
	more than 301 carriers	9	23.1
Number of passenger (per year)	less than 15 millions	10	25.6
	15-30 millions	12	30.8
	31-45 millions	7	18
	more than 46 millions	10	25.6

Table 17 discuses the characteristics of sample airlines for the year 2012. It present the age of the airlines; the region of the airlines; employee size; fleet size and the number of the airlines per for the year. 35.9 percent of the sample airlines have more than 61 years old, 25.6 percent of sample airlines have less than 20 years old and 18.0 percent of the sample airlines have between 41 and 60 years old and 20.5 percent of the sample airlines have between 20 and 40 years of old.

Concerning the regions of sample airlines, the same percentage of 25.6 percent of the sample airlines belong to the Europe; Asia and North America and is the highest percent in 2014; the same 5.1 percentage of regions belong to Australia and Africa group. Latin America has 10.3 percent of the regional representation of sample airlines.

The table 17 shows the employee size of the sample airlines and it is subdivided into four groups: a group of employees less than 10,000 and a group of employees between 30,000 and 40,000 has the same 15.4 percent; a group of employees between 10,000 and 20,000 has 23.1 percent; a group of employee size between 20,001 and 0,000 employees has 18 percent and the last group is an employee size more than 40,001 employees has 28.2 percent of employees.

When we look at the fleet size of the sample airline, two groups have the same percentage of 28.2 i.e. a group less than 100 carriers and a group between 100 and two hundred carriers; 20.5 percent of the sample airlines has between 201 and 300 carriers; and 23.1 percent has between has more than 301 carriers.

The number of the passenger indicates another characteristic of sample airlines and it has four groups. 25.6 percent of the sample airlines equally have for a group of more than 46 millions of passenger flown per year and a group of number of passengers flown for a group less than 15 million. 38.8 percent have another group between 15 and 30 millions of the passengers. Finally, 18 percent of the sample airlines have between 31 and 45 millions of passenger per year.

Table 18 Characteristics of the Sample Airlines 2011

Item	Description	Frequency	Percent
Age of the airline	less than 20 years old	11	30.6
	20-40 years old	5	13.9
	41-60 years old	6	16.7
	more than 61 years old	14	38.9
Region	Asia	9	25
	Europe	10	27.8
	North America	6	16.7
	Australia & Oceania	3	8.3
	Africa	3	8.3
	Latin America	4	11.1
	Middle East	1	2.8
Employee Size	less than 10,000 employees	14	38.9
	10,000-20,000 employees	7	19.4
	20,001-30,000 employees	4	11.1
	30,000-40,000 employees	4	11.1
	more than 40,001 employees	7	19.4
Fleet size	less than 100 carriers	14	38.9
	100-200 carriers	8	22.2
	201-300 carriers	6	16.7
	more than 301 carriers	8	22.2
Number of passenger (per year)	less than 15 millions	12	33.3
	15-30 millions	9	25
	31-45 millions	3	8.3
	more than 46 millions	11	30.6

Table 18 discuses the characteristics of sample airlines for the year 2011. It present the age of the airlines; the region of the airlines; employee size; fleet size and the number of the airlines per for the year. 38.9 percent of the sample airlines have more than 61 years old, 30.6 percent of sample airlines have less than 20 years old and 16.7 percent of the sample airlines have between 41 and 60 years old and 13.9 percent of the sample airlines have between 20 and 40 years of old.

Concerning the regions of sample airlines, 17.8 percent of the sample airlines belong to the Europe; 25 percent belongs to Asia and 16.7 percent belongs to North America. Latin America has 11.1 percent of the regional representation of sample airlines.

The table 18 shows the employee size of the sample airlines and it is subdivided into four groups: a group of employees less than 10,000 has 38.9 percent; a group of employees between 10,000 and 20,000 and a group of employees more than 40,001 employees has the same 19.4

percent; a group of employees between 20,001 and 30,000 and a group of employee size between 30,001 and 40,000 employees has the same 11 percent.

When we look at the fleet size of the sample airline, two groups have the same percentage of 22.2 i.e. a group more than 301 carriers and a group between 100 and two hundred carriers; the highest 38.9 percent of the sample airlines has less than 100 carriers; and 16.7 percent has between has between 201 and 300 carriers.

The number of the passenger indicates another characteristic of sample airlines and it has four groups. 30.6 percent of the sample airlines have more than 46 millions of passenger flown per year and 33.3 percent have a number of passengers flown for a group of less than 15 million; 25 percent have another group between 15 and 30 millions of the passengers and 8.3 percent of the sample airlines have between 31 and 45 millions of passenger per year.

Table 19 Characteristics of the Sample Airlines 2010

Item	Description	Frequency	Percent
Age of the airline	less than 20 years old	10	25
	20-40 years old	5	12.5
	41-60 years old	8	20
	more than 61 years old	7	17.5
Region	Asia	8	20
	Europe	10	25
	North America	9	22.5
	Australia & Oceania	3	7.5
	Africa	4	10
	Latin America	4	10
	Middle East	2	5
Employee Size	less than 10,000 employees	18	45
	10,000-20,000 employees	9	22.5
	20,001-30,000 employees	6	15
	30,000-40,000 employees	2	5
	more than 40,001 employees	5	12.5
Fleet size	less than 100 carriers	20	50
	100-200 carriers	9	22.5
	201-300 carriers	3	7.5
	more than 301 carriers	8	20
Number of passenger (per year)	less than 15 millions	18	45
	15-30 millions	10	25
	31-45 millions	3	7.5
	more than 46 millions	9	22.5

Table 19 discuses the characteristics of sample airlines for the year 2010. It present the age of the airlines; the region of the airlines; employee size; fleet size and the number of the airlines per for the year. 17.5 percent of the sample airlines have more than 61 years old, 25 percent of sample airlines have less than 20 years old; 20 percent of the sample airlines have between 41 and 60 years old and 12.5 percent of the sample airlines have between 20 and 40 years of old.

Concerning the regions of sample airlines, 25 percent of the sample airlines belong to the Europe; 20 percent belongs to Asia; 22.5 percent belongs to North America; 10 percent have Africa and Latin America equally. Middle East and Latin America has 7.5 and 5 percent respectively.

The table 19 shows the employee size of the sample airlines and it is subdivided into four groups: a group of employees less than 10,000 has 45 percent; a group of employees between 10,000 and 20,000 has 22.5 percent and a group of employees between 20,001 and 30,000 employees has the 15 percent; a group of employees between 30,001 and 40,000 and a group of employee size more than 40,001 employees has the same 5 and 12.5 percent respectively.

When we look at the fleet size of the sample airline, a group more sample airlines which has less than 100 carriers are the highest 50 percent; and a group sample airlines between 100 and two hundred carriers has 22.5 percent; the highest 20 percent of the sample airlines has more than 301 carriers; and 7.5 percent has between has between 201 and 300 carriers.

The number of the passenger indicates another characteristic of sample airlines and it has four groups. 22.5 percent of the sample airlines have more than 46 millions of passenger flown per year and the highest 45 percent have a number of passengers flown for a group of less than 15 million; 25 percent have another group between 15 and 30 millions of the passengers and 7.5 percent of the sample airlines have between 31 and 45 millions of passenger per year.

Table 20 Characteristics of the Sample Airlines 2009

Item	Description	Frequency	Percent
Age of the airline	less than 20 years old	7	24.1
	20-40 years old	5	17.2
	41-60 years old	4	13.7
	more than 61 years old	13	44.8
Region	Asia	7	24.1
	Europe	7	24.1
	North America	6	20.7
	Australia & Oceania	2	6.9
	Africa	3	10.3
	Latin America	3	10.3
	Middle East	1	3.5
Employee Size	less than 10,000 employees	12	41.4
	10,000-20,000 employees	10	34.5
	20,001-30,000 employees	4	13.8
	30,000-40,000 employees	2	6.9
	more than 40,001 employees	1	3.5
Fleet size	less than 100 carriers	14	48.3
	100-200 carriers	9	31
	201-300 carriers	4	13.8
	more than 301 carriers	2	6.9
Number of passenger (per year)	less than 15 millions	17	58.6
	15-30 millions	6	20.7
	31-45 millions	4	13.7
	more than 46 millions	2	6.9

Table 20 discuses the characteristics of sample airlines for the year 2009. It present the age of the airlines; the region of the airlines; employee size; fleet size and the number of the airlines per for the year. 44.8 percent of the sample airlines have more than 61 years old, 24.1 percent of sample airlines have less than 20 years old; 13.7 percent of the sample airlines have between 41 and 60 years old and 17.2 percent of the sample airlines have between 20 and 40 years of old.

Concerning the regions of sample airlines, 24 percent of the sample airlines belong to the Europe and Asia; 20.7 percent belongs to North America; 10.3 percent have Africa and Latin America equally.

The table 20 shows the employee size of the sample airlines and it is subdivided into four groups: a group of employees less than 10,000 has 41.4 percent; a group of employees between 10,000 and 20,000 has 34.5 percent and a group of employees between 20,001 and 30,000 employees has the 13.8 percent; a group of employees between 30,001 and 40,000 and a group of employee size more than 40,001 employees has the same 6.9 and 3.5 percent respectively.

When we look at the fleet size of the sample airline, a group more sample airlines which has less than 100 carriers are the highest 48.3 percent; and a group sample airlines between 100 and two hundred carriers has 31 percent; 6.9 percent of the sample airlines has more than 301 carriers; and 13.8 percent has between has between 201 and 300 carriers.

The number of the passenger indicates another characteristic of sample airlines and it has four groups. The highest 58.6 percent have a number of passengers flown for a group of less than 15 million; 20.7 percent have another group between 15 and 30 millions of the passengers; 13.7 percent of the sample airlines have between 31 and 45 millions of passenger per year and finally, 6.9 percent of the sample airlines have more than 46 millions of passenger flown per year and.

Table 21 Characteristics of the Sample Airlines 2008

Item	Description	Frequency	Percent
Age of the airline	less than 20 years old	6	20.7
	20-40 years old	7	24.1
	41-60 years old	5	17.2
	more than 61 years old	11	45.8
Region	Asia	4	13.8
	Europe	10	34.5
	North America	5	17.2
	Australia & Oceania	3	10.3
	Africa	3	10.3
	Latin America	3	10.3
	Middle East	1	3.5
Employee Size	less than 10,000 employees	13	44.8
	10,000-20,000 employees	6	20.7
	20,001-30,000 employees	3	10.3
	30,000-40,000 employees	3	10.3
	more than 40,001 employees	4	13.8
Fleet size	less than 100 carriers	15	51.7
	100-200 carriers	5	17.2
	201-300 carriers	5	17.2
	more than 301 carriers	4	13.8
Number of passenger (per year)	less than 15 millions	14	48.3
	15-30 millions	5	17.2
	31-45 millions	4	13.8
	more than 46 millions	6	20.7

Table 21 discuses the characteristics of sample airlines for the year 2008. It present the age of the airlines; the region of the airlines; employee size; fleet size and the number of the airlines per for the year. 45.8 percent of the sample airlines have more than 61 years old; 24.1 percent of sample airlines have between 20 and 40 years; 17.2 percent of the sample airlines have between 41 and 60 years old and 20.7 percent of the sample airlines have less than 20 years of old.

Concerning the regions of sample airlines, 34.5 percent of the sample airlines belong to the Europe; 17.2 have North America; 13.8 percent have Asia; 10.3 percent belong; Australia, Africa and Latin America equally.

The table 21 shows the employee size of the sample airlines and it is subdivided into four groups: a group of employees less than 10,000 has 44.8 percent; a group of employees between 10,000 and 20,000 has 20.7 percent; a group of employees between 20,001 and 30,000 employees a group of employees between 30,001 and 40,000 has the 10.3 percent; and a group of employee size more than 40,001 employees has 13.8 percent.

When we look at the fleet size of the sample airline, a group more sample airlines which has less than 100 carriers are the highest 51.7 percent; and a group sample airlines between 100 and two hundred carriers and a group sample airlines between has between 201 and 300 carriers has 17.2 and 13.8 percent of the sample airlines has more than 301 carriers.

The number of the passenger indicates another characteristic of sample airlines and it has four groups. The highest 48.3 percent have a number of passengers flown for a group of less than 15 million; 17.2 percent have another group between 15 and 30 millions of the passengers; 13.8 percent of the sample airlines have between 31 and 45 millions of passenger per year and finally, 20.7 percent of the sample airlines have more than 46 millions of passenger flown per year and.

Table 22 Characteristics of the Sample Airlines 2007

Item	Description	Frequency	Percent
	less than 20 years old	12	27.9
Age of the airline	20-40 years old	9	20.9
	41-60 years old	8	18.6
	more than 61 years old	14	32.6
Region	Asia	8	18.6
	Europe	15	34.9
	North America	10	23.3
	Australia & Oceania	3	7
	Africa	3	7
	Latin America	2	4.7
	Middle East	2	4.7
Employee Size	less than 10,000 employees	20	46.5
	10,000-20,000 employees	7	16.3
	20,001-30,000 employees	6	14
	30,000-40,000 employees	3	7
	more than 40,001 employees	7	16.3
Fleet size	less than 100 carriers	21	48.8
	100-200 carriers	8	18.6
	201-300 carriers	7	16.3
	more than 301 carriers	7	16.3
Number of passenger (per year)	less than 15 millions	17	39.5
	15-30 millions	9	20.9
	31-45 millions	8	18.6
	more than 46 millions	9	20.9

Table 22 discuses the characteristics of sample airlines for the year 2007. It present the age of the airlines; the region of the airlines; employee size; fleet size and the number of the airlines per for the year. 32.6 percent of the sample airlines have more than 61 years old; 20.9 percent of sample airlines have between 20 and 40 years; 18.6 percent of the sample airlines have between 41 and 60 years old and 27.9 percent of the sample airlines have less than 20 years of old.

Concerning the regions of sample airlines, 34.9 percent of the sample airlines belong to the Europe; 23.3 percent have North America; 18.6 percent have Asia; 7.0 percent belong; Australia and Africa equally.

The table 22 shows the employee size of the sample airlines and it is subdivided into four groups: a group of employees less than 10,000 has 46.5 percent; a group of employees between 10,000 and 20,000 has 16.3 percent; a group of employees between 20,001 and 30,000 employees has 14 percent; a group of employees between 30,001 and 40,000 has the 7 percent; and a group of employee size more than 40,001 employees has 16.3 percent.

When we look at the fleet size of the sample airline, a group more sample airlines which has less than 100 carriers are the highest 48.8 percent; and a group sample airlines between 100 and two hundred carriers; a group sample airlines between 201 and 300 carriers and a group sample airlines more than 301 has 18.6, 16.3 and 16.3 percent of respectively.

The number of the passenger indicates another characteristic of sample airlines and it has four groups. The highest 39.5 percent have a number of passengers flown for a group of less than 15 million; 20.9 percent have another group between 15 and 30 millions of the passengers; 18.6 percent of the sample airlines have between 31 and 45 millions of passenger per year and finally, 20.9 percent of the sample airlines have more than 46 millions of passenger flown per year and.

4.1.3 DEA Efficiency and Benchmark Peer of Each DMUs for the Sample Airlines

Table 23 DEA Efficiency and Benchmark Peer of Each DMU for the Sample Airlines of Year 2014

DMU	**Airlines**	crste	vrste	scale		Peer Count	Peers					
1	Aegean Airlines Group	1.000	1.000	1.000	-	2	1					
2	Air Canada	0.310	0.405	0.765	irs	0	6	24	27			
3	Air china	0.462	0.529	0.875	drs	0	22	10	15	26	27	18
4	Air New Zealand Group	0.657	0.785	0.837	irs	0	6	19	27	15		
5	AirAsia	0.510	1.000	0.510	irs	0	5					
6	Allegiant Air	1.000	1.000	1.000	-	6	6					
7	American Airlines Group	0.802	1.000	0.802	drs	3	7					
8	ANA Group	0.363	0.377	0.962	irs	0	1	27	15	28		
9	Avianca Holdings	0.343	0.433	0.793	irs	0	15	6	27	27	12	
10	British Airways	1.000	1.000	1.000	-	4	10					
11	Cathay Pacific Group	0.609	0.635	0.958	irs	0	19	15	27	22		
12	Cebu Pacific Air	0.570	1.000	0.570	irs	1	12					
13	China Eastern Airlines	0.419	0.535	0.783	drs	0	15	10	26	27	18	22
14	China Southern Air Holding	0.239	0.264	0.905	drs	0	15	7	27	26	22	10
15	Copa Holdings	1.000	1.000	1.000	-	10	15					
16	Delta airlines	0.348	1.000	0.348	drs	0	16					
17	EasyJet PL	1.000	1.000	1.000	-	1	17					
18	Emirates Group	1.000	1.000	1.000	-	2	18					
19	Ethiopian	0.906	1.000	0.906	irs	2	19					
20	Hawaiian Airlines	0.406	0.994	0.408	irs	0	6	24	27			
21	IAG	0.818	1.000	0.818	drs	0	21					
22	Japan Airlines	1.000	1.000	1.000	-	8	22					
23	JetBlue Airways	0.822	0.872	0.943	irs	0	6	15	17	22	27	
24	Lufthansa group	1.000	1.000	1.000	-	2	24					
25	Republic Airways Holdings	1.000	1.000	1.000	-	1	25					
26	Ryanair	1.000	1.000	1.000	-	4	27					
27	SAS Group	1.000	1.000	1.000	-	13	28					
28	Singapore Airlines	1.000	1.000	1.000	-	1	7	27	22	15		
29	Southwest Airlines Co.	0.781	0.977	0.800	drs	0	30					
30	Sprit airlines	1.000	1.000	1.000	-	0	27	7	26	22	10	15
31	Turkish Airlines	0.719	0.742	0.968	drs	0	32					
32	United-Continental Holdings	0.411	1.000	0.411	drs	0	6	25	22	1	27	
33	WestJet	0.573	0.680	0.843	irs	0						
	mean	**0.729**	**0.855**	**0.855**								

The detailed DEA results are shown in Table 23 Production efficiency (VRS) multi stage input oriented model was calculated based on a CCR model. Production efficiency equals to 1 demonstrates that the DMU has achieved highest efficiency relative to other DMUs, whereas production efficiency less than 1 demonstrates the DMU to be inefficient relative to other DMUs.

Table 23 reveals that 12 airline DMUs had excellent performance. However, there were 21 inefficient DMUs which need to improve their performance according to the operating mode of other airlines. For example, No. 19 DMU (Ethiopian) should learn from No. 1, 6, 10, 15, 17, 18, and 24 DMUs.

Table 23 also shows that, among inefficient airlines there was 9 DMUs in the condition of decreasing return scale (DRS) and there were 11 DMUs in the condition of increasing return scale (IRS). At the individual airline level, the efficiency slacks measures how much output should be proportionally expanded by using the same amount of inputs. For example, the scale efficiency score of AirAsia (No. 5 DMU) is 0.510, implying that the efficiency of this airline is far behind the benchmarking airlines, such as Lufthansa, Jet Airways, Emirates Group, EasyJet PLC , Ryanair, Singapore Airlines, Sprit airlines British Airways, Japan Airlines, etc. Based on the above results, it can be concluded that although 12 of 33 airlines are performed in efficient frontiers, there are still 21 airlines that need to be improved. As a summary, the integrated DEA-BSC model is useful for decision-making units of airlines because it provides information on how much an airline can decrease input without decreasing output, or how much an airline can increase output by keeping the same inputs.

Table 24 DEA Efficiency and Benchmark Peer of Each DMU for the Sample Airlines of Year 2013

DMU	**Airlines**	crste	vrste	scale		Peer count	Peers						
1	Aegean Airlines Group	1.000	1.000	1.000	-	4	1						
2	Aer Lingus	1.000	1.000	1.000	-	2	2						
3	Aeroflot	1.000	1.000	1.000	-	4	3						
4	Air Canada	1.000	1.000	1.000	-	0	4						
5	Air china	0.860	0.906	0.950	drs	0	17	26	38	33			
6	Air New Zealand Group	0.837	0.997	0.934	irs	0	19	28	1	33	9	16	2
7	AirAsia	1.000	1.000	1.000	-	0	7						
8	Allegiant Air	1.000	1.000	1.000	-	2	8						
9	ANA Group	1.000	1.000	1.000	-	6	9						
10	Avianca Holdings	0.877	0.881	0.995	irs	0	17	9	16	33	26	3	1
11	British Airways	1.000	1.000	1.000	-	0	11						
12	Cathay Pacific Group	0.958	0.958	1.000	-	0	19	33	3	17	26		
13	Cebu Pacific Air	0.777	1.000	0.777	irs	0	13						
14	China Eastern Airlines	0.794	0.799	0.993	drs	0	28	33	16	17	35	9	
15	China Southern Air Holding	0.729	0.733	0.994	drs	0	33	28	35	26	17	16	
16	Copa Holdings	1.000	1.000	1.000	-	7	16						
17	Delta airlines	1.000	1.000	1.000	-	8	17						
18	EasyJet PLC	1.000	1.000	1.000	-	1	18						
19	El Al	1.000	1.000	1.000	-	3	19						
20	Emirates Group	1.000	1.000	1.000	-	1	20						
21	Ethiopian	1.000	1.000	1.000	-	0	21						
22	Finnair	0.847	0.983	0.862	irs	0	26	9	33	19	1		
23	Garuda Indonesia	0.710	0.721	0.985	drs	0	16	33	28	31	17	9	
24	Hawaiian Airlines	1.000	1.000	1.000	-	1	24						
25	IAG	1.000	1.000	1.000	-	0	25						
26	Japan Airlines	1.000	1.000	1.000	-	7	26						
27	JetBlue Airways	0.957	0.959	0.997	irs	0	17	24	35	26	16	8	
28	Lufthansa group	1.000	1.000	1.000	-	4	28						
29	Norwegian	1.000	1.000	1.000	-	0	29						
30	Qantas Group	1.000	1.000	1.000	-	0	30						
31	Republic Airways Holdings	1.000	1.000	1.000	-	1	31						
32	Ryanair	1.000	1.000	1.000	-	0	32						
33	Singapore Airlines	1.000	1.000	1.000	-	9	33						
34	SkyWest, Inc	1.000	1.000	1.000	-	0	34						
35	Southwest Airlines Co.	1.000	1.000	1.000	-	3	35						
36	Sprit airlines	1.000	1.000	1.000	-	0	36						
37	Turkish Airlines	0.727	0.727	1.000	-	0	16	20	3	2	17	9	
38	United-Continental Holdings	0.959	1.000	0.959	drs	1	38						
39	WestJet	0.765	0.793	0.965	irs	0	26	1	3	18	33	8	
	mean	**0.944**	**0.958**	**0.985**									

The detailed DEA results are shown in Table 24 Production efficiency (VRS) multi stage input oriented model was calculated based on a CCR model. Production efficiency equals to 1 demonstrates that the DMU has achieved highest efficiency relative to other DMUs, whereas production efficiency less than 1 demonstrates the DMU to be inefficient relative to other DMUs.

Table 24 reveals that 26 airline DMUs had excellent performance. However, there were 13 inefficient DMUs which need to improve their performance according to the operating mode of other airlines. For example, No. 13 DMU (Cebu Pacific Air**)** should learn from No. 1, 7, 17, 21, 28, 32, 33, 34, 36, and 2 DMUs.

Table 24 also shows that, among inefficient airlines there was 4 DMUs in the condition of decreasing return scale (DRS) and there were 4 DMUs in the condition of increasing return scale (IRS). At the individual airline level, the efficiency slacks measures how much output should be proportionally expanded by using the same amount of inputs. For example, the scale efficiency score of Cebu Pacific Air (No. 13 DMU) is 0.777 implying that the efficiency of this airline is far behind the benchmarking airlines, such as Lufthansa, Jet Airways, Emirates Group, Easy Jet PLC, Ryanair, Singapore Airlines, Sprit airlines British Airways, Japan Airlines, etc. Based on the above results, it can be concluded that although 26 of 39 airlines are performed in efficient frontiers, there are still 13 airlines that need to be improved. As a summary, the integrated DEA-BSC model is useful for decision-making units of airlines because it provides information on how much an airline can decrease input without decreasing output, or how much an airline can increase output by keeping the same inputs.

Table 25 DEA Efficiency and Benchmark Peer of Each DMU for the Sample Airlines of Year 2012

DMU	**Airlines**	crste	vrste	scale		peers count	peers						
1	Aer Lingus	1.000	1.000	1.000	-	5	1						
2	Aeroflot	1.000	1.000	1.000	-	5	2						
3	Air Berlin	1.000	1.000	1.000	-	4	3						
4	Air Canada	1.000	1.000	1.000	-	0	4						
5	Air china	0.960	1.000	0.960	drs	1	5						
6	Air New Zealand Group	0.911	0.951	0.958	irs	0	24	1	26	29	2		
7	AirAsia	1.000	1.000	1.000	-	1	7						
8	Allegiant Air	1.000	1.000	1.000	-	1	8						
9	ANA Group	1.000	1.000	1.000	-	0	9						
10	Avianca Holdings	0.874	0.785	0.998	drs	0	30	16	1	2	3	22	24
11	British Airways	1.000	1.000	1.000	-	1	11						
12	Cathay Pacific Group	1.000	1.000	1.000	-	0	12						
13	Cebu Pacific Air	1.000	1.000	1.000	-	1	13						
14	China Eastern Airlines	0.901	1.000	0.901	drs	1	14						
15	China Southern Air Holding	0.808	0.901	0.896	drs	0	24	16	17	5	14	11	
16	Copa Holdings	1.000	1.000	1.000	-	5	16						
17	Delta airlines	1.000	1.000	1.000	-	1	17						
18	EasyJet PLC	1.000	1.000	1.000	-	1	18						
19	Emirates Group	1.000	1.000	1.000	-	0	19						
20	Ethiopian	1.000	1.000	1.000	-	0	20						
21	Finnair	0.922	0.955	0.965	irs	0	26	29	1	24	2		
22	Garuda Indonesia	1.000	1.000	1.000	-	2	22						
23	Hawaiian Airlines	0.981	1.000	0.981	irs	0	23						
24	Japan Airlines	1.000	1.000	1.000	-	8	24						
25	JetBlue Airways	0.933	0.994	0.999	irs	0	24	8	7	16	35		
26	Kenya Airways	1.000	1.000	1.000	-	2	26						
27	Korean Air	1.000	1.000	1.000	-	0	27						
28	LATAM Airlines	1.000	1.000	1.000	-	0	28						
29	Lufthansa group	1.000	1.000	1.000	-	3	29						
30	Norwegian	1.000	1.000	1.000	-	2	30						
31	Republic Airways Holdings	1.000	1.000	1.000	-	1	31						
32	Ryanair	1.000	1.000	1.000	-	0	32						
33	Singapore Airlines	1.000	1.000	1.000	-	1	33						
34	SkyWest, Inc	1.000	1.000	1.000	-	1	34						
35	Southwest Airlines Co.	1.000	1.000	1.000	-	1	35						
36	Sprit airlines	1.000	1.000	1.000	-	0	36						
37	Turkish Airlines	0.758	0.758	1.000	-	0	24	16	3	2	33	22	18
38	Virgin Australia	0.835	0.841	0.994	drs	0	1	29	2	3	34	24	30
39	WestJet	0.777	0.825	0.942	irs	0	16	1	13	3	24	31	
	mean	**0.967**	**0.977**	**0.990**									

The detailed DEA results are shown in Table 25 Production efficiency (VRS) multi stage input oriented model was calculated based on a CCR model. Production efficiency equals to 1 demonstrates that the DMU has achieved highest efficiency relative to other DMUs, whereas production efficiency less than 1 demonstrates the DMU to be inefficient relative to other DMUs.

Table 25 reveals that 28 airline DMUs had excellent performance. However, there were 11 inefficient DMUs which need to improve their performance according to the operating mode of other airlines. For example, No. 21 DMU (Finnair) should learn from No. 26, 29,1,24 and 2 DMUs.

Table 25 also shows that, among inefficient airlines there was 5 DMUs in the condition of decreasing return scale (DRS) and there were 5 DMUs in the condition of increasing return scale (IRS). At the individual airline level, the efficiency slacks measures how much output should be proportionally expanded by using the same amount of inputs. For example, the scale efficiency score of China Southern Air Holding (No. 15 DMU) is 0.896 implying that the efficiency of this airline is behind the benchmarking airlines, such as Lufthansa, Emirates Group, Easy Jet PLC, Ryanair, Singapore Airlines, Sprit airlines British Airways, Japan Airlines, etc.

Based on the above results, it can be concluded that although 28 of 39 airlines are performed in efficient frontiers, there are still 11 airlines that need to be improved. As a summary, the integrated DEA-BSC model is useful for decision-making units of airlines because it provides information on how much an airline can decrease input without decreasing output, or how much an airline can increase output by keeping the same inputs.

Table 26 DEA Efficiency and Benchmark Peer of Each DMU for the Sample Airlines of Year 2011

DMU	**Airlines**	crste	vrste	scale		peers count	peers					
1	Aer Lingus	1.000	1.000	1.000	-	2	1					
2	Aeroflot	1.000	1.000	1.000	-	3	2					
3	Air china	1.000	1.000	1.000	-	0	3					
4	Air New Zealand Group	1.000	1.000	1.000	-	1	4					
5	AirAsia	0.875	0.889	0.985	irs	0	14	27	1	34	2	33
6	Allegiant Air	1.000	1.000	1.000	-	1	6					
7	ANA Group	1.000	1.000	1.000	-	0	7					
8	British Airways	1.000	1.000	1.000	-	0	8					
9	Cathay Pacific Group	1.000	1.000	1.000	-	0	9					
10	Cebu Pacific Air	0.934	1.000	0.934	drs	0	10					
11	China Eastern Airlines	1.000	1.000	1.000	-	1	11					
12	China Southern Air Holding	1.000	1.000	1.000	-	0	12					
13	Copa Holdings	1.000	1.000	1.000	-	0	13					
14	Delta airlines	1.000	1.000	1.000	-	3	14					
15	EasyJet PLC	1.000	1.000	1.000	-	0	15					
16	Emirates Group	0.973	1.000	0.973	drs	0	16					
17	Ethiopian	1.000	1.000	1.000	-	0	17					
18	Garuda Indonesia	0.960	0.962	0.999	drs	0	11	6	14	2	32	
19	Grupo Aeromexico	1.000	1.000	1.000	-	0	19					
20	IAG	1.000	1.000	1.000	-	0	20					
21	Jet Airways	1.000	1.000	1.000	-	1	21					
22	JetBlue Airways	0.985	1.000	0.985	irs	1	22					
23	Kenya Airways	1.000	1.000	1.000	-	0	23					
24	LATAM Airlines	0.926	1.000	0.926	irs	0	24					
25	Lufthansa group	1.000	1.000	1.000	-	1	25					
26	Norwegian	1.000	1.000	1.000	-	0	26					
27	Qantas Group	1.000	0.953	1.000	-	1	27					
28	Ryanair	0.941	1.000	0.987	drs	0	1	2	21	4	14	25
29	Singapore Airlines	0.981	1.000	0.981	irs	0	29					
30	South African Airways	0.946	1.000	0.946	drs	0	30					
31	Southwest Airlines Co.	1.000	1.000	1.000	-	0	31					
32	Sprit airlines	1.000	1.000	1.000	-	1	32					
33	Turkish Airlines	1.000	1.000	1.000	-	1	33					
34	United-Continental Holdings	1.000	1.000	1.000	-	1	34					
35	Virgin Australia	1.000	1.000	1.000	-	0	35					
36	WestJet	1.000	1.000	1.000	-	0	36					
	mean	**0.987**	**0.995**	**0.992**								

The detailed DEA results are shown in Table 26 Production efficiency (VRS) multi stage input oriented model was calculated based on a CCR model. Production efficiency equals to 1 demonstrates that the DMU has achieved highest efficiency relative to other DMUs, whereas production efficiency less than 1 demonstrates the DMU to be inefficient relative to other DMUs.

Table 26 reveals that 26 airline DMUs had excellent performance. However, there were 10 inefficient DMUs which need to improve their performance according to the operating mode of other airlines. For example, No. 28 DMU (Ryanair) should learn from No. 1,2,21,4,14 and 25 DMUs.

Table 26 also shows that, among inefficient airlines there was 5 DMUs in the condition of decreasing return scale (DRS) and there were 4 DMUs in the condition of increasing return scale (IRS). At the individual airline level, the efficiency slacks measures how much output should be proportionally expanded by using the same amount of inputs. For example, the scale efficiency score of South African Airways (No. 30 DMU) is 0.946 implying that the efficiency of this airline is behind the benchmarking airlines, such as Lufthansa, Ethiopian, IAG, Easy Jet PLC, WestJet, Singapore Airlines, Sprit airlines, British Airways, Japan Airlines, etc.

Based on the above results, it can be concluded that although 26 of 36 airlines are performed in efficient frontiers, there are still 10 airlines that need to be improved. As a summary, the integrated DEA-BSC model is useful for decision-making units of airlines because it provides information on how much an airline can decrease input without decreasing output, or how much an airline can increase output by keeping the same inputs.

Table 27 DEA Efficiency and Benchmark Peer of Each DMU for the Sample Airlines of Year 2010

DMU	**Airlines**	crste	vrste	scale		peers count	peers						
1	Aer Lingus	1.000	1.000	1.000	-	3	1						
2	Aeroflot	1.000	1.000	1.000	-	4	2						
3	Air Canada	1.000	1.000	1.000	-	1	3						
4	Air china	1.000	1.000	1.000	-	1	4						
5	Air New Zealand Group	0.875	0.889	0.985	irs	0	27	1	22	2	34	33	14
6	AirAsia	1.000	1.000	1.000	-	2	6						
7	Allegiant Air	1.000	1.000	1.000	-	0	7						
8	Cathay Pacific Group	1.000	1.000	1.000	-	0	8						
9	Cebu Pacific Air	1.000	1.000	1.000	-	0	9						
10	China Eastern Airlines	0.934	1.000	0.934	drs	0	10						
11	Copa Holdings	1.000	1.000	1.000	-	1	11						
12	Delta airlines	1.000	1.000	1.000	-	0	12						
13	EasyJet PLC	1.000	1.000	1.000	-	0	13						
14	Egyptair	1.000	1.000	1.000	-	3	14						
15	El Al	1.000	1.000	1.000	-	0	15						
16	Emirates Group	0.973	1.000	0.973	drs	0	16						
17	Ethiopian	1.000	1.000	1.000	-	0	17						
18	Garuda Indonesia	0.960	0.962	0.999	drs	0	2	11	6	14	32		
19	Grupo Aeromexico	1.000	1.000	1.000	-	0	19						
20	Hawaiian Airlines	1.000	1.000	1.000	-	0	20						
21	IAG	1.000	1.000	1.000	-	1	21						
22	Jet2	0.985	1.000	0.985	irs	1	22						
23	JetBlue Airways	1.000	1.000	1.000	-	1	23						
24	Kenya Airways	0.924	1.000	0.926	irs	0	24						
25	Korean Air	1.000	1.000	1.000	-	1	25						
26	LATAM Airlines	1.000	1.000	1.000		0	26						
27	lufthansa group	1.000	1.000	1.000		2	27						
28	Malaysia Airlines	0.941	0.953	0.987	drs	0	4	21	25	1	14	2	
29	Norwegian	0.981	1.000	0.981	irs	0	29						
30	Qantas Group	0.946	1.000	0.946	drs	1	30						
31	Ryanair	1.000	1.000	1.000		1	31						
32	Singapore Airlines	1.000	1.000	1.000		1	32						
33	SkyWest, Inc	1.000	1.000	1.000		3	33						
34	South African Airways	1.000	1.000	1.000		2	34						
35	Southwest Airlines Co.	1.000	1.000	1.000		0	35						
36	Sprit airlines	1.000	1.000	1.000		0	36						
37	**Turkish Airlines**	0.842	0.864	0.975	drs	0	33	27	3	2	30		
38	United-Continental Holdings	1.000	1.000	1.000		0	38						
39	Virgin Australia	0.963	0.963	1.000		0	1	31	33	6	34	23	40
40	WestJet	1.000	1.000	1.000		1	40						
	Mean	**0.983**	**0.991**	**0.992**									

The detailed DEA results are shown in Table 27 Production efficiency (CRS) was calculated based on a CCR model. Production efficiency equals to 1 demonstrates that the DMU has achieved highest efficiency relative to other DMUs, whereas production efficiency less than 1 demonstrates the DMU to be inefficient relative to other DMUs.

Table 27 reveals that 28 airline DMUs had excellent performance. However, there were 12 inefficient DMUs which need to improve their performance according to the operating mode of other airlines. For example, No. 18 DMU (Garuda Indonesia) should learn from No. 2, 11,6,14 and 35 DMUs.

Table 27 also shows that, among inefficient airlines there was 6 DMUs in the condition of decreasing return scale (DRS) and there were 4 DMUs in the condition of increasing return scale (IRS). At the individual airline level, the efficiency slacks measures how much output should be proportionally expanded by using the same amount of inputs.

Based on the above results, it can be concluded that although 28 of 40 airlines are performed in efficient frontiers, there are still 12 airlines that need to be improved. As a summary, the integrated DEA-BSC model is useful for decision-making units of airlines because it provides information on how much an airline can decrease input without decreasing output, or how much an airline can increase output by keeping the same inputs.

Table 28 DEA Efficiency and Benchmark Peer of Each DMU for the Sample Airlines of Year 2009

DMU	**Airlines**	crste	vrste	scale		peers count	peers							
1	Aegean Airlines Group	1.000	1.000	1.000	-	0	1							
2	Aeroflot	1.000	1.000	1.000	-	2	2							
3	Air china	0.999	1.000	0.999	-	2	3							
4	Air New Zealand Group	1.000	1.000	1.000	-	1	4							
5	AirAsia	1.000	1.000	1.000	-	0	5							
6	Allegiant Air	1.000	1.000	1.000	-	1	6							
7	Cathay Pacific Group	1.000	1.000	1.000	-	0	7							
8	Cebu Pacific Air	1.000	1.000	1.000	-	0	8							
9	China Eastern Airlines	0.824	0.912	0.903	drs	0	4	2	3	23	12			
10	Copa Holdings	1.000	1.000	1.000	-	2	10							
11	EasyJet PLc	1.000	1.000	1.000	-	1	11							
12	Egyptair	1.000	1.000	1.000	-	3	12							
13	Emirates Group	1.000	1.000	1.000	-	0	13							
14	Ethiopian	1.000	1.000	1.000	-	0	14							
15	Garuda Indonesia	1.000	1.000	1.000	-	0	15							
16	Hawaiian Airlines	1.000	1.000	1.000	-	0	16							
17	JetBlue Airways	1.000	1.000	1.000	-	1	17							
18	LATAM Airlines	1.000	1.000	1.000	-	0	18							
19	Malaysia Airlines	0.862	0.890	0.968	drs	0	12	2	26	25	27	21	3	10
20	Norwegian	1.000	1.000	1.000	-	0	20							
21	Qantas Group	0.946	1.000	0.946	drs	1	21							
22	Republic Airways Holdings	1.000	1.000	1.000	-	1	22							
23	Singapore Airlines	1.000	1.000	1.000	-	1	23							
24	SkyWest, Inc	1.000	1.000	1.000	-	0	24							
25	South African Airways	1.000	1.000	1.000	-	1	25							
26	Southwest Airlines Co.	1.000	1.000	1.000	-	1	26							
27	TAP Portugal	1.000	1.000	1.000	-	2	27							
28	Turkish Airlines	0.843	1.000	0.843	drs	0	28							
29	WestJet	0.978	0.983	0.995	irs	0	6	27	10	12	11	22	17	
	Mean	**0.978**	**0.983**	**0.988**	**-**									

The detailed DEA results are shown in Table 28 Production efficiency (CRS) was calculated based on a CCR model. Production efficiency equals to 1 demonstrates that the DMU has achieved highest efficiency relative to other DMUs, whereas production efficiency less than 1 demonstrates the DMU to be inefficient relative to other DMUs.

Table 28 reveals that 23 airlines DMUs had excellent performance. However, there were 6 inefficient DMUs which need to improve their performance according to the operating mode of other airlines. For example, No. 9 DMU (China Eastern Airlines) should learn from No. 4, 2, 3, 23and 12 DMUs.

Table 28 also shows that, among inefficient airlines there was 4 DMUs in the condition of decreasing return scale (DRS) and there were 1DMUs in the condition of increasing return scale (IRS). At the individual airline level, the efficiency slacks measures how much output should be proportionally expanded by using the same amount of inputs.

Based on the above results, it can be concluded that although 23 of 29 airlines are performed in efficient frontiers, there are still 6 airlines that need to be improved. As a summary, the integrated DEA-BSC model is useful for decision-making units of airlines because it provides information on how much an airline can decrease input without decreasing output, or how much an airline can increase output by keeping the same inputs.

Table 29 Table DEA Efficiency and Benchmark Peer of Each DMU for the Sample of Airlines 2008

DMU	**Airlines**	crste	vrste	scale		peers count	peers				
1	Aegean Airlines Group	0.945	1.000	0.945	irs	1	1				
2	Aeroflot	0.435	0.579	0.750	irs	0	13	27	5		
3	Air France klm	0.540	1.000	0.540	drs	1	3				
4	Air New Zealand Group	0.469	0.555	0.846	irs	0	13	10	5	16	27
5	Allegiant Air	1.000	1.000	1.000		9	5				
6	ANA Group	0.461	0.461	0.999		0	8	18	13	9	
7	British Airways	0.932	1.000	0.932	drs	1	7				
8	Copa Holdings	1.000	1.000	1.000		3	8				
9	EasyJet PLC	1.000	1.000	1.000		7	9				
10	Egyptair	1.000	1.000	1.000		4	10				
11	Emirates Group	1.000	1.000	1.000		1	11				
12	Ethiopian	1.000	1.000	1.000		0	12				
13	Garuda Indonesia	1.000	1.000	1.000		12	13				
14	Hawaiian Airlines	0.420	0.873	0.481	irs	0	13	18	5	8	
15	Japan Airlines	0.243	0.545	0.446	drs	0	3				
16	Kenya Airways	1.000	1.000	1.000		4	16				
17	LATAM Airlines	1.000	1.000	1.000		0	17				
18	Lufthansa group	1.000	1.000	1.000		2	18				
19	Malaysia Airlines	0.281	0.393	0.715	irs	0	16	9	5	10	13
20	Norwegian	0.238	1.000	0.238	irs	0	20				
21	Qantas Group	0.589	0.605	0.975	drs	0	11	7	13	27	9
22	Republic Airways Holdings	0.720	0.871	0.827	irs	0	13	9	5	1	
23	Ryanair	1.000	1.000	1.000		0	23				
24	Singapore Airlines	1.000	1.000	1.000		0	24				
25	SkyWest, Inc	0.360	0.419	0.859	irs	0	10	5	27	13	
26	Southwest Airlines Co.	0.301	0.319	0.943	irs	0	9	5	8	13	
27	Turkish Airlines	1.000	1.000	1.000		4	27				
28	Virgin Australia	0.392	0.599	0.654	irs	0	13	9	16	5	
29	WestJet	0.442	0.543	0.813	irs	0	9	5	13	10	16
	Mean	**0.726**	**0.819**	**0.861**							

The detailed DEA results are shown in Table 29 Production efficiency (CRS) was calculated based on a CCR model. Production efficiency equals to 1 demonstrates that the DMU has achieved highest efficiency relative to other DMUs, whereas production efficiency less than 1 demonstrates the DMU to be inefficient relative to other DMUs.

Table 29 reveals that 13 airline DMUs had excellent performance. However, there were 13 inefficient DMUs which need to improve their performance according to the operating mode of other airlines. For example, No. 29 DMU (WestJet) should learn from No. 9, 5, 13, 10 and 16 DMUs.

Table 29 also shows that, among inefficient airlines there was 4 DMUs in the condition of decreasing return scale (DRS) and there were 11 DMUs in the condition of increasing return scale (IRS). For example, DMU No. 20 (Norwegian airlines) scale efficiency score is 0.238 is far behind the benchmarking airlines. At the individual airline level, the efficiency slacks measures how much output should be proportionally expanded by using the same amount of inputs.

Based on the above results, it can be concluded that although 23 of 29 airlines are performed in efficient frontiers, there are still 6 airlines that need to be improved. As a summary, the integrated DEA-BSC model is useful for decision-making units of airlines because it provides information on how much an airline can decrease input without decreasing output, or how much an airline can increase output by keeping the same inputs.

Table 30 DEA Efficiency and Benchmark Peer of Each DMU for the Sample Airlines of 2007

	Airlines	crste	vrste	scale		peers count	peers						
1	Aegean Airlines Group	1.000	1.000	1.000		1	1						
2	Aer Lingus	1.000	1.000	1.000		3	2						
3	Aeroflot	1.000	1.000	1.000		7	3						
4	Air Berlin	1.000	1.000	1.000		2	4						
5	Air Canada	0.507	0.730	0.694	Drs	0	38	29	34	15	43		
6	Air china	0.595	0.660	0.901	Drs	0	3	15	36	34	23	43	
7	Air France klm	0.606	1.000	0.606	Drs	0	7						
8	Air New Zealand Group	0.555	0.564	0.984	Irs	0	35	29	28	2	15		
9	Allegiant Air	1.000	1.000	1.000		11	9						
10	American Airlines Group	0.280	0.294	0.951	Drs	0	36	29	35	34	13		
11	ANA Group	0.276	0.325	0.850	Drs	0	43	29	38	34	15		
12	British Airways	0.628	0.730	0.860	Drs	0	13	29	35	34	3	36	
13	Cathay Pacific Group	1.000	1.000	1.000		5	13						
14	China Eastern Airlines	0.345	0.372	0.926	Irs	0	9	18	4	43			
15	Copa Holdings	1.000	1.000	1.000		10	15						
16	Delta airlines	0.421	0.506	0.831	Drs	0	34	29	18	35			
17	EasyJet PLC	0.604	0.628	0.963	Irs	0	3	43	15	34	9		
18	Egyptair	1.000	1.000	1.000		7	18						
19	El Al	0.557	0.857	0.649		0	9	27	21	43			
20	Emirates Group	1.000	1.000	1.000		0	20						
21	Ethiopian	0.450	1.000	0.450	Irs	4	21						
22	Finnair	1.000	1.000	1.000		2	22						
23	Garuda Indonesia	0.363	0.834	0.435	Irs	0	21	9	43				
24	Hawaiian Airlines	0.330	0.726	0.454	Irs	0	29	35	9				
25	Jet Airways	0.301	0.426	0.706	Irs	0	4	9	43	18			
26	JetBlue Airways	0.243	0.392	0.622	Irs	0	9	43					
27	Kenya Airways	0.966	1.000	0.966	Irs	2	27						
28	Korean Air	0.270	0.326	0.828	Irs	0	43	9	21				
29	Lufthansa group	1.000	1.000	1.000		10	29						
30	Malaysia Airlines	0.591	0.602	0.982	Drs	0	18	34	36	25	3	43	
31	Norwegian	0.843	1.000	0.843	Irs	0	31						
32	Qantas Group	0.572	0.647	0.883	Drs	0	34	13	29	35	43	36	3
33	Republic Airways Holdings	0.456	0.652	0.699	Irs	0	15	22	43	9	1		
34	Ryanair	1.000	1.000	1.000		14	34						
35	SAS Group	1.000	1.000	1.000		9	35						
36	Singapore Airlines	1.000	1.000	1.000		5	36						
37	SkyWest, Inc	0.553	0.558	0.991	Irs	0	2	18	34	15	35	9	
38	Southwest Airlines Co.	0.681	1.000	0.681	Drs	2	38						
39	TAP Portugal	0.263	0.466	0.565	Irs	0	21	43	27				
40	Turkish Airlines	0.500	0.510	0.981	Drs	0	18	34	2	15	3	29	35
41	United-Continental Holdings	0.357	0.421	0.849	Drs	0	29	34	35	13	3		
42	Virgin Australia	0.721	0.754	0.957	Irs	0	15	22	9	34	43		
43	WestJet	1.000	1.000	1.000		15	43						
	Mean	**0.671**	**0.767**	**0.863**									

The detailed DEA results are shown in Table 30 Production efficiency (CRS) was calculated based on a CCR model. Production efficiency equals to 1 demonstrates that the DMU has achieved highest efficiency relative to other DMUs, whereas production efficiency less than 1 demonstrates the DMU to be inefficient relative to other DMUs.

Table 30 reveals that 15 airline DMUs had excellent performance. However, there were 28 inefficient DMUs which need to improve their performance according to the operating mode of other airlines. For example, No. 5 DMU (Air Canada) should learn from No. 38,29,34,15 and 43 DMUs.

Table 30 also shows that, among inefficient airlines there was 15 DMUs in the condition of decreasing return scale (DRS) and there were 15 DMUs in the condition of increasing return scale (IRS). For example, the scale efficiency score of Ethiopian (No. 21 DMU) is 0.450, implying that the efficiency of this airline is far behind the benchmarking airlines, such as Lufthansa Group, Finnair, Egyptair, Emirates Group, Singapore airlines etc. At the individual airline level, the efficiency slacks measures how much output should be proportionally expanded by using the same amount of inputs.

Based on the above results, it can be concluded that although 15 of 43 airlines are performed in efficient frontiers, there are still 28 airlines that need to be improved. As a summary, the integrated DEA-BSC model is useful for decision-making units of airlines because it provides information on how much an airline can decrease input without decreasing output, or how much an airline can increase output by keeping the same inputs.

4.1.4 Summary of Output Slacks for Eight Airlines

Table 31 Summary of the Output Slacks for the Year 2014

DMU	Op Revenue	NI	ROA (%)	ROI (%)
1	0.00	0.00	0.00	0.00
2	0.00	6.203	4.807	5.701
3	0.00	0.00	5.478	5.478
4	0.00	0.00	5.871	6.842
5	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00
8	0.00	0.00	8.107	6.08
9	0.00	0.00	5.555	5.81
10	0.00	0.00	0.00	0.00
11	0.00	0.00	5.716	7.388
12	0.00	0.00	0.00	0.00
13	0.00	0.00	5.806	6.241
14	0.00	0.00	7.718	8.155
15	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00
20	0.00	18.837	4.174	4.827
21	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00
23	0.00	0.00	4.553	3.515
24	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00
29	0.00	0.00	3.592	3.223
30	0.00	0.00	0.00	0.00
31	0.00	0.00	4.328	6.326
32	0.00	0.00	0.00	0.00
33	0.00	0.00	2.111	3.42
mean	**0.00**	**0.76**	**2.06**	**2.21**

Table 31 shows the slacks of input of airlines that need to be improved without changing output factors. For example, as shown in Table 31, Air Canada (No. 2 of DMU) needs to improve 4.807 percent of ROA, and 5.701 percent of ROI, and increase 6.203 millions of net income to become efficient. Once Air Canada can improve this operating performance, then it becomes one of the members of efficiency frontiers.

Table 32 Summary of the Output Slacks for the Year 2013:

DMU	Op Revenue	NI	ROA (%)	ROI (%)
1	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
5	0.00	1542.359	6.871	9.029
6	0.00	0.00	3.512	3.579
7	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00
10	0.00	258.115	7.239	6.27
11	0.00	0.00	0.00	0.00
12	0.00	1032.623	2.111	5.107
13	0.00	0.00	0.00	0.00
14	0.00	1517.805	7.451	10.171
15	0.00	2361.127	10.157	15.198
16	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	0.00
22	0.00	70.894	2.672	2.425
23	0.00	602.234	15.816	16.808
24	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	0.00
27	0.00	383.066	12.042	11.748
28	0.00	0.00	0.00	0.00
29	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00
31	0.00	0.00	0.00	0.00
32	0.00	0.00	0.00	0.00
33	0.00	0.00	0.00	0.00
34	0.00	0.00	0.00	0.00
35	0.00	0.00	0.00	0.00
36	0.00	0.00	0.00	0.00
37	0.00	39.248	3.742	3.999
38	0.00	0.00	0.00	0.00
39	0.00	97.224	3.234	4.112
mean	**0.00**	**202.684**	**1.919**	**2.268**

Table 32 shows the slacks of input of airlines that need to be improved without changing output factors. For example, as shown in Table 32, Avianca Holdings (No. 10 of DMU) needs to improve 7.239 percent of ROA, and 6.27 percent of ROI, and increase 258.115 millions of net income to become efficient. Once Avianca Holdings can improve this operating performance, then it becomes one of the members of efficiency frontiers.

Table 33 Summary of Output Slacks for the Year 2012:

DMU	Op Revenue	NI	ROA (%)	ROI (%)
1	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00
6	0	87.755	1.14	1.516
7	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00
10	0.00	339.81	7.147	7.305
11	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00
15	0.00	240.431	0.00	3.302
16	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00
21	0.00	247.085	2.926	2.881
22	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00
25	0.00	293.989	9.959	11.308
26	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00
29	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00
31	0.00	0.00	0.00	0.00
32	0.00	0.00	0.00	0.00
33	0.00	0.00	0.00	0.00
34	0.00	0.00	0.00	0.00
35	0.00	0.00	0.00	0.00
36	0.00	0.00	0.00	0.00
37	0.00	0.00	0.17	0.49
38	0.00	301.356	3.045	4.127
39	0.00	153.054	2.507	11.348
mean	**0.00**	**42.653**	**0.69**	**1.084**

Table 33 shows the slacks of input of airlines that need to be improved without changing output factors. For example, as shown in Table 33, Air New Zealand Group (No. 6 of DMU) needs to improve 1.140 percent of ROA, and 1.516 percent of ROI, and increase 87.755 millions of net income to become efficient. Once Air New Zealand Group can improve this operating performance, then it becomes one of the members of efficiency frontiers.

Table 34 Summary of Output Slacks for the Year 2011:

DMU	Op Revenue	NI	ROA (%)	ROI (%)
1	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000
5	0.000	62.884	2.396	2.487
6	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000
18	0.000	185.437	4.516	16.727
19	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000
28	0.000	162.585	1.349	4.016
29	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000
31	0.000	0.000	0.000	0.000
32	0.000	0.000	0.000	0.000
33	0.000	0.000	0.000	0.000
34	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000
36	0.000	0.000	0.000	0.000
mean	**0.000**	**11.414**	**0.229**	**0.645**

Table 34 shows the slacks of input of airlines that need to be improved without changing output factors. For example, as shown in Table 34, Airasia (No. 5 of DMU) needs to improve 2.396 percent of ROA, and 2.487 percent of ROI, and increase 62.884 millions of net income to become efficient. Once Airasia can improve this operating performance, then it becomes one of the members of efficiency frontiers.

Table 35 Summary of Output Slacks for the Year 2010:

DMU	Op Revenue	NI	ROA (%)	ROI (%)
1	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000
5	0.000	62.884	2.396	2.487
6	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000
18	0.000	185.437	4.516	16.727
19	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000
28	0.000	162.585	1.349	4.016
29	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000
31	0.000	0.000	0.000	0.000
32	0.000	0.000	0.000	0.000
33	0.000	0.000	0.000	0.000
34	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000
36	0.000	0.000	0.000	0.000
37	0.000	53.864	2.213	3.619
38	0.000	0.000	0.000	0.000
39	0.000	89.177	2.437	4.815
40	0.000	0.000	0.000	0.000
mean	**0.000**	**13.849**	**0.323**	**0.792**

Table 34 shows the slacks of input of airlines that need to be improved without changing output factors. For example, as shown in Table 34, Malaysia Airlines (No. 28 of DMU) needs to improve 1.349 percent of ROA, and 4.016 percent of ROI, and increase 162.585 millions of net income to become efficient. Once Malaysia Airlines can improve this operating performance, then it becomes one of the members of efficiency frontiers.

Table 36 Summary of Output Slacks for the Year 2009:

DMU	Op Revenue	NI	ROA (%)	ROI (%)
1	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000
9	0.000	378.592	3.315	5.848
10	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000
18	0.000	0.000	0.000	0.000
19	0.000	42.432	0.000	7.265
20	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000
28	0.000	0.000	0.000	0.000
29	0.000	0.000	3.955	6.364
mean	**0.000**	**14.518**	**0.251**	**0.672**

Table 36 shows the slacks of input of airlines that need to be improved without changing output factors. For example, as shown in Table 36, China Eastern Airlines (No. 9 of DMU) needs to improve 3.315 percent of ROA, and 5.848 percent of ROI, and increase 378.592 millions of net income to become efficient. Once China Eastern Airlines can improve this operating performance, then it becomes one of the members of efficiency frontiers.

Table 37 Summary of Output Slacks for the Year 2008:

DMU	Op Revenue	NI	ROA (%)	ROI (%)
1	0.000	0.000	0.000	0.000
2	0.000	60.921	7.019	6.809
3	0.000	0.000	0.000	0.000
4	0.000	0.000	3.772	4.909
5	0.000	0.000	0.000	0.000
6	0.000	0.000	9.803	13.148
7	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000
14	0.000	34.599	5.727	6.227
15	0.000	159.2	4.775	3.45
16	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000
18	0.000	0.000	0.000	0.000
19	0.000	0.000	4.348	5.075
20	0.000	0.000	0.000	0.000
21	0.000	0.000	6.758	6.356
22	0.000	0.000	6.077	1.895
23	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000
25	0.000	0.000	5.268	4.495
26	0.000	0.000	7.023	6.379
27	0.000	0.000	0.000	0.000
28	0.000	0.000	4.423	3.358
29	0.000	0.000	3.685	4.197
mean	**0.000**	**8.783**	**2.368**	**2.286**

Table 37 shows the slacks of input of airlines that need to be improved without changing output factors. For example, as shown in Table 37, Japan Airlines (No. 15 of DMU) needs to improve 4.775 percent of ROA, and 3.450 percent of ROI, and increase 159.200 millions of net income to become efficient. Once Japan Airlines can improve this operating performance, then it becomes one of the members of efficiency frontiers.

Table 38 Summary of Output Slacks for the Year 2007:

DMU	Op Revenue	NI	ROA (%)	ROI (%)
1	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000
5	0.000	0.000	6.547	10.815
6	0.000	0.000	3.343	7.632
7	0.000	0.000	0.000	0.000
8	0.000	0.000	9.409	10.731
9	0.000	0.000	0.000	0.000
10	0.000	0.000	2.874	9.97
11	0.000	0.000	7.764	10.952
12	0.000	0.000	2.782	4.23
13	0.000	0.000	0.000	0.000
14	0.000	37.54	5.741	6.617
15	0.000	0.000	0.000	0.000
16	0.000	0.000	3.671	5.65
17	0.000	0.000	6.003	9.376
18	0.000	0.000	0.000	0.000
19	0.000	0.000	1.387	2.537
20	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000
23	0.000	9.168	5.674	7.145
24	0.000	30.845	6.827	8.715
25	0.000	45.409	7.174	8.807
26	0.000	45.409	7.174	8.807
27	0.000	0.000	0.000	0.000
28	0.000	83.756	5.588	6.209
29	0.000	0.000	0.000	0.000
30	0.000	0.000	5.46	9.095
31	0.000	0.000	0.000	0.000
32	0.000	0.000	3.591	5.392
33	0.000	0.000	7.58	8.038
34	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000
36	0.000	0.000	0.000	0.000
37	0.000	0.000	4.415	7.184
38	0.000	0.000	0.000	0.000
39	0.000	28.536	3.486	4.884
40	0.000	0.000	8.698	11.98
41	0.000	0.000	4.063	6.888
42	0.000	0.000	4.965	5.688
43	0.000	0.000	0.000	0.000
mean	**0.000**	**6.69**	**2.891**	**4.119**

Table 38 shows the slacks of input of airlines that need to be improved without changing output factors. For example, as shown in Table 38, TAP Portugal (No. 39 of DMU) needs to improve

3.486 percent of ROA, and 4.884 percent of ROI, and increase 28.536 millions of net income to become efficient. Once TAP Portugal can improve this operating performance, then it becomes one of the members of efficiency frontiers.

4.1.5 Summary of Input Slacks for Each Airlines

Table 39 Summary of Input Slacks for the Year 2014

DMU	Passenger	RPK	Energy	Capital	Labor	Material	Other
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	658.062	101.494	133.503	238.457	492.53
3	0.00	18726.9	739.089	519.68	0.00	0.00	0.00
4	0.00	9195.2	38.945	895.579	110.19	421.195	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.697	0.00	228.737	146.607	0.00	486.864	441.451
9	0.462	3259.876	51.06	0.00	0.00	97.022	199.598
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0	42628.52	1980.954	383.69	0	2922.871	273.287
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.476	0.00	288.622	399.949	0.00	0.00	0.00
14	0.00	10196.88	169.521	198.832	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.887	0.00	230.935	0.00	159.114	214.336	54.349
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	10.771	0.00	686.028	0.00	479.684	124.061	0.00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	48.352	0.00	1812.06	834.096	2582.066	259.769	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	0.00	25643.77	793.294	0.00	0.00	2286.637	0.00
32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33	0.00	6967.925	0.00	0.00	13.591	77.52	774.472
Mean	**1.868**	**3533.907**	**232.646**	**105.452**	**105.398**	**216.022**	**67.748**

Table 39 shows the slacks of input of the airlines have to improve without changing any output factors. For example, No. 2 of DMUs (Air Canada) needs to reduce US$ 238.457 million of material cost, US$ 658.0632 million of fuel cost, US$ 101.494 million of capital cost, US$

133.503 millions of labour cost and $ 492.530 million of the other operating expense in order to become efficiency frontiers**.**

Table 40 Summary of Input Slacks for the Year 2013:

DMU	Passenger	RPK	Energy	Capital	Labor	Material	Other
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	29.788	21489.71	567.97	543.238	0.00	0.00	0.00
6	0.00	9639.094	0.00	0.00	0.00	202.566	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	4.765	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	487.01	0.00	891.409	3391.55	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	23.234	0.00	0.00	0.00	0.00	33.882	0.00
15	22.454	0.00	0.00	685.928	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	2490.848	0.00	424.573	0.00	0.00	206.042
23	1.712	2697.334	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	3.464	0.00	272.792	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
34	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35	0.00	0.00	0.00	0.00	0.00	0.00	0.00
36	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37	3.925	0.00	0.00	0.00	0.00	520.334	0.00
38	0.00	0.00	0.00	0.00	0.00	0.00	0.00
39	0.00	4305.815	0.00	0.00	0.00	0.00	794.427
mean	**2.291**	**1041.61**	**34.045**	**42.404**	**22.857**	**106.368**	**25.653**

Table 40 shows the slacks of input of the airlines have to improve without changing any output factors. For example, No. 22 of DMUs (Finnair) needs to reduce US$ 424.573 million of capital cost, US$ 2490.848 millions of RPK and $ 206.042 million of the other operating expense in order to become efficiency frontiers

Table 41 Summary of Input Slacks for the Year 2012:

DMU	Passenger	RPK	Energy	Capital	Labor	Material	Other
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	9826.028	0.000	0.000	31.006	180.151	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.895	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	23.55	13405.28	523.967	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0.000	6490.234	0.000	119.975	0.000	42.835	0.000
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	2.376	0.000	236.521	93.171	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	0.000	0.000	0.000	0.000	0.000	0.000	0.000
34	0.000	0.000	0.000	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000	0.000	0.000	0.000
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	0.000	4670.05	0.000	0.000	0.000	0.000	11491.06
38	0.000	1747.619	0.000	0.000	0.000	0.000	0.000
39	0.000	7150.439	0.000	0.000	0.000	0.000	950.217
mean	**0.688**	**1109.991**	**19.5**	**5.465**	**0.795**	**5.718**	**319.007**

Table 41 shows the slacks of input of the airlines have to improve without changing any output factors. For example, No. 6 of DMUs (Air New Zealand Group) needs to reduce US$

180.151million of material cost and $ 9826.028 million of RPK million in order to become efficiency frontiers.

Table 42 Summary of Input Slacks for the Year 2011:

DMU	Passenger	RPK	Energy	Capital	Labor	Material	Other
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	5945.639	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	2.79	2904.464	0.000	0.000	0.000	74.655	0.000
19	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	0.000	6474.187	236.103	0.000	0.000	0.000	0.000
29	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	0.000	0.000	0.000	0.000	0.000	0.000	0.000
34	0.000	0.000	0.000	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000	0.000	0.000	0.000
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000
mean	**0.078**	**425.675**	**6.558**	**0.000**	**0.000**	**2.074**	**0.000**

Table 42 shows the slacks of input of the airlines have to improve without changing any output factors. For example, No. 28 of DMUs (Ryanair) needs to reduce US$ 236.103 million of energy cost and US$ 6474.187 million cost of RPK in order to become efficiency frontiers.

Table 43 Summary of Input Slacks for the Year 2010

DMU	Passenger	RPK	Energy	Capital	Labor	Material	Other
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	5945.639	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	2.79	2904.464	0.000	0.000	0.000	74.655	0.000
19	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	0.000	6474.187	236.103	0.000	0.000	0.000	0.000
29	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	0.000	0.000	0.000	0.000	0.000	0.000	0.000
34	0.000	0.000	0.000	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000	0.000	0.000	0.000
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	9.202	0.000	0.000	0.000	0.000	765.786	142.42
38	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	0.000	3975.103	0.000	0.000	0.000	0.000	0.000
40	0.000	0.000	0.000	0.000	0.000	0.000	0.000
mean	**0.300**	**482.485**	**5.903**	**0.000**	**0.000**	**21.011**	**3.561**

Table 43 shows the slacks of input of the airlines have to improve without changing any output factors. For example, No. 37 of DMUs (Turkish Airlines) needs to reduce US$ 765.786 million of material cost and US$ 142.420 million other operating cost in order to become efficiency frontiers.

Table 44 Summary of Input Slacks for the Year 2009:

DMU	Passenger	RPK	Energy	Capital	Labor	Material	Other
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	17.889	10601.3	0.000	0.000	0.000	606.843	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.000	7415.785	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	0.000	7500.263	0.000	0.000	0.000	0.000	904.662
mean	**0.617**	**879.908**	**0.000**	**0.000**	**0.000**	**20.926**	**31.195**

Table 44 shows the slacks of input of the airlines have to improve without changing any output factors. For example, No. 9 of DMUs (China Eastern Airlines) needs to reduce US$ 606.843million of material cost, US$ 10601.296 million RPK cost and US$ 17.889 million passenger cost in order to become efficiency frontiers.

Table 45 Summary of Input Slacks for the Year 2008:

DMU	Passenger	RPK	Energy	Capital	Labor	Material	Other
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	9423.727	482.838	0.000	260.551	591.84	36.853
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	5541.537	0.000	650.908	194.036	179.848	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.288	0.000	199.445	0.000	745.643	288.434	5757.719
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	1.597	0.000	57.173	0.000	91.85	36.633	0.000
15	13.225	13484.45	810.186	0.000	286.642	364.716	2485.761
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.000	5357.615	352.952	0.000	133.629	0.000	128.829
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0.000	11349.87	157.383	0.000	329.122	0.000	168.566
22	10.55	7718.524	0.000	325.896	128.063	31.459	0.000
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	7.661	2453.493	21.951	0.000	144.918	33.591	0.000
26	17.469	0.000	579.768	86.569	926.629	0.000	301.072
27	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	5.004	4112.766	0.000	32.73	155.885	0.000	129.127
29	0.000	2653.41	14.575	0.000	97.429	0.000	585.626
mean	**1.924**	**2141.22**	**92.285**	**37.797**	**120.496**	**52.639**	**330.812**

Table 45 shows the slacks of input of the airlines have to improve without changing any output factors. For example, No. 2 of DMUs (Aeroflot of Russia) needs to reduce US$ 199.445 of energy cost, US$ 745.643 million labour cost and US$ 288.434 million material and US$ 5757.719 million other operating cost in order to become efficiency frontiers.

Table 46 Summary of Input Slacks for the Year 2007:

DMU	Passenger	RPK	Energy	Capital	Labor	Material	Other
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	891.833	0.000	650.238	302.184	869.038
6	0.000	0.000	98.562	0.000	152.679	0.000	101.97
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	4977.017	0.000	144.7	90.512	189.877	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	16.765	52280.43	625.442	0.000	270.099	0.000	0.000
11	0.000	0.000	80.917	0.000	220.884	159.421	1800.299
12	0.000	29829.15	597.092	0.000	1809.553	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	5.578	7180.695	344.868	141.786	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	6.959	42650.01	587.319	167.427	303.411	0.000	0.000
17	215.559	2993.499	0.000	0.000	84.193	0.000	436.001
18	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.000	5170.745	193.225	52.939	282.058	0.000	210.333
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	116.591	0.000	217.673	192.529	0.000	231.379	81.978
24	1.329	0.000	34.409	0.000	52.182	55.613	9.935
25	0.514	0.000	22.507	19.617	0.000	43.659	0.000
26	3.866	1111.897	171.146	108.388	156.683	0.000	43.38
27	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	0.000	6656.825	586.31	202.397	252.969	0.000	405.972
29	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.000	6983.35	186.865	0.000	157.696	0.000	0.000
31	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32	0.000	15228.84	0.000	0.000	720.71	0.000	0.000
33	5.837	3295.699	0.000	140.557	0.000	0.000	513.615
34	0.000	0.000	0.000	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000	0.000	0.000	0.000
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	9.41	0.000	144.648	0.000	29.246	0.000	0.000
38	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	0.000	224.644	0.000	15.585	182.817	70.072	82.916
40	0.000	2499.842	0.000	0.000	0.000	559.372	0.000
41	12.027	54921.75	783.203	0.000	22.724	0.000	0.000
42	2.458	3214.164	0.000	44.97	81.347	0.000	0.000
43	0.000	0.000	0.000	0.000	0.000	0.000	0.000
mean	**9.23**	**5563.222**	**129.442**	**28.625**	**128.372**	**37.479**	**105.94**

Table 46 shows the slacks of input of the airlines have to improve without changing any output factors. For example, No. 5 of DMUs (Air Canada) needs to reduce US$ 891.83 of energy cost, US$ 650.238 million labour cost and US$ 302.184 million material and US$ 869.038 million other operating cost in order to become efficiency frontiers.

4.1.6 Percent of Potential Improvement for Pure Technically Inefficient Airlines

Table 47 displays potential improvement for inefficient airlines for the year of 2014. Out of 33 sample airlines, 13 airlines are inefficient in terms of input slacks and output slacks. The Table shows the percentage of improvement required for each airline to achieve an efficiency frontier. The input slacks suggest how many percentage points should be reduced for each input item, including material cost, energy cost, labour cost, and other operating expense. For example, AirCanada should reduce energy cost by 17.36 percent, capital cost by 3.06 percent, labour cost by 5.26 percent and the other operating expenses by 9.98 percent of the input slacks in order to achieve efficiency frontier. On the other hand, if AirCanada decides to maintain the same level of the input variables, then ROI should be increased by 105.77 percent, ROA should be increased by 102.57 percent and NI should be increased by 1.12 percent in order to achieve the status of efficiency frontier. These results could be very useful for a firm's manager to identify the benchmarks for further improvements.

Table 47 Percent Potential Improvement for 13 Pure Technically Inefficient Airlines 2014

		Input slacks								output targets	
	Airlines	Passenger (%)	RPK (%)	Energy (%)	Capital (%)	Labor (%)	Other (%)	Material (%)	NI (%)	ROA (%)	ROI (%)
1	Air Canada (40.5%)	-		-17.36	-3.06	-5.26	-9.98	-29.63	1.12	102.57	105.77
2	Air china (52.9)	-	-21.35	-19.50	-15.67	-	-	-	-	116.86	101.69
3	ANA Group (78.5%)	-	-10.49	-1.03	-27.00	-4.34	-17.63		-	125.39	126.93
4	Avianca Holdings (37.7%)	-1.33	-	-6.03	-4.42		-20.38	-26.56	-	173.16	112.83
5	Cathay Pacific Group (43.3%)	-0.88	-3.72	-1.35	-	-	-4.06	-12.01	-	118.57	107.82
6	China Eastern Airlines (63.5%0		-48.61	-52.27	-11.57		-122.37	-16.45	-	121.98	137.14
7	China Southern Air Holding (53.5%)	-0.91	-	-7.61	-12.06	-	-	-	-	123.90	115.80
8	Hawaiian Airlines (26.4%)	-	-11.63	-4.47	-5.99	-	-	-	-	164.58	151.43
9	JetBlue Airways (99.4%)	-	-	-	-	-	-	-	-	-	-
10	Southwest Airlines Co. (87.2%)	-	-	-	-	-	-	-	-	-	-
11	Turkish Airlines (97.7%)	-1.69	-	-6.09		-6.27	-8.97	-3.27		89.14	89.63
12	United-Continental Holdings (74.2%)	-	-	-	-	-	-	-	-	-	-
13	WestJet (68%)	20.49	-	-18.10		-18.91	-5.19	-	-	97.03	65.14
	Mean (%)	3.138	- 19.158	-13.382	-11.396	-8.696	-26.943	-17.581	1.118	123.316	111.416
	SD (%)	8.681	15.764	14.507	7.649	5.935	39.358	9.621	9.621	25.588	22.978
	Median (%)	-0.905	11.627	-6.854	-11.568	-5.767	-9.984	-16.446	1.118	120.271	110.321

Turkish Airlines is 97.7 percent less efficient airlines which needs decrease the input slacks 6.09 percent energy cost; 6.27 percent other cost and 8.97 percent material cost and the Turkish Airlines need to increase the output slacks by ROA 89.14 percent and by ROI 89.63 percent. JetBlue Airways (99.4%) and Southwest Airlines Co. (87.2%) should improve the output slacks and input slacks.

Table 48 Percent potential Improvement for 11 Pure Technically Inefficient Airlines 2013

	Airlines	Input slacks							output targets		
		Passenger (%)	RPK (%)	Energy (%)	Capital (%)	Labor (%)	Other (%)	Material (%)	NI (%)	ROA (%)	ROI (%)
1	Air china (90.6%)	-71.02	-29.24	-18.42	-22.74	-	-	-	268.94	157.65	166.53
2	Air New Zealand Group (89.7%)	-	-13.11	-	-	-	-10.90	-	-	80.55	66.00
3	Avianca Holdings (88.7%)	-11.37	-	-	-	-	-	-	45.01	166.14	115.63
4	Cathay Pacific Group (95.8%)	-	-	-15.80	-	-45.23	-182.56	-	1.80	48.42	94.24
5	China Eastern Airlines (79.9%)	-55.63	-	-		-	-1.82	-	264.66	170.96	187.57
6	China Southern Air Holding (73.3%)	-53.53	-	-	-28.71	-	-	-	411.71	233.15	280.31
7	Finnair (98.3%)	-	-3.39	-	-17.77	-	-	-13.76	12.36	61.27	44.81
8	Garuda Indonesia (72.1%)	-4.18	-3.67	-	-	-	-	-	105.01	363.04	310.00
9	JetBlue Airways (95.9%)	-8.25	-	-8.85	-	-	-	-	66.80	276.29	216.69
10	Turkish Airlines (72.7%)	-9.37	-	-	-	-	-28.01	-	6.84	85.83	73.77
11	WestJet (79.35%)	-	-5.86	-	-	-	-	-53.06	16.95	74.12	75.79
	Mean (%)	-30.478	-11.054	-14.354	-23.074	-45.233	-55.823	-33.409	120.009	156.129	148.302
	SD (%)	26.197	9.749	4.039	4.473	4.473	73.772	19.648	136.333	96.051	86.555
	Median (%)	-11.373	-5.858	-15.795	-22.739	-45.233	-19.456	-33.409	55.902	157.652	115.627

Table 48 displays potential improvement for inefficient airlines for the year of 2013. Out of 39 sample airlines, 11 airlines are inefficient in terms of input slacks and output slacks. The Table shows the percentage of improvement required for each airline to achieve an efficiency frontier. The input slacks suggest how many percentage points should be reduced for each input item, including material cost, energy cost, labour cost, and other operating expense. For example, Air china (90.6%) should reduce number of passenger by 71.02%; RPK by 29.24, energy cost by 18.42 percent and capital cost by 22.74 percent of the input slacks in order to achieve efficiency frontier. On the other hand, if Air china decides to maintain the same level of the input variables, then ROI should be increased by 166.53 percent, ROA should be increased by 157.65 percent and NI should be increased by 268.94 percent in order to achieve the status of efficiency frontier. These results could be very useful for a firm's manager to identify the benchmarks for further improvements.

Cathay Pacific Group has 95.8 percent efficiency scores airlines which needs decrease the input slacks 15.80 percent energy cost; 45.23 percent labour cost and 182.56 percent other cost and the Cathay Pacific Group need to increase the output slacks by ROA 48.42 percent and by ROI 94.24 percent.

Table 49 Percent Potential Improvement for 8 Pure Technically Inefficient Airlines 2012

		Input slacks							output targets		
	Airlines	Passenger (%)	RPK (%)	Energy (%)	Capital (%)	Labor (%)	Other (%)	Material (%)	NI (%)	ROA (%)	ROI (%)
1	Air New Zealand Group (95.1%)	-	-16.56	-	-	-1.96	-8.24	-	27.68	30.24	26.73
2	Avianca Holdings (87.5%)	-2.43	-	-	-	-	-	-	107.17	189.59	128.57
3	China Southern Air Holding(90.1)	-63.89	-22.59	-19.09	-	-	-	-	75.82	-	58.04
4	Finnair (95.5%)	-	-10.94	-	-5.21	-	-1.96		77.92	77.73	50.65
5	JetBlue Airways (99.4%0	-6.46	-	-8.62	-4.05	-	-	-	92.72	264.21	198.92
6	Turkish Airlines (75.8%)	-	-7.87	-	-	-	-	-847.67	-	4.51	8.62
7	Virgin Australia (84.1%)	-	-2.95	-	-	-	-		95.04	80.91	72.64
8	WestJet (82.5%)	-	-12.05	-	-	-	-	-70.10	48.27	66.58	199.63
			-	-							
	Mean (%)	-24.259	12.161	13.851	-4.627	-1.965	-5.098	-458.884	74.944	101.967	92.976
	SD (%)	28.073	6.232	5.236	0.582	0.582	3.139	388.788	25.949	85.295	69.638
			-	-							
	Median (%)	-6.457	11.496	13.851	-4.627	-1.965	-5.098	-458.884	77.924	77.725	65.341

Table 49 displays potential improvement for inefficient airlines for the year of 2012. Out of 39 sample airlines, 8 airlines are inefficient in terms of input slacks and output slacks. The Table shows the percentage of improvement required for each airline to achieve an efficiency frontier. The input slacks suggest how many percentage points should be reduced for each input item, including material cost, energy cost, labour cost, and other operating expense. For example, Finnair (95.5%) should reduce other cost by 1.96 percent and capital cost by 5.21 percent of the input slacks in order to achieve efficiency frontier. On the other hand, if Finnair decides to maintain the same level of the input variables, then ROI should be increased by 50.6 percent, ROA should be increased by 77.73 percent and NI should be increased by 77.92 percent in order to achieve the status of efficiency frontier. These results could be very useful for a firm's manager to identify the benchmarks for further improvements. Additionally, WestJet has 82.5 percent efficiency scores which need decrease the input slacks 70.10 percent material cost and the WestJet need to increase the output slacks by ROA 66.58 percent, by NI 48.27 and by ROI 199.63 percent.

Table 50 Percent Potential Improvement for 3 Pure Technically Inefficient Airlines 2011

		Input slacks						output targets			
	Airlines	**Passenger (%)**	**RPK (%)**	**Energy (%)**	**Capital (%)**	**Labor (%)**	**Other (%)**	**Material (%)**	**NI (%)**	**ROA (%)**	**ROI (%)**
1	AirAsia (88.9%)	-	-8.52		-	-	-	-	15.33	50.79	42.37
2	Garuda Indonesia (96.2%)	-	-4.16		-	-	-	0.00	45.22	11.01	284.66
3	Ryanair (95.3%)	-	-9.28	-8.06	-	-	-	-	39.65	28.57	68.40
	Mean (%)	-	-7.321	-8.059	-	-	-	-	33.403	30.123	131.809
	SD (%)	-	2.255	2.255	-	-	-	-	12.977	16.281	108.603
	Median (%)	-	-8.522	-8.059	-	-	-	-	39.651	28.571	68.400

Table 50 displays potential improvement for inefficient airlines for the year of 2011. Out of 36 sample airlines, 3 airlines are inefficient in terms of input slacks and output slacks. The Table shows the percentage of improvement required for each airline to achieve an efficiency frontier. The input slacks suggest how many percentage points should be reduced for each input item, including material cost, energy cost, labour cost, and other operating expense. For example, if AirAsia (88.9%) decides to maintain the same level of the input variables, then ROI should be increased by 42.37 percent, 50.79 should be increased by 77.73 percent and NI should be increased by 15.3 percent in order to achieve the status of efficiency frontier. These results could be very useful for a firm's manager to identify the benchmarks for further improvements. Moreover, Ryanair has 95.3 percent efficiency scores which need decrease the input slacks 8.06 percent energy cost and the Ryanair need to increase the output slacks by ROA 28.57 percent, by NI 39.65 and by ROI 68.40 percent.

Table 51 Percent Potential Improvement for 5 Pure Technically Inefficient Airlines 2010

		Input slacks							output targets		
	Airlines	**Passenger (%)**	**RPK(%)**	**Energy (%)**	**Capital (%)**	**Labor (%)**	**Other (%)**	**Material (%)**	**NI (%)**	**ROA (%)**	**ROI (%)**
1	Air New Zealand Group (88.9%)	-	-11.47	-	-	-	-	-	17.46	43.29	35.11
2	Garuda Indonesia (96.2%)	-9.62	-5.60	-	-	-	-6.03	-	51.48	81.52	235.87
3	Malaysia Airlines (95.3%)	-	-12.49	-11.29	-	-		-	45.13	24.35	56.68
4	Turkish Airlines (86.4%)	-		-	-	-	-61.86	-13.69	14.95	39.86	51.04
5	Virgin Australia (96.3%)	-	-7.67	-	-	-	-	-	24.76	44.01	67.95
	Mean (%)	-9.62	-9.310	-11.29	-	-	-33.944	-13.69	30.754	46.606	89.328
	SD (%)	0	2.794	0	-	-	27.913	0	14.824	18.857	74.031
	Median (%)	-9.62	-9.572	-11.29	-	-	-33.944	-13.69	24.756	43.287	56.676

Table 51 displays potential improvement for inefficient airlines for the year of 2010. Out of 40 sample airlines, 5 airlines are inefficient in terms of input slacks and output slacks. The Table shows the percentage of improvement required for each airline to achieve an efficiency frontier. The input slacks suggest how many percentage points should be reduced for each input item, including material cost, energy cost, labour cost, and other operating expense. For example, if Malaysia Airlines (95.3%) decides to reduce energy cost by 11.29 percent of the input slacks in order to achieve efficiency frontier. On the other hand, if Malaysia Airlines decides to maintain the same level of the input variables, then ROI should be increased by 56.68 percent, ROA should be increased by 24.35 percent and NI should be increased by 45.13 percent in order to achieve the status of efficiency frontier.

Table 52 Percent Potential Improvement for 3 Pure Technically Inefficient Airlines 2009

		Input slacks						output targets			
	Airlines	**Passenger (%)**	**RPK (%)**	**Energy (%)**	**Capital (%)**	**Labor (%)**	**Other (%)**	**Material (%)**	**NI (%)**	**ROA (%)**	**ROI (%)**
1	China Eastern Airlines (91.2%)	-90.43	-33.00	-	-	-	-74.46	-	216.73	75.36	97.97
2	Malaysia Airlines (89.0%)	-	-23.08	-	-	-	-	-	24.29	-	121.71
3	WestJet (98.3%)	-	-23.35	-	-	-	-	-109.36	-	90.02	106.71
	Mean (%)	-90.427	- 26.475	-	-	-	-74.462	-109.359	120.512	82.689	108.796
	SD (%)	0.000	4.613	-	-	-	0.000	0.000	96.222	7.331	9.802
	Median (%)	-90.427	- 23.346	-	-	-	-74.462	-109.359	120.512	82.689	106.713

Table 52 displays potential improvement for inefficient airlines for the year of 2009. Out of 29 sample airlines, 3 airlines are inefficient in terms of input slacks and output slacks. These airlines are China Eastern Airlines, Malaysia Airlines and WestJet have efficiency scores 9.12 percent, 89.0 percent and 98.3 percent respectively. The Table shows the percentage of improvement required for each airline to achieve an efficiency frontier. The input slacks suggest how many percentage points should be reduced for each input item, including material cost, energy cost, labour cost, and other operating expense. For example, if China Eastern Airlines (91.2%) decides to reduce other cost by 11.29 percent of the input slacks in order to achieve efficiency frontier. On the other hand, if China Eastern Airlines decides to maintain the same level of the input variables, then ROI should be increased by 97.97 percent, ROA should be increased by 75.36 percent and NI should be increased by 216.73 percent in order to achieve the status of efficiency frontier.

Table 53 Percent Potential Improvement for 12 Pure Technically Inefficient Airlines 2008

		Input slacks						output targets			
	Airlines	**Passenger (%)**	**RPK (%)**	**Energy (%)**	**Capital (%)**	**Labor (%)**	**Other (%)**	**Material (%)**	**NI (%)**	**ROA (%)**	**ROI (%)**
1	Aeroflot (57.9%)	-	-21.75	-25.36	-	-17.21	-31.78	-3.52	15.76	127.9	102.8
2	Air New Zealand Group (55.5%)	-	-	-	-33.68	-12.82	-9.66	-	-	68.7	74.1
3	ANA Group (46.0%)	-1.11	-	-10.48	-	-49.25	-15.49	-550.77	-	178.5	198.4
4	Hawaiian Airlines (87.3%)	-6.14	-	-3.00	-	-6.07	-19.74	-	8.95	104.4	94.0
5	Japan Airlines (54.5%)	-50.73	-31.12	-0.43	-	-18.93	-19.59	-237.78	41.20	87.1	52.1
6	Malaysia Airlines (39.3%)	-	-12.37	-18.54	-	-8.83	-	-12.32	-	79.3	76.6
7	Qantas Group (60.5%)	-	-0.26	-8.27	-	-21.74	-	-16.12	-	123.5	96.0
8	Republic Airways Holdings (87.1%)	-40.46	-17.81	-	-16.87	-8.46	-1.69	-	-	110.8	28.7
9	SkyWest, Inc (41.9%)	-29.37	-5.66	-1.15		-9.57	-1.80	-	-	96.0	67.9
10	Southwest Airlines Co.(31.9%)	-66.99	-	-0.30	-4.48	-61.20	-	-28.80	-	127.9	96.3
11	Virgin Australia (59.9%)	-19.17	-9.49	-	-1.69	-10.30	-	-12.35	-	80.5	50.7
12	WestJet (54.3%)	-	-6.12	-0.77	-	-6.44	-	-56.02	-	67.2	63.4
	Mean (%)	-30.568	-13.074	-7.588	-14.181	-19.233	-14.250	-114.712	21.972	104.320	83.401
	SD (%)	22.126	9.382	8.549	12.626	16.952	10.009	179.986	13.876	30.602	40.681
	Median (%)	-29.373	-10.929	-3.003	-10.672	-11.556	-15.489	-22.462	15.764	100.206	75.367

Table 53 displays potential improvement for inefficient airlines for the year of 2008. Out of 29 sample airlines, 12 airlines are inefficient in terms of input slacks and output slacks.. The Table shows the percentage of improvement required for each airline to achieve an efficiency frontier. The input slacks suggest how many percentage points should be reduced for each input item, including material cost, energy cost, labour cost, and other operating expense. For example, if ANA Group (46.0%) decides to reduce other cost by 15.49 percent, energy cost by 10.48 percent and labour cost by 49.25 percent of the input slacks in order to achieve efficiency frontier. On the other hand, if ANA Group decides to maintain the same level of the input variables, then ROI should be increased by 198.40 percent and ROA should be increased by 178.5 percent.

Table 54 Percent Potential Improvement for 23 Pure Technically Inefficient Airlines 2007

				Input slacks				output targets			
	Airlines	Passenger (%)	RPK (%)	Energy (%)	Capital (%)	Labor (%)	Other (%)	Material (%)	NI (%)	ROA (%)	ROI (%)
1	Air Canada (73.0%)	-	-	-53.99	-	-44.15	-21.05	-87.48	-	145.67	199.48
2	Air china (66%)	-	-	-5.97	-	-10.37	-	-10.26	-	74.28	140.12
3	Air New Zealand Group (56.4%)	-	-9.82	-	-	-6.15	-13.23	-	-	209.27	197.82
4	American Airlines Group (29.4%)	-42.24	-103.19	-37.87	-	-18.34	-	-	-	63.83	183.81
5	ANA Group (32.5%)	-	-	-4.90	-	-15.00	-11.11	-181.23		172.57	201.88
6	British Airways (73%)	-	-58.87	-36.20	-	-122.86	-	-	-	61.82	77.99
7	China Eastern Airlines (37.2%)	-14.06	-14.17	-20.88	-8.47	-	-	-	11.69	127.65	122.05
8	Delta airlines (50.6%)	-17.53	-0.08	-35.56	-10.00	-20.60	-	-	-	81.62	104.17
9	EasyJet PLC (62.8%)	-543.00	-5.91	-	-5.03	-	-30.38	-	-	133.43	172.94
10	El Al (85.7%)	-	-10.21	-11.70	-3.16	-19.15	-	-21.17	-	30.91	46.83
11	Garuda Indonesia (83.4%)	-293.69	-	-13.18	-11.50	-	-16.12	-8.25	9.09	126.10	131.82
12	Hawaiian Airlines (72.6%)	-3.35	-	-2.06	-	-3.54	-3.87	-1.00	9.61	151.89	160.77
13	Jet Airways (42.6%)	-1.29	-	-1.36	-1.17		-3.04	-	14.14	159.45	162.43
14	JetBlue Airways (39.2%)	-9.75	-2.19	-10.36	-6.48	-10.64	-	-4.37	10.09	161.90	158.19
15	Korean Air (32.6%)	-	-13.14	-35.50	-12.09	-17.17	-	-40.87	26.09	124.32	114.49
16	Malaysia Airlines (60.2%)	-	-13.78	-11.31	-	-10.71	-	-	-	121.43	167.77
17	Qantas Group (64.7%0	-	-30.06	-	-	-48.93	-	-	-	79.84	99.37
18	Republic Airways Holdings (65.2%)	-14.71	-6.50	-	-8.40	-	-	-51.70	-	168.57	148.23
19	SkyWest, Inc (55.8%)	-23.70	-	-8.76	-	-1.99	-	-	-	98.30	132.37
20	TAP Portugal (46.6%)	-	-0.44	-	-0.93	-12.41	-4.88	-8.35	8.89	77.61	89.97
21	Turkish Airlines (51.0%)	-	-4.93	-	-	-	-38.98	-	-	193.48	220.87
22	United-Continental Holdings (42.1%)	-30.30	-108.40	-47.42	-	-1.54	-	-	-	90.29	127.03
23	Virgin Australia (75.4%)	-6.20	-6.54	-	-2.69	-5.52	-	-	-	110.53	104.90
	Mean (%)	-83.319	-24.266	-21.063	-6.358	-21.709	-15.852	-41.469	12.801	120.207	141.970
	SD (%)	-16.122	-10.014	-12.439	-6.476	-12.412	-13.230	-15.719	10.092	124.316	140.118
	Median (%)	-16.122	-10.014	-12.439	-6.476	-12.412	-13.230	-15.719	10.092	124.316	140.118

Table 54 displays potential improvement for inefficient airlines for the year of 2007. Out of 43 sample airlines, 23 airlines are inefficient in terms of input slacks and output slacks. The Table shows the percentage of improvement required for each airline to achieve an efficiency frontier. American Airlines Group (29.4%), ANA Group (32.5%), China Eastern Airlines (37.2%), Jet Airways (42.6%), JetBlue Airways (39.2%), Korean Air (32.6%) and United-Continental Holdings (42.1%) should work hard improve the technical efficiency since the score indicate below fifty percent. The rest airlines still need to improve for they are below 100 percent which means there is a room for improvement either by decreasing the input slacks or the output slacks. The input slacks suggest how many percentage points should be reduced for each input item, including material cost, energy cost, labour cost, and other operating expense. For example, if British Airways (73%) decides to reduce energy cost by 36.20 percent and labour cost by 122.86 percent of the input slacks in order to achieve efficiency frontier. On the other hand, if British Airways decides to maintain the same level of the input variables, then ROI should be increased by 77.99 percent and ROA should be increased by 61.82 percent.

4.1.7 Frequency Distributions and Descriptive Statistics of Technical and Scale efficient scores

Table 55 Frequency Distributions and Descriptive Statistics of Technical Efficiency of Year 2014

	Technically efficiency (VRS)		scale efficiency	
Efficiency range	No. of airlines	% of airlines	No. of airlines	% of airlines
0-60%	6	18%	5	15%
60-80%	4	12%	3	9%
80-90%	1	3%	6	18%
90-100%	22	67%	19	58%
Total	**33**	**100%**	**33**	**100%**
Mean	0.855		0.855	
SD	0.232		0.194	
Variance (n-1)	0.054		0.038	
Min.	0.264		0.348	
Max.	1.000		1.000	

Note: VRS means variable return of scale

Table 55indicates the frequency distribution and descriptive statistics of technical and scale efficiency for the years of 2014. There are about total of 33 sample airlines in this observation. Four group of efficiency rang is categorised. These are an efficiency range from 0 to 60%, 60 to 80%, 80 to 90% and 90 to 100%. The efficiency distribution is divided into technical efficiency and scale efficiency. From these samples of airlines, 22 (the highest) of sample airlines have a technical efficiency range between 90 and 100%; six sample airlines have technical efficiency between 0 and 60 and 4 airlines have between 60 and 80 % of technical efficiency.

The scale efficiency of the airline shows that the highest 19 sample of airlines score scale efficiency between 90 and 100%; six airlines score between 80 and 90% and five airlines between 0 and 60%.

It is important that those airlines exist below the efficiency range of 100% especially below 90% of sample airlines must find a way to improve their efficiency and become more successful in the business. The descriptive statistics of both technical and scale efficiency have the same mean 0.855 and the standard division of this efficiency are 0.232 and 0.194 respectively.

Table 56 Frequency Distributions and Descriptive Statistics for Technical Efficiency of Year 2013

Efficiency range	Technically efficiency (VRS) No. of airlines	% of airlines	scale efficiency No. of airlines	% of airlines
0-60%	0	0%	0	0%
60-80%	4	10%	1	3%
80-90%	2	5%	1	3%
90-100%	33	85%	37	95%
Total	**39**	**100%**	**39**	**100%**
Mean	0.960		0.985	
SD	0.085		0.043	
Variance (n-1)	0.007		0.002	
Min.	0.721		0.777	
Max.	1.000		1.000	

Table 56 indicates the frequency distribution and descriptive statistics of technical and scale efficiency for the years of 2013. There are about total of 39 sample airlines in this observation. Four group of efficiency rang is categorised. These are an efficiency range from 0 to 60%, 60 to 80%, 80 to 90% and 90 to 100%. The efficiency distribution is divided into technical efficiency and scale efficiency. From these samples of airlines, 33 (the highest) of sample airlines have a technical efficiency range between 90 and 100%; 4 sample airlines have technical efficiency between 0 and 60 and 2 airlines have between 60 and 80 % of technical efficiency.

The scale efficiency of the airline shows that the highest 37 sample of airlines score scale efficiency between 90 and 100%; 1 airlines score between 80 and 90% and none airlines between 0 and 60%. It is important that those airlines exist below the efficiency range of 100% especially below 90% of sample airlines must find a way to improve their efficiency and become more successful in the business. The descriptive statistics of both technical and scale efficiency have the same mean 0.960 and 0.985 respectively.

Table 57 Frequency Distributions and Descriptive Statistics for Technical Efficiency of Year 2012

	Technically efficiency (VRS)		scale efficiency	
Efficiency range	No. of airlines	% of airlines	No. of airlines	% of airlines
0-60%	0	0%	0	0%
60-80%	2	5%	0	0%
80-90%	2	5%	0	0%
90-100%	35	90%	39	100%
Total	**39**	**100%**	**39**	**100%**
Mean	0.975		0.990	
SD	0.063		0.026	
Variance (n-1)	0.004		0.001	
Min.	0.758		0.896	
Max.	1.000		1.000	

Table 57 indicates the frequency distribution and descriptive statistics of technical and scale efficiency for the years of 2012. There are about total of 39 sample airlines in this observation. Four group of efficiency rang is categorised. These are an efficiency range from 0 to 60%, 60 to 80%, 80 to 90% and 90 to 100%. The efficiency distribution is divided into technical efficiency and scale efficiency.

From these samples of airlines, 35 (the highest) of sample airlines have a technical efficiency range between 90 and 100%; no sample airlines have technical efficiency between 0 and 60 and 2 airlines have between 60 and 80 % of technical efficiency.

The scale efficiency of the airline shows that the highest 39 sample of airlines score scale efficiency between 90 and 100%; none airlines score between 80 and 90% and none airlines between 0 and 60%. It is important that those airlines exist below the efficiency range of 100% especially below 90% of sample airlines must find a way to improve their efficiency and become more successful in the business. The descriptive statistics of both technical and scale efficiency have the same mean 0.975 and 0.990 respectively.

Table 58 Frequency Distributions and Descriptive Statistics for Technical Efficiency of Year 2011

	Technically efficiency (VRS)		scale efficiency	
Efficiency range	No. of airlines	% of airlines	No. of airlines	% of airlines
0-60%	0	0%	0	0%
60-80%	0	0%	0	0%
80-90%	0	0%	0	0%
90-100%	36	100%	36	100%
Total	36	100%	36	100%
Mean	0.995		0.992	
SD	0.021		0.019	
Variance (n-1)	0.000		0.000	
Min.	0.889		0.926	
Max.	1.000		1.000	

Table 58 indicates the frequency distribution and descriptive statistics of technical and scale efficiency for the years of 2011. There are about total of 36 sample airlines in this observation. Four group of efficiency rang is categorised. These are an efficiency range from 0 to 60%, 60 to 80%, 80 to 90% and 90 to 100%. The efficiency distribution is divided into technical efficiency and scale efficiency.

From these samples of airlines, 36 (the highest) of sample airlines have a technical efficiency range between 90 and 100%; none sample airlines have technical efficiency between 0 and 60 and none airlines have between 60 and 80 % of technical efficiency.

The scale efficiency of the airline shows that the highest 36 sample of airlines score scale efficiency between 90 and 100%; none airlines score between 80 and 90% and none airlines between 0 and 60%.

It is important that those airlines exist below the efficiency range of 100% especially below 90% of sample airlines must find a way to improve their efficiency and become more successful in the business. The descriptive statistics of both technical and scale efficiency have the same mean 0.995 and 0.992 respectively.

Table 59 Frequency Distributions and Descriptive Statistics for Technical Efficiency of Year 2010

Efficiency range	Technically efficiency (VRS) No. of airlines	% of airlines	scale efficiency No. of airlines	% of airlines
0-60%	0	0%	0	0%
60-80%	0	0%	0	0%
80-90%	0	0%	0	0%
90-100%	40	100%	40	100%
Total	**40**	**100%**	**40**	**100%**
Mean	0.991		0.992	
SD	0.029		0.018	
Variance (n-1)	0.001		0.000	
Min.	0.864		0.926	
Max.	1.000		1.000	

Table 59 indicates the frequency distribution and descriptive statistics of technical and scale efficiency for the years of 2010. There are about total of 40 sample airlines in this observation. Four group of efficiency rang is categorised. These are an efficiency range from 0 to 60%, 60 to 80%, 80 to 90% and 90 to 100%. The efficiency distribution is divided into technical efficiency and scale efficiency.

From these samples of airlines, 40 (the highest) of sample airlines have a technical efficiency range between 90 and 100%; none of the sample airlines have technical efficiency between 0 and 60 and between 60 and 80 % of technical efficiency.

The scale efficiency of the airline shows that the highest 40 sample of airlines score scale efficiency between 90 and 100%; none of airlines score between 80 and 90% and between 0 and 60%. It is important that those airlines exist below the efficiency range of 100% especially below 90% of sample airlines must find a way to improve their efficiency and become more successful in the business. The descriptive statistics of both technical and scale efficiency have the same mean 0.991 and 0.992 respectively.

Table 60 Frequency Distributions and Descriptive Statistics for Technical Efficiency of Year 2009

	Technically efficiency (VRS)		scale efficiency	
Efficiency range	No. of airlines	% of airlines	No. of airlines	% of airlines
0-60%	0	0%	0	0%
60-80%	0	0%	0	0%
80-90%	0	0%	0	0%
90-100%	29	100%	29	100%
Total	29	100%	29	100%
Mean	0.993		0.988	
SD	0.026		0.035	
Variance (n-1)	0.001		0.001	
Min.	0.890		0.843	
Max.	1.000		1.000	

Table 60 indicates the frequency distribution and descriptive statistics of technical and scale efficiency for the years of 2009. There are about total of 29 sample airlines in this observation. Four group of efficiency rang is categorised. These are an efficiency range from 0 to 60%, 60 to 80%, 80 to 90% and 90 to 100%. The efficiency distribution is divided into technical efficiency and scale efficiency.

From these samples of airlines, all of the 29 (the highest) of sample airlines have a technical efficiency and scale efficient range between 90 and 100%. It is important that those airlines exist below the efficiency range of 100% especially below 90% of sample airlines must find a way to improve their efficiency and become more successful in the business. The descriptive statistics of both technical and scale efficiency have the same mean 0.993 and 0.988 respectively.

Table 61 Frequency Distributions and Descriptive Statistics for Technical Efficiency of Year 2008

Efficiency range	Technically efficiency (VRS) No. of airlines	% of airlines	scale efficiency No. of airlines	% of airlines
0-60%	8	28%	4	14%
60-80%	2	7%	3	10%
80-90%	2	7%	4	14%
90-100%	17	59%	18	62%
Total	**29**	**100%**	**29**	**100%**
Mean	0.819		0.861	
SD	0.243		0.206	
Variance (n-1)	0.059		0.043	
Min.	0.319		0.238	
Max.	1.000		1.000	

Table 61 indicates the frequency distribution and descriptive statistics of technical and scale efficiency for the years of 2008. There are about total of 29 sample airlines in this observation. Four group of efficiency rang is categorised. These are an efficiency range from 0 to 60%, 60 to 80%, 80 to 90% and 90 to 100%. The efficiency distribution is divided into technical efficiency and scale efficiency. From these samples of airlines, 17 (the highest) of sample airlines have a technical efficiency range between 90 and 100%; 8 sample airlines have technical efficiency between 0 and 60 and 2 airlines have between 60 and 80 % of technical efficiency.

The scale efficiency of the airline shows that the highest 18 sample of airlines score scale efficiency between 90 and 100%; 3 samples of airlines score between 80 and 90% and 4 airlines between 0 and 60%. It is important that those airlines exist below the efficiency range of 100% especially below 90% of sample airlines must find a way to improve their efficiency and become more successful in the business. The descriptive statistics of both technical and scale efficiency have the same mean 0.819 and 0.861 respectively.

Table 62 Frequency Distributions and Descriptive Statistics for Technical Efficiency of Year 2007

Efficiency range	Technically efficiency (VRS) No. of airlines	% of airlines	scale efficiency No. of airlines	% of airlines
0-60%	11	26%	4	9%
60-80%	9	21%	6	14%
80-90%	2	5%	6	14%
90-100%	21	49%	27	63%
Total	**43**	**100%**	**43**	**100%**
Mean	0.767		0.863	
SD	0.251		0.175	
Variance (n-1)	0.063		0.030	
Min.	0.294		0.435	
Max.	1.000		1.000	

Table 62 indicates the frequency distribution and descriptive statistics of technical and scale efficiency for the years of 2007. There are about total of 43 sample airlines in this observation. Four group of efficiency rang is categorised. These are an efficiency range from 0 to 60%, 60 to 80%, 80 to 90% and 90 to 100%. The efficiency distribution is divided into technical efficiency and scale efficiency.

From these samples of airlines, 21 (the highest) of sample airlines have a technical efficiency range between 90 and 100%; 11 sample airlines have technical efficiency between 0 and 60 and 9 airlines have between 60 and 80 % of technical efficiency.

The scale efficiency of the airline shows that the highest 27 sample of airlines score scale efficiency between 90 and 100%; 6 airlines score between 80 and 90% and 4 airlines between 0 and 60%. It is important that those airlines exist below the efficiency range of 100% especially below 90% of sample airlines must find a way to improve their efficiency and become more successful in the business. The descriptive statistics of both technical and scale efficiency have the same mean 0.767 and 0.863 respectively.

4.1.8 Canonical Correlation

Table 63 Canonical Loading of the Year 2014

Canonical Loading 2014

Learning & Growth →Customer	**Learning & Growth →Financial**	**Learning & Growth →Internal Business Perspective**
No 1 Canonical Test	No 2 Canonical Test	No 3 Canonical Test
$\lambda_{11}=-0.84011$	$\lambda_{11}=-0.90258$	$\lambda_{11}=-0.91831$
$\lambda_{12}=-0.96730$	$\lambda_{12}=-0.92691$	$\lambda_{12}=-0.78833$
$\lambda_{21}=-0.96012$	$\lambda_{41}=-0.90483$	$\lambda_{31}=-0.64773$
$\lambda_{22}=-0.88301$	$\lambda_{42}=0.237423$	$\lambda_{32}=-0.94777$
	$\lambda_{43}=0.321193$	$\lambda_{33}=-0.73805$
	$\lambda_{44}=-0.78227$	
$R_1^2=0.11302$	$R_2^2=0.14491$	$R_3^2=0.02495$
Eigenvalues =0.86848	*Eigenvalues =0.82661*	*Eigenvalues =0.93792*
$RI_1=0.71278$	$RI_2=0.90918$	$RI_3=0.58911$
F-Value =28.63137	*F-Value* =10.9818055693383	*F-Value* =49.75363
p-value < 0.0001	*p-value* < 0.0001	*p-value* < 0.0001
Customer →Financial	**Internal Business Perspective → Customer**	**Internal Business Perspective → Financial**
No 4 Canonical Test	No 5 Canonical Test	No 6 Canonical Test
$\lambda_{21}=-0.95805$	$\lambda_{31}=-0.41989$	$\lambda_{31}=-0.54594$
$\lambda_{22}=-0.88642$	$\lambda_{32}=-0.98252$	$\lambda_{32}=-0.99381$
	$\lambda_{33}=-0.35919$	$\lambda_{33}=-0.56423$
$\lambda_{41}=0.86732$	$\lambda_{21}=-0.87206$	$\lambda_{41}=-0.93126$
$\lambda_{42}=0.26969$	$\lambda_{22}=-0.96626$	$\lambda_{42}=0.338530$
$\lambda_{43}=0.31167$		$\lambda_{43}=0.404353$
$\lambda_{44}=-0.81503$		$\lambda_{44}=-0.71741$
$R_1^4=0.22384$	$R_1^5=0.05055$	$R_1^6=0.10359$
Eigenvalues =0.76704	*Eigenvalues =0.93068*	*Eigenvalues =0.84034*
$RI_4=0.65336$	$RI_5=0.39420$	$RI_6=0.44932$
F-Value =7.51698	*F-Value* =32.180004	*F-Value* =7.80623
p-value =< 0.0001	*p-value* < 0.0001	*p-value* < 0.0001

Interrelationships among Four Perspectives of the BSC

In order to examine the interrelationships between the four perspectives of the BSC, canonical correlation analyses were used in this study. Detailed information for the canonical results is shown in table 63. There are a number of results among the inputs and output of the linear combinations for each year. The study considers six multi linear combinations of the variables.

First the relationship between the linear combination learning and growth perspectives variables and that of two customer perspective variables has a canonical correlation R^2 value of 0.11302 with p-value<0.0001. The redundancy index is moderately high (RI =0.7127) indicating that 71.3 percent of the variance of customer perspectives can be explained by learning and growth improvement.

Second, the relation between the set of two learning and growth variables with the set of four financial perspectives variables has a canonical correlation R^2-value 0.1449 with p-value <0.0001. The redundancy index is very high (RI_2=0.909) indicating that 90.9 percent of the variance on financial perspective can be explained by learning and growth improvement.

Third, the relation between the set of two learning and growth variables with the set of three internal business process perspective variables has a canonical correlation R^2-value 0.0249 with p-value <0.0001. The redundancy index is medium (RI_3=0.589) indicating that 58.9 percent of the variance on internal business process perspective can be explained by learning and growth improvement.

Fourth, the relation between the set of two customer variables with the set of four financial perspective variables has a canonical correlation R^2-value 0.223 with p-value <0.0001. The redundancy index is moderately high (RI_4=0.6533) indicating that 65.33 percent of the variance on financial perspective can be explained by customer improvement.

Fifth, the relation between the set of three internal business process variables with the set of two customer perspective variables has a canonical correlation R^2-value 0.05 with p-value <0.0001. The redundancy index is low (RI_5=0.3942) indicating that 39.42 percent of the variance on customer perspective can be explained by internal business process improvement.

Sixth, the relation between the set of three internal business process variables with the set of four financial perspective variables has a canonical correlation R^2-value 0.1035 with p-value <0.0001. The redundancy index is low (RI_5=0.449) indicating that 44.9 percent of the variance on financial perspectives perspective can be explained by internal business process improvement.

In summary, from the six canonical analyses, only four relationships are significant. The result seems to suggest that the four perspectives of BSC are dependent. However, customer improvement is highly related to learning and growth so is financial improvement to learning and growth; internal process improvement is highly related to learning and growth; financial improvement to customer orientation.

Table 64 Canonical Loading of the Year 2013

Canonical Loading 2013

Learning & Growth →Customer	**Learning & Growth →Financial**	**Learning & Growth →Internal Business Perspective**
No 1 Canonical Test	No 2 Canonical Test	No 3 Canonical Test
λ11=-0.84903	λ11=-0.96490	λ11=-0.97347
λ12=0.931668	λ12=-0.78831	λ12=-0.76637
λ21=0.952903	λ41=-0.99844	λ31=-0.48043
λ22=0.91228	λ42=-0.00617	λ32=-0.91331
	λ43=-0.13610	λ33=-0.69297
	λ44=-0.45172	
$\boldsymbol{R_1^2}$=0.12844	$\boldsymbol{R_2^2}$ =0.07774	$\boldsymbol{R_3^2}$=0.04058
Eigenvalues =0.83745	*Eigenvalues =0.92176*	*Eigenvalues =0.90739*
RI_1 =0.66529	RI_2 =0.71550	RI_3=0.69641
F-Value =31.32987	*F-Value* =21.33791	*F-Value* =44.92970
p-value < 0.0001	*p-value* =< 0.0001	*p-value* =< 0.0001
Customer →Financial	**Internal Business Perspective → Customer**	**Internal Business Perspective → Financial**
No 4 Canonical Test	No 5 Canonical Test	No 6 Canonical Test
λ21=-0.94745	λ31=-0.46923	λ31=-0.65337
λ22=-0.91930	λ32=-0.96747	λ32=-0.92977
	λ33=-0.18350	λ33=-0.72862
λ41=-0.97859	λ21=-0.76996	λ41=-0.98591
λ42=-0.05163	λ22=-0.99927	λ42=0.10586
λ43=-0.27542		λ43=-0.01651
λ44=-0.60425		λ44=-0.33638
$\boldsymbol{R_4^2}$ =0.19721	$\boldsymbol{R_5^2}$=0.06122	$\boldsymbol{R_6^2}$=0.01671
Eigenvalues =0.78474	*Eigenvalues =0.892725*	*Eigenvalues =0.97993*
RI_4 =0.68381	RI_5=0.35407	RI_6 =0.59523
F-Value =10.32758	*F-Value* =34.46947	*F-Value* =26.15430
p-value < 0.0001	*p-value* < 0.0001	*p-value* < 0.0001

Interrelationships among Four Perspectives of the BSC

In order to examine the interrelationships between the four perspectives of the BSC, canonical correlation analyses were used in this study. Detailed information for the canonical results is shown in table 64. There are a number of results among the inputs and output of the linear combinations for each year. The study considers six multi linear combinations of the variables.

First the relationship between the linear combination learning and growth perspectives variables and that of two customer perspective variables has a canonical correlation R^2 value of 0.12844 with p-value<0.0001. The redundancy index is moderately high (RI =0.66529) indicating that 66.33 percent of the variance of customer perspectives can be explained by learning and growth improvement.

Second, the relation between the set of two learning and growth variables with the set of four financial perspectives variables has a canonical correlation R^2-value 0.0777 with *p*-value <0.0001. The redundancy index is moderately high (RI_2=0.716) indicating that 71.6 percent of the variance on financial perspective can be explained by learning and growth improvement.

Third, the relation between the set of two learning and growth variables with the set of three internal business process perspective variables has a canonical correlation R^2-value 0.0406 with *p*-value <0.0001. The redundancy index is very high (RI_3=0.6964) indicating that 69.6 percent of the variance on internal business process perspective can be explained by learning and growth improvement.

Fourth, the relation between the set of two customer variables with the set of four financial perspective variables has a canonical correlation R^2-value 0.197 with *p*-value <0.0001. The redundancy index is medium high (RI_4=0.6838) indicating that 68.38 percent of the variance on financial perspective can be explained by customer improvement.

Fifth, the relation between the set of three internal business process variables with the set of two customer perspective variables has a canonical correlation R^2-value 0.06122 with *p*-value <0.0001. The redundancy index is low (RI_5=0.3354072) indicating that 33.54 percent of the variance on customer perspective can be explained by internal business process improvement.

Sixth, the relation between the set of three internal business process variables with the set of four financial perspective variables has a canonical correlation R^2-value 0.0167 with p-value <0.0001. The redundancy index is medium (RI_5=0.595) indicating that 59.5 percent of the variance on financial perspectives perspective can be explained by internal business process improvement.

In summary, from the six canonical analyses, only five relationships are relatively significant. The result seems to suggest that the five perspectives of BSC are dependent. However, customer improvement is highly related to learning and growth so is financial improvement to learning and growth; internal process improvement is highly related to learning and growth; financial improvement to customer orientation.

Table 65 Canonical Loading of the Year 2012

Canonical Loading 2012

Learning & Growth →Customer	**Learning & Growth →Financial**	**Learning & Growth →Internal Business Perspective**
No 1 Canonical Test	No 2 Canonical Test	No 3 Canonical Test
λ11=0.99286	λ11=-0.99405	λ11=-0.99892
λ12=0.39306	λ12=-0.38342	λ12=-0.23578
λ21=0.99999	λ41=-0.99846	λ31=-0.58399
λ22=0.65903	λ42=0.090602	λ32=-0.89445
	λ43=0.21894	λ33=-0.95806
	λ44=-0.63639	
R_1^2=0.96336	R_2^2=0.08295	R_3^2=0.08450
Eigenvalues =0.60326	*Eigenvalues =0.91076*	*Eigenvalues =0.90548*
RI_1 =0.34394	RI_2=0.51693	RI_3=0.47693
F-Value =1.36885	*F-Value* =20.39377	*F-Value* =27.65353
p-value =0.24969	*p-value* < 0.0001	*p-value* =< 0.0001
Customer →Financial	**Internal Business Perspective → Customer**	**Internal Business Perspective → Financial**
No 4 Canonical Test	No 5 Canonical Test	No 6 Canonical Test
λ21=-0.72214	λ31=-0.47663	λ31=0.04743
λ22=0.36448	λ32=-0.96961	λ32=-0.7615
	λ33=-0.58489	λ33=-0.3317
λ41=0.90924	λ21=-0.88384	λ41=-1.0809
λ42=0.15858	λ22=-0.93314	λ42=-0.0285
λ43=-0.0626		λ43=-0.0243
λ44=-0.1236		λ44=0.11665
R_4^2=0.976356569070832	R_5^2=0.18825	R_6^2=0.040576
Eigenvalues =0.31228	*Eigenvalues =0.75483*	*Eigenvalues =0.95628*
RI_4=0.55356	RI_5=0.38526	RI_6=0.67100
F-Value =6.513206	*F-Value* =14.78735	*F-Value* =16.69060
p-value =< 0.0001	*p-value* =< 0.0001	*p-value* < 0.0001

Interrelationships among Four Perspectives of the BSC

In order to examine the interrelationships between the four perspectives of the BSC, canonical correlation analyses were used in this study. Detailed information for the canonical results is shown in table 65. There are a number of results among the inputs and output of the linear combinations for each year. The study considers six multi linear combinations of the variables.

First the relationship between the linear combination learning and growth perspectives variables and that of two customer perspective variables has a canonical correlation R^2 value of 0.9633 with p-value<0.0001. The redundancy index is relatively low (RI =0.3439) indicating that 34.39 percent of the variance of customer perspectives can be explained by learning and growth improvement.

Second, the relation between the set of two learning and growth variables with the set of four financial perspectives variables has a canonical correlation R^2-value 0.0829 with *p*-value <0.0001. The redundancy index is medium (RI_2=0.5169) indicating that 51.69 percent of the variance on financial perspective can be explained by learning and growth improvement.

Third, the relation between the set of two learning and growth variables with the set of three internal business process perspective variables has a canonical correlation R^2-value 0.0045 with *p*-value <0.0001. The redundancy index is low (RI_3=0.4769) indicating that 47.69 percent of the variance on internal business process perspective can be explained by learning and growth improvement.

Fourth, the relation between the set of two customer variables with the set of four financial perspective variables has a canonical correlation R^2-value 0.9763 with *p*-value <0.0001. The redundancy index is medium (RI_4=0.5535) indicating that 55.35 percent of the variance on financial perspective can be explained by customer improvement.

Fifth, the relation between the set of three internal business process variables with the set of two customer perspective variables has a canonical correlation R^2-value 0.18825 with *p*-value <0.0001. The redundancy index is low (RI_5=0.38526) indicating that 38.52 percent of the variance on customer perspective can be explained by internal business process improvement.

Sixth, the relation between the set of three internal business process variables with the set of four financial perspective variables has a canonical correlation R^2-value 0.04057 with *p*-value <0.0001. The redundancy index is low (RI_5=0.671) indicating that 67.1 percent of the variance on financial perspectives perspective can be explained by internal business process improvement.

In summary, from the six canonical analyses, only one relationship is highly significant and the two relationship is relatively medium significant. The result seems to suggest that it is inconsistent with the previous results of 2013 and 2014. However, financial improvement is highly related to internal process improvement.

Table 66 Canonical Loading of the Year 2011

Canonical Loading 2011

Learning & Growth →Customer	**Learning & Growth →Financial**	**Learning & Growth →Internal Business Perspective**
No 1 Canonical Test	No 2 Canonical Test	No 3 Canonical Test
λ11=0.93799	λ11=-0.99249	λ11=-0.99982
λ12=0.83346	λ12=-0.68453	λ12=-0.60515
λ21=0.98916	λ41=-0.98593	λ31=-0.65963
λ22=0.84728	λ42=0.340151	λ32=-0.93476
	λ43=0.322737	λ33=-0.86235
	λ44=-0.43560	
R_1^2=0.28045	R_2^2=0.02706	R_3^2=0.05055
Eigenvalues =0.70282	*Eigenvalues =0.96986*	*Eigenvalues =0.93111*
RI_1 =0.55330	RI_2 =0.704910	RI_4 =0.96494
F-Value =14.21280	*F-Value* =38.08811	*F-Value* =35.6224
p-value < 0.0001	*p-value < 0.0001*	*p-value*< 0.0001

Customer →Financial	**Internal Business Perspective → Customer**	**Internal Business Perspective → Financial**
No 4 Canonical Test	No 5 Canonical Test	No 6 Canonical Test
λ21=0.87518	λ31=-0.413297	λ31=-0.660107
λ22=0.97960	λ32=-0.959061	λ32=-0.978564
	λ33=-0.394161	λ33=-0.776346
λ41=0.92012	λ21=-0.887783	λ41=-0.999262
λ42=0.19630	λ22=-0.973895	λ42=0.2793627
λ43=0.17905		λ43=0.2546577
λ44=-0.8411		λ44=-0.593876
R_4^2=0.10336	R_5^2=0.074347	R_6^2=0.01904
Eigenvalues =0.82588	*Eigenvalues =0.88378*	*Eigenvalues =0.96538*
RI_4 =0.7125	RI_5=0.36705	RI_6=0.69760
F-Value =15.82781	*F-Value* =27.56400	*F-Value* =22.26330
p-value < 0.0001	*p-value* < 0.0001	*p-value*< 0.0001

Interrelationships among Four Perspectives of the BSC

In order to examine the interrelationships between the four perspectives of the BSC, canonical correlation analyses were used in this study. Detailed information for the canonical results is shown in table 66. There are a number of results among the inputs and output of the linear combinations for each year. The study considers six multi linear combinations of the variables.

First the relationship between the linear combination learning and growth perspectives variables and that of two customer perspective variables has a canonical correlation R^2 value of 0.28045 with p-value<0.0001. The redundancy index is medium (RI =0.5533) indicating that 55.33 percent of the variance of customer perspectives can be explained by learning and growth improvement.

Second, the relation between the set of two learning and growth variables with the set of four financial perspectives variables has a canonical correlation R^2-value 0.02706 with p-value <0.0001. The redundancy index is relatively high (RI_2=0.7049) indicating that 70.49 percent of the variance on financial perspective can be explained by learning and growth improvement.

Third, the relation between the set of two learning and growth variables with the set of three internal business process perspective variables has a canonical correlation R^2-value 0.05055 with p-value <0.0001. The redundancy index is very high (RI_3=0.96494) indicating that 96.49 percent of the variance on internal business process perspective can be explained by learning and growth improvement.

Fourth, the relation between the set of two customer variables with the set of four financial perspective variables has a canonical correlation R^2-value 0.10336 with p-value <0.0001. The redundancy index is moderately high (RI_4=0.71.25) indicating that 71.25 percent of the variance on financial perspective can be explained by customer improvement.

Fifth, the relation between the set of three internal business process variables with the set of two customer perspective variables has a canonical correlation R^2-value 0.0743 with p-value <0.0001. The redundancy index is low (RI_5=0.3670) indicating that 36.70 percent of the variance on customer perspective can be explained by internal business process improvement.

Sixth, the relation between the set of three internal business process variables with the set of four financial perspective variables has a canonical correlation R^2-value 0.01904 with p-value <0.0001. The redundancy index is moderately high (RI_5=0.69.76) indicating that 69.67 percent of the variance on financial perspectives perspective can be explained by internal business process improvement.

In summary, from the six canonical analyses, only five relationships are significant. The result seems to suggest that the five perspectives of BSC are dependent. There is less relationship between the set of three internal business process variables with the set of two customer perspective variable. However, customer improvement is highly related to learning and growth so is financial improvement to learning and growth; internal process improvement is highly related to learning and growth; financial improvement to customer orientation.

Table 67 Canonical Loading of the Year 2010

	Canonical Loading 2010	
Learning & Growth →Customer	**Learning & Growth →Financial**	**Learning & Growth →Internal Business Perspective**
No 1 Canonical Test	**No 2 Canonical Test**	**No 3 Canonical Test**
λ11=0.82554	λ11=-0.97621	λ11=-0.99736
λ12=0.95920	λ12=-0.78524	λ12=-0.57447
λ21=0.951157	λ41=-0.99838	λ31=-0.73922
λ22=0.914216	λ42=0.226412	λ32=-0.68156
	λ43=0.254815	λ33=-0.97672
	λ44=-0.63051	
R_1^2=0.148647	R_2^2=0.03339	R_3^2=0.07262
Eigenvalues =0.81215	*Eigenvalues =0.96287*	*Eigenvalues =0.85250*
RI_1=0.69194	RI_2=0.77728	RI_3=0.73606
F-Value =28.68708	*F-Value* =38.01124	*F-Value* =31.62568
p-value< 0.0001	*p-value* < 0.0001	*p-value* < 0.0001
Customer →Financial	**Internal Business Perspective → Customer**	**Internal Business Perspective → Financial**
No 4 Canonical Test	No 5 Canonical Test	No 6 Canonical Test
λ21=0.979037	λ31=-0.907600	λ31=--0.77989
λ22=0.864850	λ32=-0.119810	λ32=-0.810070
	λ33=-0.580180	λ33=-0.904273
λ41=0.98407	λ21=-0.960194	λ41=-0.997864
λ42=0.25837	λ22=-0.733681	λ42=0.1582461
λ43=0.16008		λ43=0.230779
λ44=-0.7425		λ44=-0.69262
R_4^2=0.23827	R_5^2=0.288679	R_6^2=0.13122
Eigenvalues =0.756989	*Eigenvalues =0.6159*	*Eigenvalues =0.84228*
RI_4=0.64875	RI_5=0.399521	RI_6=0.60806
F-Value =8.91341	*F-Value* =10.04726	*F-Value* =8.42845
p-value < 0.0001	*p-value* < 0.0001	*p-value* < 0.0001

Interrelationships among Four Perspectives of the BSC for the year 2010

In order to examine the interrelationships between the four perspectives of the BSC, canonical correlation analyses were used in this study. Detailed information for the canonical results is shown in table 67. There are a number of results among the inputs and output of the linear combinations for each year. The study considers six multi linear combinations of the variables.

First the relationship between the linear combination learning and growth perspectives variables and that of two customer perspective variables has a canonical correlation R^2 value of 0.1486 with p-value<0.0001. The redundancy index is moderately high (RI =0.69194) indicating that 69.194 percent of the variance of customer perspectives can be explained by learning and growth improvement.

Second, the relation between the set of two learning and growth variables with the set of four financial perspectives variables has a canonical correlation R^2-value 0.03339 with *p*-value <0.0001. The redundancy index is moderately high (RI_2=077728) indicating that 77.7 percent of the variance on financial perspective can be explained by learning and growth improvement.

Third, the relation between the set of two learning and growth variables with the set of three internal business process perspective variables has a canonical correlation R^2-value 0.07262 with *p*-value <0.0001. The redundancy index is moderately high (RI_3=0.736) indicating that 73.60 percent of the variance on internal business process perspective can be explained by learning and growth improvement.

Fourth, the relation between the set of two customer variables with the set of four financial perspective variables has a canonical correlation R^2-value 0.23827 with *p*-value <0.0001. The redundancy index is moderately high (RI_4=0.64875) indicating that 64.87 percent of the variance on financial perspective can be explained by customer improvement.

Fifth, the relation between the set of three internal business process variables with the set of two customer perspective variables has a canonical correlation R^2-value 0.288679 with *p*-value <0.0001. The redundancy index is low (RI_5=0399521) indicating that 39.95 percent of the variance on customer perspective can be explained by internal business process improvement.

Sixth, the relation between the set of three internal business process variables with the set of four financial perspective variables has a canonical correlation R^2-value 0.13122 with p-value <0.0001. The redundancy index is moderately high (RI_5=0.6086) indicating that 44.9 percent of the variance on financial perspectives perspective can be explained by internal business process improvement.

In summary, from the six canonical analyses, only four relationships are significant. The result seems to suggest that the four perspectives of BSC are dependent. There is moderately high and significant relationship. And these are customer improvement is highly related to learning and growth so is financial improvement to learning and growth; internal process improvement is highly related to learning and growth; financial improvement to customer orientation.

Table 68 Canonical Loading of the Year 2009

	Canonical Loading 2009	
Learning & Growth →Customer	**Learning & Growth →Financial**	**Learning & Growth →Internal Business Perspective**
No 1 Canonical Test	No 2 Canonical Test	No 3 Canonical Test
λ11=-0.92512	λ11=-0.95653	λ11=-0.75471
λ12=-0.87786	λ12=-0.82930	λ12=-0.98502
λ21=-0.87197	λ41=-0.97209	λ31=-0.686673
λ22=-0.88837	λ42=0.555872	λ32=-0.98175
	λ43=0.50855	λ33=-0.67325
	λ44=-0.282523	
R_1^2=0.16174	R_2^2=0.14871	R_3^2=0.33361
Eigenvalues =0.83247	*Eigenvalues =0.76840*	*Eigenvalues =0.65264*
RI_1=0.68344	RI_2=0.68684	RI_3=0.51159
F-Value =18.58064	*F-Value* =9.16035	*F-Value* =5.85048
p-value < 0.0001	*p-value* < 0.0001	*p-value* >0.000123
Customer →Financial	**Internal Business Perspective → Customer**	**Internal Business Perspective → Financial**
No 4 Canonical Test	No 5 Canonical Test	No 6 Canonical Test
λ21=-0.78605	λ31=0.971581	λ31=-0.742202
λ22=-0.948553	λ32=0.701010	λ32=-0.985360
	λ33=0.786473	λ33=-0.838448
λ41=-0.98199	λ21=0.285151	λ41=-0.985007
λ42=0.570650	λ22=0.957361	λ42=0.345166
λ43=0.482469		λ43=0.286323
λ44=-0.36189		λ44=-0.62605
R_4^2=0.21087	R_5^2=0.18933	R_6^2=0.080818
Eigenvalues =0.76661	*Eigenvalues =0.73908*	*Eigenvalues =0.91212*
RI_4=0.60498	RI_{15}=0.55731	RI_6=0.68637
F-Value =6.77153	*F-Value* =10.38553	*F-Value* =7.74004
p-value < 0.0001	*p-value* < 0.0001	*p-value* < 0.0001

Interrelationships among Four Perspectives of the BSC for the year 2009

In order to examine the interrelationships between the four perspectives of the BSC, canonical correlation analyses were used in this study. Detailed information for the canonical results is shown in table 68. There are a number of results among the inputs and output of the linear combinations for each year. The study considers six multi linear combinations of the variables.

First the relationship between the linear combination learning and growth perspectives variables and that of two customer perspective variables has a canonical correlation R^2 value of 0.16174 with p-value <0.0001. The redundancy index is moderately high (RI =0.68344) indicating that 68.34 percent of the variance of customer perspectives can be explained by learning and growth improvement.

Second, the relation between the set of two learning and growth variables with the set of four financial perspectives variables has a canonical correlation R^2-value 0.1487 with p-value <0.0001. The redundancy index is moderately high (RI_2=0.6868) indicating that 68.68 percent of the variance on financial perspective can be explained by learning and growth improvement.

Third, the relation between the set of two learning and growth variables with the set of three internal business process perspective variables has a canonical correlation R^2-value 0.33361with p-value <0.0001. The redundancy index is relatively medium (RI_3=0.51159) indicating that 51.15 percent of the variance on internal business process perspective can be explained by learning and growth improvement.

Fourth, the relation between the set of two customer variables with the set of four financial perspective variables has a canonical correlation R^2-value 0.21087 with p-value <0.0001. The redundancy index is moderately high (RI_4=0.605) indicating that 60.5 percent of the variance on financial perspective can be explained by customer improvement.

Fifth, the relation between the set of three internal business process variables with the set of two customer perspective variables has a canonical correlation R^2-value 0.18933 with p-value <0.0001. The redundancy index is medium (RI_5=0.5573) indicating that 55.73 percent of the variance on customer perspective can be explained by internal business process improvement.

Sixth, the relation between the set of three internal business process variables with the set of four financial perspective variables has a canonical correlation R^2-value 0.0808 with p-value <0.0001. The redundancy index is moderately high (RI_5=0.68637) indicating that 68.64 percent of the variance on financial perspectives perspective can be explained by internal business process improvement.

In summary, from the six canonical analyses, all of the relationships are significant with a relative range between relatively medium and moderately high. The result seems to suggest that the six perspectives of BSC are dependent. These are customer improvement is highly related to learning and growth so is financial improvement to learning and growth; internal process improvement is highly related to learning and growth; financial improvement to customer orientation etc.

Table 69 Canonical Loading of the Year 2008

Canonical Loading 2008		
Learning & Growth →Customer	**Learning & Growth →Financial**	**Learning & Growth →Internal Business Perspective**
No 1 Canonical Test	No 2 Canonical Test	No 3 Canonical Test
λ11=-0.93416	λ11=-0.99000	λ11=-0.99989
λ12=-0.78929	λ12=-0.63368	λ12=-0.50565
λ21=-0.94039	λ41=-0.98158	λ31=-0.78557
λ22=-0.81935	λ42=0.187609	λ32=-0.98650
	λ43=0.194959	λ33=-0.82433
	λ44=-0.55624	
R_1^2=0.30555	R_2^2=0.15825	R_3^2=0.10900
Eigenvalues=0.68696	*Eigenvalues =0.84087*	*Eigenvalues =0.85407*
RI_1=0.51976	RI_2=0.28329	RI_3=0.63032
F-Value =10.11350	*F-Value* =8.70382	*F-Value* =16.23092
p-value< 0.0001	*p-value*< 0.0001	*p-value*< 0.0001
Customer →Financial	**Internal Business Perspective → Customer**	**Internal Business Perspective → Financial**
No 4 Canonical Test	No 5 Canonical Test	No 6 Canonical Test
λ21=-0.87305	λ31=-0.83452	λ31=-0.83047
λ22=-0.90124	λ32=-0.99647	λ32=-0.98749
	λ33=-0.79830	λ33=-0.70760
λ41=-0.85501	λ21=-0.77321	λ41=-0.95052
λ42=0.082944	λ22=-0.66270	λ42=0.172915
λ43=-0.03384		λ43=0.181493
λ44=-0.69447		λ44=-0.61142
R_4^2=0.18471	R_5^2=0.02867	R_6^2=0.06759
Eigenvalues =0.78003	*Eigenvalues =0.95027*	*Eigenvalues =0.88065*
RI_4=0.64816	RI_5=0.86845	RI_6=0.67763
F-Value =7.62895	*F-Value* =39.24647	*F-Value* =8.62154
p-value< 0.0001	*p-value*< 0.0001	*p-value*< 0.0001

Interrelationships among Four Perspectives of the BSC for the year 2008

In order to examine the interrelationships between the four perspectives of the BSC, canonical correlation analyses were used in this study. Detailed information for the canonical results is shown in table 69. There are a number of results among the inputs and output of the linear combinations for each year. The study considers six multi linear combinations of the variables.

First the relationship between the linear combination learning and growth perspectives variables and that of two customer perspective variables has a canonical correlation R^2 value of 0.5055 with p-value<0.0001. The redundancy index is relatively medium (RI =0.51976) indicating that 51.976 percent of the variance of customer perspectives can be explained by learning and growth improvement.

Second, the relation between the set of two learning and growth variables with the set of four financial perspectives variables has a canonical correlation R^2-value 0.109 with p-value <0.0001. The redundancy index is moderately high (RI_2=0.63032) indicating that 63.032 percent of the variance on financial perspective can be explained by learning and growth improvement.

Third, the relation between the set of two learning and growth variables with the set of three internal business process perspective variables has a canonical correlation R^2-value 0.0249 with p-value <0.0001. The redundancy index is relatively medium (RI_3=0.589) indicating that 58.9 percent of the variance on internal business process perspective can be explained by learning and growth improvement.

Fourth, the relation between the set of two customer variables with the set of four financial perspective variables has a canonical correlation R^2-value 0.1847 with p-value <0.0001. The redundancy index is moderately high (RI_4=0.64816) indicating that 64.816 percent of the variance on financial perspective can be explained by customer improvement.

Fifth, the relation between the set of three internal business process variables with the set of two customer perspective variables has a canonical correlation R^2-value 0.02867 with p-value <0.0001. The redundancy index is very high (RI_5=0.86845) indicating that 86.845 percent of the variance on customer perspective can be explained by internal business process improvement.

Sixth, the relation between the set of three internal business process variables with the set of four financial perspective variables has a canonical correlation R^2-value 0.06759 with p-value <0.0001. The redundancy index is moderately high (RI_5=0.67759) indicating that 67.759 percent of the variance on financial perspectives perspective can be explained by internal business process improvement.

In summary, from the six canonical analyses, all six relationships are significant with a difference of ranges. For example, the relation between the set of two customer variables with the set of four financial perspective variables is moderately high indicating that 64.82%) percent of the variance on financial perspective can be explained by customer improvement. The result seems to suggest that the four perspectives of BSC are dependent. Hence, customer improvement is averagely related to learning and growth so is financial improvement to learning and growth; internal process improvement is highly related to learning and growth; financial improvement to customer orientation.

Table 70 Canonical Loading of the Year 2007

	Canonical Loading 2007	
Learning & Growth →Customer	**Learning & Growth →Financial**	**Learning & Growth →Internal Business Perspective**
No 1 Canonical Test	No 2 Canonical Test	No 3 Canonical Test
λ11=-0.94697	λ11=-0.999975402709776	λ11=-0.999702099885147
λ12=0.88270	λ12=-0.689963710957981	λ12=-0.666881105483858
λ21=0.42896	λ41=-0.907279770178835	λ31=-0.708840092830982
λ22=0.997217	λ42=0.0818213659936903	λ32=-0.953073196114675
	λ43=0.21233991094828	λ33=-0.822418826439587
	λ44=-0.819121198469044	
R_1^2=0.50931	R_2^2=0.18148	R_3^2=0.12710
Eigenvalues =0.49012	*Eigenvalues =0.80069*	*Eigenvalues =0.83848*
RI_1=0.41087	RI_2=0.61434	RI_3=0.66465
F-Value =7.82394	*F-Value* =12.4631	*F-Value* =22.86197
p-value < 0.0001	*p-value* < 0.0001	*p-value* < 0.0001
Customer →Financial	**Internal Business Perspective → Customer**	**Internal Business Perspective → Financial**
No 4 Canonical Test	No 5 Canonical Test	No 6 Canonical Test
λ21=-0.41760	λ31=-0.28257	λ31=-0.41299
λ22=-0.99807	λ32=-0.90480	λ32=-0.29387
	λ33=-0.23121	λ33=-0.40686
λ41=-0.91095	λ21=-0.33834	λ41=-0.10718
λ42=0.40700	λ22=-0.99972	λ42=-0.11526
λ43=0.23024		λ43=0.378276
λ44=-0.49653		λ44=-0.92315
R_4^2=0.62241	R_5^2=0.14018	R_6^2=0.06214
Eigenvalues =0.37211	*Eigenvalues =0.85746*	*Eigenvalues =0.90210*
RI_4=0.22140	RI_5=0.27351	RI_6=0.76839
F-Value =2.47469	*F-Value* =21.16414	*F-Value* =14.79222
p-value >0.01954	*p-value* < 0.0001	*p-value* < 0.0001

Interrelationships among Four Perspectives of the BSC for the year 2007

In order to examine the interrelationships between the four perspectives of the BSC, canonical correlation analyses were used in this study. Detailed information for the canonical results is shown in table 70. There are a number of results among the inputs and output of the linear combinations for each year. The study considers six multi linear combinations of the variables.

First the relationship between the linear combination learning and growth perspectives variables and that of two customer perspective variables has a canonical correlation R^2 value of 0.50931with p-value<0.0001. The redundancy index is low (RI =0.41087) indicating that 41.087 percent of the variance of customer perspectives can be explained by learning and growth improvement.

Second, the relation between the set of two learning and growth variables with the set of four financial perspectives variables has a canonical correlation R^2-value 0.18148 with *p*-value <0.0001. The redundancy index is moderately high (RI_2=0.61434) indicating that 61.434 percent of the variance on financial perspective can be explained by learning and growth improvement.

Third, the relation between the set of two learning and growth variables with the set of three internal business process perspective variables has a canonical correlation R^2-value 0.1271 with *p*-value <0.0001. The redundancy index is moderately high (RI_3=0.66465) indicating that 66.47 percent of the variance on internal business process perspective can be explained by learning and growth improvement.

Fourth, the relation between the set of two customer variables with the set of four financial perspective variables has a canonical correlation R^2-value 0.62241with *p*-value <0.0001. The redundancy index is very low (RI_4=0.22140) indicating that 22.14 percent of the variance on financial perspective can be explained by customer improvement.

Fifth, the relation between the set of three internal business process variables with the set of two customer perspective variables has a canonical correlation R^2-value 0.14018 with *p*-value <0.0001. The redundancy index is low (RI_5=0.2735) indicating that 27.35 percent of the variance on customer perspective can be explained by internal business process improvement.

Sixth, the relation between the set of three internal business process variables with the set of four financial perspective variables has a canonical correlation R^2-value 0.06214 with p-value <0.0001. The redundancy index is moderately high (RI_5=0.76839) indicating that 76.83 percent of the variance on financial perspectives perspective can be explained by internal business process improvement.

In summary, from the six canonical analyses, only two relationships are significant. The result seems to suggest that the two perspectives of BSC are dependent. Hence, financial improvement is highly related to learning and growth so is financial improvement to learning and growth.

4.2 Stochastic Frontier Analysis Results

4.2.1 SFA and OLS Result of the Study for the Year 2014

The table 71 below summarise the Ordinary Least Squares (OLS). The estimates of the function result are obtained using the program FRONTIER (Version 4.1c) based on Error Components Frontier (see B&C 1992). Production function model is selected and applied. All β estimators with the exception of the intercept are unbiased. The OLS estimates, the estimates after the grid search and the final maximum likelihood estimate are presented in the output table. Approximate standard errors are taken from the direction matrix used in the iteration of the Davidon-Fletcher-Powell procedure. The final results indicate the Beta value, Coefficient, approximate standards errors, t-ratios, individual and mean technical efficiency estimates. This estimate of the covariance matrix is also listed in the output. Estimates of individual technical efficiency are calculated using the expression presented in Battese and Coelli (1992). When any estimates of mean efficiency are reported, these are simply the arithmetic averages of the individual efficiencies in the output file by changing it is value from 1 to 0. When we look at the first row for the result of Beta zero, we read 3969.059 coefficients, 3315.4558 standard-errors and 1.1971383 t-ratios. The list of the rest OLS result continues till beta 7. The sigma-squared and log likelihood function are 45959193 and -333.35791 respectively.

Table 71 Summary of the OLS Estimates for 2013

	coefficient	standard-error	t-ratio
beta 0	3969.059	3315.4558	1.1971383
beta 1	0.9482782	4.8679693	0.19479954
beta 2	445.09255	776.24394	0.57339262
beta 3	-675.83567	833.94405	-0.81040889
beta 4	2.9669145	54.147459	0.054793237
beta 5	0.025164171	0.05223379	0.48176038
beta 6	1.5593689	1.9106538	0.81614417
beta 7	0.76262791	0.39145097	1.948208
sigma-squared	45959193		
log likelihood function =	-333.35791		

Table 72 below shows the relative technical efficiency of world airlines using SFA model of Frontier 4.1 version. The technical efficiency scores 1.00 means the firm is 100% efficient and less than 1.00 means the firm is less efficient. Among 33 sample airlines in 2014, none of sample airlines scored 1.00 technical efficiency score. 31 sample airlines scored between 0.8 and 0.99. Allegiant Air and Copa Holding scored the lowest point and below 0.8. Their results are 0.786 and 0.728 respectively. Delta Airlines, American Airline Group and United Continental Holdings are the three highest technical efficient airlines 0.983, 0.982 and 0.977 in 2014 in the world.

Table 72 Technical Efficiency Estimation of SFA for the Year 2014

DMU	**Airlines**	eff.-est.	Regions
1	Aegean Airlines Group	0.86211	Europe
2	Air Canada	0.346744	N. America
3	Air china	0.462465	Asia
4	Air New Zealand Group	0.703164	Australia
5	AirAsia	0.923862	Asia
6	Allegiant Air	0.785505	N. America
7	American Airlines Group	**0.977369**	N. America
8	ANA Group	0.9449688	Asia
9	Avianca Holdings	0.905323	Asia
10	British Airways	0.96457	Europe
11	Cathay Pacific Group	0.557919	Asia
12	Cebu Pacific Air	0.876169	Asia
13	China Eastern Airlines	0.45812	Asia
14	China Southern Air Holding	0.246829	Asia
15	Copa Holdings	0.727535	L. America
16	Delta airlines	**0.982765**	N. America
17	EasyJet PLC	0.915223	Europe
18	Emirates Group	0.97345	M. East
19	Ethiopian	0.844355	Africa
20	Hawaiian Airlines	0.870935	N. America
21	IAG	0.977953	Europe
22	Japan Airlines	0.9233	Asia
23	JetBlue Airways	0.892146	N. America
24	Lufthansa group	0.982754	Europe
25	Republic Airways Holdings	0.792243	N. America
26	Ryanair	0.909268	Europe
27	SAS Group	0.940555	Europe
28	Singapore Airlines	0.950549	Asia
29	Southwest Airlines Co.	0.937769	N. America
30	Sprit airlines	0.818775	N. America
31	Turkish Airlines	0.647976	Europe
32	United-Continental Holdings	**0.981649**	N. America
33	WestJet	0.598025	N. America
	mean efficiency	0.815972	

4.2.2 SFA and OLS Result of the Study for the Year 2013

The table 73 below summarise the Ordinary Least Squares (OLS). The estimates of the function result are obtained using the program FRONTIER (Version 4.1c) based on Error Components Frontier (see B&C 1992). Production function model is selected and applied. All β estimators with the exception of the intercept are unbiased. The OLS estimates, the estimates after the grid search and the final maximum likelihood estimate are presented in the output table. Approximate standard errors are taken from the direction matrix used in the iteration of the Davidon-Fletcher-Powell procedure. The final results indicate the Beta value, Coefficient, approximate standards errors, t-ratios, individual and mean technical efficiency estimates. This estimate of the covariance matrix is also listed in the output. Estimates of individual technical efficiency are calculated using the expression presented in Battese and Coelli (1992). When any estimates of mean efficiency are reported, these are simply the arithmetic averages of the individual efficiencies in the output file by changing it is value from 1 to 0. When we look at the first row for the result of Beta zero, we read 293.38049 coefficients, 518.83588 standard-errors and 0.56545914 t-ratios. The list of the rest OLS result continues till beta 7. The sigma-squared and log likelihood function are 2218969.2 and -335.80669 respectively.

Table 73 Summary of the OLS Estimates for 2013

the OLS estimates are :

	coefficient	standard-error	t-ratio
beta 0	293.38049	518.83588	0.56545914
beta 1	1.5497409	0.42343511	3.6599254
beta 2	189.16445	164.94056	1.1468643
beta 3	-209.34912	174.27978	-1.2012244
beta 4	22.332895	12.822203	1.7417362
beta 5	-0.001246232	0.011613998	-0.10730426
beta 6	2.2794942	0.29407667	7.7513603
beta 7	0.73829706	0.075184346	9.8198242
sigma-squared	2218969.2		

log likelihood function = -335.80669

Table 74 below shows the relative technical efficiency of world airlines using SFA model of Frontier 4.1 version. The technical efficiency scores 1.00 means the firm is 100% efficient and less than 1.00 means the firm is less efficient.

Among 39 sample airlines in 2013, none of them scored 1.00 technical efficiency score. All of the airlines scored between 0.8 and 0.99. Allegiant Air and Copa Holding scored the lowest point and below 0.8. Their results are 0.786 and 0.728 respectively. Lufthansa Group, Delta Airlines and IAG are the three highest technical efficient airlines 0.9953, 0.995 and 0.994 respectively in 2013 in the world.

Table 74 Technical Efficiency Estimation of SFA for the Year 2013

Technical efficiency estimates:

:

	Airlines	eff.-est.
1	Aegean Airlines Group	0.88895533
2	Aer Lingus	0.8945409
3	Aeroflot	0.97761655
4	Air Canada	0.98430103
5	Air china	0.8884697
6	Air New Zealand Group	0.9555002
7	AirAsia	0.89913672
8	Allegiant Air	0.87418571
9	ANA Group	0.98667743
10	Avianca Holdings	0.86011861
11	British Airways	0.98967619
12	Cathay Pacific Group	0.88593097
13	Cebu Pacific Air	0.89889185
14	China Eastern Airlines	0.78726637
15	China Southern Air Holding	0.68835257
16	Copa Holdings	0.93731305
17	Delta airlines	0.99501354
18	EasyJet PLC	0.97287582
19	El Al	0.92297176
20	Emirates Group	0.99111867
21	Ethiopian	0.92712185
22	Finnair	0.9465862
23	Garuda Indonesia	0.65992278
24	Hawaiian Airlines	0.92525747
25	IAG	0.99370131
26	Japan Airlines	0.98467371
27	JetBlue Airways	0.86829836
28	Lufthansa group	0.99531504
29	Norwegian	0.94315343
30	Qantas Group	0.98777539
31	Republic Airways Holdings	0.84626118
32	Ryanair	0.97477726
33	Singapore Airlines	0.98506518
34	SkyWest, Inc	0.93403062
35	Southwest Airlines Co.	0.98957066
36	Sprit airlines	0.92991749
37	Turkish Airlines	0.68207771
38	United-Continental Holdings	0.99541175
39	WestJet	0.75302966
	mean efficiency	**0.85643231**

4.2.3 SFA and OLS Result of the Study for the Year 2012

The table 75 below summarise the Ordinary Least Squares (OLS). The estimates of the function result are obtained using the program FRONTIER (Version 4.1c) based on Error Components Frontier (see B&C 1992). Production function model is selected and applied. All β estimators with the exception of the intercept are unbiased. The OLS estimates, the estimates after the grid search and the final maximum likelihood estimate are presented in the output table. Approximate standard errors are taken from the direction matrix used in the iteration of the Davidon-Fletcher-Powell procedure. The final results indicate the Beta value, Coefficient, approximate standards errors, t-ratios, individual and mean technical efficiency estimates. This estimate of the covariance matrix is also listed in the output. Estimates of individual technical efficiency are calculated using the expression presented in Battese and Coelli (1992). When any estimates of mean efficiency are reported, these are simply the arithmetic averages of the individual efficiencies in the output file by changing it is value from 1 to 0. When we look at the first row for the result of Beta zero, we read 1104.9637 coefficients, 670.66267 standard-errors and 1.6475701 t-ratios. The list of the rest OLS result continues till beta 7. The sigma-squared and log likelihood function are 3245154 and -343.21903 respectively.

Table 75 Summary of the OLS Estimate for the Year 2012

	coefficient	standard-error	t-ratio
beta 0	1104.9637	670.66267	1.6475701
beta 1	3.4282262	1.137432	3.0140054
beta 2	-122.62831	113.58488	-1.0796182
beta 3	-35.12788	39.660601	-0.88571225
beta 4	19.265404	15.921615	1.2100158
beta 5	0.005879191	0.009152434	0.64236366
beta 6	1.8657724	0.30207431	6.1765346
beta 7	0.50599687	0.097504739	5.1894592
sigma-squared	3245154		
log likelihood function =	-343.21903		

Table 76 below shows the relative technical efficiency of world airlines using SFA model of Frontier 4.1 version. The technical efficiency scores 1.00 means the firm is 100% efficient and less than 1.00 means the firm is less efficient.

Among 39 sample airlines in 2012, none of them scored 1.00 technical efficiency score. 37 of the airlines scored between 0.8 and 0.99. Cebu Pacific Air scored 0.1034 far behind the benchmarking and the mean technical efficiency. Allegiant Air scored 0.771 the second lowest point result of technical efficiency. Delta Airlines, Lufthansa Group, and Emirates Group are the three highest technical efficient airlines 0.994, 0.994 and 0.987 respectively in 2012 in the world.

Table 76 Technical Efficiency Estimation of SFA for the Year 2012

Frontier technical efficiency estimates

	Airlines	eff.-est.
1	Aer Lingus	0.90217299
2	Aeroflot	0.96875169
3	Air Berlin	0.95588173
4	Air Canada	0.97986153
5	Air china	0.9859363
6	Air New Zealand Group	0.94439262
7	AirAsia	0.91082045
8	Allegiant Air	0.77105335
9	ANA Group	0.98510128
10	Avianca Holdings	0.95098123
11	British Airways	0.98657764
12	Cathay Pacific Group	0.9823669
13	Cebu Pacific Air	0.10339207
14	China Eastern Airlines	0.9835015
15	China Southern Air Holding	0.98579782
16	Copa Holdings	0.8514394
17	Delta airlines	0.99389054
18	EasyJet PLC	0.965521
19	Emirates Group	0.98667232
20	Ethiopian	0.92868433
21	Finnair	0.93499677
22	Garuda Indonesia	0.94483304
23	Hawaiian Airlines	0.91072662
24	Japan Airlines	0.98479994
25	JetBlue Airways	0.95931647
26	Kenya Airways	0.89517175
27	Korean Air	0.9807358
28	LATAM Airlines	0.98105452
29	Lufthansa group	0.99394076
30	Norwegian	0.91987711
31	Republic Airways Holdings	0.89979643
32	Ryanair	0.96918576
33	Singapore Airlines	0.97894473
34	SkyWest, Inc	0.94007489
35	Southwest Airlines Co.	0.98666153
36	Sprit airlines	0.81324582
37	Turkish Airlines	0.97451377
38	Virgin Australia	0.94553869
39	WestJet	0.93905033
	mean efficiency	0.9250067

4.2.4 SFA and OLS Result of the Study for the Year 2011

The table 77 below summarise the Ordinary Least Squares (OLS). The estimates of the function result are obtained using the program FRONTIER (Version 4.1c) based on Error Components Frontier (see B&C 1992). Production function model is selected and applied. All β estimators with the exception of the intercept are unbiased. The OLS estimates, the estimates after the grid search and the final maximum likelihood estimate are presented in the output table. Approximate standard errors are taken from the direction matrix used in the iteration of the Davidon-Fletcher-Powell procedure.

The final results indicate the Beta value, Coefficient, approximate standards errors, t-ratios, individual and mean technical efficiency estimates. This estimate of the covariance matrix is also listed in the output. Estimates of individual technical efficiency are calculated using the expression presented in Battese and Coelli (1992). When any estimates of mean efficiency are reported, these are simply the arithmetic averages of the individual efficiencies in the output file by changing it is value from 1 to 0. When we look at the first row for the result of Beta zero, we read 871.3096 coefficients, 712.99445 standard-errors and 1.2220426 t-ratios. The list of the rest OLS result continues till beta 7. The sigma-squared and log likelihood function are 3607310.4 and -318.33064respectively.

Table 77-The OLS Estimates for the Year 2011

	coefficient	standard-error	t-ratio
beta 0	871.3096	712.99445	1.2220426
beta 1	-0.31259795	1.3923588	-0.22450963
beta 2	28.459981	128.37826	0.22168848
beta 3	-102.31449	83.893902	-1.2195701
beta 4	18.014402	18.708934	0.962877
beta 5	0.030308441	0.013859339	2.1868606
beta 6	1.7114589	0.37034617	4.6212411
beta 7	0.69268289	0.10631495	6.5153855
sigma-squared	3607310.4		
log likelihood function =	-318.33064		

Table 78 below shows the relative technical efficiency of world airlines using SFA model of Frontier 4.1 version. The technical efficiency scores 1.00 means the firm is 100% efficient and less than 1.00 means the firm is less efficient.

Among 36 sample airlines in 2011, none of them scored 1.00 technical efficiency score. 35 of the airlines scored between 0.8 and 0.99. AirAisa scored 0.1034 far behind the benchmarking and the mean technical efficiency. Delta Airlines, IAG, Lufthansa Group, and United Continental Group are the four highest technical efficient airlines 0.995, 0.994, 0.996 and 0.996 respectively in 2011 in the world.

Table 78 Summary Technical Efficiency Estimation of SFA for the Year 2011

1	Aer Lingus	0.9051417
2	Aeroflot	0.96460449
3	Air china	0.98952568
4	Air New Zealand Group	0.96316032
5	AirAsia	0.65000555
6	Allegiant Air	0.89122585
7	ANA Group	0.98771017
8	British Airways	0.98969709
9	Cathay Pacific Group	0.98771244
10	Cebu Pacific Air	0.87509292
11	China Eastern Airlines	0.98788146
12	China Southern Air Holding	0.98934628
13	Copa Holdings	0.82299316
14	Delta airlines	0.99539142
15	EasyJet PLC	0.97261506
16	Emirates Group	0.9891488
17	Ethiopian	0.93706983
18	Garuda Indonesia	0.96110809
19	Grupo Aeromexico	0.92297137
20	IAG	0.99373887
21	Jet Airways	0.96059211
22	JetBlue Airways	0.9681534
23	Kenya Airways	0.90374186
24	LATAM Airlines	0.98398638
25	Lufthansa group	0.99593988
26	Norwegian	0.9457542
27	Qantas Group	0.98863665
28	Ryanair	0.97543699
29	Singapore Airlines	0.98427736
30	South African Airways	0.95105431
31	Southwest Airlines Co.	0.98959377
32	Sprit airlines	0.87650285
33	Turkish Airlines	0.97969602
34	United-Continental Holdings	0.99559332
35	Virgin Australia	0.9597253
36	WestJet	0.95631897
	mean efficiency	**0.949754**

4.2.5 SFA and OLS Result of the Study for the Year 2010

The table 79 below summarise the Ordinary Least Squares (OLS). The estimates of the function result are obtained using the program FRONTIER 41 (Version 4.1c) based on Error Components Frontier (see B&C 1992). Production function model is selected and applied. All β estimators with the exception of the intercept are unbiased. The OLS estimates, the estimates after the grid search and the final maximum likelihood estimate are presented in the output table. Approximate standard errors are taken from the direction matrix used in the iteration of the Davidon-Fletcher-Powell procedure. The final results indicate the Beta value, Coefficient, approximate standards errors, t-ratios, individual and mean technical efficiency estimates. This estimate of the covariance matrix is also listed in the output. Estimates of individual technical efficiency are calculated using the expression presented in Battese and Coelli (1992). When any estimates of mean efficiency are reported, these are simply the arithmetic averages of the individual efficiencies in the output file by changing it is value from 1 to 0. When we look at the first row for the result of Beta zero, we read 832.39789 coefficients, 620.18228 standard-errors and 1.3421826 t-ratios. The list of the rest OLS result continues till beta 7. The sigma-squared and log likelihood function are 3526664.1 and -353.81193 respectively.

Table 79 Summary of the OLS Estimate for the Year 2010

	coefficient	standard-error	t-ratio
beta 0	832.39789	620.18228	1.3421826
beta 1	0.35556124	0.89625575	0.39671851
beta 2	-26.382796	73.934938	-0.356838
beta 3	-41.555629	50.931538	-0.81591151
beta 4	33.097495	20.269107	1.6329035
beta 5	0.056230857	0.00860328	6.5359787
beta 6	0.17684961	0.1931843	0.91544507
beta 7	1.0607105	0.094795523	11.189458
sigma-squared	3526664.1		
log likelihood function =	-353.81193		

Table 80 below shows the relative technical efficiency of world airlines using SFA model of Frontier 4.1 version. The technical efficiency scores 1.00 means the firm is 100% efficient and less than 1.00 means the firm is less efficient.

Among 40 sample airlines in 2010, none of them scored 1.00 technical efficiency score. 35 out of 40 airlines scored between 0.8 and 0.99. Seven airlines scored below 0.8 point. Cebu Pacific Air scored 0.522 far behind the benchmarking and the mean technical efficiency. Delta Airlines, IAG and Lufthansa Group are the three highest technical efficient airlines 0.990, 0.989 and 0.992 respectively in 2010 in the world.

Table 80 Summary Technical Efficiency Estimation of SFA for the Year 2010

	Airlines	eff.-est.
1	Aer Lingus	0.86840723
2	Aeroflot	0.92572033
3	Air Canada	0.96689053
4	Air china	0.97608167
5	Air New Zealand Group	0.92701411
6	AirAsia	0.77188637
7	Allegiant Air	0.73164017
8	Cathay Pacific Group	0.97315773
9	Cebu Pacific Air	0.52191037
10	China Eastern Airlines	0.97409463
11	Copa Holdings	0.71516686
12	Delta airlines	0.99018219
13	EasyJet PLC	0.95661877
14	Egyptair	0.94662103
15	El Al	0.88051729
16	Emirates Group	0.97637405
17	Ethiopian	0.81000976
18	Garuda Indonesia	0.90180329
19	Grupo Aeromexico	0.77255937
20	Hawaiian Airlines	0.78215619
21	IAG	0.98797416
22	Jet2	0.80948589
23	JetBlue Airways	0.9224712
24	Kenya Airways	0.82772509
25	Korean Air	0.96804367
26	LATAM Airlines	0.8958544
27	Lufthansa group	0.99198667
28	Malaysia Airlines	0.93749114
29	Norwegian	0.88584842
30	Qantas Group	0.97675464
31	Ryanair	0.95410191
32	Singapore Airlines	0.96517288
33	SkyWest, Inc	0.9342137
34	South African Airways	0.9060541
35	Southwest Airlines Co.	0.97318469
36	Sprit airlines	0.77588185
37	Turkish Airlines	0.95105429
38	United-Continental Holdings	0.98773899
39	Virgin Australia	0.92065635
40	WestJet	0.91272483
	mean efficiency	0.89633077

4.2.6 SFA and OLS Result of the Study for the Year 2009

The table 81 below summarise the Ordinary Least Squares (OLS). The estimates of the function result are obtained using the program FRONTIER 41 (Version 4.1c) based on Error Components Frontier (see B&C 1992). Production function model is selected and applied. All β estimators with the exception of the intercept are unbiased. The OLS estimates, the estimates after the grid search and the final maximum likelihood estimate are presented in the output table. Approximate standard errors are taken from the direction matrix used in the iteration of the Davidon-Fletcher-Powell procedure.

The final results indicate the Beta value, Coefficient, approximate standards errors, t-ratios, individual and mean technical efficiency estimates. This estimate of the covariance matrix is also listed in the output. Estimates of individual technical efficiency are calculated using the expression presented in Battese and Coelli (1992). When any estimates of mean efficiency are reported, these are simply the arithmetic averages of the individual efficiencies in the output file by changing it is value from 1 to 0. When we look at the first row for the result of Beta zero, we read -53.358499 coefficients, 503.14235 standard-errors and -0.1060505 t-ratios. The list of the rest OLS result continues till beta 7. The sigma-squared and log likelihood function are 865856.41 and 234.70538 respectively.

Table 81 Summary of the OLS Estimate for the Year 2009

	coefficient	standard-error	t-ratio
beta 0	-53.358499	503.14235	-0.1060505
beta 1	-0.68085827	1.3682175	-0.4976243
beta 2	10.109195	81.583222	0.12391267
beta 3	-12.191694	59.696913	-0.20422654
beta 4	29.625659	14.385075	2.059472
beta 5	0.03360074	0.010114614	3.3219993
beta 6	1.6876525	0.32953856	5.1212596
beta 7	0.61556833	0.45647714	1.3485195
sigma-squared	865856.41		
log likelihood function =	-234.70538		

Table 82 below shows the relative technical efficiency of world airlines using SFA model of Frontier 4.1 version. The technical efficiency scores 1.00 means the firm is 100% efficient and less than 1.00 means the firm is less efficient. Among 29 sample airlines in 2009, none of them scored 1.00 technical efficiency score. 14 airlines scored between 0.8 and 0.99. Fifteen airlines scored below 0.8 point. LATAM airlines scored the lowest of all time which is 0.0009 score point followed by AirAsia, Allegiant Air and Cebu Pacific Air score of 0.375, 0.382 and 0.303 respectively. Ethiopian airlines belong to the lower score group of technical efficiency score of 0.511 which is far behind the benchmarking and the mean technical efficiency. Egyptair and Singapore Airlines are the highest technical efficiency scorer of in 2009 (0.99 and 0.999) respectively.

Table 82 Summary Technical Efficiency Estimation of SFA for the Year 2009

Frontier technical efficiency estimates

	Airlines	eff.-est.
1	Aegean Airlines Group	0.53171719
2	Aeroflot	0.93459252
3	Air china	0.88467201
4	Air New Zealand Group	0.98782428
5	AirAsia	0.37511499
6	Allegiant Air	0.38187177
7	Cathay Pacific Group	0.96709869
8	Cebu Pacific Air	0.30290098
9	China Eastern Airlines	0.69447766
10	Copa Holdings	0.88157228
11	EasyJet PLC	0.64753219
12	Egyptair	0.99895342
13	Emirates Group	0.91536229
14	Ethiopian	0.51068633
15	Garuda Indonesia	0.6064124
16	Hawaiian Airlines	0.70397622
17	JetBlue Airways	0.84126729
18	LATAM Airlines	0.000909027
19	Malaysia Airlines	0.72505469
20	Norwegian	0.5462917
21	Qantas Group	0.98350119
22	Republic Airways Holdings	0.61359658
23	Singapore Airlines	0.99993897
24	SkyWest, Inc	0.67261094
25	South African Airways	0.82993897
26	Southwest Airlines Co.	0.97601167
27	TAP Portugal	0.95169917
28	Turkish Airlines	0.94744536
29	WestJet	0.64115783
	mean efficiency	0.7260065

4.2.7 SFA and OLS Result of the Study for the Year 2008

The table 83 below summarise the Ordinary Least Squares (OLS). The estimates of the function result are obtained using the program FRONTIER 41 (Version 4.1c) based on Error Components Frontier (see B&C 1992). Production function model is selected and applied. All β estimators with the exception of the intercept are unbiased. The OLS estimates, the estimates after the grid search and the final maximum likelihood estimate are presented in the output table. Approximate standard errors are taken from the direction matrix used in the iteration of the Davidon-Fletcher-Powell procedure.

The final results indicate the Beta value, Coefficient, approximate standards errors, t-ratios, individual and mean technical efficiency estimates. This estimate of the covariance matrix is also listed in the output. Estimates of individual technical efficiency are calculated using the expression presented in Battese and Coelli (1992). When any estimates of mean efficiency are reported, these are simply the arithmetic averages of the individual efficiencies in the output file by changing it is value from 1 to 0. When we look at the first row for the result of Beta zero, we read -1867.7795 coefficients, 1971.7592 standard-errors and --0.94726553 t-ratios. The list of the rest OLS result continues till beta 7. The sigma-squared and log likelihood function are 16470338 and -277.41654 respectively.

Table 83 Summary of the OLS Estimates for the Year 2008

	coefficient	standard-error	t-ratio
beta 0	-1867.7795	1971.7592	-0.94726553
beta 1	-6.2286103	4.8320751	-1.2890136
beta 2	1051.5425	536.82856	1.9588051
beta 3	-653.54889	359.86697	-1.8160847
beta 4	113.67867	64.74131	1.7558908
beta 5	0.15296264	0.060355067	2.5343794
beta 6	-0.58769627	2.0550608	-0.28597513
beta 7	1.249376	0.50697771	2.4643607
sigma-squared	16470338		
log likelihood function =	-277.41654		

Table 84 below shows the relative technical efficiency of world airlines using SFA model of Frontier 4.1 Version. The technical efficiency scores 1.00 means the firm is 100% efficient and less than 1.00 means the firm is less efficient.

Among 29 sample airlines in 2008, none of them scored 1.00 technical efficiency score. 22 airlines scored between 0.8 and 0.99. Seven airlines scored below 0.8 point. Kenya Airways, Turkish Airlines, and Norwegian Air are the lowest score of 2008 (0.356, 0.662 and 0.631) respectively. Air France KLM and Lufthansa Group are the two highest technical efficient airlines 0.987and 0.987 respectively in 2008 in the world.

Table 84 Summary Technical Efficiency Estimation of SFA for the Year 2008

	Airlines	eff.-est.
1	Aegean Airlines Group	0.9013173
2	Aeroflot	0.8956345
3	Air France klm	0.98689911
4	Air New Zealand Group	0.92711922
5	Allegiant Air	0.84853841
6	ANA Group	0.96199976
7	British Airways	0.97117716
8	Copa Holdings	0.76825503
9	EasyJet PLC	0.91598638
10	Egyptair	0.89748354
11	Emirates Group	0.96128907
12	Ethiopian	0.781942
13	Garuda Indonesia	0.93412462
14	Hawaiian Airlines	0.72653391
15	Japan Airlines	0.97664905
16	Kenya Airways	0.35612428
17	LATAM Airlines	0.85870899
18	Lufthansa group	0.98731235
19	Malaysia Airlines	0.92512123
20	Norwegian	0.63063158
21	Qantas Group	0.96729801
22	Republic Airways Holdings	0.75015082
23	Ryanair	0.90317754
24	Singapore Airlines	0.96201911
25	SkyWest, Inc	0.92727507
26	Southwest Airlines Co.	0.96448836
27	Turkish Airlines	0.66227183
28	Virgin Australia	0.85336228
29	WestJet	0.89972549
	mean efficiency	**0.86560745**

4.2.8 SFA and OLS Result of the Study for the Year 2007

The table 85 below summarise the Ordinary Least Squares (OLS). The estimates of the function result are obtained using the program FRONTIER 41 (Version 4.1c) based on Error Components Frontier (see B&C 1992). Production function model is selected and applied. All β estimators with the exception of the intercept are unbiased. The OLS estimates, the estimates after the grid search and the final maximum likelihood estimate are presented in the output table. Approximate standard errors are taken from the direction matrix used in the iteration of the Davidon-Fletcher-Powell procedure.

The final results indicate the Beta value, Coefficient, approximate standards errors, t-ratios, individual and mean technical efficiency estimates. This estimate of the covariance matrix is also listed in the output. Estimates of individual technical efficiency are calculated using the expression presented in Battese and Coelli (1992). When any estimates of mean efficiency are reported, these are simply the arithmetic averages of the individual efficiencies in the output file by changing it is value from 1 to 0. When we look at the first row for the result of Beta zero, we read 3408.3513 coefficients, 2470.4745 standard-errors and --1.3796343 t-ratios. The list of the rest OLS result continues till beta 7. The sigma-squared and log likelihood function are 45865202 and -435.87471 respectively.

Table 85 Summary of OLS Estimate for the Year 2007

	coefficient	standard-error	t-ratio
beta 0	3408.3513	2470.4745	1.3796343
beta 1	3.3761002	7.2002745	0.46888493
beta 2	-41.698581	483.75832	-0.086197134
beta 3	-248.21639	388.00579	-0.63972342
beta 4	-1.9226642	17.884122	-0.10750677
beta 5	0.033199121	0.051553467	0.64397455
beta 6	1.4896468	2.7484243	0.54200028
beta 7	0.57578781	0.63942552	0.90047674
sigma-squared	45865202		
log likelihood function =	-435.87471		

Table 86 below shows the relative technical efficiency of world airlines using SFA model of Frontier 4.1 version. The technical efficiency scores 1.00 means the firm is 100% efficient and less than 1.00 means the firm is less efficient.

Among 43 sample airlines in 2007, one of the airlines scored 1.00 technical efficiency score. Copa Holdings is 100% efficient in 2007. Thirty six airlines scored a between 0.8 and 0.99. Allegiant Air scored 0.603 far behind the benchmark of airlines. American Airline Group and Lufthansa Group scored highest technical efficient airlines 0.970 and 0.977 in 2007 in the world.

Table 86 Technical Efficiency Estimation of SFA for the Year 2007

Table Frontier technical efficiency estimates:

	Airlines	eff.-est.
1	Aegean Airlines Group	0.7682419
2	Aer Lingus	0.74868162
3	Aeroflot	0.83684395
4	Air Berlin	0.88842952
5	Air Canada	0.92334082
6	Air china	0.92183901
7	Air France klm	0.97239152
8	Air New Zealand Group	0.87968689
9	Allegiant Air	0.60291635
10	American Airlines Group	0.97004324
11	ANA Group	0.93142303
12	British Airways	0.95569499
13	Cathay Pacific Group	0.93990296
14	China Eastern Airlines	0.91842128
15	Copa Holdings	1.000000
16	Delta airlines	0.95352245
17	EasyJet PLC	0.83502223
18	Egyptair	0.87420567
19	El Al	0.85284845
20	Emirates Group	0.93177171
21	Ethiopian	0.83296127
22	Finnair	0.83174098
23	Garuda Indonesia	0.84697313
24	Hawaiian Airlines	0.84081407
25	Jet Airways	0.86565746
26	JetBlue Airways	0.87777123
27	Kenya Airways	0.75128423
28	Korean Air	0.92931678
29	Lufthansa group	0.97658739
30	Malaysia Airlines	0.89036035
31	Norwegian	0.8191328
32	Qantas Group	0.94414702
33	Republic Airways Holdings	0.83412988
34	Ryanair	0.72565649
35	SAS Group	0.93127253
36	Singapore Airlines	0.93911447
37	SkyWest, Inc	0.87666683
38	Southwest Airlines Co.	0.92653042
39	TAP Portugal	0.86954449
40	Turkish Airlines	0.40509386
41	United-Continental Holdings	0.96495844
42	Virgin Australia	0.74407984
43	WestJet	0.85753752
	mean efficiency	**0.7582602**

4.3 Comparative Results of DEA and SFA

Table 87 Comparative Results of DEA and SFA for the Year 2014

DMU	Airlines	DEA-vrste	SFA	Regions
1	Aegean Airlines Group	**1.000**	0.8621	Europe
2	Air Canada	0.405	0.3467	N. America
3	Air china	0.529	0.4625	Asia
4	Air New Zealand Group	0.785	0.7032	Australia
5	AirAsia	1.000	0.9239	Asia
6	Allegiant Air	**1.000**	0.7855	N. America
7	American Airlines Group	1.000	**0.9774**	N. America
8	ANA Group	0.377	0.4497	Asia
9	Avianca Holdings	0.433	0.4053	Asia
10	British Airways	**1.000**	0.9646	Europe
11	Cathay Pacific Group	0.635	0.5579	Asia
12	Cebu Pacific Air	1.000	0.8762	Asia
13	China Eastern Airlines	0.535	0.4581	Asia
14	China Southern Air Holding	0.264	0.2468	Asia
15	Copa Holdings	**1.000**	0.7275	L. America
16	Delta airlines	1.000	**0.9828**	N. America
17	EasyJet PLC	**1.000**	0.9152	Europe
18	Emirates Group	**1.000**	0.9734	M. East
19	Ethiopian	1.000	0.8444	Africa
20	Hawaiian Airlines	0.994	0.8709	N. America
21	IAG	1.000	0.9780	Europe
22	Japan Airlines	**1.000**	0.9233	Asia
23	JetBlue Airways	0.872	0.8421	N. America
24	Lufthansa group	**1.000**	0.9828	Europe
25	Republic Airways Holdings	**1.000**	0.7922	N. America
26	Ryanair	**1.000**	0.9093	Europe
27	SAS Group	**1.000**	0.9406	Europe
28	Singapore Airlines	**1.000**	0.9505	Asia
29	Southwest Airlines Co.	0.977	0.9378	N. America
30	Sprit airlines	**1.000**	0.8188	N. America
31	Turkish Airlines	0.742	0.6480	Europe
32	United-Continental Holdings	1.000	**0.9816**	N. America
33	WestJet	0.680	0.5980	N. America
	mean	**0.855**	0.8160	

The above table 87 shows comparative technical efficiency result of DEA, SFA and region for the year 2014. The table contains the DMUs, DEA-variable return scale technical efficiency (vrste), SFA and regions of the airlines. Production efficiency of both DEA and SFA equals to 1 demonstrates that the DMU has achieved highest efficiency relative to other DMUs, whereas production efficiency less than 1 demonstrates the DMU to be inefficient relative to other DMUs. There are about 33 DMUs of the samples. Both DEA and SFA efficiency result ranges between 0 and 1. Here is the SFA result is less than the result of DEA scores.

Table 87 reveals that 20 DMUs had excellent performance of DEA scores out of 33 sample airlines. However, 13 airlines are less inefficient which needs improvement according to the operating mode of other airlines. All results of the SFA are less than 1.000 and it is also less than the result of DEA technical efficiency. The first DMU is Aegean Airlines Group and it scores 1.000 DEA vrste and 0.8621 SFA technical efficiency result and it is located in European regions.

The second row of DMU is Air Canada which belongs to North America region; and has 0.405 and 0.3467 technical efficiency results of DEA and SFA respectively. The result of both DEA and SFA for these particular airlines indicates that it very inefficient which is below less than 50 percent technical efficiency. This airlines need to work hard to attain the efficiency.

There are about 20 DMUs score highest points of technical efficiency for both DEA and SFA though the relative efficiency between the two models differs slightly. The major difference between the two models is the result technical efficiency of DEA model is greater than the technical efficiency of SFA model. However, 13 sample airlines are less inefficient which generally less than 1.00 which needs improvement.

From Africa region, the 19th DMU in the samples is the Ethiopian airlines which scores 1.00 and 0.8444 technical efficiency result of DEA and SFA model respectively. Both relative technical efficiency results of the airline is higher while the SFA is less than 1.00. Finally, the Singapore Airlines which is found in the Asia region and it is the 28th DMU; relatively scores the highest relative efficiency. Likewise Ethiopian airlines, the Singapore Airlines has 1.000 and 0.9505 technical efficiency of DEA and SFA result. From the DEA model perspective, this airline is efficient because it is 100 percent efficient. From the SFA model perspective, the airline is less than 100 percent efficient still it maintains the highest relative efficient.

Table 88 Comparative Results of DEA & SFA for the Year 2013

DMU	Airlines	DEA-vrste	SFA	Regions
1	Aegean Airlines Group	1.000	0.8890	Europe
2	Aer Lingus	1.000	0.8945	Europe
3	Aeroflot	1.000	0.9776	Europe
4	Air Canada	1.000	0.9843	N. America
5	Air china	0.906	0.8885	Asia
6	Air New Zealand Group	0.997	0.9555	Australia
7	AirAsia	1.000	0.8991	Asia
8	Allegiant Air	1.000	0.8742	N. America
9	ANA Group	1.000	0.9867	Asia
10	Avianca Holdings	0.881	0.8601	L. America
11	British Airways	1.000	0.9897	Europe
12	Cathay Pacific Group	0.958	0.8859	Asia
13	Cebu Pacific Air	1.000	0.8989	Asia
14	China Eastern Airlines	0.799	0.7873	Asia
15	China Southern Air Holding	0.733	0.6884	Asia
16	Copa Holdings	1.000	0.9373	L. America
17	Delta airlines	1.000	0.9950	N. America
18	EasyJet PLC	1.000	0.9729	Europe
19	El Al	1.000	0.9230	M. East
20	Emirates Group	1.000	0.9911	M. East
21	Ethiopian	1.000	0.9271	Africa
22	Finnair	0.983	0.9466	Europe
23	Garuda Indonesia	0.721	0.6599	Asia
24	Hawaiian Airlines	1.000	0.9253	N. America
25	IAG	1.000	0.9937	Europe
26	Japan Airlines	1.000	0.9847	Asia
27	JetBlue Airways	0.959	0.8683	N. America
28	Lufthansa group	1.000	0.9953	Europe
29	Norwegian	1.000	0.9432	Europe
30	Qantas Group	1.000	0.9878	Australia
31	Republic Airways Holdings	1.000	0.8463	N. America
32	Ryanair	1.000	0.9748	Europe
33	Singapore Airlines	1.000	0.9851	Asia
34	SkyWest, Inc	1.000	0.9340	N. America
35	Southwest Airlines Co.	1.000	0.9896	N. America
36	Sprit airlines	1.000	0.9299	N. America
37	Turkish Airlines	0.727	0.6821	Europe
38	United-Continental Holdings	1.000	0.9954	N. America
39	WestJet	0.793	0.7530	N. America
	mean	0.958	0.8564	

The above table 88 shows comparative technical efficiency result of DEA, SFA and regions for the year 2013. The table contains the DMUs, DEA-variable return scale technical efficiency (vrste), SFA and regions of the airlines. Production efficiency of both DEA and SFA equals to 1 demonstrates that the DMU has achieved highest efficiency relative to other DMUs, whereas production efficiency less than 1.00 demonstrates the DMU to be inefficient relative to other DMUs. There are about 39 DMUs of the samples. Both DEA and SFA efficiency result ranges between 0 and 1. Here is the SFA result is less than the result of DEA scores.

Table 88 reveals that 28 DMUs had excellent performance of DEA scores out of 39 sample airlines. However, 11 airlines are less inefficient which needs improvement according to the operating mode of other airlines. All results of the SFA are less than 1.000 and it is also less than the result of DEA technical efficiency. The first DMU is Aegean Airlines Group and it scores 1.000 DEA vrste and 0.889 SFA technical efficiency result and it is located in European regions.

The 23th row of DMU is Garuda Indonesia which belongs to Asia region; and has 0.721 and 0.6599 technical efficiency results of DEA and SFA respectively. The result of both DEA and SFA for these particular airlines indicates that it very inefficient and these airlines need to work hard to attain the efficiency.

There are about 28 DMUs score highest points of technical efficiency for both DEA and SFA though the relative efficiency between the two models differs slightly. The major difference between the two models is the result technical efficiency of DEA model is greater than the technical efficiency of SFA model. However, 11 sample airlines are less inefficient which generally less than 1.00 which needs improvement.

From Africa region, the 21th DMU in the samples is the Ethiopian airlines which scores 1.00 and 0.9271 technical efficiency result of DEA and SFA model respectively. Both relative technical efficiency results of the airline are higher while the SFA is less than 1.00. Finally, the WestJet Airlines which is found in the North America region and it is the 39th DMU; relatively scores the lower relative efficiency. Unlike the Ethiopian airlines, the WestJet Airlines has 0.793 and 0.7530 technical efficiency of DEA and SFA result. From both DEA and SFA model perspective, this airline is inefficient because it is less than 100 percent efficient.

Table 89 Comparative Results of DEA & SFA for the Year 2012

DMU	**Airlines**	DEA-vrste	SFA	Regions
1	Aer Lingus	**1.000**	0.9022	Europe
2	Aeroflot	**1.000**	0.9688	Europe
3	Air Berlin	**1.000**	0.9559	Europe
4	Air Canada	**1.000**	0.9799	N. America
5	Air china	1.000	0.9859	Asia
6	Air New Zealand Group	0.951	0.9444	Australia
7	AirAsia	**1.000**	0.9108	Asia
8	Allegiant Air	**1.000**	0.7711	N. America
9	ANA Group	**1.000**	0.9851	Asia
10	Avianca Holdings	0.785	0.7510	L. America
11	British Airways	**1.000**	0.9866	Europe
12	Cathay Pacific Group	**1.000**	0.9824	Asia
13	Cebu Pacific Air	**1.000**	0.1034	Asia
14	China Eastern Airlines	1.000	0.9835	Asia
15	China Southern Air Holding	0.901	0.8858	Asia
16	Copa Holdings	**1.000**	0.8514	L. America
17	Delta airlines	**1.000**	**0.9939**	N. America
18	EasyJet PLC	**1.000**	0.9655	Europe
19	Emirates Group	**1.000**	**0.9867**	M. East
20	Ethiopian	**1.000**	0.9287	Africa
21	Finnair	0.955	0.9350	Europe
22	Garuda Indonesia	1.000	0.9448	Asia
23	Hawaiian Airlines	1.000	0.9107	N. America
24	Japan Airlines	**1.000**	0.9848	Asia
25	JetBlue Airways	0.994	0.9593	N. America
26	Kenya Airways	**1.000**	0.8952	Africa
27	Korean Air	**1.000**	0.9807	Asia
28	LATAM Airlines	**1.000**	0.9811	L. America
29	Lufthansa group	**1.000**	**0.9939**	Europe
30	Norwegian	**1.000**	0.9199	Europe
31	Republic Airways Holdings	**1.000**	0.8998	N. America
32	Ryanair	**1.000**	0.9692	Europe
33	Singapore Airlines	**1.000**	0.9789	Asia
34	SkyWest, Inc	**1.000**	0.9401	N. America
35	Southwest Airlines Co.	**1.000**	0.9867	N. America
36	Sprit airlines	**1.000**	0.8132	N. America
37	Turkish Airlines	0.758	0.6945	Europe
38	Virgin Australia	0.841	0.8405	Australia
39	WestJet	0.825	0.8091	N. America
	mean	**0.977**	0.9250	

The above table 89 shows comparative technical efficiency result of DEA and SFA for the year 2012. The table contains the DMUs, DEA-variable return scale technical efficiency (vrste), SFA and regions of the airlines. Production efficiency of both DEA and SFA equals to 1 demonstrates that the DMU has achieved highest efficiency relative to other DMUs, whereas production efficiency less than 1 demonstrates the DMU to be inefficient relative to other DMUs. There are about 39 DMUs of the samples. Both DEA and SFA efficiency result ranges between 0 and 1. Here is the SFA result is less than the result of DEA scores.

Table 89 reveals that 33 DMUs had excellent performance of DEA scores out of 39 sample airlines. However, 6 airlines are less inefficient which needs improvement according to the operating mode of other airlines. All results of the SFA are less than 1.000 and it is also less than the result of DEA technical efficiency. The first DMU is Aer Lingus Group and it scores 1.000 DEA vrste and 0.9022 SFA technical efficiency result and it is located in European regions.

The 10th row of DMU is Avianca Holdings which belongs to Latin America region; and has 0.785 and 0.7510 technical efficiency results of DEA and SFA respectively. The result of both DEA and SFA for these particular airlines indicates that it very inefficient which need to work hard to attain the efficiency.

There are about 31 DMUs score highest points of technical efficiency for both DEA and SFA though the relative efficiency between the two models differs slightly. The major difference between the two models is the result technical efficiency of DEA model is greater than the technical efficiency of SFA model. However, 8 sample airlines are less inefficient which generally less than 1.00 which needs improvement.

From Africa region, the 20th DMU in the samples is the Ethiopian airlines which scores 1.00 and 0.9287 technical efficiency result of DEA and SFA model respectively. Both relative technical efficiency results of the particular airline are higher while the SFA is less than 1.00. Finally, the Lufthansa group Airlines which is found in the Asia region and it is the 29th DMU; relatively scores the highest relative efficiency. Likewise Ethiopian airlines, the Lufthansa group Airlines has 1.000 and 0.9939 technical efficiency of DEA and SFA result. From the DEA model perspective, this airline is efficient because it is 100 percent efficient. From the SFA model perspective, the airline is less than 100 percent efficient still it maintains the highest relative efficient.

Table 90 Comparative Results of DEA & SFA for the Year 2011

DMU	**Airlines**	**DEA-vrste**	**SFA**	**Regions**
1	Aer Lingus	**1.000**	0.9051	Europe
2	Aeroflot	**1.000**	0.9646	Europe
3	Air china	**1.000**	0.9895	Asia
4	Air New Zealand Group	**1.000**	0.9632	Australia
5	AirAsia	0.889	0.6500	Asia
6	Allegiant Air	**1.000**	0.8912	N. America
7	ANA Group	**1.000**	0.9877	Asia
8	British Airways	**1.000**	0.9897	Europe
9	Cathay Pacific Group	**1.000**	0.9877	Asia
10	Cebu Pacific Air	1.000	0.8751	Asia
11	China Eastern Airlines	**1.000**	0.9879	Asia
12	China Southern Air Holding	**1.000**	0.9893	Asia
13	Copa Holdings	**1.000**	0.8230	L. America
14	Delta airlines	**1.000**	**0.9954**	N. America
15	EasyJet PLC	**1.000**	0.9726	Europe
16	Emirates Group	1.000	0.9891	M. East
17	Ethiopian	**1.000**	0.9371	Africa
18	Garuda Indonesia	0.962	0.9611	Asia
19	Grupo Aeromexico	**1.000**	0.9230	L. America
20	IAG	**1.000**	**0.9937**	Europe
21	Jet Airways	**1.000**	0.9606	Asia
22	JetBlue Airways	1.000	0.9682	N. America
23	Kenya Airways	**1.000**	0.9037	Africa
24	LATAM Airlines	1.000	0.9840	L. America
25	Lufthansa group	**1.000**	**0.9959**	Europe
26	Norwegian	**1.000**	0.9458	Europe
27	Qantas Group	0.953	0.9386	Australia
28	Ryanair	1.000	0.9754	Europe
29	Singapore Airlines	1.000	0.9843	Asia
30	South African Airways	1.000	0.9511	Africa
31	Southwest Airlines Co.	**1.000**	0.9896	N. America
32	Sprit airlines	**1.000**	0.8765	N. America
33	Turkish Airlines	**1.000**	0.9797	Europe
34	United-Continental Holdings	**1.000**	**0.9956**	N. America
35	Virgin Australia	**1.000**	0.9597	Australia
36	WestJet	**1.000**	0.9563	N. America
	mean	0.995	0.9498	

The above table 90 shows comparative technical efficiency result of DEA and SFA for the year 2011. The table contains the DMUs, DEA-variable return scale technical efficiency (vrste), SFA and regions of the airlines. Production efficiency of both DEA and SFA equals to 1 demonstrates that the DMU has achieved highest efficiency relative to other DMUs, whereas production efficiency less than 1 demonstrates the DMU to be inefficient relative to other DMUs. There are about 36 DMUs of the samples. Both DEA and SFA efficiency result ranges between 0 and 1. Here is the SFA result is less than the result of DEA scores.

Table 90 reveals that 33 DMUs had excellent performance of DEA scores out of 36 sample airlines. However, 3 airlines are less inefficient which needs improvement according to the operating mode of other airlines. All results of the SFA are less than 1.000 and it is also less than the result of DEA technical efficiency. The first DMU is Aer Lingus Airlines and it scores 1.000 DEA vrste and 0.9051 SFA technical efficiency result and it is located in European regions.

The 5th row of DMU is AirAsia which belongs to Asia region; and has 0.889 and 0.6500 technical efficiency results of DEA and SFA respectively. The result of both DEA and SFA for these particular airlines indicates that it less efficient which is below less than 100 percent technical efficiency. This airlines need to work hard to attain the efficiency.

There are about 33 DMUs score highest points of technical efficiency for both DEA and SFA though the relative efficiency between the two models differs slightly. The major difference between the two models is the result technical efficiency of DEA model is greater than the technical efficiency of SFA model. However, 13 sample airlines are less inefficient which generally less than 1.00 which needs improvement.

From Africa region, the 17th DMU in the samples is the Ethiopian airlines which scores 1.00 and 0.9371 technical efficiency result of DEA and SFA model respectively. Both relative technical efficiency results of the airline is higher while the SFA is less than 1.00. Finally, the Qantas Group Airlines which is found in the Australia region and it is the 27th DMU; relatively scores the highest relative efficiency. Likewise Ethiopian airlines, the Qantas Group Airlines has 0.953 and 0.9386 technical efficiency of DEA and SFA result. From the DEA model perspective, this airline is efficient because it is below 100 percent efficient. From the SFA model perspective, the airline is also less than 100 percent efficient still it maintains the highest relative efficient.

Table 91 Comparative Results of DEA & SFA for the Year 2010

DMU	**Airlines**	**DEA-vrste**	**SFA**	**Regions**
1	Aer Lingus	**1.000**	0.8684	Europe
2	Aeroflot	**1.000**	0.9257	Europe
3	Air Canada	**1.000**	0.9669	N. America
4	Air china	**1.000**	0.9761	Asia
5	Air New Zealand Group	0.889	0.8270	Australia
6	AirAsia	**1.000**	0.7719	Asia
7	Allegiant Air	**1.000**	0.7316	N. America
8	Cathay Pacific Group	**1.000**	0.9732	Asia
9	Cebu Pacific Air	**1.000**	0.5219	Asia
10	China Eastern Airlines	1.000	0.9741	Asia
11	Copa Holdings	**1.000**	0.7152	L. America
12	Delta airlines	**1.000**	**0.9902**	N. America
13	EasyJet PLC	**1.000**	0.9566	Europe
14	Egyptair	**1.000**	0.9466	Africa
15	El Al	**1.000**	0.8805	M. East
16	Emirates Group	1.000	0.9764	M. East
17	Ethiopian	**1.000**	0.8100	Africa
18	Garuda Indonesia	0.962	0.9018	Asia
19	Grupo Aeromexico	**1.000**	0.7726	L. America
20	Hawaiian Airlines	**1.000**	0.7822	N. America
21	IAG	**1.000**	**0.9880**	Europe
22	Jet2	1.000	0.8095	Asia
23	JetBlue Airways	**1.000**	0.9225	N. America
24	Kenya Airways	1.000	0.8277	Africa
25	Korean Air	**1.000**	0.9680	Asia
26	LATAM Airlines	**1.000**	0.8959	L. America
27	Lufthansa group	**1.000**	**0.9920**	Europe
28	Malaysia Airlines	0.953	0.9375	Asia
29	Norwegian	1.000	0.8858	Europe
30	Qantas Group	1.000	0.9768	Australia
31	Ryanair	**1.000**	0.9541	Europe
32	Singapore Airlines	**1.000**	0.9652	Asia
33	SkyWest, Inc	**1.000**	0.9342	N. America
34	South African Airways	**1.000**	0.9061	Africa
35	Southwest Airlines Co.	**1.000**	0.9732	N. America
36	Sprit airlines	**1.000**	0.7759	N. America
37	**Turkish Airlines**	0.864	0.8511	Europe
38	United-Continental Holdings	**1.000**	0.9877	N. America
39	Virgin Australia	0.963	0.9207	Australia
40	WestJet	**1.000**	0.9127	N. America
	Mean	**0.991**	0.8963	

The above table 91 shows comparative technical efficiency result of DEA and SFA for the year 2010. The table contains the DMUs, DEA-variable return scale technical efficiency (vrste), SFA and regions of the airlines. Production efficiency of both DEA and SFA equals to 1 demonstrates that the DMU has achieved highest efficiency relative to other DMUs, whereas production efficiency less than 1 demonstrates the DMU to be inefficient relative to other DMUs. There are about 40 DMUs of the samples. Both DEA and SFA efficiency result ranges between 0 and 1. Here is the SFA result is less than the result of DEA scores.

Table 91 reveals that 35 DMUs had excellent performance of DEA scores out of 40 sample airlines. However, 6 airlines are less inefficient which needs improvement according to the operating mode of other airlines. All results of the SFA are less than 1.000 and it is also less than the result of DEA technical efficiency. The second DMU is Aeroflot Airlines Group and it scores 1.000 DEA vrste and 0.9257 SFA technical efficiency result and it is located in European regions.

The 5th row of DMU is Air New Zealand Group which belongs to Australia region; and has 0.889and 0.8270 technical efficiency results of DEA and SFA respectively. The result of both DEA and SFA for these particular airlines indicates that it less efficient which is below less than 100 percent technical efficiency. This airlines need to work hard to attain the efficiency.

There are about 35 DMUs score highest points of technical efficiency for both DEA and SFA though the relative efficiency between the two models differs slightly. The major difference between the two models is the result technical efficiency of DEA model is greater than the technical efficiency of SFA model. However, 5 sample airlines are less inefficient which generally less than 1.00 which needs improvement.

From Africa region, the 17th DMU in the samples is the Ethiopian airlines which scores 1.00 and 0.8100 technical efficiency result of DEA and SFA model respectively. Both relative technical efficiency results of the airline is higher while the SFA is less than 1.00. Finally, the United-Continental Holdings Airlines which is found in the North America region and it is the 38th DMU; relatively scores the highest relative efficiency. Likewise Ethiopian airlines, the United-Continental Holding Airlines has 1.000 and 0.9877 technical efficiency of DEA and SFA result. From the DEA model perspective, this airline is efficient because it is 100 percent efficient.

From the SFA model perspective, the airline is less than 100 percent efficient still it maintains the highest relative efficient.

Table 92 Comparative Results of DEA & SFA for the Year 2009

DMU	**Airlines**	DEA-vrste	SFA	Regions
1	Aegean Airlines Group	**1.000**	0.5317	Europe
2	Aeroflot	**1.000**	0.9346	Europe
3	Air china	1.000	0.8847	Asia
4	Air New Zealand Group	**1.000**	0.9878	Australia
5	AirAsia	**1.000**	0.3751	Asia
6	Allegiant Air	**1.000**	0.3819	N. America
7	Cathay Pacific Group	**1.000**	0.9671	Asia
8	Cebu Pacific Air	**1.000**	0.3029	Asia
9	China Eastern Airlines	0.912	0.6945	Asia
10	Copa Holdings	**1.000**	0.8816	L. America
11	EasyJet PLC	**1.000**	0.6475	Europe
12	Egyptair	**1.000**	**0.9990**	Africa
13	Emirates Group	**1.000**	0.9154	M. East
14	Ethiopian	**1.000**	0.5107	Africa
15	Garuda Indonesia	**1.000**	0.6064	Asia
16	Hawaiian Airlines	**1.000**	0.7040	N. America
17	JetBlue Airways	**1.000**	0.8413	N. America
18	LATAM Airlines	**1.000**	0.0009	L. America
19	Malaysia Airlines	0.890	0.7251	Asia
20	Norwegian	**1.000**	0.5463	Europe
21	Qantas Group	1.000	0.9835	Australia
22	Republic Airways Holdings	**1.000**	0.6136	N. America
23	Singapore Airlines	**1.000**	**0.9999**	Asia
24	SkyWest, Inc	**1.000**	0.6726	N. America
25	South African Airways	**1.000**	0.8299	Africa
26	Southwest Airlines Co.	**1.000**	0.9760	N. America
27	TAP Portugal	**1.000**	0.9517	Europe
28	Turkish Airlines	1.000	0.9474	Europe
29	WestJet	0.983	0.6412	N. America
	Mean	**0.983**	0.7260	

The above table 92 shows comparative technical efficiency result of DEA and SFA for the year 2009. The table contains the DMUs, DEA-variable return scale technical efficiency (vrste), SFA and regions of the airlines. Production efficiency of both DEA and SFA equals to 1 demonstrates that the DMU has achieved highest efficiency relative to other DMUs, whereas production efficiency less than 1 demonstrates the DMU to be inefficient relative to other DMUs. There are about 29 DMUs of the samples. Both DEA and SFA efficiency result ranges between 0 and 1. Here is the SFA result is less than the result of DEA scores.

Table 92 reveals that 26 DMUs had excellent performance of DEA scores out of 29 sample airlines. However, 3 airlines are less inefficient which needs improvement according to the operating mode of other airlines. All results of the SFA are less than 1.000 and it is also less than the result of DEA technical efficiency. The first DMU is Aegean Airlines Group and it scores 1.000 DEA vrste and 0.5317 SFA technical efficiency result and it is located in European regions.

The 9th row of DMU is China Eastern Airlines which belongs to Asia region; and has 0.912 and 0.6945 technical efficiency results of DEA and SFA respectively. The result of both DEA and SFA for these particular airlines indicates that it very inefficient which is below less than 100 percent technical efficiency. This airlines need to work hard to attain the efficiency.

There are about 26 DMUs score highest points of technical efficiency for both DEA and SFA though the relative efficiency between the two models differs slightly. The major difference between the two models is the result technical efficiency of DEA model is greater than the technical efficiency of SFA model. However, 3 sample airlines are less inefficient which generally less than 1.00 which needs improvement.

From Africa region, the 19th DMU in the samples is the Ethiopian airlines which scores 1.00 and 0.5107 technical efficiency result of DEA and SFA model respectively. The SFA result for Ethiopian Airlines is much less than the DEA result. Both relative technical efficiency results of the airline are higher while the SFA is less than 1.00. Finally, the Malaysia Airlines which is found in the Asia region and it is the 19th DMU; relatively scores the highest relative efficiency. Likewise Ethiopian airlines, the Malaysia Airlines has 0.890 and 0.7251 technical efficiency of DEA and SFA result. From the DEA model perspective, this airline is less efficient than the Ethiopian Airlines because it is below 100 percent efficient. From the SFA model perspective, the airline is less than 100 percent efficient still it maintains the highest relative efficient.

Table 93 Comparative Results of DEA & SFA for the Year 2008

DMU	Airlines	DEA-vrste	DEA	Regions
1	Aegean Airlines Group	1.000	0.9013	Europe
2	Aeroflot	0.579	0.4956	Europe
3	Air France klm	1.000	0.9869	Europe
4	Air New Zealand Group	0.555	0.5271	Australia
5	Allegiant Air	1.000	0.8485	N. America
6	ANA Group	0.461	0.3620	Asia
7	British Airways	1.000	0.9712	Europe
8	Copa Holdings	1.000	0.7683	L. America
9	EasyJet PLC	1.000	0.9160	Europe
10	Egyptair	1.000	0.8975	Africa
11	Emirates Group	1.000	0.9613	M. East
12	Ethiopian	1.000	0.7819	Africa
13	Garuda Indonesia	1.000	0.9341	Asia
14	Hawaiian Airlines	0.873	0.7265	N. America
15	Japan Airlines	0.545	0.4966	Asia
16	Kenya Airways	1.000	0.7561	Africa
17	LATAM Airlines	1.000	0.8587	L. America
18	Lufthansa group	1.000	0.9873	Europe
19	Malaysia Airlines	0.393	0.3251	Asia
20	Norwegian	1.000	0.6306	Europe
21	Qantas Group	0.605	0.5673	Australia
22	Republic Airways Holdings	0.871	0.7502	N. America
23	Ryanair	1.000	0.9032	Europe
24	Singapore Airlines	1.000	0.9620	Asia
25	SkyWest, Inc	0.419	0.3273	N. America
26	Southwest Airlines Co.	0.319	0.2945	N. America
27	Turkish Airlines	1.000	0.6623	Europe
28	Virgin Australia	0.599	0.5534	Australia
29	WestJet	0.543	0.4997	N. America
	Mean	0.819	0.8656	

The above table 93 shows comparative technical efficiency result of DEA and SFA for the year 2008. The table contains the DMUs, DEA-variable return scale technical efficiency (vrste), SFA and regions of the airlines. Production efficiency of both DEA and SFA equals to 1 demonstrates that the DMU has achieved highest efficiency relative to other DMUs, whereas production efficiency less than 1 demonstrates the DMU to be inefficient relative to other DMUs. There are about 29 DMUs of the samples. Both DEA and SFA efficiency result ranges between 0 and 1. Here is the SFA result is less than the result of DEA scores.

Table 93 reveals that 17 DMUs had excellent performance of DEA scores out of 29 sample airlines. However, 14 airlines are less inefficient which needs improvement according to the operating mode of other airlines. All results of the SFA are less than 1.000 and it is also less than the result of DEA technical efficiency. The third DMU is Air France klm Airlines and it scores 1.000 DEA vrste and 0.9869 SFA technical efficiency result and it is located in European regions.

The 15th row of DMU is Japan Airlines which belongs to Asia region; and has 0.545and 0.4966 technical efficiency results of DEA and SFA respectively. The result of both DEA and SFA for these particular airlines indicates that it very inefficient which is below less than 50 percent technical efficiency. This airlines need to work hard to attain the efficiency. Additionally, ANA Group, Malaysia Airlines, SkyWest, Inc and Southwest Airlines Co are very inefficient airlines which are below 50 percent efficient.

There are about 17 DMUs score highest points of technical efficiency for both DEA and SFA though the relative efficiency between the two models differs slightly. The major difference between the two models is the result technical efficiency of DEA model is greater than the technical efficiency of SFA model. However, 13 sample airlines are less inefficient which generally less than 1.00 which needs improvement.

From Africa region, the 12th DMU in the samples is the Ethiopian airlines which scores 1.00 and 0.7819 technical efficiency result of DEA and SFA model respectively. Both relative technical efficiency results of the airline is higher while the SFA is less than 1.00 and is also less than DEA. Finally, the Ryanair Airlines which is found in the Europe region and it is the 23rd DMU; relatively scores the highest relative efficiency. Likewise Ethiopian airlines, the Ryanair Airlines has 1.000 and 0.9032technical efficiency of DEA and SFA result. From the DEA model perspective, this airline is efficient because it is 100 percent efficient. From the SFA model perspective, the airline is less than 100 percent efficient still it maintains the highest relative efficient.

Table 94 Comparative Results of DEA & SFA for the Year 2007

DMU	Airlines	DEA - vrste	SFA	Regions
1	Aegean Airlines Group	1.000	0.7682	Europe
2	Aer Lingus	1.000	0.7487	Europe
3	Aeroflot	1.000	0.8368	Europe
4	Air Berlin	1.000	0.8884	Europe
5	Air Canada	0.730	0.7233	N. America
6	Air china	0.660	0.6218	Asia
7	Air France klm	1.000	0.9724	Europe
8	Air New Zealand Group	0.564	0.5497	Australia
9	Allegiant Air	1.000	0.6029	N. America
10	American Airlines Group	0.294	0.2700	N. America
11	ANA Group	0.325	0.3134	Asia
12	British Airways	0.730	0.6557	Europe
13	Cathay Pacific Group	1.000	0.9399	Asia
14	China Eastern Airlines	0.372	0.2984	Asia
15	Copa Holdings	1.000	1.0000	L. America
16	Delta airlines	0.506	0.4935	N. America
17	EasyJet PLC	0.628	0.5350	Europe
18	Egyptair	1.000	0.8742	Africa
19	El Al	0.857	0.8528	M. East
20	Emirates Group	1.000	0.9318	M. East
21	Ethiopian	1.000	0.8330	Africa
22	Finnair	1.000	0.8317	Europe
23	Garuda Indonesia	0.834	0.8070	Asia
24	Hawaiian Airlines	0.726	0.7048	N. America
25	Jet Airways	0.426	0.3657	Asia
26	JetBlue Airways	0.392	0.3778	N. America
27	Kenya Airways	1.000	0.7513	Africa
28	Korean Air	0.326	0.3253	Asia
29	Lufthansa group	1.000	0.9766	Europe
30	Malaysia Airlines	0.602	0.5904	Asia
31	Norwegian	1.000	0.8191	Europe
32	Qantas Group	0.647	0.6441	Australia
33	Republic Airways Holdings	0.652	0.6341	N. America
34	Ryanair	1.000	0.7257	Europe
35	SAS Group	1.000	0.9313	Europe
36	Singapore Airlines	1.000	0.9391	Asia
37	SkyWest, Inc	0.558	0.5067	N. America
38	Southwest Airlines Co.	1.000	0.9265	N. America
39	TAP Portugal	0.466	0.4695	Europe
40	Turkish Airlines	0.510	0.4791	Europe
41	United-Continental Holdings	0.421	0.4050	N. America
42	Virgin Australia	0.754	0.7441	Australia
43	WestJet	1.000	0.8575	N. America
	Mean	0.767	0.7558	

The above table 94 shows comparative technical efficiency result of DEA and SFA for the year 2007. The table contains the DMUs, DEA-variable return scale technical efficiency (vrste), SFA and regions of the airlines. Production efficiency of both DEA and SFA equals to 1 demonstrates that the DMU has achieved highest efficiency relative to other DMUs, whereas production efficiency less than 1 demonstrates the DMU to be inefficient relative to other DMUs. There are about 43 DMUs of the samples. Both DEA and SFA efficiency result ranges between 0 and 1. Here is the SFA result is less than the result of DEA scores.

Table 94 reveals that 21 DMUs had excellent performance of DEA scores out of 43 sample airlines. However, 22 airlines are less inefficient which needs improvement according to the operating mode of other airlines. All results of the SFA are less than 1.000 and it is also less than the result of DEA technical efficiency. The fourth DMU is Air Berlin Airlines Group and it scores 1.000 DEA vrste and 0.8884 SFA technical efficiency result and it is located in European regions.

The 26th row of DMU is JetBlue Airways which belongs to North America region; and has 0.392and 0.3778 technical efficiency results of DEA and SFA respectively. The result of both DEA and SFA for these particular airlines indicates that it very inefficient which is below less than 50 percent technical efficiency. This airlines need to work hard to attain the efficiency.

There are about 21 DMUs score highest points of technical efficiency for both DEA and SFA though the relative efficiency between the two models differs slightly. The major difference between the two models is the result technical efficiency of DEA model is greater than the technical efficiency of SFA model. However, 13 sample airlines are less inefficient which generally less than 1.00 which needs improvement.

From Africa region, the 21th DMU in the samples is the Ethiopian airlines which scores 1.00 and 0.8330 technical efficiency result of DEA and SFA model respectively. Both relative technical efficiency results of the airline is higher while the SFA is less than 1.00. Finally, the Kenya Airways which is found in the Africa region and it is the 27th DMU; relatively scores the highest relative efficiency. Likewise Ethiopian airlines, the Singapore Airlines has 1.000 and 0.7513 technical efficiency of DEA and SFA result. From the DEA model perspective, this airline is efficient because it is 100 percent efficient. From the SFA model perspective, the airline is less than 100 percent efficient still it maintains the highest relative efficient.

Summary of the Results

Table 95-Summary of DEA Variable Return of Scale Technical Efficiency

	2014	2013	2012	2011	2010	2009	2008	2007
G1=1.00	13	28	27	26	29	23	13	15
G2=	12	10	12	9	10	6	9	8
G3=	8	1	0	0	0	0	7	20
Inefficient Total	20	11	12	9	10	6	16	28
Total samples	80	80	80	80	80	80	80	80
irs	11	6	5	4	4	1	11	irs
drs	9	5	5	5	6	5	4	drs
Total								

Note: G1= VRSTE=1.00, G2=VRSTE=0.8-0.99 & G3=VRSTE >0.79

The above table 95 summarizes the major results of the study for DEA variable return of scale for the year 2007 to 2014. Eight years of unbalanced data were selected and cross-sectional method is employed for each years. There are about 80 samples of DMU or airlines for the study selected using the random sampling techniques. However, the exact samples of data differ from those samples taken data using the random sample of techniques. For example, in 2014, 33 samples of airlines are selected, 39 samples are selected in 2013 and 2012; 40 samples of airlines are selected in 2010. The difference come in between the exact samples and those samples are selected using the random sampling techniques are due to the availability of data, the similarity of data variables and the net income positive or negative.

Three group of VRSTE is identified. Group one belongs to those samples of airlines scored 1.00 (100%) VRSTE, group 2 belongs to a score of technical efficiency that ranges between 0.8 and 0.99 and group 3 belongs to those airlines that score technical efficiency below 0.79.

Therefore, in 2014 there are about 13 airlines are efficient and 20 airlines are inefficient; 28 airlines are efficient and 11 are inefficient in 2013; and 29 samples of airlines are efficient and 10 samples of airlines are inefficient in 2012.

Table 96- Regional Analysis of DEA results for 100%Efficient No. of DMU

	2014	2013	2012	2011	2010	2009	2008	2007
Africa	-	1	2	2	4	3	3	1
N. America	3	8	7	6	10	6	1	2
Latin America	1	1	2	2	3	2	2	1
Europe & Russia	6	9	8	8	6	5	4	8
Middle East	1	2	1	-	1	1	1	1
Asia	2	4	7	6	5	5	2	2
Australia& New Zealand	-	1	-	2	-	1	-	-
Total	13	26	27	26	29	23	13	15

Table 96 indicates the regional analysis of the results for 100% efficient DMU. Seven regions are indentified. These regions are Africa, North America, Latin America, Europe and Russia, Australia, Middle East, Asia, Australia and New Zealand. Among 33 samples of DMU, there are not efficient airlines in Africa and Australia and New Zealand. The highest regions are in across the years are Europe regions having highest number of efficient airlines from 2011 to 2014 and from 2007 to 2018. Europe regions of airlines are the most efficient airlines in the world and North America regions are the second most efficient airlines in the world.

Table 97-Regional Analysis of SFA results for (0.8-0.99) Efficient No. of DMU

	2014	2013	2012	2011	2010	2009	2008	2007
Africa	1	1	2	3	4	2	1	2
N. America	8	11	9	6	7	3	4	10
Latin America	-	-	3	3	1	1	1	1
Europe & Russia	8	11	10	9	8	3	7	11
Middle East	1	2	1	1	2	1	1	2
Asia	11	10	10	9	8	3	5	9
Australia& New Zealand	-	2	2	3	3	2	3	2
Total	29	37	37	34	33	15	22	37

Table 97 summarizes the highest results of stochastic frontier analysis (SFA) scores for the years from 2007 to 2014. It is nearly impossible for airlines to score 1.00 (100%) SFA efficient airlines in the world since the SFA model separate the statistical noise and the technical inefficiency from the technical efficiency results. Therefore, the highest technical efficiency results which range from 0.8 to 0.99 are tabulated in the above table. Total of highest samples are listed below. For example, 37 samples of airlines are highest efficient in 2007 and 29 sample of airlines are relatively highest efficient in 2014.

These samples of highest technical efficiency of SFA are classified into seven regions. Europe and Russia regions are the most dominant technical efficiency of SFA scores in eight years and North America is the second most efficient using the SFA measure of technical efficiency.

Chapter: 5 Discussion, Conclusions and Recommendations

The following chapter discuss about the discussion of the results, the conclusion and the recommendation of the study. It starts by discussing the results of the study in alignments of the objectives of the stated on the first chapter of the study, then it proceeds to the conclusion of the study and finally it ends up by forwarding a recommendation. This section has six major theme of discussion. For the determinants of efficiency, dealing with unbalanced panel data, Frontier Version 4.1 and DEAP 2.1 are used to analyse the time-variant efficiency model of Battese and Coelli (1992 and 1995). Furthermore, this research paper is has followed the guideline of the UNISA school of Business Leadership policy. The study inculcates the valuable, relevant and critical comments and feedbacks given by the UNISA scholars and other academic member into the research part.

5 .1 Discussion of the Study

1. The primary objective of this study is to develop an integrated comparative technical efficiency measurement model which enhances strategic operating efficiency.

The newly developed proposed model is a paramount that encompass three models together. It integrates the concept of BSC (Kaplan and Norton, 1992) into DEA (Banker, Charnes & Cooper, 1984) and SFA (Aigner et al., 1977, Coelli et al., 2005) using the three core models:

1. Balanced Scorecard (BSC)-Strategic management tool
2. Data Envelopment Analysis (DEA)-non-parametric statistical tool
3. Stochastic Frontier Analysis (SFA)-parametric econometric tool

This study presents a new mode called "Balanced-Frontier-Envelopment (BFE)" to measure the overall performance of the airlines industry. This new developed model is an extension of the model designed by Wu et al. (2014) and it has considered four major BSC factors as the input/output based on the previous model of Wu et al. (2014) methods for integration into DEA and SFA. This model typically added the integration of the third model of econometric model which is the integration of additional SFA model into the previous model. By integrating the balanced scorecard into DEA and SFA, BSC identifies the inputs and outputs much more effective than the traditional way of selecting the inputs and outputs. The BSC helps us to identify four lagging factors and seven leading factors. The DEA aids us to identify the relative efficiency of the airlines, to benchmark the airlines and to identify the slack variables for the input and out variables. The SFA model facilitates to estimate the technical estimation of efficiency and inefficiency of the airlines and also separate the technical inefficiency from residuals errors or noise. By the implementation of DEA and SFA, the technical efficiency of the unbalanced panel of data from 2007-2014 major airlines in the world was generated and compared to identify the efficient frontier group and inefficient group. This study seems by far advanced than the previous models in terms of the greater number of sample size of the world airlines and higher number of panel of data.

In this paper we have endeavoured to address both of these drawbacks, by developing and implementing a multi-stage DEA model and SFA model. The first stage is to analyse a multi stage deterministic DEA model using the BSC index as inputs and outputs. The second stage is to analyse the same inputs and outputs based on stochastic frontier analysis (SFA).

The objective of the second stage is to explain variation in first stage performance in terms of three phenomena: observable characteristics of the operating technical efficiency, statistical noise, and technical inefficiency. The structure of the second alternative econometric model is a set of SFA analysis, operational variables by using the same inputs and outputs through constructing stochastic frontiers analysis. The structure of these frontiers reflects the direction and the intensity of the impact of each operational variable each inputs and outputs. The structure of the disturbance terms associated with these frontiers apportions excess input slacks to statistical noise and technical inefficiency.

The function of DEA is to identify efficiency frontiers, benchmarking partners, and inefficient slacks of DMUs. From the perspective of DEA, it could accommodate leading and lagging variables of BSC and identify the relationships between these variables. A DEA–VRS and DEA-CRS- input oriented model, which allows for the incorporation of multiple inputs and outputs in determining relative efficiencies using BSC index, is estimated simultaneously slack of inputs and outputs that explains the efficiency drivers. Benchmarks are provided for improving the operations of poorly performing airline companies.

After the indentifying inputs and outputs using the concept of the Balanced Scorecard we integrated into the DEA and SFA model one after another. We examined our results from a panel sample of airlines using two alternative methodologies: the DEA and SFA model, the comparative results indicate that the results of the two models are slightly different. The same inputs and outputs are analysed using the integrated two models. The result of the DEA is greater than the result of SFA; and the SFA results are more robust than DEA in identifying the component errors.

The main advantage of SFA to the nonparametric DEA is its robustness to outliers, data errors, and other stochastic noise in the data. While in DEA the frontier is spanned by a relatively small number of efficient firms, all observations have equal influence on the shape of the SFA frontier. The Function of SFA is to identify efficiency frontiers, inefficiency and component errors. From the perspective of SFA, it has ability to incorporate the efficiency of statistical noise, their fulfilment of theoretical restrictions, and the possibility to test these restrictions. Specifically, the "Balanced-Frontier-Envelopment (BFE)" model as presented in this study is more advanced than the capabilities of individual BSC, DEA, or SFA.

The advantage of the stochastic frontier analysis (SFA) approach under the specification of Battese and Coelli (1995) is that it allows investigation of technical progress through an estimated production function. The SFA approach can investigate types of returns to scale for the industry-level context but the DEA approach can examine types of returns to scale for the firm-level context. The empirical results from both estimation approaches are found to produce consistent results.

2. **The first specific objective is to measure the operational performance of world major airlines after constructing of an integrated comparative model**

In this paper, we have analysed the technical efficiency of a representative sample of world major airlines by integrating BSC, DEA and SFA models using unbalanced panel of data from 2007 to 2014 where a period of intense market volatility is highest due to financial crises and skyrocketing of oil price in the market (for DEA results see table 23 to 30 on pp. 134-148; for SFA results see table 71 – 86 on pp. 209-231; and for both DEA & SFA results & Comparison analysis see on table 232-247).

The introduction of a new way of combining the nonparametric DEA-type frontier with the stochastic SFA-type treatment of inefficiency and noise: and the Balanced Scorecard, we have adapted the framework of Stochastic Frontier Analysis (SFA), Data Envelopment Analysis (DEA) and Balanced Scorecard as a unique and important method of performance measurement proposed by this research. First, the BSC concept identify inputs and output as significant variables of inputs and outputs for explaining operating efficiency scores of airlines. From the perspective of DEA, it can evaluate the performance of DMUs through a quantitative comparison between the efficient and inefficient DMUs. Basically we have applied the identification of inputs and output variable of BSC concepts using Wu et al. (2014) methods of identifying the seven input and the four outputs.

The research steps are taken briefly as follows. Annual reports and financial reports are collected from the relevant airlines websites. A great care has been seriously taken to check the authenticity of the website address against International Air Transport Association (IATA), International Civil Aviation Organization (ICAO) and Centre for Aviation (CEPA).Then data are categorized according to cost and data classification of the study on the excel sheet. On the third stage, all financial data are changed into US dollar currency. Next, the same inputs and outputs are integrated into the proposed DEA first and into SFA model next one after the other and then the results of relative technical efficiency issues are discussed.

The study measures different number of decision making units (DMU) across 8 years from different regions. Basically, samples are taken using simple random sampling techniques but subsequent further analyses are made for comparison reasons. For example 33 DMUs are taken in 2014 year, 39 DMUs in 2013 and in 2012, 36 DMUs in 2011, 40 DMUs in 2010, 29 DMUs in 2009 and 2008; and in 43 DMUs are considered for the 2007. Only net income (NI) positive financial data are included for the technical efficiency analysis. All the negative net income and cargo airlines are excluded from the sample.

DEAP version 2.1 is used for the analysis of the DEA model. Technical efficiency, inefficiency, slacks of inputs and outputs, potential percentage of improvements, canonical correlations etc are discussed for each year from 2007 to 2014. VRSTE, VRSTE and scale efficiency are identified including the increasing return of scale and decreasing return of scale. The peer of each sample airlines and the peer counts are listed using this model. Further analysis is made comparing against the counter alternative of the SFA model.

FNOTIER 41 is applied to analyse the SFA model. Using this software, technical efficiency, technical inefficiency, statistical noise, Ordinary Least Square (OLS), coefficient, standard-error t-ratio and log likelihood function.

Furthermore, characteristics of the airlines are given further analysis if they show any relationship with the performance of the airlines or if there is any performance variation among the airlines based on those characteristics. These characteristics are age of the airlines, regions, employee size, fleet size and number of passengers (see table 15-22 on pages 118-132) are given with the description, frequency and percentages.

3. **The second specific objective is to assess the comparative efficiency of world major airlines with a particular emphasis of Ethiopian Airlines through the comparative analysis of the model**

The table 98 below on page 258 briefly summarize the particular technical efficiency of Ethiopian Airlines case using the two alternative performance measuring model (DEA and SFA) models by integrating the BSC concepts or variables. Ethiopian airlines technical efficiency results have been discussed comparatively against African regions and the rest or regions year by year for the eight years. Additionally, both the results of DEA and SFA models are compared against each other.

Ethiopian Airlines is one of African regional airline. According to the annual report from 2007 to 2014, this particular airline does not show net income (NI) loss. The DEA technical efficiency results of the Ethiopian Airline indicate 100 percent technically efficient from the year 2008 to 2013. It seems that the airline has less technically efficient or technically inefficient for the year of 2007 and 2014. The SFA result seems relatively high still the SFA results of the Ethiopian Airlines are less than the DEA results. It is important to look at in details year by years.

In 2014, the Ethiopian airline is order at the 19th DMU. Here is the scored 90.6 percent for both constant return of scale technical efficiency (VRSTE) and scale efficiency (see table 23 on pp 134). The variable return of scale (VRSTE) for this airline is 100 percent. Scale efficiency is calculated by dividing CRSTE to VRSTE. The Ethiopian airline show increasing return of scale (IRS) since it increases from technical efficiency of CRS to VRS. There is no Africa regional airlines are reported to be efficient because the sample airlines are found to be NI negative do they are excluded from the sample in this particular year. The peer count of Ethiopian airlines is itself.

In 2013, the Ethiopian airline is ranked the 21th DMU out of 39 samples of airlines (see table 24 on pp 136). It has 100 percent technical efficient for VRSTE, CRSTE and scale efficiency. There is no African airline in the sample (i.e. Egypt Air, South African Airways and Kenya Air Ways) to technical efficient to be compare against the Ethiopian Airlines.

In 2012, the Ethiopian airline is ranked the 20th DMU out of 39 samples of airlines (see table 25 on pp. 138). It has 100 percent technical efficient for VRSTE, CRSTE and scale efficiency. The Kenya Airways are 100 percent technical efficient for VRSTE, CRSTE and scale efficiency. So these two airlines seem technically efficient in the African regions.

In 2011, the Ethiopian airline is found the 17th DMU out of 36 samples of airlines (see table 26 on pp 140). It has 100 percent technical efficient for VRSTE, CRSTE and scale efficiency. The Kenya Airways is 100 percent technical efficient for VRSTE, CRSTE and scale efficiency. But South African Airways is 94.6 percent for both CRSTE and scale efficiency; and 100 percent for VRSTE. However, among these three airlines South African Airways is in decreasing rate of return. So these two airlines seem technically efficient in the African regions. The Egyptair is excluded out of the sample because of net income negative.

In 2010, the Ethiopian Airline is staged the 17th DMU out of 40 samples of airlines (see table 27 on pp 142). It has 100 percent technical efficient for VRSTE, CRSTE and scale efficiency. The South African Airways is 100 percent technical efficient for VRSTE, CRSTE and scale efficiency. But Kenya Airways is 92.4 percent for both CRSTE and 92.6 percent for scale efficiency and 100 percent for VRSTE. Kenya Airways is at increasing return of scale. So the Ethiopian Airline and the South African Airways seem technically efficient in the African regions. The Egyptair is excluded out of the sample because of net income negative.

In 2009, Egyptair, Ethiopian Airline, and the South African airways are put at 12th, 14th and 25th DMU out of 29 samples of airlines. (See table 28 on pp144) All the three airlines are technically efficient in terms of CRS, VRS and scale efficiency. In this particular year, most of the sample airlines are technically efficient.

In 2008, Egyptair, Ethiopian Airline, and the Kenya Airways are ranked at 10^{th}, 12^{th} and 16^{th} DMU out of 29 samples of airlines. (See table 29 on pp146). All these three airlines are technically efficient in terms of CRS, VRS and scale efficiency. In this particular year, most of the sample airlines are technically efficient. But the South African Airways are excluded from the sample in this particular year for it has net income losses.

Finally, in 2007, Egyptair, Ethiopian Airline, and the Kenya Airways are ranked at 18^{th}, 20^{th} and 27^{th} DMU out of 29 samples of airlines. (See table 30 on pp148). Out of the three airlines, Egyptair is 100 percent technically efficient in terms of CRS, VRS and scale efficiency. Ethiopian Airline is 100 percent technically efficient in terms VRS; 45 percent in terms of CRS and 45 percent in scale efficiency. The Ethiopian Airlines is at increasing return of scale. The Kenya Airways has CRS and VRS technical efficiency 96.6 and 100 percent respectively. The Kenya Airways shows increasing return of scale. In this particular year, one of the sample airlines is 100 technically efficient in all CRS, VRS and scale technical efficiency. In this year, the Ethiopian Airlines has scored the lowest technical efficiency in terms of CRS and scale technical efficiency. But the South African Airways are excluded from the sample in this particular year for it has net income losses.

The DEA employed multi stage input oriented results. It shows variable return of scale technical efficiency (VRSTE) is 100% efficient from 2007-2014. But the constant return of scale (CRS) depicts slight different result. Year 2007 and year 2014 results show less result 45% and 90.6% efficiency respectively. Both years are revealing increasing return of scale. In these years the ET is showing inefficient. The rest indicates from the year 2008 to 2013 ET is 100% technical efficient according to DEA-VRS technical efficiency.

Table 98 Summarizes the Particular Case of Ethiopian Airlines

	DEA -Input Oriented				SFA Result
	crste	vrste	scale		
2014	0.906	1.000	0.906	irs	0.84435452
2013	1.000	1.000	1.000	-	0.92712185
2012	1.000	1.000	1.000	-	0.92868433
2011	1.000	1.000	1.000	-	0.93706983
2010	1.000	1.000	1.000	-	0.81000976
2009	1.000	1.000	1.000	-	0.51068633
2008	1.000	1.000	1.000		0.781942
2007	0.450	1.000	0.450	irs	0.83296127

The SFA result on the above table 98 indicates that overall efficiency results are below 94%. The highest efficiency score is 93.7% in 20011 and the lowest efficiency result is 51% in 2009. The second lowest efficiency result is 78.2% in 2008. May be this is the period of financial crises that the world faces. There are found two striking result opposite result between DEA and SFA. One result is that the SFA result 83.3% greater than DEA result (45%) in 2007. And the second result is DEA result (90.6%) is greater than SFA result (84.4%) in 2014. Generally speaking the SFA result shows technical efficiency score is less than DEAR-VRS and DEA-SRS except in 2007 where SFA result is 83.3% and DEA result is 45%.

4. **The third specific objective is to identify the potential percentage of efficiency improvement for inefficient airlines that determines the source of deriving factors for efficiency by using the new developed model.**

Determinant factors that explain the source of efficiency have been identified for each airline (see table 31 – 46 on pp 150 to 195). These input slacks and output slacks are the determinant driving factors that explain the sources of efficiency for each. The DEAP 2.1 version has clearly separated the deriving factors of technical efficiency both in terms of input and output slacks. The eight years summary of input and output slacks are tabulated years by year.

The potential improvements for inefficient airlines for the years from 2007 to 2014 are identified (see Table 47 to 54 on pp 167-175). The percentage of output slack target and input slack target are displayed. In 2014, the percentages of potential improvement for 14 inefficient airlines are listed. These airlines are Air Canada (40.5%), Air China (52.9%), ANA Group (78.95), Avianca

Holdings (37.75), Cathy Pacific Group (43.3%), China Easter Airlines (63.5%), China Southern Air Holding,(53.5%), Hawaiian Airlines (26.4%), JetBlue Airways (99.4%), Southwest Airlines(87.2%), Turkish Airlines United-Continental Holdings (74.25) and WestJet (68%).

Some of the airlines have very low technical efficiency score like Hawaiian Airlines (26.4%) and Avianca Holdings (37.75) which need high percentage improvement of efficiency whereas some airlines like JetBlue Airways (99.4%) need a little percentage of improvement. Let see Turkish Airlines how percentage of potential improvement for this particular airlines. The Turkish airlines need to decrease percentage of input slacks such as 6.09 percent of energy cost, 1.69 percent passenger cost, 6.27 percent of labour cost and 8.97 percent of material cost without changing the output target in order to be 100 percent efficient. Or else the Turkish airlines can increase the output slacks such as 89.14 percent of Return on Asset and 89.63 percent of Return on Investment with the same amount of inputs.

In the same fashion we have listed and tabulated for other years (2007-2014) of tables with descriptions. From year of 2013 to 2007 in recent to earliest years, the numbers of potential improvements inefficient airlines which need improvements are 11, 8, 3, 5, 3, 12 and 23 respectively. The year 2007 has the highest number of percentage of potential improvement for the inefficient airlines. The year 2009 and the year 2011 have the lowest number of inefficient airlines for the potential percentage of improvement.

5. **The final specific objective is to determine the significant correlation among variables of inputs and outputs based on newly designed model.**

The interrelationships between four perspectives of the BSC, canonical correlation analyses are examined for eight year in this study. Detailed information for the canonical fixtures of inputs and outputs are shown in (see fig 4 on pp. 105)**.** Canonical correlation is conducted among six pairs of inputs and outputs variables. The seven inputs and the four outputs are identified by employing four perspectives of BSC concepts. According to Kaplan and Norton (1996), the four perspectives are the customer perspectives, the internal perspectives, the learning and growth perspectives, and the financial perspectives. Labour cost and other operating cost are selected from the learning and growth perspectives. Material cost, energy cost and capital cost are chosen from internal process perspectives. Passenger and Revenue passenger Kilometre are grouped under the customer perspectives while the four financial perspectives include the operating revenue, return on asset, return on investment and the net income (see fig 4 on pp. 105). Basically, the input and output identification process using the concept of the BSC is based on the pervious study of Wu et al. (2014).

The canonical correlation is analysed using the XLSTAT trail version by freely accessing from the internet. This version has successfully carried out the canonical correlation tests. The canonical correlation is important to show the correlation among the variables of inputs and outputs. Several multivariate statistics and F-tests approximate are provided. Three major values are identified: the highest results, the medium and the lowest linear correlation among the four perspectives of variables.

Tables 63-70 (see on pp. 185- 206) show the results of canonical test of lambda values, canonical correlation values, Eigenvalues, redundancy index, f-value and p-values. These values are selected and summarised for simplicity purpose otherwise the result of the XLSTAT gives a lot of details.

The statistics test rejects the null hypothesis that all canonical correlation is zero. The small P-values for this test (0.05), except for Pillai's Trace, suggest rejecting the null hypothesis that all canonical correlation is zero. The research study for all canonical tests rejects the hypothesis reject below $\alpha = 0.05$ significant level of canonical correlation.

The canonical variables for the BSC six pairs of variables may show mixtures of both negative and positive signs. All the correlations that are negative indicate that the value is also a suppressor variable. It may seem contradictory that variables should have a coefficient of opposite sign from that of its correlation with the canonical variable. In order to understand how this can happen. Therefore, the general interpretation of the negative variables acts as suppressor variables to enhance the correlation between variables. This canonical correlation may be strong enough to be of practical interest, but the samples size is not large enough to draw definite conclusion.

5.2 Conclusion of the Study

Several conclusions can be drawn from our results. First, it is important to note that a major finding of this study was that there is a growth trend in the efficiency of technical efficiency of airline operation which is consistent with Barros and Peypoch (2009), Wu et al. (2014) and Barros et al.(2015)**.** By integrating seven inputs and four output parameters from BSC into DEA and SFA implementation, the result become more meaningful. According to the measure the relative technical efficiency of world major airlines by DEA and SFA we find out the average of it is in a medium level.

Generally speaking, there are some similarity and contradicting findings among the performance measurement of technical efficiency of the airlines though most of the studies are not directly related.

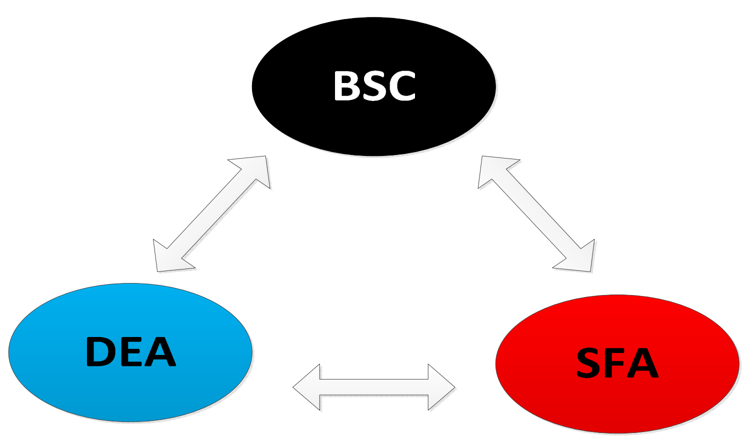
For example, the similarities of other findings with this study as follow: Barbot et al., (2008) found out that LCC are in general more efficient than full service carrier which is similar with this study; Barros and Peypoch (2009) remarked that operational efficiency is in a growing trend; Fowler and Joo (2014) claimed that European airlines are the lowest efficient airlines among the airlines; Molhotra (2012) found DEA brings out the high and poor performing airlines; Barros et al. (2015) refuted that efficiency level were stagnated over the period of analyzed implying inexistence of a learning curve; Yank and Zhu (2015) claimed that large airlines have higher technical efficiency but less Increasing Return of Scale technical efficiency that the small one and the trend of technical of airlines in china is growing up every year; Barros et al. (2013) supported that Us airlines display a reasonable level of efficiency with some airlines maintaining a remarkable level of efficiency in all years while the other airlines present inefficiency in some years. One way or other way these studies have similarity with the finding of this research thesis.

However, there are also some contradiction with this researcher's finding such as Chow and Kong (2010) proved that non state-owned airlines are performing better than state-owned airlines; Bhadra (2009) noted that airlines productivity appears to be converging overtime; Barros and Couto (2012) found that most European airlines did not experience productivity growth between 2001 and 2011; Lee and Worthington (2014) asserted that non-US and non-European international airlines do perform at efficient levels which provides a benchmarking for poorly performing airlines in US; Assaf and Josiassen (2011) supported that European airlines have slightly higher efficiency and productivity growth that US airlines; Arjomandi and Seufert (2014) proved that many of the most technically efficient airlines are from china and North Asia; Karlaftis et al. (2009) supported that airlines experience constant returns to scale while technical efficiency ranges between 50% and 97% approximately and Nagpal and Saranga (2016) claimed that while some of structural and regulatory factors have an undesirable impact on airlines performance, lowest carriers in India have managed to achieve significant operational efficiency.

First**,** by integrating the BSC model into DEA model and SFA model, the proposed three models together bring much more effective method of performance measurement than using one or two of the models separately. These models avoid the limitation of each models used separately. The previous model proposed by Wu and Laio (2014) as envelopment balanced scorecard lacks to identify the technical inefficiency and residual errors. The proposed model of this study can eliminate the faults of BSC, DEA and SFA individually. This model fills the gap of the previous literature. We named it "Balanced Frontier Envelopment" or "BFE" Model.

Whereas the superiority of SFA over to the DEA was revealed as 1) including statistical noise into the frontier 2) allowing statistical tests on the estimates, DEA is seen advantageous at times due to the fact that it doesn't require any specific functional form for production function and technical form for inefficiency terms. For that reason, trade-off between misspecification bias (in SFA) and measurement error (in DEA) determines the preference of researchers conducting efficiency analysis.

Figure 5 Integrated Comparative Model



In conclusion, as figure 5 reveals "Balanced-Frontier-Envelopment (BFE)" model addresses the main point of critique presented against DEA or BSC or SFA and melds the advantages of all approaches into a unified framework. The main advantage of "Balanced-Frontier-Envelopment (BFE)" to the alternative estimation approaches is its utilization of the established concepts and principles of DEA, BSC and SFA: the approach is based on the standard assumptions that practitioners of DEA and SFA are comfortable with.

Thus, readers familiar with classic BSC, SFA and DEA approaches are expected to easily grasp the essential features of the proposed approach. The conceptual bridges between BSC, DEA and SFA are also important for the further integration of the parametric and nonparametric fields of productive efficiency analysis. Since the three integrated models is a genuine hybrid of BSC, DEA and SFA, many existing tools and techniques from BSC, DEA and SFA can be easily incorporated into the proposed framework. On the other hand, stochastic noise does not necessarily restrict to the output data, also input data may be perturbed by measurement errors and other noise. Noisy input data remains somewhat problematic for SFA, and the same applies to the "Balanced-Frontier-Envelopment (BFE)" model. Despite these shared limitations, the benefits of the unified amalgam model clearly outweigh the costs.

We have tested this framework extensively year by year with two methods, DEA and SFA. We have evaluated these methods on the basis of their ability to incorporate the efficiency of statistical noise, their fulfilment of theoretical restrictions, and the possibility to test these restrictions. Both DEA and SFA can estimate operational efficiency scores, although only SFA incorporates noise. However SFA allows the estimation of operational efficiency scores only in the two operational detrimental input cases. The appropriate DEA is able to calculate operational efficiency for every operational detrimental input model. However DEA is deterministic, and is unable to identify whether the operationally detrimental variables suit the model.
Comparing DEA to SFA estimates, the results show greater efficiencies when employing DEA models relative to SFA models. The mean efficiency difference is largest when employing a variable returns to scale DEA model compared to a SFA model with a normal efficiency distribution. The findings offer caution in using a single DEA or SFA modelling approach for purposes of ranking individual airlines according to their efficiency performances.

As it is conventionally employed, DEA has two drawbacks. First and foremost, it is deterministic, and so is plagued by measurement errors in included variables and by the omission of unobserved but potentially relevant variables, the impacts of which would be captured by a disturbance term in a stochastic model. Second, chief among the omitted variables are what we have referred to as operational variables, those that capture features of the operating performance which are posited to have an impact on the efficiency with which conventional inputs are used to produce conventional outputs. These variables are typically omitted not because they are unobserved, but because the lack of prior knowledge of the direction of their impacts precludes their introduction in a multi stage DEA analysis.

Second**,** one of the fascinating finding of the study is the relative efficiency for airlines industry has been increasing from year to year as Barros et al. (2015) indirectly refuted that efficiency level were stagnated over the period of analyzed implying inexistence of a learning curve . According to the rank of efficiency included in this study can help people in selecting and evaluating airlines companies that have good performance as benchmarking airlines.

Different airlines show different technical efficiency relative to their counter airlines of the samples: the large airlines have higher technical efficiency but less increasing rate of technical efficiency than the small ones which is supported by Yank and Zhu (2015) claimed that large airlines have higher technical efficiency but less irs technical efficiency that the small one and the trend of technical of airlines in china is growing up every year however it seem to contradict with Barros and Couto (2012) found that most European airlines did not experience productivity growth between 2001 and 2011 and the Assaf and Josiassen (2011) contradicts that European airlines have slightly higher efficiency and productivity growth than US airlines**.**

And high revenues of the airlines do not indicate profitability and hence high technical efficiency. Large airlines can become inefficient at the same time small airlines can be relatively technical efficient consistent with Bhadra (2009) and Barbot et al. (2008) which is inconsistent with Yank and Zhu (2015) claimed that large airlines have higher technical efficiency but less irs technical efficiency that the small one and the trend of technical of airlines in china is growing up every year**.**

Technical efficient airlines can be profitable but the reverse is not necessarily that profitable airlines are technical efficient. In addition, the trend of technical efficiency of airlines is going up every year is supported by Barros and Peypoch (2009 but against Barros et al. (2015) and Bhadra (2009). Besides, the airline industry shows decreasing returns to scale, which means the output does not match the level of inputs. From our analysis, we show that it is possible for airlines to be profitable despite hard economic times. We remain optimistic that operational improvements in airlines can be achieved and hope that cost savings achieved are through the integrated comparative performance measurement of this model.

Overall the DEA multi stage input oriented relative scale efficiency indicates the lowest and second lowest number of efficient airlines is 12 DMU in 2014 and 15 DMU in 2007. Apparently, the highest number (28 airlines) of efficient airlines is 2010 and 2012. Relatively, the number of efficient and benchmarking airlines varies through time. The reason of the decreasing number of efficient airlines may be due to many reasons. But we speculate that the lowest number of efficient airlines in 2014 may be due to highest oil price.

Even though it is increasing the number of efficient airlines trend for the period of 2007-2009, this period is relatively less number of efficient airlines due to the effect of financial crises in the world. For example, the technical efficiency of the world airlines in 2014, among 33 airlines, 12 achieves the efficiency score of 1.00; twenty one achieve the efficiency score less than one. These efficiency scores are all below 1.00, which implies that there are rooms for these 21 airlines to improve. This is the period where the number of Airlines in the world is less efficient.

The regional analysis of the technical efficiency indicates that Europe region supported by Assaf and Josiassen (2011) and North America regions are the highest and the second highest relative technical efficiency in the world though the representative samples of DMUs vary from region to region which is against the study of Arjomandi and Seufert (2014) proved that many of the most technically efficient airlines are from china and North Asia while many of the best environmental performers are from European; and lee and Worthington (2011) asserted that non-US and non-European international airlines do perform at efficient levels which provides a benchmarking for poorly performing airlines. Comparative studies with the above findings are worth taking to investigate.

The comparison between the model of DEA and SFA shows that DEA result is higher than the SFA result like DEA result can be 100 percent efficient while the counter SFA result is always less than 100 percent and is always less than the DEA result. The SFA result cannot attain 100 percent technical efficiency since it has the capability of identifying the relative technical efficiency, inefficiency and the statistical noise.

We have come to major conclusion to the application and measurement of this newly developed model cannot be seen as alternative way of performance measurement in this case relative technical efficiency performance measurement tools instead airline must use this integrated technical efficiency measurement tool to make their organizations more efficient and hence profitability.

Third, the results of a DEA analysis show Ethiopian Airlines has relatively performed better and 100% efficient from the year 2008 to 2013. Apart from the impact of the external factors, the managerial causes of technical efficiency may have been due to variations in the strategies adopted by the airline; the networks served, or differences in its historic resource base resources.

The results of the finding on Ethiopian airlines is contradicting on the result of Nagpal and Saranga (2016) claimed that while some of structural and regulatory factors have an undesirable impact on airlines performance. Even tough, the Ethiopian airlines is state owned, some of structural and regulatory factors have not an undesirable impact on the airlines performance. Instead, the Ethiopian airline has managed to achieve significant operational efficiency.

The efficiency estimates indicated that the performance of Ethiopian airlines experienced strong increase between 2008 and 2014, while from 2007, the average technical efficiency declined to reach its lowest level in 2007. The decrease in efficiency of Ethiopian airlines in 2007 might be due to factors such as increase in oil price, intense market competition and financial crises. For small airlines like Ethiopian airlines the impact of these factors might have also been stronger as they usually suffer from weak economies of scale.

Generally we can conclude that the SFA result shows technical efficiency score is less than DEA-CRS and DEA-VRS in all years. After the extensive DEA and SFA analysis have been estimated, the particular case of Ethiopian airlines demonstrates higher technical efficiency in both results than the rest of African Airlines and is competent with the other technical efficient airlines in the world. The input and output sacks cannot be identified because the Ethiopian airlines is relatively technical efficient among sample of airlines.

Fourth, one of the critical findings from our study is the fact that technical efficiency is not just required to manage operations more efficiently and to cut-down costs; it is also needed to be on continuous improvement of operational efficiency. Hence, the study has successfully identified the potential percentage of improvements for the inefficient airlines year by year for from 2007 to 2014. These percentage of improvements can be applied either output slack target or input slack target.

The particular inefficient airlines can improve the percentage of increasing input slacks without changing the output slacks or increase the percentage of output target without changing the input slack target. While our analysis finds various drivers of cost and operational efficiency, the technical efficiency seems to be the determinant of future success in the world airline industry. While the variables included in the empirical study do help explain some of the differences in efficiency of various airlines, this study has clearly shown the percentage of potential improvements for particular inefficient airlines with both input and output target.

Even though, the findings of some studies are irrelevant to this study such as the study of Lee et al (2013) concluded that a pollution abatement activity of airlines lowers productivity growth; Wu and Liao (2014) found that excellent efficiency frontier performing airlines perform better in energy, capital and other operating costs; Joo and Min (2015) rejected that airlines alliances did not necessarily improve the participating airlines comparative operating official despite it cost saving potential due to share resources; Assaf et al. (2013) assumed that airlines performance have been sprawling around multifaceted topics including management, institution and organizational structure; Arjomandi and Seufert (2014) proved many of the best environmental performers are from European, it is important to look at in-depth to the in other studies by the researcher but it is beyond the shadow of doubt they are beyond the objectives of the study.

Our final conclusion concerns about the results of correlation test of canonical relation among the four perspectives of the BSC variables. The eight years of cross-sectional data analysis for the canonical correlation test indicates that, in conclusion, the researcher found out that from six canonical analyses, relatively the four relationships are significant at different level which seems partially differ the results of Wu et al. (2014) that they said only two relationships are significant. In fact, the level of significance varies from low level to high level. Still the test shows there are interrelationship among the four perspectives BSC variables of the six pairs of the canonical correlation.

5. 3 Recommendation of the Study

A number of recommendations are forwarded to managers, academician and researchers; Ethiopian Airlines, Airlines industry, other organizations and future directions are set.

First, Airline should try to apply a tri-model which integrates BSC concept into SFA and DEA is proposed to measure the technical performance of airlines. This model is by far greater than using either one or two of the models separately. We called it Frontier-Envelopment-Scorecard model. It measures Technical efficiency, identify slack variables separate the operating inefficiency and statistical noise. The "Balanced-Frontier-Envelopment (BFE)" model avoids the faulty or the limitation of each model if they are used separately.

Second**,** the development of this model is to measure and benchmark comparative operating efficiencies in the global airlines industry to gain insight on the future strategies and competitive efforts of these airlines. From a strategic perspective, insight is gained to compare efficiency ratings of specific airlines with BSC, DEA and SFA performance measurement. Because we can merely speculate as to the causes of our findings, it is necessary to measure further the efficiency of airlines in their technical performance.

The results of "Balanced-Frontier-Envelopment (BFE)" model can serve as baseline of management by objectives (MBO). Managers can use the results of "Balanced-Frontier-Envelopment (BFE)" to improve and become more competitive. The results can also be used for international benchmarking purpose. Thus, it is possible for world major airlines to compare their average efficiency score with those international airlines that share similar characteristics. Airlines that are not listed at the efficient frontier should select benchmark partners based on the results of this study.

The managers of these inefficient airlines should make their best efforts to examine the model of resource allocations and operations of the benchmark airlines and follow their business model to catch up. The slacks required to improve can be used as a guideline for resource allocations and strategic moves to improve efficiency. The management of different airlines is also strongly encouraged to adopt a benchmarking management procedure in order to perform a continuous evaluation of their performance against operational strategies and to make the necessarily corrective actions.

Based on comparison of the results, analyst will recommend whether the airline is doing well or underperforming relative to its peers or relative to its own past performance. DEA employs relative efficiency, a concept enabling comparison of companies with a pool of known efficient companies. The DEA model compares a firm with the pool of efficient companies by creating an efficiency frontier of good firms. We also provide an insight into the benefits of DEA methodology in analyzing operational efficiency of the airlines industry. The competitive firm's data, and other industry specific data, and uses the DEA methodology to analyze a firm's performance.

Moreover, DEA modelling does not require prescription of the functional forms between inputs and outputs. DEA uses techniques such as mathematical programming that can handle a large number of variables and constraints. As DEA does not impose a limit on the number of input and output variables to be used in calculating the desired evaluation measures to deal with complex problems and other considerations they are likely to confront.

The integrated "Balanced-Frontier-Envelopment (BFE)" model is a useful framework for both academic and practitioners to identify the interrelationships among four perspectives of BSC, the efficient frontiers, the input slacks, and the benchmark learning partners, inefficiency and residual effects. Since none of previous studies have integrated BSC, DEA and SFA to assess the operational efficiency of the airlines industry, the results of this study have served as a baseline for further academic validation.

The proposed model of this study can eliminate the faults of BSC, DEA and SFA individually. Second, the "Balanced-Frontier-Envelopment (BFE)" model can be used to perform optimization analysis on every individual DMU to generate relative efficiency values. By comparing the relative efficiency values and slacks with other DMUs, managers of the airlines can design certain strategies to catch up, using the efficiency frontiers as the benchmark learning partners.

Fourth, through the implementation of "Balanced-Frontier-Envelopment (BFE)" model, managers can find the efficient frontiers and also to determine the origins of inefficiency and residual component by monitoring operational efficiency among competitors. Particularly, the amount of slacks and the amount of operational efficiency that airlines need to improve are essential for top management leaders to identify strategies and methods that airlines should exert in order to be both efficient and competitive.

The new model "Balanced-Frontier-Envelopment (BFE)" analysis can serve as baseline of management by objectives (MBO). Managers can use the results of "Balanced-Frontier-Envelopment (BFE)" model to improve and become more competitive. Airlines that are not listed at the efficient frontier should select benchmark partners based on the results of this study. The managers of these inefficient airlines should make their best efforts to examine the model of resource allocations and operations of the benchmark airlines and follow their business model to catch up. The slacks required to improve can be used as a guideline for resource allocations and strategic moves to improve efficiency.

Third, the "Balanced-Frontier-Envelopment (BFE)" model can be used to perform optimization analysis on every individual DMU to generate relative efficiency values. It is also possible for future efficiency improvements. By comparing the relative efficiency values and slacks with other DMUs, managers of the airlines can design certain strategies to catch up, using the efficiency frontiers as the benchmark learning partners.

Fifth this study also will help the management and administration of Airlines Company involved in making and improves the weaknesses, such as formulating business strategy or marketing strategy to be the most efficient firm as fast as possible. This study can also be used as a benchmark in determining the efficiency of Airline Company according to the appropriate model. Airline managers should put their efforts on monitoring operational efficiency among competitors.

For example, the managers of different airlines are also strongly encouraged to adopt a benchmarking management procedure in order to perform a continuous evaluation of their operational performance against operational strategies and to make the necessarily corrective actions. Through the implementation of "Balanced-Frontier-Envelopment (BFE)" model, managers should be able to find the efficient frontiers and also to determine the origins of inefficiency. Particularly, the amount of slacks and the amount of operational efficiency that airlines need to improve are essential for top management leaders to identify strategies and methods that airlines should exert in order to be both efficient and competitive.

Hence, we strongly recommend for the managers of inefficient airline companies should do the following three points to improve efficiency. First, they should adopt a benchmark management procedure in order to evaluate their relative position and to adopt appropriate managerial procedures for catching up with the frontier of ‘‘best practices’’. Second, they should upgrade the quality of their management practices, responding to the results of the present research. Finally, they should pursue market-oriented strategies, which increase outputs and decrease inputs.

Sixth, the results could generate a starting point for policy makers at the different airlines by providing them with a comprehensive figure on their level of scale and efficiency position. The results can be used as an incentive to target operational inefficiencies and seek new area of improvements.

Second, the results of this study can serve as a baseline for further academic validation. It is also possible to validate the results of this study with some qualitative case investigations of the major airlines involved, so future strategies taken by these airlines in response to the current industry trends can be identified. The proposed model of this study can eliminate the faults of BSC, DEA and SFA individually.

The methodology we used is popular and appropriate but it should be treated with caution since the measures of technical efficiency are estimates whose accuracy cannot be treated as certain. Of course, there are still several issues that could serve as good examples for future investigation which go beyond the widening of the database and the inclusion of a dummy variable to account for the change in the ownership structure of the firms. For instance, one could make an attempt to identify the causal factors that are associated with efficiency performance and incorporate them into the model. Moreover, one could make an effort to extend the model to account for spill-over across sectors. No doubt, future and more extended research on the subject would be of great interest.

Seventh, a fruitful avenue for future research might involve an extension of those methodologies to more rigorous validations of comparisons between DEA and SFA efficiency rankings. Based on the present findings, it is recommended that additional research be conducted along those lines but also to investigate and provide a better understanding of the underlying determinants of institutional efficiency. While technical factors have been integrated into SFA models and multi-stage techniques have been developed for DEA models, little has been accomplished in the way of rigorously offering to decision makers the managerial and institutional ingredients that create efficiency.

Using the inputs and outputs of the benchmark partners, the managers can develop certain strategies to either increase the outputs without changing inputs, or decrease the inputs without changing outputs. It is recommended that for these airlines whose efficiency scores are lower than 0.80, strategic changes are required to become more competitive.

Second, we therefore recommend that airlines operating in inefficient airlines should first focus on getting their strategic positioning right by paying close attention to structural and regulatory factors, align the operations strategy to the chosen competitive strategy and execute it well during the day to day operations. Management must continuously seek operational improvements that lower costs, increase revenue. We hope that our analysis and findings indicate that there continue to be areas for improvement. We performed no analysis on the area of aircraft technology itself beyond the observation that more use was being made of regional jets which are more fuel efficient and capable of longer ranges. Some consideration should be given to the technological direction of aircraft and upcoming potential innovations. Airplanes use the most fuel taking off and getting to cruising altitudes and should there be innovative engineering efforts to significantly reduce fuel consumption, this major cost factor may become less important to operations.

Third, we highly recommend the Ethiopian airlines to apply this newly developed integrated model to measure the technical efficiency and inefficiency, to indentify the determinant factors of slacks inputs and outputs, the percentage potential improvement of technical inefficiency, the correlation between the variables of BSC, the statistical noise of the sampling. It has been indicted that Ethiopian Airline is relatively technical efficient in most of the years and this does not mean Ethiopian Airline is perfect. Still to remain to improve it technical efficiency into highest stage and remain at the same time competent in the airline industry, it should apply the newly model because this model seems more competent, more applicable and more problem solving than other models. Therefore, it would be wiser for the Ethiopian Airline to test this model and apply to one of their performance measurement tools to measure the technical the relative efficiency of the airlines against the other benchmarking of world or regional airlines based on their purpose. Hence, this model helps to sustain its profitability; it helps to slash its cost and continue to dominate to be the sprite Africa.

Our fifth recommendation goes to those particular inefficient airlines in the samples of this study or other inefficient airlines and organizations which are interested in pursuing the improvement of technical efficiency. Our empirical findings from the integration of the three models of SFA, DEA and BSC model analysis have significant implications for airlines operating in world currently, as well as for future aspirants to be efficient. In an industry such as this, where loss-making is a norm and any profits by an airline are reported as front page news, one has to be extra vigilant in understanding the various linkages between drivers of performance of both operational and financial.

Since Airlines industry is considered to be one of the most cost conscious businesses to operate in, one has to pay special attention to costs and operational efficiencies, as there is very little scope to system on the price front. Our empirical study findings therefore provide important percentage of potential improvement pointers in both output target and input target to senior executives to emphasize on the operational technical performance of the airline.

Our final recommendation goes to the airlines industry and the other organization to implement the Balanced Score Card concepts since the four perspectives have interrelation among themselves. These six pairs of the four BSC perspectives have different significant level. This result seems to suggest that the all six perspectives of BSC are dependent. For example, by improving the internal process perspectives airlines can improve the customer orientation and financial performance. The same is true that by improving the learning and growth airlines can improve customer orientation, financial perspectives and the internal process perspectives. The study suggests airlines to carefully find ways to improve each perspective of the four BSC categories.

Direction to Future Study

To the best of our knowledge, this study is one of few attempts to assess the efficiency of major airline using three models (BSC, DEA and SFA) and propose a Frontier –envelopment-Scorecard model. Furthermore, we assessed the relative efficiency of airline on their operational performances based on time-series data (2007-2014). Despite our novel effort, first, this study is far from being perfect due in part to its reliance on the limited time frame and surrogate measures extracted from financial and traffic data. Second, this study used seven input variables as the leading factors and four output variables as the lagging factors to implement DEA and SFA. These factors may not be sufficient to all types of airlines.

Future studies might reconsider the input and output variables based on the objectives of each type of airlines. Third, the data are collected from the airlines website. This kind of information must be checked and triangulated using other source of data. Another limitation of this study includes the potential presence of an unobserved bias due to the limited variables in the DEA and SFA analysis.

To overcome some of the shortcomings of this study, future research efforts can be geared toward assessment of using other variables such as code sharing practices, airline service quality, labour quality, airlines business model and airfare pricing from both the airline and its customers' (airline passengers') perspectives, organizational culture, human resource practices, and branding which are difficult to quantify etc. In addition, there appears to be a lack of comparative efficiency evaluations between for-profit and non-profit institutions and types of ownership such as government or private etc.

Finally, our empirical study is one of the first attempts at investigating the operational efficiency. Due to the small size of the industry, fewer players and lack of detailed data, we could not consider other important factors, e.g., fleet variety, size, optimal routing, network structure etc. in this study. Future studies may consider these and other variables.

References

Aaron, H., & Hussain, G. R. (2010).The grounding of the "flying bank". *Management Decision*, [online] Vol. 48 Iss 7, p. 1048 – 1062. Available at: http://dx.doi.org/10.1108/00251741011068761 (accessed, 01 December 2016).

Abdel, M., and Ahmed, M.B. (2008). Create superior customer values: new direction for Middle Eastern airlines. *Education, Business and Society: Contemporary Middle Eastern Issues*, Vol. 1 Iss 4 pp. 287 – 299. Available at: http://dx.doi.org/10.1108/17537980810930009 (accessed, 01 December 2016).

Abdollah, N., Mahdi, M., & Reza, F. S. (2013). Evaluating relative value of customers via data envelopment analysis. *Journal of Business & Industrial Marketing*, [online] Vol. 28 Iss 7 pp. 577 – 588. Available at: http://dx.doi.org/10.1108/JBIM-11-2010-0144, (accessed, 01 December 2016).

Abdul, L.A. (2015). Income diversification and bank efficiency in an emerging market.*Managerial Finance*, [online] Vol. 41 Iss 12 pp. 1318 – 1335. Available at: http://dx.doi.org/10.1108/MF-12-2014-0304 (accessed, 01 December 2016).

Abdul-Hanan, A. (2016). Agricultural credit and technical efficiency in Ghana: is there a nexus? *Agricultural Finance Review*, [online] Vol. 76 Iss 2 pp. 309 – 324. Available at: http://dx.doi.org/10.1108/AFR-01-2016-0002 (accessed, 01 December 2016).

Abdulkareem, A., & Dr. Mamoun, N. A. (2016).New product development performance success measures: an exploratory research", EuroMed Journal of Business, [online] Vol. 11 Iss 1 pp. 2 – 29. Available at: http://dx.doi.org/10.1108/EMJB-12-2014-0043(accessed, 01 December 2016).

Abhay, K.S., Rajendra, S., & Shalini, B.(2010). Portfolio evaluation using OWA-heuristic algorithm and data envelopment analysis. *The Journal of Risk Finance*, [online] Vol. 11 Iss 1 pp. 75 – 88. Available at: http://dx.doi.org/10.1108/15265941011012697 (accessed, 01 December 2016).

Abhijeet, K. D. Ashok, R. T. and Vivek, K. S., (2013),"Green manufacturing performance measures: an empirical investigation from Indian manufacturing industries", *Measuring Business Excellence*, [online] Vol. 17 Iss 4 pp. 59 – 75. Available at: http://dx.doi.org/10.1108/MBE-09-2012-0046 (accessed, 01 December 2016).

Adishwar,K. and Jain Raymond, A.K. Cox, (2011). Airfare price insurance: a real option model. *The Journal of Risk Finance*, [online] Vol. 12 Iss 1 pp. 5 – 14. Available at: http://dx.doi.org/10.1108/15265941111100030 (accessed, 01 December 2016).

Aditi, B. and Raju, M. (2016). A generalized stochastic production frontier analysis of technical efficiency of rice farming. *Indian Growth and Development Review*, [online] Vol. 9 Iss 2 pp. 114

– 128. Available at: http://dx.doi.org/10.1108/IGDR-10-2015-0041(accessed, 01 December 2016).

Aditya, P., Uday, K., Diego, G., & Christer, S. (2015). Performance measurement and management for maintenance: a literature review. *Journal of Quality in Maintenance Engineering*, [online] Vol. 21 Iss 1 pp. 2 – 33. Available at: http://dx.doi.org/10.1108/JQME-10-2013-0067(accessed, 01 December 2016).

Adrien, C., Mark, G., & Sin-Hoon, H.(2009). Performance measurement in supply chain entities: balanced scorecard perspective. *Benchmarking: An International Journal*, [online] Vol. 16 Iss 5 pp. 605 – 620. Available at: http://dx.doi.org/10.1108/14635770910987832 (accessed, 01 December 2016).

Aegean Air (2016) *Annual Report* (2007-2014). Available at: https://en.about.aegeanair.com/investor-relations/annual-reports-information-bulletins/ (accessed, 20 April 2016).

Aeroflot (2016) *Annual Report* (2007-2014). Available at: http://www.aeroflot.com/ru-en/reports_item/369 (accessed, 17 April 2016).

Aeromexico (2016) *Annual Report* (2007-2014). Available at: http://aeromexico.com/investors/informacion-financiera/reportes-anuales.html (accessed, 20 April 2016).

Aibing, J., Hui, L., Hong-jie, Q., & Haobo, L.(2015). Data envelopment analysis with interactive variables. *Management Decision*, [online] Vol. 53 Iss 10 pp. 2390 – 2406. Available at: http://dx.doi.org/10.1108/MD-11-2014-0631(accessed, 01 December 2016).

Aidan, D.,Stephen, J. G., Michael, J. D., & Raymond, P. F. (2009). The impact of improvisation training on service employees in a European airline: a case study. *European Journal of Marketing*, [online] Vol. 43 Iss 3/4 pp. 459 – 472. Available at: http://dx.doi.org/10.1108/03090560910935532 (accessed, 01 December 2016).

Aigner, D., C.A.K. L., and Schmidt, P. (1977). Formulation and Estimation of Stochastic Frontier Production Function Models. Journal of Econometrics 6:21{37.

Air Berlin (2016) *Annual Report* (2007-2014). Available at: http://ir.airberlin.com/en/ir/financial-reports/interim-and-annual-reports/2016 (accessed, 19 April 2016).

Air china (2016) *Annual Report* (2007-2014). Available at: http://www.airchina.com.cn/en/investor_relations/financial_info_and_roadshow.shtml (accessed, 19 April 2016).

Air France-klm (2016) *Annual Report* (2007-2014). Available at: http://www.airfranceklm.com/en/finance/publications (accessed, 19 April 2016).

Air France-KLM (2016) *Annual Report* (2007-2014). Available at: http://airfranceklmfinance.fr/en/Financial-information/Annual-documents (accessed, 20 April 2016).

Air India (2016) *Annual Report* (2007 -2014). Available at: http://www.airindia.in/AnnualReport.htm?13 (accessed, 19 April 2016).

Air New Zealand (2016) *Annual Report* (2007-2014). Available at: http://www.airnewzealand.com.au/previous-reports (accessed, 20 April 2016).

Air Transat (2016) *Annual Report* (2007 -2014). Available at: http://www.transat.com/en/investors/financial.documents.aspx (accessed, 21 April 2016).

Airasia (2016) *Annual Report* (2007-2014). Available at: http://www.airasia.com/my/en/about-us/ir-annual-reports.page (accessed, 21 April 2016).

AirCanada (2016) *Annual Report* (2007-2014). Available at: http://www.aircanada.com/en/about/investor/reports.html (accessed, 16 April 2016).

Aki, J., & Juho-Matias, R. (2016).Visualization techniques supporting performance measurement system development. *Measuring Business Excellence*, [online] Vol. 20 Iss 2 pp. 13 – 25. Available at: http://dx.doi.org/10.1108/MBE-09-2014-0032 (accessed, 01 December 2016).

Aki, J., Harri, L., & Antti, L. (2014). Distinctive features of service performance measurement. *International Journal of Operations & Production Management*, [online] Vol. 34 Iss 12 pp. 1466 – 1486. Available at: http://dx.doi.org/10.1108/IJOPM-02-2013-0067 (accessed, 01 December 2016).

Aki, J., Harri, L., Antti, L., Miikka, P., Virpi, S.,Sanna, P., & Juhani, U.(2012). A contingency approach to performance measurement in service operations. *Measuring Business Excellence*, [online] Vol. 16 Iss 1 pp. 43 – 52. Available at: http://dx.doi.org/10.1108/13683041211204662 (accessed, 01 December 2016).

Alexander, K., Michael, S., & Armin, W. (2012). Measuring the efficiency of English Premier League football. *Sport, Business and Management: An International Journal*, [online] Vol. 2 Iss 3 pp. 177 -195. Available at: http://dx.doi.org/10.1108/20426781211261502 (accessed, 01 December 2016).

Alireza, T., & Elkafi, H.(2015). Performance measurement of sustainable supply chains: a review and research questions. *International Journal of Productivity and Performance Management*, [online] Vol. 64 Iss 6 pp. 744 – 783. Available at: http://dx.doi.org/10.1108/IJPPM-03-2013-0056, (accessed, 01 December 2016).

Alka, A. N., Prakash, J. S., & Damien, P.(2013).Testing an integrated model of operations capabilities. *International Journal of Operations & Production Management*, [online] Vol. 33 Iss 7 pp. 887 – 911. Available at: http://dx.doi.org/10.1108/IJOPM-12-2011-0484 (accessed, 01 December 2016).

Allegiant Air (2016) *Annual Report* (2007-2014). Available at: http://ir.allegiantair.com/phoenix.zhtml?c=197578&p=irol-reportsAnnual_pdf (accessed, 20 April 2016).

Alok, K. S. (2015). Modelling passengers' future behavioural intentions in airline industry using SEM. *Journal of Advances in Management Research*, [online] Vol. 12 Iss 2 pp. 107 – 127. Available at: http://dx.doi.org/10.1108/JAMR-06-2014-0033(accessed, 01 December 2016).

Alok, K. S.(2013). Modelling enablers of TQM to improve airline performance. *International Journal of Productivity and Performance Management,* [online] Vol. 62 Iss 3 pp. 250 – 275. Available at: http://dx.doi.org/10.1108/17410401311309177 (accessed, 01 December 2016).

Alok, K.S. (2016). Competitive service quality benchmarking in airline industry using AHP. *Benchmarking: An International Journal*, [online] Vol. 23 Iss 4 pp. 768 - 791. Available at: http://dx.doi.org/10.1108/BIJ-05-2013-0061(accessed, 01 December 2016).

Alok, M., Dangayach, G.S., Mittal, M.L., & Milind, K. S. (2011). Performance measurement in automated manufacturing. *Measuring Business Excellence*, [online] Vol. 15 Iss 1 pp. 77 - 91. Available at: http://dx.doi.org/10.1108/13683041111113268 (accessed, 01 December 2016).

Amel Ben, H. S.(2013). Performance measurement practices in software ecosystem. *International Journal of Productivity and Performance Management*, [online] Vol. 62 Iss 5 pp. 514 – 533. Available at: (accessed, 01 December 2016).

Amirteimoori, A. & Kordrostami, S. (2010). A Euclidean Distance-based Measure of Efficiency in Data Envelopment Analysis. *Optimization*, Vol. 59, No.7, pp. 985-996.

Amit, V., Mukul, K., & Mudit, K. (2012). Efficiency evaluation of municipal solid waste management utilities in the urban cities of the state of Madhya Pradesh, India, using stochastic frontier analysis. *Benchmarking: An International Journal*, [online]Vol. 19 Iss 3 pp. 340 – 357. Available at: http://dx.doi.org/10.1108/14635771211242996 (accessed, 01 December 2016).

Amjad, D. Al., & Abdel, R.Y. (2011). Information theoretic approach for constructing a super data envelopment analysis. *Asian Journal on Quality*, [online] Vol. 12 Iss 1 pp. 54 – 66. Available at: http://dx.doi.org/10.1108/15982681111140543 [Accessed, 01 December 2016].

ANA (2016) *Annual Report* (2007-2014). Available at: https://www.ana.co.jp/group/en/investors/irdata/annual/ (accessed, 19 April 2016).

Anastasia, K.,Dimitris, M.,& Christos, S.(2009). Profit efficiency under a directional technology distance function approach. *Managerial Finance*, [online] Vol. 35 Iss 3 pp. 276 – 296. Available at: http://dx.doi.org/10.1108/03074350910931780 (accessed, 01 December 2016).

Andreas, W., & Hans, W. A.(2015). Benchmarking the efficiencies of Indonesia's municipal water utilities using Stackelberg data envelopment analysis. *Benchmarking: An International Journal*, [online] Vol. 22 Iss 4 pp. 588 – 609. Available at: http://dx.doi.org/10.1108/BIJ-01-2014-0009 (accessed, 01 December 2016).].

Andreia, P.B., Sergio E. G., Edson, P. L., & Lilian, A. B. (2016). Measuring environmental performance in hospitals: a framework and process. *Measuring Business Excellence*, [online] Vol. 20 Iss 2 pp. 52 – 64. Available at: http://dx.doi.org/10.1108/MBE-03-2015-0011 (accessed, 01 December 2016).

Andrey, P., & Mike, B. (2011). Explaining the effects of performance measurement on performance. *International Journal of Operations & Production Management*, [online] Vol. 31 Iss 1 pp. 101 – 122. Available at: http://dx.doi.org/10.1108/01443571111098762 (accessed, 01 December 2016).

Anup, K., Kampan, M., & Amit, A.(2015). Dynamic performance assessment of a supply chain process. *Business Process Management Journal*, [online] Vol. 21 Iss 4 pp. 743 – 770. Available at: http://dx.doi.org/10.1108/BPMJ-09-2014-0086 (accessed, 01 December 2016).

Aradhana, G., & Ravi, S. (2014). Efficiency measurement of Indian retailers using Data Envelopment Analysis. *International Journal of Retail & Distribution Management*, [online] Vol. 42 Iss 6 pp. 500 - 520. Available at: http: //dx.doi.org/10.1108/IJRDM-10-2012-0094 (accessed, 01 December 2016).

Aradhana, G., & Ravi, S. (2016). Strategic resource management model and data envelopment analysis for benchmarking of Indian retailers. *Benchmarking: An International Journal*, [online] Vol. 23 Iss 2 pp. 286 – 312. Available at: http://dx.doi.org/10.1108/BIJ-02-2014-0013 (accessed, 01 December 2016).

Arash, S., Angappa, G., Azam, K., & Hadi, S. (2016). A new approach for estimating leagile decoupling point using data envelopment analysis. *Assembly Automation*, [online] Vol. 36 Iss 3 pp. 233 – 245 Available at: http://dx.doi.org/10.1108/AA-07-2015-063 (accessed, 01 December 2016).

Arash, S., Javad, S. N., & Javad, K. P. (2014). Developing a model for the influence of perceived organizational climate on organizational citizenship behaviour and organizational performance based on balanced score card. *International Journal of Productivity and Performance Management*, [online] Vol. 63 Iss 3 pp. 290 – 307 Available at: http://dx.doi.org/10.1108/IJPPM-03-2013-0044 (accessed, 01 December 2016).

Arne, H. (2014) Introduction to Econometric Production Analysis with R; Department of Food and Resource Economics, University of Copenhagen.

Asiana Airlines (2016) *Annual Report* (2007-2014). Available at: https://us.flyasiana.com/C/en/homepage.do?menuId=005006003000000&menuType=CMS (accessed, 19 April 2016).

Asosheh, A., Nalchigar, S., & Jamporazmey, M. (2010). Information technology project evaluation: an integrated data envelopment analysis and balanced scorecard approach. Expert *Systems with Applications: An International Journal*, [online] Vol. 37 No. 8, pp. 5931-5938 (accessed, 01 December 2016).

Atlas Air (2016) *Annual Report* (2007-2014). Available at: http://www.atlasair.com/holdings/financial-reports.asp (accessed, 01 December 2016).

Atri, S., Venkatesh, D.N., & Arun, K. S.(2013). Developing performance-linked competency model: a tool for competitive advantage. *International Journal of Organizational Analysis*, [online] Vol. 21 Iss 4 pp. 504 – 527 Available at: http://dx.doi.org/10.1108/IJOA-05-2011-0488 (accessed, 01 December 2016).

Avianca holdings (2016) *Annual Report* (2007-2014). Available at: http://www.avianca.com/en-hn/our-company/corporate-information/investor-relations.aspx (accessed, 21 April 2016).

Avianca holdings (2016) *Annual Report* (2007-2014). Available at: http://www.aviancaholdings.com/en/annual-reports (accessed, 21 April 2016).

Avianca holdings (2016) *Annual Report* (2007-2014). Available at: http://www.aviancaholdings.com/en/financial-statements (accessed, 21 April 2016).

Azzouz, E. (2015). The relationship between budgetary evaluation, firm size and performance. *Journal of Management Development*, [online] Vol. 34 Iss 8 pp. 973 – 986 Available at: http://dx.doi.org/10.1108/JMD-06-2014-0053 (accessed, 01 December 2016).

Baliga, B.R., Moyer, R.C., & Rao, R.S. (1996). CEO duality and firm performance: what's the fuss? *Strategic Management Journal*, Vol. 17 No. 1, pp. 41-53.

Barry, W., & Richard, M. (2008). Evaluating the performance of open source software projects using data envelopment analysis. *Information Management & Computer Security*, [online] Vol. 16 Iss 5 pp. 449 – 462 Available at: http://dx.doi.org/10.1108/09685220810920530 (accessed, 01 December 2016).

Bart, W. & Sander, D. (2016). Benchmarking deep-sea port performance in the HamburgLe Havre range. *Benchmarking: An International Journal,* [online] Vol. 23 Iss 1 pp. 96 – 112, Available at: http://dx.doi.org/10.1108/BIJ-04-2013-0050m (accessed, 01 December 2016).

Bee,Y.L., & Pei, P.T. (2014). Gaining customer knowledge in low cost airlines through text mining. *Industrial Management & Data Systems*, [online] Vol. 114 Iss 9 pp. 1344 – 1359, Available at: http://dx.doi.org/10.1108/IMDS-07-2014-0225 (accessed, 01 December 2016).

Belinda, L., Jo, B., & Robyn, E. (2013). Measurement as legitimacy versus legitimacy of measures. *Qualitative Research in Accounting & Management*, [online] Vol. 10 Iss 3/4 pp. 234 – 258 Available at: http://dx.doi.org/10.1108/QRAM-08-2012-0034 (accessed, 01 December 2016).

Belobaba, P., Odoni, A. & Barnhart, C. (2009) The Global Airline Industry, Wiley, London.

Bereket, Z. G., & Hailemichael, T. G. (2016). Technical efficiency of Microfinance Institutions (MFIs). *International Journal of Development Issues*, [online] Vol. 15 Iss 3 pp. 224 - 239 Available at: http://dx.doi.org/10.1108/IJDI-04-2016-0026 (accessed, 01 December 2016).

Beriha, G.S., Patnaik, B., & Mahapatra, S.S. (2011),"Safety performance evaluation of Indian organizations using data envelopment analysis", Benchmarking: An International Journal, Vol. 18 Iss 2 pp. 197 – 220 http://dx.doi.org/10.1108/14635771111121676, (accessed, 01 December 2016).

Bernadette, N. K. (2015). Evaluating implementation of strategic performance management practices in universities in Uganda. Measuring *Business Excellence*, [online] Vol. 19 Iss 2 pp. 42 – 56 Available at: http://dx.doi.org/10.1108/MBE-06-2014-0017 (accessed, 01 December 2016).

Bernhard, S., Andreas, B., Jens, W., & Peter, U. (2010). Balanced score card implementation for IP rights management in a public research institution. Measuring Business Excellence, [online] Vol. 14 Iss 4 pp. 65 – 75 Available at: http://dx.doi.org/10.1108/13683041011093767 (accessed, 01 December 2016).

Bjelicic, B. (2012). Financing airlines in the wake of the airline markets crisis. *Journal of Air Transport Management*, Vol. 21, pp. 10-16.

Bogetoft, P., and Otto, L. (2011) Benchmarking with DEA, SFA, and R, International Series in Operations Research & Management Science , Springer Science Business Media, LLC 2011.

Byoung, K.C., Hyoung, K. M., & Wook, K. (2013). An organization's ethical climate, innovation, and performance. *Management Decision*, [online] Vol. 51 Iss 6 pp. 1250 – 1275 Available at: http://dx.doi.org/10.1108/MD-Sep-2011-0334(accessed, 01 December 2016).

Carlos, P. B., & Ricardo, S. (2008). Analysing cost efficiency in Spanish retailers with a random frontier model. International Journal of Retail & Distribution Management, [online] Vol. 36 Iss 11 pp. 883 -900, http://dx.doi.org/10.1108/09590550810911665 (accessed, 01 December 2016).

Carol A. A., Stephen, M., & Zahirul, H. (2014),"Measurement of sustainability performance in the public sector", Sustainability Accounting, Management and Policy Journal, [online] Vol. 5 Iss 1 pp. 46 – 67 http://dx.doi.org/10.1108/SAMPJ-04-2012-0018 (accessed, 01 December 2016).

Caroline, F., Michael, M. P., Jerry, R. G., & Marina, H. O.(2010),"Developing measurements of success for performing musical groups", Journal of Services Marketing, [online] Vol. 24 Iss 4 pp. 325 – 334, http://dx.doi.org/10.1108/08876041011053033(accessed, 01 December 2016).

Carolyn, C., & Rowena, S. (2013),"Measuring performance in the third sector", Qualitative Research in Accounting & Management, [online] Vol. 10 Iss 3/4 pp. 196 – 212, http://dx.doi.org/10.1108/QRAM-03-2013-0014 (accessed, 01 December 2016).

Casado-Díaz, B. A., Nicolau, L. J., Ruiz-Moreno, F., & Sellers, R. (2014). Industry-specific effect of CSR initiatives: hotels and airlines. Kybernetes, [online] Vol. 43 Iss 3/4 pp. 547 – 564, Available at: http://dx.doi.org/10.1108/K-12-2013-0271(accessed, 01 December 2016).

Catarina, M. C., & Geetha, R. (2015),"Productivity growth and convergence: a stochastic frontier analysis", Journal of Economic Studies, [online] Vol. 42 Iss 2 pp. 224 – 236, http://dx.doi.org/10.1108/JES-08-2013-0121 (accessed, 01 December 2016).

Cathay Pacific (2016) *Annual Report* (2007-2014). Available at: http://www.cathaypacific.com/cx/en_US/about-us/investor-relations/interim-annual-reports.html (accessed, 16 April 2016).

Cebu Pacific Air (2016) *Annual Report* (2007-2014). Available at: https://www.cebupacificair.com/about-us/Pages/annual-reports.aspx (accessed, 21 April 2016).

Chaiwat, R., & Theo, V. (2015),"Measuring the added value of workplace change", Facilities, [online] Vol. 33 Iss 11/12 pp. 773 – 792, http://dx.doi.org/10.1108/F-12-2014-0095 (accessed, 01 December 2016).

Changiz, V., & Mohsen, A. (2015),"The impact of knowledge management practices on organizational performance", Journal of Enterprise Information Management, [online] Vol. 28 Iss 1 pp. 131 - 159, http://dx.doi.org/10.1108/JEIM-09-2013-0066 (accessed, 01 December 2016).

Charles, D., Sara,V., & Cathy, M. 2015),"Measuring while moving (humanitarian supply chain performance measurement – status of research and current practice)", Journal of Humanitarian Logistics and Supply Chain Management, [online] Vol. 5 Iss 2 pp. 146 - 161 http://dx.doi.org/10.1108/JHLSCM-04-2013-0016 (accessed, 01 December 2016).

Charles, J. P. (2009),"A balanced scorecard model with incremental analysis for the motor homes industry based on survey results", Competitiveness Review: An International Business

Journal, [online] Vol. 19 Iss 1 pp. 63 – 80, http://dx.doi.org/10.1108/10595420910929077 (accessed, 01 December 2016).

Charles, K.D. Adjasi, (2009),"Macroeconomic uncertainty and conditional stock-price volatility in frontier African markets", The Journal of Risk Finance, Vol. 10 Iss 4 pp. 333 – 349, http://dx.doi.org/10.1108/15265940910980641, (accessed, 01 December 2016).

Chen, T., Chen, C., & Peng, S. (2008), "Firm operation performance analysis using data envelopment analysis and balanced scorecard: a case study of a credit cooperative bank", International Journal of Productivity and Performance Management, Vol. 57 No. 7, pp. 523-539.

Chenchen, Y., Feng, Y., Qiong, X., & Sheng, A. (2012),"What makes sales in Chinese shampoo industry?", Asia Pacific Journal of Marketing and Logistics, Vol. 24 Iss 4 pp. 678 – 689, http://dx.doi.org/10.1108/13555851211259089, (accessed, 01 December 2016).

China Airlines (2016) *Annual Report* (2007 -2014). Available at: https://www.china-airlines.com/it/en/investor-relations/annual-report (Accessed: 21 April 2016).

Chris, K. Z., & Pedro, M. R. (2010),"Airlines' plight: where has all the luggage gone?", Management Research Review, Vol. 33 Iss 7 pp. 767 – 782, http://dx.doi.org/10.1108/01409171011055834 (accessed, 01 December 2016).

Christine, F. D., Daniel, J. P., Sander, S., & Göran, S. (2013),"Perceived justice in South African airline and hospital industries: measurement model", International Journal of Quality and Service Sciences, Vol. 5 Iss 2 pp. 120 – 139, http://dx.doi.org/10.1108/IJQSS-04-2013-0021 (accessed, 02 December 2016).

Chunyan, D., Yacheng, X., & Weiyin, L. (2014),"Performance evaluation of the science and technology policy in Chongqing", Journal of Science and Technology Policy Management, Vol. 5 Iss 2 pp. 122 – 135 http://dx.doi.org/10.1108/JSTPM-02-2014-0005, (accessed, 01 December 2016).

Claire, M. (2014),"Understanding third sector performance measurement system design: a literature review", International Journal of Productivity and Performance Management, Vol. 63 Iss 6 pp. 704 – 726 http://dx.doi.org/10.1108/IJPPM-08-2013-0143, (accessed, 01 December 2016).

Coelli, T.J., Rao, D.S.P., O'Donnell, C.J, & Battese, G.E. (2005). An Introduction to Efficiency and Productivity Analysis, 2nd ed. New York: Springer.

Constantine, M., Alexandros, A., & George, D. (2013),"Using data envelopment analysis to measure hotel efficiency in Crete", International Journal of Contemporary Hospitality Management, Vol. 25 Iss 4 pp. 510 – 535, http://dx.doi.org/10.1108/09596111311322907, (accessed, 01 December 2016).

Copa Holdings (2016) *Annual Report* (2007 -2012). Available at: http://investor.shareholder.com/copa/annuals.cfm (Accessed: 20 April 2016).

Craig, L. (2014),"Construction efficiency: a tale of two developed countries", Engineering, Construction and Architectural Management, Vol. 21 Iss 3 pp. 320 – 335, http://dx.doi.org/10.1108/ECAM-02-2013-0014, (accessed, 01 December 2016).

Craig, M. R., Clemens, K., & Bryan, T. A. (2016),"Performance measures for road managers facing diverse environments", Benchmarking: An International Journal, Vol. 23 Iss 7 pp. 1876 – 1891, http://dx.doi.org/10.1108/BIJ-01-2015-0005, (accessed, 01 December 2016).

Daniel, Bryan., Guy, D. F., & Arindam, T. (2013),"Bankruptcy risk, productivity and firm strategy", Review of Accounting and Finance, Vol. 12 Iss 4 pp. 309 – 326, http://dx.doi.org/10.1108/RAF-06-2012-0052, (accessed, 01 December 2016).

Daniel, C.W. H., & Ervi, L. (2016),"Measuring the performance of property management companies in high-rise flats", Facilities, Vol. 34 Iss 3/4 pp. 161 – 176, http://dx.doi.org/10.1108/F-06-2014-0056, (accessed, 01 December 2016).

Daniela P. B. (2011),"Adaptation of allocation of resources and attention in response to external shocks", Management Research Review, Vol. 34 Iss 3 pp. 284 – 293, http://dx.doi.org/10.1108/01409171111116303, (accessed, 01 December 2016)

David, A. M. (2016),"Assessing the research efficiency of higher education institutions in Chile", International Journal of Educational Management, Vol. 30 Iss 6 pp. 809 – 825, http://dx.doi.org/10.1108/IJEM-03-2015-0022, (accessed, 01 December 2016).

David, A. M., & Juan, P. Q. (2016),"Assessing the efficiency of secondary schools in Chile: a data envelopment analysis", Quality Assurance in Education, Vol. 24 Iss 3 pp. 306 – 328, http://dx.doi.org/10.1108/QAE-05-2015-0022, (accessed, 01 December 2016).

David, M., & Rosa, R. (2006),"Performance evaluation considering the coskewness", Managerial Finance, Vol. 32 Iss 4 pp. 375 – 392, http://dx.doi.org/10.1108/03074350610652279, (accessed, 01 December 2016).

Dawna, L. R., & Blaise, W. J. (2008),"Twenty years of service quality performance in the US airline industry", Managing Service Quality: An International Journal, Vol. 18 Iss 1 pp. 20 – 33, http://dx.doi.org/10.1108/09604520810842821 (accessed, 01 December 2016).

Delta airlines (2016) *Annual Report* (2007-2014). Available at: http://ir.delta.com/stock-and-financial/sec-filings/ (Accessed: 20 April 2016).

Dexiang, W., & Desheng, D. W. (2010),"Performance evaluation and risk analysis of online banking service", Kybernetes, Vol. 39 Iss 5 pp. 723 – 734, http://dx.doi.org/10.1108/03684921011043215 (accessed, 01 December 2016).

Dinesh, K. U., Haritha, S., José, E. R., & David, N. (2007),"Six sigma project selection using data envelopment analysis", The TQM Magazine, Vol. 19 Iss 5 pp. 419 – 441, http://dx.doi.org/10.1108/09544780710817856, (accessed, 01 December 2016).

Dipasha, S., Anil, K. S., & Mukesh, K. B. (2013),"Efficiency and productivity of banking sector", Qualitative Research in Financial Markets, Vol. 5 Iss 2 pp. 195 – 224, http://dx.doi.org/10.1108/QRFM-10-2011-0025, (accessed, 01 December 2016).

Dorothea, G. (2006),"Performance measurement: a remedy for increasing the efficiency of public services?", International Journal of Productivity and Performance Management, Vol. 55 Iss 6 pp. 448 – 465 http://dx.doi.org/10.1108/17410400610682488, (accessed, 01 December 2016).

EasyJet (2016) *Annual Report* (2007-2014). Available at: http://corporate.easyjet.com/investors/reports-and-accounts.aspx?sc_lang=en (Accessed: 20 April 2016).

Edward, R. B., Michael, Y. H., & Wei, (Andrew) H. (2009),"Cross-national segmentation", European Journal of Marketing, Vol. 43 Iss 11/12 pp. 1498 – 1522, http://dx.doi.org/10.1108/03090560910990009 (accessed, 02 December 2016).

Eero, J. P.,Timo, H. L., & Samuli, H.J.V. (2010),"Enhancement of value portfolio performance using data envelopment analysis", Studies in Economics and Finance, Vol. 27 Iss 3 pp. 223 – 246, http://dx.doi.org/10.1108/10867371011060036, (accessed, 01 December 2016).

Ehsan, H. F., Sanjay, G., & Raymond, L. R. (2008),"Performance measurement for accountability in corporate governance ", Review of Accounting and Finance, Vol. 7 Iss 2 pp. 121 – 130, http://dx.doi.org/10.1108/14757700810874100, (accessed, 01 December 2016).

EL AL (2016) *Annual Report* (2007 -2014). Available at: http://www.elal.com/en/About-ELAL/About-ELAL/Investor-Relations/FinancialInformation/Pages/2009.aspx (Accessed: 21 April 2016).

Elena, G., & Maria, P. M. (2013),"The challenges of integrated performance measurement systems", Accounting, Auditing & Accountability Journal, Vol. 26 Iss 6 pp. 978 – 1008, http://dx.doi.org/10.1108/AAAJ-04-2013-1312, (accessed, 01 December 2016).

Emirates (2016) *Annual Report* (2007 -2014). Available at: http://www.emirates.com/et/english/about/annual-reports.aspx (accessed, 21 April 2016).

Eric, G. F. (2009),"Towards using organizational measurements to assess corporate performance", Journal of Human Resource Costing & Accounting, Vol. 13 Iss 2 pp. 105 – 117, http://dx.doi.org/10.1108/14013380910968629,(accessed, 01 December 2016)

Erin, K., & Lee, W.B. (2009),"Knowledge elicitation in reliability management in the airline industry", Journal of Knowledge Management, Vol. 13 Iss 2 pp. 35 – 48, http://dx.doi.org/10.1108/13673270910942682 (accessed, 01 December 2016).

Ethiad (2016) *Annual Report* (2007 -2014). Available at: http://www.etihad.com/en-us/about-us/corporate-profile/ (Accessed: 17 April 2016).

Ethiopian Airlines (2016) *Annual Report* (2007-2014). Available at: https://www.ethiopianairlines.com/corporate/media/news/performance-reports (accessed: 16 April 2016).

Eva Air (2016) *Annual Report* (2007-2014). Available at: http://www.evaair.com/en-global/investor-relations/financial-reports/ (accessed, 17 April 2016).

Evangelos, P., & Dimitrios, K. (2014),"Performance measures of ISO 9001 certified and noncertified manufacturing companies", Benchmarking: An International Journal, Vol. 21 Iss 5 pp. 756 – 774, http://dx.doi.org/10.1108/BIJ-04-2012-0028, (01 December 2016).

Fadzlan, S. (2007),"Trends in the efficiency of Singapore's commercial banking groups", International Journal of Productivity and Performance Management, Vol. 56 Iss 2 pp. 99 – 136, http://dx.doi.org/10.1108/17410400710722626, (accessed, 03 December 2016).

Fadzlan, S. (2011),"Benchmarking the efficiency of the Korean banking sector: a DEA approach", Benchmarking: An International Journal, Vol. 18 Iss 1 pp. 107 – 127.

Fakarudin, K., Fadzlan, S., & Annuar, Md. N. (2016),"Does country governance foster revenue efficiency of Islamic and conventional banks in GCC countries?" EuroMed Journal of Business, Vol. 11 Iss 2 pp. 181 – 211, http://dx.doi.org/10.1108/EMJB-06-2015-0026, (accessed, 01 December 2016).

Farhana, I., Shabri, Abd. M., & Rossazana, Ab. R. (2013),"Efficiency of Islamic and conventional banks in Malaysia", Journal of Financial Reporting and Accounting, Vol. 11 Iss 1 pp. 92 - 107http://dx.doi.org/10.1108/JFRA-03-2013-0011, (accessed, 01 December 2016).

Fariborz, R., & Naghmeh, K. (2016),"Objectives priority in university strategy map for resource allocation", Benchmarking: An International Journal, Vol. 23 Iss 2 pp. 371 – 387, http://dx.doi.org/10.1108/BIJ-09-2013-0094, (accessed, 01 December 2016).

FedEx (2014) *Annual Report* (2007-2014). Available at: http://annualreport.van.fedex.com/2014/(Accessed: 20 April 2016).

Fekri, A. S., Mohamed, A., Shaikh Hamzah, A. R. (2015),"Efficiency assessment of banking sector in Yemen using data envelopment window analysis", Benchmarking: An International Journal, Vol. 22 Iss 6 pp. 1115 – 1140, http://dx.doi.org/10.1108/BIJ-10-2014-0097, (accessed, 01 December 2016).

Fernando, A., & Slaibe, P. (2016),"Oil windfalls and X-inefficiency: evidence from Brazil", Journal of Economic Studies, Vol. 43 Iss 5 pp. 699 – 718, http://dx.doi.org/10.1108/JES-02-2014-0036 (accessed, 01 December 2016).

Finnair Group (2016) *Annual Report* (2007-2014). Available at: http://www.finnairgroup.com/group/group_12_2.html (accessed, 17 April 2016).

Francesco, S., & Giovanni, S. (2010),"Using performance measures in public organisations: challenges of Italian public administrations", Measuring Business Excellence, Vol. 14 Iss 3 pp. 70 – 84 http://dx.doi.org/10.1108/13683041011074227, (accessed, 01 December 2016).

Fu, W. Y., & Kwok, T. C. (2013),"Energy management of chiller systems by data envelopment analysis", Facilities, Vol. 31 Iss 3/4 pp. 106 – 118, http://dx.doi.org/10.1108/02632771311299395, (accessed, 01 December 2016).

Garcı´a-Valderrama, T., Mulero-Mendigorri, E. & Revuelta-Bordoy, D. (2009), “Relating the perspectives of the balanced scorecard for R&D by means of DEA”, European Journal of Operational Research, Vol. 196 No. 3, pp. 1177-1189.

Garuda Indonesia (2016) *Annual Report* (2007-2014). Available at: https://www.garuda-indonesia.com/id/en/investor-relations/financial-report-and-presentations/annual-report/index.page (Accessed: 19 April 2016).

Geert, J.M. B., Jos, B., & Stefan, H. (2007),"The balanced scorecard in The Netherlands", Journal of Organizational Change Management, Vol. 20 Iss 6 pp. 866 – 879, http://dx.doi.org/10.1108/09534810710831064, (accessed, 01 December 2016).

Gengui, Z., Hokey, M., Chao, X., & Zhenyu, C. (2008),"Evaluating the comparative efficiency of Chinese third-party logistics providers using data envelopment analysis", International Journal of Physical Distribution & Logistics Management, Vol. 38 Iss 4 pp. 262 – 279, http://dx.doi.org/10.1108/09600030810875373, (accessed, 01 December 2016).

George, A., & Josiassen, A. (2011). The operational performance of UK airlines: 2002-2007. *Journal of Economic Studies*, [online] Vol. 38 Iss 1, p. 5 – 16. Available at: http://dx.doi.org/10.1108/01443581111096114 (accessed, 01 December 2016).

George, C. L. B., & Carlos, F. G. (2016),"Performance measurement in airport settings: a systematic literature review", Benchmarking: An International Journal, Vol. 23 Iss 4 pp. 1027 – 1050 http://dx.doi.org/10.1108/BIJ-10-2015-0099, (accessd,01 December 2016).

George, H. (2015),"Performance measurement effects on organizational responses to threats", Measuring Business Excellence, Vol. 19 Iss 1 pp. 24 – 32, http://dx.doi.org/10.1108/MBE-11-2014-0048 (accessed, 01 December 2016).

Geraint, H. (2009),"Employment relations in liberal market economy airlines", Employee Relations, Vol.31 Iss 2 pp. 168 – 181, http://dx.doi.org/10.1108/01425450910925319, (accessed, 01 December 2016).

Girish, P. (2007),"Assessing international tourists' perceptions of service quality at Air Mauritius", International Journal of Quality & Reliability Management, Vol. 24 Iss 5 pp. 492 – 514, http://dx.doi.org/10.1108/02656710710748367, (accessed, 01 December 2016).

Giulia, S., Hella, A., Matthias, K., & Alberto, R. (2015),"Humanitarian supply chains and performance measurement schemes in practice", International Journal of Productivity and Performance Management, Vol. 64 Iss 6 pp. 784 – 810, http://dx.doi.org/10.1108/IJPPM-11-2013-0185 (accessed, 01 December 2016).

Giustina, S., & Gianluca, E. (2014),"A performance measurement system for academic entrepreneurship: a case study", Measuring Business Excellence, Vol. 18 Iss 3 pp. 23 - 37 http://dx.doi.org/10.1108/MBE-11-2013-0061, (accessed, 01 December 2016).

Giustina, S., Christle, D. B., & Giuseppina, P. (2016),"Measuring university technology transfer efficiency: a maturity level approach", Measuring Business Excellence, Vol. 20 Iss 3 pp. 42 – 54 http://dx.doi.org/10.1108/MBE-03-2016-0018, (accessed, 02 December 2016).

Godfrey, Y., & Vincent, M. (2008),"ISO 9000 certification and technical efficiency of foreign-financed manufacturing firms in southern China", Journal of Economic Studies, Vol. 35 Iss 5 pp. 385 – 404, http://dx.doi.org/10.1108/01443580810903545, (accessed, 01 December 2016).

Gour,C. S., & Theingi (2009),"Service quality, satisfaction, and behavioural intentions", Managing Service Quality: An International Journal, Vol. 19 Iss 3 pp. 350 – 372, http://dx.doi.org/10.1108/09604520910955348, (accessed, 01 December 2016).

Gunjan, M. S. (2007),"Measuring efficiency of the hotel and restaurant sector: the case of India", International Journal of Contemporary Hospitality Management, Vol. 19 Iss 5 pp. 378 – 387, http://dx.doi.org/10.1108/09596110710757543, (accessed, 01 December 2016).

Hamad, A., Andrew, P., & Mohamed, N. (2007),"An outsourcing decision model for airlines' MRO activities", Journal of Quality in Maintenance Engineering, Vol. 13 Iss 3 pp. 217 – 227, http://dx.doi.org/10.1108/13552510710780258 (accessed, 01 December 2016).

Hana, H., Dag, N., & Andreas, N. (2016),"Framework for measuring performance of the sales and operations planning process", International Journal of Physical Distribution & Logistics Management, Vol. 46 Iss 9 pp. 809 – 835, http://dx.doi.org/10.1108/IJPDLM-05-2016-0139, (accessed, 01 December 2016).

Hannigan, T.J., Robert, D. H. III, & Ram, M. (2015),"Competition and competitiveness in the US airline industry", Competitiveness Review, Vol. 25 Iss 2 pp. 134 – 155, http://dx.doi.org/10.1108/CR-11-2014-0036, (accessed, 01 December 2016).

Hawaiian Airlines (2016) *Annual Report* (2007-2014). Available at: https://newsroom.hawaiianairlines.com/investor-relations/reports (accessed, 21 April 2016).

He-Boong, K., Jooh, L., & James, J. R. (2016),"Best performance modelling using complementary DEA-ANN approach", Benchmarking: An International Journal, Vol. 23 Iss 3 pp. 704 - 721, http://dx.doi.org/10.1108/BIJ-09-2014-0083, (accessed, 01 December 2016).

He-Boong, K., Philipp, A. S., & Seong-Jong, J. (2008),"Measuring comparative efficiencies and merger impacts of wireless communication companies", Benchmarking: An International Journal, Vol. 15 Iss 3 pp. 212 – 224, http://dx.doi.org/10.1108/14635770810876566, (accessed, 01 December 2016).

Héctor, R., & Augusto, V. (2014),"A frontier-based hierarchical clustering for airport efficiency benchmarking", Benchmarking: An International Journal, Vol. 21 Iss 4 pp. 486 – 508, http://dx.doi.org/10.1108/BIJ-09-2012-0057, (accessed, 01 December 2016).

Heidi, R, Johanna, A., & Suvi, N. (2010),"Using balanced scorecard in operationalising FM strategies", Journal of Corporate Real Estate, Vol. 12 Iss 4 pp. 279 – 288, http://dx.doi.org/10.1108/14630011011094694, (accessed, 01 December 2016).

Hill, C.W., Hitt, M.A. & Hoskisson, R.E. (1992), "Cooperative vs. competitive structures in diversified firms", Organization Science, Vol. 3 No. 4, pp. 501-521.

Hokey, M., & Hyesung, M. (2015),"Benchmarking the service quality of airlines in the United States: an exploratory analysis", Benchmarking: An International Journal, Vol. 22 Iss 5 pp. 734 – 751 http://dx.doi.org/10.1108/BIJ-03-2013-0029, (accessed, 01 December 2016).

Hokey, M., & Hyesung, M., & Seong-Jong, J. (2008),"A data envelopment analysis-based balanced scorecard for measuring the comparative efficiency of Korean luxury hotels", International Journal of Quality & Reliability Management, Vol. 25 Iss 4 pp. 349 – 365, http://dx.doi.org/10.1108/02656710810865249 (accessed, 01 December 2016).

Hokey, M., & Seong-Jong, J. (2009),"Benchmarking third-party logistics providers using data envelopment analysis: an update", Benchmarking: An International Journal, Vol. 16 Iss 5 pp. 572 – 587, http://dx.doi.org/10.1108/14635770910987814, (accessed, 01 December 2016).

Hsin-Hung, C. (2008),"Stock selection using data envelopment analysis", Industrial Management & Data Systems, Vol. 108 Iss 9 pp. 1255 – 1268, http://dx.doi.org/10.1108/02635570810914928 (accessed, 01 December 2016).

Huseyin, A. (2012),"The efficiency of police stations in the city of Ankara: an application of data envelopment analysis", Policing: An International Journal of Police Strategies & Management, Vol. 35 Iss 1 pp. 25 – 38, http://dx.doi.org/10.1108/13639511211215432, (accessed, 01 December 2016).

IATA – International Air Transport Association (2009) "Airlines to Lose $5.2 billion in 2009 – Slowing Demand and High Oil to Blame," Press Release, September 3.

IATA. (2015), "About Us", Available: http://www.iata.org/about/Pages/index.aspx, (accessed, 17 July 2015.

Ibrahim, H. G. (2014),"Performance analysis and measurement of reconfigurable manufacturing systems", Journal of Manufacturing Technology Management, Vol. 25 Iss 7 pp. 934 – 957, http://dx.doi.org/10.1108/JMTM-07-2011-0070, (accessed, 01 December 2016).

Ilkka,S. (2015),"Empirical study of measuring supply chain performance", Benchmarking: An International Journal, Vol. 22 Iss 2 pp. 290 – 308, http://dx.doi.org/10.1108/BIJ-01-2013-0009 (accessd,01 December 2016).

Ilsuk, K., & Hokey, M. (2011),"Measuring supply chain efficiency from a green perspective", Management Research Review, Vol. 34 Iss 11 pp. 1169 – 1189, http://dx.doi.org/10.1108/01409171111178738, (accessed, 01 December 2016).

International Air Group (2016) *Annual Report* (2007-2014). Available at: http://www.iairgroup.com/phoenix.zhtml?c=240949&p=irol-reportsannual (Accessed: 21 April 2016).

International Air Group (2016) *Annual Report* (2007-2014). Available at: http://www.iairgroup.com/phoenix.zhtml?c=240949&p=irol-reportsannual (Accessed: 21 April 2016).

International Air Group (2016) *Annual Report* (2007-2014). Available at: http://www.iairgroup.com/phoenix.zhtml?c=240949&p=irol-reportsannual (Accessed: 21 April 2016).

International Air Group (2016) *Annual Report* (2007-2014). Available at: http://www.investors.ups.com/phoenix.zhtml?c=62900&p=irol-reportsannual (Accessed: 21 April 2016).

Ioannis, E. T. (2011),"Bank branch-level DEA to assess overall efficiency", EuroMed Journal of Business, Vol. 6 Iss 3 pp. 359 – 377, http://dx.doi.org/10.1108/14502191111170178, (accessed, 01 December 2016).

Irene, G., Nancy, B. J., & Abdul, A. R. (2008),"Top management team demographic characteristics, business strategy, and firm performance in the US airline industry", Management

Decision,Vol. 46 Iss 2 pp. 201 – 222, http://dx.doi.org/10.1108/00251740810854122, (accessed 01 December 2016)

Ivan, K.W. L. (2010),"Benchmarking performance measures for extended enterprise in China", Benchmarking: An International Journal, Vol. 17 Iss 5 pp. 692 – 704, http://dx.doi.org/10.1108/14635771011076443, (accessed, 01 December 2016).

Jamal, I. B., & Abeer, F.A. (2008),"Predicting change in bank efficiency in Jordan: a data envelopment analysis", Journal of Accounting & Organizational Change, Vol. 4 Iss 2 pp. 162 – 181, http://dx.doi.org/10.1108/18325910810878955, (accessed, 01 December 2016).

James, R., & Paul, F. (2009),"Strategic alliances as a competitive strategy", International Journal of Commerce and Management, Vol. 19 Iss 2 pp. 93 – 114, http://dx.doi.org/10.1108/10569210910967860 (accessed, 01 December 2016).

James, S. K., & Richard, E. P. (2009),"Logistics performance measurement in the supply chain: a benchmark", Benchmarking: An International Journal, Vol. 16 Iss 6 pp. 785 - 798 http://dx.doi.org/10.1108/14635770911000114 (accessed,01 December 2016).

Japan Airlines (2016) *Annual Report* (2007-2014). Available at: https://www.jal.com/en/investor/library/report/ (Accessed: 16 April 2016).

Jeevan, V. K. J. (2015),"Theoretical framework for performance evaluation of university libraries in India", New Library World, Vol. 116 Iss 9/10 pp. 540 – 563, http://dx.doi.org/10.1108/NLW-01-2015-0009 (accessed, 01 December 2016).

Jelle, V. C., & Johan, B. (2016),"Taxonomizing performance measurement systems' failures", International Journal of Productivity and Performance Management, Vol. 65 Iss 5 pp. 672 – 693 http://dx.doi.org/10.1108/IJPPM-03-2015-0054, (accessed, 01 December 2016).

Jet Airways (2016) *Annual Report* (2007-2014). Available at: http://www.jetairways.com/EN/IN/Investorinformation/key-financial-information.aspx (Accessed: 21 April 2016).

Jet2 -Dart Group (2016) *Annual Report* (2007-2014). Available at: http://www.dartgroup.co.uk/report_and_accounts_2015/ (Accessed: 21 April 2016).

JetBlue (2016) *Annual Report* (2007-2014). Available at: http://investor.jetblue.com/investor-relations/financial-information/reports/annual-reports.aspx 16 (accessed, 20 April 2016).

Jie, J. Z., Nitin, J., & Rohit, V. (2012),"Pushing the frontier of sustainable service operations management", Journal of Service Management, Vol. 23 Iss 3 pp. 377 – 399, http://dx.doi.org/10.1108/09564231211248462,(accessed, 01 December 2016).

Jiefang, W., & Sifeng, L. (2012),"Efficiency measures in DEA with grey interval data under the hypotheses of data consistency", Grey Systems: Theory and Application, Vol. 2 Iss 1 pp. 63 – 69, http://dx.doi.org/10.1108/20439371211197686, (accessed, 01 December 2016).

Jim, T., Dennis, R., & Denise, M. B. (2009),"Multi-factor menu analysis using data envelopment analysis", International Journal of Contemporary Hospitality Management, Vol. 21 Iss 2 pp. 213 – 225, http://dx.doi.org/10.1108/09596110910935705, (accessed, 01 December 2016).

João, C. N., & Sofia, L. (2009),"Using data envelopment analysis to select strategies that improve the performance of hotel companies", International Journal of Contemporary Hospitality Management, Vol. 21 Iss 6 pp. 698 – 712, http://dx.doi.org/10.1108/09596110910975963, (accessed, 01 December 2016).

Job, P. A., & Sanghamitra, B. (2010),"Measuring organizational performance and organizational excellence of SMEs – Part 2: an empirical study on SMEs in India", Measuring Business Excellence, Vol. 14 Iss 3 pp. 42 – 52, http://dx.doi.org/10.1108/13683041011074209, (accessed, 01 December 2016).

Jochen, W., Loizos, H., & Nitin, P. (2008),"Managing human resources for service excellence and cost effectiveness at Singapore Airlines", Managing Service Quality: An International Journal, Vol. 18 Iss 1 pp. 4 - 19, http://dx.doi.org/10.1108/09604520810842812, (accessed, 01 December 2016)

John, W., Wickramanayke, J., & Premachandra, I.M. (2011),"The value of Morningstar ratings: evidence using stochastic data envelopment analysis", Managerial Finance, Vol. 37 Iss 2 pp. 94 – 116, http://dx.doi.org/10.1108/03074351111103659, (accessed, 01 December 2016).

Jonghyun, P., & Jin, P. (2015),"Enterprise resource planning and efficiency", Managerial Finance, Vol. 41 Iss 4 pp. 405 – 415, http://dx.doi.org/10.1108/MF-07-2014-0182, (accessed, 01 December 2016).

Jose, F. R., Kabir, H.M., & Hesham, J. M. (2012),"Non-parametric performance measurement of international and Islamic mutual funds", Accounting Research Journal, Vol. 25 Iss 3 pp. 208 – 226, http://dx.doi.org/10.1108/10309611211290176, (accessed, 01 December 2016).

Juliet, N. (2013),"The influence of airline service quality on passenger satisfaction and loyalty ", The TQM Journal, Vol. 25 Iss 5 pp. 520 – 532, http://dx.doi.org/10.1108/TQM-11-2012-0092, (accessed, 01 December 2016).

Junxiao, L., Peter, E.D. L., Jim, S., Michael, R., & Ekambaram, P. (2015),"Review of performance measurement: implications for public–private partnerships", Built Environment Project and Asset Management, Vol. 5 Iss 1 pp. 35 – 51, http://dx.doi.org/10.1108/BEPAM-12-2013-0070, (accessed, 01 December 2016).

Junxiao, L., Peter, E.D. L., Jim, S., Michael, R.,& Monty, S. (2014),"Public-Private Partnerships: a review of theory and practice of performance measurement", International Journal of Productivity and Performance Management, Vol. 63 Iss 4 pp. 499 – 512, http://dx.doi.org/10.1108/IJPPM-09-2013-0154, (accessed, 01 December 2016).

Justo, De J., & Oscar, R. C. (2015),"Technical efficiency and its determinants factors in Spanish textiles industry (2002-2009)", Journal of Economic Studies, Vol. 42 Iss 3 pp. 346 - 357, http://dx.doi.org/10.1108/JES-06-2013-0085, (accessed, 01 December 2016).

Kaplan, R.S. & Norton, D.P. (1996), "The Balanced Scorecard: Translating Strategy into Action", Harvard Business Press, Boston, MA.

Kathleen, O., Seong-Jong, J., & Philipp, A. S. (2016),"Benchmarking public school performance by unionized status", Benchmarking: An International Journal, Vol. 23 Iss 7 pp. 1626 - 1642, http://dx.doi.org/10.1108/BIJ-08-2014-0080, (accessed, 01 December 2016).

Kazi, A., & Nazmul, A. A.M.M. (2014),"Lean supply chain performance measurement", International Journal of Productivity and Performance Management, Vol. 63 Iss 5 pp. 588 – 612 http://dx.doi.org/10.1108/IJPPM-05-2013-0092, (accessed, 01 December 2016).

Keith, D.D. (2010),"Performance measurement and intranets: a natural partnership", International Journal of Productivity and Performance Management, Vol. 59 Iss 7 pp. 701 – 706, http://dx.doi.org/10.1108/17410401011075675, (accessed, 01 December 2016).

Kenya Airways (2016) *Annual Report* (2007-2014). Available at: https://www.kenya-airways.com/global/About_Kenya_Airways/Investor_Information/Annual_Reports/ (accessed: 21 April 2016).

Kevin, D., Peter, P., & Mark, P. (2012),"Using stochastic frontier regression to estimate the construction cost inefficiency of prevailing wage laws", Engineering, Construction and Architectural Management, Vol. 19 Iss 3 pp. 320 – 334, http://dx.doi.org/10.1108/09699981211219634 (accessed, 01 December 2016).

Khalid, A., Said, G., & Saeed, A. (2012),"Analyzing the technical efficiency of insurance companies in GCC", The Journal of Risk Finance, Vol. 13 Iss 4 pp. 362 – 380, http://dx.doi.org/10.1108/15265941211254471, (accessed, 01 December 2016).

Kimmel, P.D., Kieso, D.E. & Weygandt, J.J. (2010), Accounting: Tools for Business Decision Makers, Wiley, New York, NY.

Koh, S.C.L., Jonathan, M., Seyed, M. E., & Raymond, O. (2016),"Integrated resource efficiency: measurement and management", International Journal of Operations & Production Management, Vol. 36 Iss 11 pp. 1576 – 1600, http://dx.doi.org/10.1108/IJOPM-05-2015-0266, (accessed, 01 December 2016).

Kolawole, O. (2010),"Estimating and analysing cost efficiency of sawmill industries in Nigeria", China Agricultural Economic Review, Vol. 2 Iss 4 pp. 420 – 432, http://dx.doi.org/10.1108/17561371011097731, (accessed, 01 December 2016).

Korean Air (2016) *Annual Report* (2007-2014). Available at: https://www.koreanair.com/global/en/about/economic-responsibility-investor-relations/investor-relations/annual_reports.html (Accessed: 16 April 2016).

Kurt, S., & Cam, S. (2012),"Balanced Scorecards in education: focusing on financial strategies", Measuring Business Excellence, Vol. 16 Iss 3 pp. 17 – 28, http://dx.doi.org/10.1108/13683041211257385, (accessed, 01 December 2016).

Kwee, K. C. (2013),"Understanding the features of performance measurement system: a literature review", Measuring Business Excellence, Vol. 17 Iss 4 pp. 102 – 121, http://dx.doi.org/10.1108/MBE-05-2012-0031, (accessed, 01 December 2016).

Latam Airlines Group (2016) *Annual Report* (2007-2014). Available at: http://www.latamairlinesgroup.net/phoenix.zhtml?c=81136&p=irol-reportsannual (Accessed: 16 April 2016).

Lee, H., Park, Y., & Choi, H. (2008), "Comparative evaluation of performance of national R&D programs with heterogeneous objectives: A DEA approach", European journal of operational research, 196, pp. 847-855.

Lídio, T. L., Duarte, P. F., & Ana, M. G. R. (2016),"The drivers of profitability in the top 30 major airlines worldwide", Measuring Business Excellence, Vol. 20 Iss 2 pp. 26 – 37, http://dx.doi.org/10.1108/MBE-09-2015-0045, (accessed, 01 December 2016).

Līga, O., & Marika, R. (2012),"A review of energy efficiency policy and measures for industries in Latvia", Management of Environmental Quality: An International Journal, Vol. 23 Iss 5 pp. 517 – 526, http://dx.doi.org/10.1108/14777831211255097, (accessed, 01 December 2016).

Lijia, W., Xuexi, H., & Md. Shajahan, K. (2013),"Technical and cost efficiency of rural household apple production", China Agricultural Economic Review, Vol. 5 Iss 3 pp. 391 – 411, http://dx.doi.org/10.1108/CAER-08-2011-0087, (accessed, 01 December 2016).

Lillian, D. N. G., Harry, B., Mateus, C. G., Frances, J., Luiz, C., Ribeiro, C. (2015),"The relationship between organizational culture and quality techniques, and its impact on operational performance", International Journal of Operations & Production Management, Vol. 35 Iss 10 pp. 1460 – 1484, http://dx.doi.org/10.1108/IJOPM-12-2013-0563 (accessed, 03 December 2016).

Lin, H., Xue-Fen, C., Yu, W., & Qin, L. (2014),"An exploration research of the independent college operation efficiency indicators based on DEA", Grey Systems: Theory and Application, Vol. 4 Iss 2 pp. 362 -369, http://dx.doi.org/10.1108/GS-04-2014-0009, (accessed, 01 December 2016).

Lisa, B., Stefan, S., & Annika, H. (2014),"Measuring capacity to perform across local government services – managers' perceptions", International Journal of Public Sector Management, Vol. 27 Iss 1 pp. 26 – 38, http://dx.doi.org/10.1108/IJPSM-09-2012-0115, (accessed, 01 December 2016).

Loay, S., & Jamal, A. (2015),"The relationship between total quality management practices and their effects on bank's technical efficiency", International Journal of Commerce and Management, Vol. 25 Iss 2 pp. 173 – 182, http://dx.doi.org/10.1108/IJCoMA-03-2013-0027, (accessed, 01 December 2016).

Loukia, E. (2012),"M&As in the airline industry: motives and systematic risk", International Journal of Organizational Analysis, Vol. 20 Iss 4 pp. 435 – 446, http://dx.doi.org/10.1108/19348831211268625, (accessed, 01 December 2016).

Lu, Q., & Hongquan, Z. (2015),"Efficiency of heterogeneity measures: an asset pricing perspective", China Finance Review International, Vol. 5 Iss 4 pp. 371 – 385, http://dx.doi.org/10.1108/CFRI-02-2015-0013, (accessed, 01 December 2016).

Lucas, S. M., Alexandre, P.S., Jr Adriel, M,de F. B., & Fábio, N. C. (2016),"Variable portfolio proposal for banking efficiency assessment", International Journal of Bank Marketing, Vol. 34 Iss 7 pp. 985 – 1008, http://dx.doi.org/10.1108/IJBM-10-2015-0164, (accessed, 01 December 2016).

Lufthansa Group (2016) *Annual Report* (2007-2014). Available at: http://investor-relations.lufthansagroup.com/en/finanzberichte/archive.html (Accessed: 16 April 2016).

Luisa, M., Rosa, P., & Consuelo, C. (2015),"Efficiency of airlines: Hub and Spoke versus Point-to-Point", Journal of Economic Studies, Vol. 42 Iss 1 pp. 157 – 166, http://dx.doi.org/10.1108/JES-07-2013-0095, (accessed, 01 December 2016).

Luliya, T., Sununta, S., Yuosre, B., & Chotchai, C. (2013),"Competitive strategies and firm performance: the mediating role of performance measurement", International Journal of Productivity and Performance Management, Vol. 62 Iss 2 pp. 168 – 184,, http://dx.doi.org/10.1108/17410401311295722, (accessed, 01 December 2016).

Luqman, O. O., Abimbola, O. W., & James, O. B. R. (2015),"Measuring strategic performance in construction companies: a proposed integrated model", Journal of Facilities Management, Vol. 13 Iss 2 pp. 109 – 132, http://dx.doi.org/10.1108/JFM-08-2013-0042, (accessed, 01 December 2016).

Ma Ángeles, D., & Rosario, S. (2011),"Gender and potential wage in Europe: a stochastic frontier approach", International Journal of Manpower, Vol. 32 Iss 4 pp. 410 – 425, http://dx.doi.org/10.1108/01437721111148531, (accessed, 01 December 2016).

Mahdi, M., Abdollah, N., & Reza, F. S. (2014),"Benchmarking suppliers' performance when some factors play the role of both inputs and outputs ", Benchmarking: An International Journal, Vol. 21 Iss 5 pp. 792 – 813, http://dx.doi.org/10.1108/BIJ-10-2012-0068, (accessed, 01 December 2016).

Mahfud, S., Richard, P, & Musa, M. (2010),"Reliance on multiple performance measures and manager performance", Journal of Applied Accounting Research, Vol. 11 Iss 1 pp. 24 – 42, http://dx.doi.org/10.1108/09675421011050018, (accessed, 01 December 2016).

Mahour, M. P., & Elham (Ellie), H. F. (2010),"The effect of productivity and quality on profitability in US airline industry", Managing Service Quality: An International Journal, Vol. 20 Iss 5 pp. 458 – 474 http://dx.doi.org/10.1108/09604521011073740, (accessed, 01 December 2016).

Maik, H. (2013),"What determines the business activities in the airline industry? A theoretical framework", Baltic Journal of Management, Vol. 9 Iss 1 pp. 71 - 90 http://dx.doi.org/10.1108/BJM-04-2013-0053 (accessed, 01 December 2016).

Manik, C., Das, B.S., & Siddhartha, R. (2015),"A performance evaluation framework for technical institutions in one of the states of India", Benchmarking: An International Journal, Vol. 22 Iss 5 pp. 773 – 790, http://dx.doi.org/10.1108/BIJ-02-2013-0019, (accessed. 01 December 2016).

Maria, B., Uni, M., & Mats, A. (2012),"Performance measurements in the greening of supply chains", Supply Chain Management: An International Journal, Vol. 17 Iss 1 pp. 29 – 39, http://dx.doi.org/10.1108/13598541211212186, (accessed, 01 December 2016).

Maria, R., &Andy, N. (2010),"Beyond words: testing alignment among inter-organizational performance measures", Measuring Business Excellence, Vol. 14 Iss 1 pp. 19 – 27, http://dx.doi.org/10.1108/13683041011027427, (accessed, 01 December 2016).

Markus, K., & Stefan, G. (2011),"Process ownership, process performance measurement and firm performance", International Journal of Productivity and Performance Management, Vol. 60 Iss 7 pp. 709 – 720, http://dx.doi.org/10.1108/17410401111167799, (accessed, 01 December 2016).

Maryam, H., Davood, F., Mohammad, R. J. & Iman, K. (2016),"Development of fuzzy two-stage DEA model for competitive advantage based on RBV and strategic agility as a dynamic capability", Journal of Modelling in Management, Vol. 11 Iss 1 pp. 288 – 308, http://dx.doi.org/10.1108/JM2-12-2013-0067, (accessed, 01 December 2016).

Massoud, B. (2016),"Airline maintenance strategies – in-house vs. outsourced – an optimization approach", Journal of Quality in Maintenance Engineering, Vol. 22 Iss 2 pp. 114 – 129, http://dx.doi.org/10.1108/JQME-08-2015-0038, (accessed, 02 December 2016).

Mattias, E., Klara, P.B., & Beata, K. (2013),"Performance measurement to drive improvements in healthcare practice", International Journal of Operations & Production Management, Vol. 33 Iss 11/12 pp. 1623 – 1651, http://dx.doi.org/10.1108/IJOPM-07-2010-0208, (accessed, 01 December 2016).

Maurice,G. (2011),"Contextual factors affecting the deployment of innovative performance measurement systems", Journal of Applied Accounting Research, Vol. 12 Iss 3 pp. 260 – 277 http://dx.doi.org/10.1108/09675421111187692, (accessed, 01 December 2016).

Meabh, S., & John, L. (2016),"Exploring strategic execution", Journal of Strategy and Management, Vol. 9 Iss 4 pp. 406 – 428, http://dx.doi.org/10.1108/JSMA-11-2015-0094 (accessed, 01 December 2016).

Meena, C. (2009),"The balanced scorecard: a new challenge", Journal of Management Development, Vol. 28 Iss 5 pp. 393 – 406, http://dx.doi.org/10.1108/02621710910955930, (accessed, 01 December 20160.

Mehran, N., Mostafa, N., & Azadeh, S. (2009),"Ranking airlines' service quality factors using a fuzzy approach: study of the Iranian society", International Journal of Quality & Reliability Management, Vol.26 Iss 3 pp. 247 – 260, http://dx.doi.org/10.1108/02656710910936726, (accessed, 01 December 2016).

Merkert, R. & Morrell, P.S. (2012), "Mergers and acquisitions in aviation – management and economic perspectives on the size of airlines", Transportation Research Part E, Vol. 48 No. 4, pp. 853-862.

Michael, A. C. (2013),"Building operational efficiencies", The Bottom Line, Vol. 26 Iss 1 pp. 21 – 24, http://dx.doi.org/10.1108/08880451311321555, (accessed, 01 December 2016).

Mike, B., Andrey, P., Monica, F., Lorenzo, L., & Matteo, M. (2013),"Generating organisational performance", International Journal of Operations & Production Management, Vol. 33 Iss11/12 pp. 1599 – 1622, http://dx.doi.org/10.1108/IJOPM-07-2010-0200, (accessed, 01 December 2016).

Mike, P., Anna, G. & Helge, R. (2014),"What do we really mean by "Balanced Scorecard"?", International Journal of Productivity and Performance Management, Vol. 63 Iss 2 pp. 148 – 169, http://dx.doi.org/10.1108/IJPPM-11-2012-0127, (accessed, 01 December 2016).

Min,T., Hongwei, L., & Huanjun, X. (2011),"Influencing factor analysis of the investment efficiency of the environmental governance", Grey Systems: Theory and Application, Vol. 1 Iss

3 pp. 240 – 249, http://dx.doi.org/10.1108/20439371111181242, (accessed, 01 December 2016).

Mini, K., & Seema, S. (2016),"Efficiency of glass firms in India: an application of data envelopment analysis", Journal of Advances in Management Research, Vol. 13 Iss 1 pp. 59 - 74 http://dx.doi.org/10.1108/JAMR-03-2015-0019, (accessed, 01 December 2016).

Minna, S. (2016),"Performance measurement approach for innovation capability in SMEs", International Journal of Productivity and Performance Management, Vol. 65 Iss 2 pp. 162 – 176, http://dx.doi.org/10.1108/IJPPM-08-2014-0123, (accessed, 01 December 2016).

Mohamed .M. (2007),"Modelling the efficiency of GCC banks: a data envelopment analysis approach", International Journal of Productivity and Performance Management, Vol. 56 Iss 7 pp. 623 – 643, http://dx.doi.org/10.1108/17410400710823651, (accessed, 02 December 2016).

Mohamed, M. (2007),"Benchmarking top Arab banks' efficiency through efficient frontier analysis", Industrial Management & Data Systems, Vol. 107 Iss 6 pp. 802 – 823, http://dx.doi.org/10.1108/02635570710758734, (accessed, 01 December 2016).

Mohamed, M. M. (2009),"Benchmarking the US specialty retailers and food consumer stores using data envelopment analysis", International Journal of Retail & Distribution Management, Vol. 37 Iss 8 pp. 661 – 679, http://dx.doi.org/10.1108/09590550910966178, (accessed, 01 December 2016).

Mohamed, M. M. (2011),"Modeling Islamic banks' efficiency: a non-parametric frontier approach", International Journal of Islamic and Middle Eastern Finance and Management, Vol. 4 Iss 1 pp. 7 – 29, http://dx.doi.org/10.1108/17538391111122186, (accessed, 01 December 2016).

Mohammad, H. A. (2013),"After the financial crisis: a cost efficiency analysis of banks from Saudi Arabia", International Journal of Islamic and Middle Eastern Finance and Management, Vol. 6 Iss 4 pp. 322- 332, http://dx.doi.org/10.1108/IMEFM-05-2013-0059,(accessed, 02 December 2016).

Mohammad, M, U., Bernhard, B., & Kurt, J.P. (2014),"Technical efficiency and metatechnology ratios under varying resource endowment in different production systems ", China Agricultural Economic Review, Vol. 6 Iss 3 pp. 485 – 505, http://dx.doi.org/10.1108/CAER-06-2013-0088 (accessed, 01 December 2016).

Mohammad, M. A., & Osama, A. (2014),"Development of assessment methodology for improving performance in SME's", International Journal of Productivity and Performance Management, Vol. 63 Iss 4 pp. 477 – 498, http://dx.doi.org/10.1108/IJPPM-06-2013-0108, (accessed, 01 December 2016).

Mohammad, S. M., Mona, A., & Morteza, S. (2011),"Targeting performance measures based on performance prediction", International Journal of Productivity and Performance Management, Vol. 61 Iss 1 pp. 46 – 68, http://dx.doi.org/10.1108/17410401211187507, (accessed, 01 December 2016).

Mohammad, Z. M. (2015),"Consistency of strategic and tactical benchmarking performance measures", Benchmarking: An International Journal, Vol. 22 Iss 6 pp. 1019 – 1032, http://dx.doi.org/10.1108/BIJ-07-2013-0074, (accessed, 01 December 2016).

Mohammed, S., & Walid, A. (2012),"Performance measurement of reverse logistics enterprise: a comprehensive and integrated approach", Measuring Business Excellence, Vol. 16 Iss 2 pp. 23 – 34 http://dx.doi.org/10.1108/13683041211230294, (accessed, 01 December 2016).

Mohsen, A., Heinz, A., & Ludmila, N. (2016),"Generalized DEA: an approach for supporting input/output factor determination in DEA", Benchmarking: An International Journal, Vol. 23 Iss 7 pp. 1892 – 1909, http://dx.doi.org/10.1108/BIJ-07-2015-0074, (accessed, 01 December 2016).

Monte, W., & Kirsty, D. (2016) "Ethical values in the evaluation of corporate social performance", Managerial Auditing Journal, Vol. 31 Iss 2 pp. 180 – 196, http://dx.doi.org/10.1108/MAJ-09-2014-1092, (01 December 2016).

Muhammad, T. M. & Abida, Z. (2016),"Efficiency analysis of Islamic banks in Pakistan", Humanomics, Vol. 32 Iss 1 pp. 19 – 32, http://dx.doi.org/10.1108/H-07-2015-0054 (accessed, 01 December 2016).

Muhammet, E. B., & Ali, T. (2014),"Performance assessment of manufacturing SMEs: a frontier approach", Industrial Management & Data Systems, Vol. 114 Iss 5 pp. 797 – 816, http://dx.doi.org/10.1108/IMDS-11-2013-0475, (accessed, 02 December 2016).

Muhammet, E. B., Ali, T., Metin, S., Muhammad, S., & Muhammad, S. (2016),"Measuring the performance efficiency of Turkish electrical machinery manufacturing SMEs with frontier method", Benchmarking: An International Journal, Vol. 23 Iss 7 pp. 2004 – 2026, http://dx.doi.org/10.1108/BIJ-09-2015-0089, (accessed, 01 December 2016).

Mukesh, K., & Partha, B. (2008),"Perspectives of productivity growth in Indian food industry: a data envelopment analysis", International Journal of Productivity and Performance Management, Vol. 57 Iss 7 pp. 503 – 522, http://dx.doi.org/10.1108/17410400810904001, (accessed, 01 December 2016).

Naveen, D., & Belgin, U. (2014),"Identifying escalation of commitment in B2B new product development projects using data envelopment analysis", Journal of Business & Industrial Marketing, Vol. 29 Iss 3 pp. 209 – 214, http://dx.doi.org/10.1108/JBIM-11-2011-0162, (accessed, 01 December 2016).

Neeraj Bhanot Harwinder Singh , (2014),"Benchmarking the performance indicators of Indian Railway container business using data envelopment analysis", Benchmarking: An International Journal, Vol. 21 Iss 1 pp. 101 – 120, http://dx.doi.org/10.1108/BIJ-05-2012-0031, (accessed, 01 December 2016).

Nehal, M., Seong-Jong, J., & Christopher, L.C. (2014),"Benchmarking the performance of department stores within an income elasticity of demand perspective", Benchmarking: An International Journal, Vol. 21 Iss 2 pp. 205 – 217, http://dx.doi.org/10.1108/BIJ-03-2012-0021, (Accessed, 01 December 2016).

Nirupama, D.S., Chei, S. L., & Dion, H.G. (2012),"Tweeting the friendly skies", Program, Vol. 46 Iss 1 pp. 21 – 42, http://dx.doi.org/10.1108/00330331211204548, (01 December 2016)

Nobuhiko, D., & Jonathan, L. G. (2014),"U.S. highway public private partnerships", Managerial Finance, Vol. 40 Iss 11 pp. 1131 – 1151, http://dx.doi.org/10.1108/MF-03-2014-0072 (accessed, 01 December 2016).

Nopadol, R., & Sakun, B. (2012),"Measuring the success of a performance measurement system in Thai firms", International Journal of Productivity and Performance Management, Vol. 61 Iss 5 pp. 548 -562, http://dx.doi.org/10.1108/17410401211232966, (accessed, 01 December 2016).

Norazlina, Abd. W., & Abdul Rahim, A. (2012),"Productivity growth of zakat institutions in Malaysia", Studies in Economics and Finance, Vol. 29 Iss 3 pp. 197 – 210, http://dx.doi.org/10.1108/10867371211246876, (accessed, 01 December 2016).

Norwegian (2016) *Annual Report* (2007-2014). Available at: http://www.norwegian.com/uk/about/company/investor-relations/reports-and-presentations/annual-reports/ (Accessed: 20 April 2016).

Olve, N.G., Roy, J. & Wetter, M. (2000), Performance Drivers: A Practical Guide to Using the Balanced Scorecard, Wiley, Chichester.

Omkarprasad, V., & Manoj, H. (2013),"Multi-criteria supply chain performance evaluation", International Journal of Productivity and Performance Management, Vol. 62 Iss 3 pp. 293 – 316 http://dx.doi.org/10.1108/17410401311309195, (accessed, 01 December 2016).

Omri, R., & Vladimir, K. (2016),"Lift offset: an analytical insight", Aircraft Engineering and Aerospace Technology, Vol. 88 Iss 6 pp. 753 – 760, http://dx.doi.org/10.1108/AEAT-09-2014-0152 (accessed, 01 December 2016).

Osamah, A., Taisier, A. Z., & Evangelos, P. K. (2010),"The Saturday effect in emerging stock markets: a stochastic dominance approach", International Journal of Emerging Markets, Vol. 5 Iss 2 pp. 227 – 246, http://dx.doi.org/10.1108/17468801011032819, (accessed, 01 December 2016).

Oxelheim, L. & Ghauri, P. (2004), European Union and the Race for Foreign Direct Investment in Europe, Elsevier, Amsterdam.

Özlem, A. (2007),"Customer complaints about airline service: a preliminary study of Turkish frequent flyers", Management Research News, Vol. 30 Iss 6 pp. 409 – 419, http://dx.doi.org/10.1108/01409170710751908 (accessed 01 December 2016).

Pakistan International Airlines (2016) *Annual Report* (2007-2014). Available at: http://www.piac.com.pk/pia_about/pia-about_corpreport.asp (Accessed: 21 April 2016).

Pamela, J. Z., Kenneth, W. G., Victor, E. S., & Roger, D. A. (2014),"Impact of RFID and information sharing on JIT, TQM and operational performance", Management Research Review, Vol. 37 Iss 11 pp. 970 – 989, http://dx.doi.org/10.1108/MRR-10-2014-273, (accessed, 03 December 2016).

Paul, R., & David, T. (2016),"Allocative and technical efficiency of New Zealand Banks", Meditari Accountancy Research, Vol. 24 Iss 4 pp. 574 – 587, http://dx.doi.org/10.1108/MEDAR-02-2016-0035, (accessed, 01 December 2016).

Pavel, R., Sergey, K., Yuri, K., & Artur, M. (2014),"Efficiency assessment of HPS for advanced airliners using different fuels", Aircraft Engineering and Aerospace Technology: An International Journal, Vol. 86 Iss 6 pp. 494 – 500, http://dx.doi.org/10.1108/AEAT-06-2014-0088 (accessed, 02 December 2016).

Pedro, M., Pedro, J. R., Ana, M. P., & Luís, C. 2015),"Measuring adaptive performance in individuals and teams", Team Performance Management, Vol. 21 Iss 7/8 pp. 339 – 360, http://dx.doi.org/10.1108/TPM-03-2015-0014, (accessed, 01 December 2016).

Pedro, S. F., Shamsuzzoha, A.H.M., Cesar, T., & Pedro, C. (2012),"Framework for performance measurement and management in a collaborative business environment", International Journal of Productivity and Performance Management, Vol. 61 Iss 6 pp. 672 – 690, http://dx.doi.org/10.1108/17410401211249210, (accessed, 01 December 2016).

Pegasus (2016) *Annual Report* (2012-2014). Available at: http://www.pegasusinvestorrelations.com/en/operational-and-financial-information/annual-reports.aspx (accessed, 21 April 2016).

Peiman, A.S., Alp, U., & Hidayet, T. (2016),"Performance evaluation of different customer segmentation approaches based on RFM and demographics analysis", Kybernetes, Vol. 45 Iss 7 pp. 1129 – 1157, http://dx.doi.org/10.1108/K-07-2015-0180, (accessed, 01 December 2016).

Pervez, N. G., Adam, H. C., & Byung Il, P. (2013),"The impact of foreign parent control mechanisms upon measurements of performance in IJVs in South Korea", Critical perspectives on international business, Vol. 9 Iss 3 pp. 251 – 270, http://dx.doi.org/10.1108/17422041311330413, (accessed, 01 December 2016).

Peter, A. A., Fakarudin, K., Mohamad, Ha.,& Bany, N. (2016),"Efficiency of Gulf Cooperation Council Banks", Review of International Business and Strategy, Vol. 26 Iss 1 pp. 118 - 136, http://dx.doi.org/10.1108/RIBS-11-2013-0111 (accessed, 01 December 2016).

Peter, H., & Alan, N. (2016),"A multidimensional measure of managers' contextual and task performance", Personnel Review, Vol. 45 Iss 2 pp. 419 – 447, http://dx.doi.org/10.1108/PR-02-2014-0038 (accessed, 01 December 2016).

Peter, P.Y., & Artie, W. N. (2012),"Towards a balanced performance measurement system in a public health care organization", International Journal of Health Care Quality Assurance, Vol. 25 Iss 5 pp. 421 - 430, http://dx.doi.org/10.1108/09526861211235919, (accessed, 01 December 2016).

Petros, V., Thérèse, W., David, G.W., & Dennis, M. P. (2016),"CSR disclosure in response to major airline accidents: a legitimacy-based exploration", Sustainability Accounting, Management and Policy Journal, Vol. 7 Iss 1 pp. 26 – 43, http://dx.doi.org/10.1108/SAMPJ-12-2014-0080, (accessed, 02 December 2016).

Philip, B., Matthew, P. J., & Stefan, S. (2015),"20 years of performance measurement in sustainable supply chain management – what has been achieved?", Supply Chain Management: An International Journal, Vol. 20 Iss 6 pp. 664 – 680, http://dx.doi.org/10.1108/SCM-06-2015-0216(accessed, 01 December 2016).

Pietro, G. L., & Giorgio, V. (2012),"The balanced scorecard in health care: a multilevel latent variable approach", Journal of Modelling in Management, Vol. 7 Iss 1 pp. 38 – 58, http://dx.doi.org/10.1108/17465661211208802, (accessed, 01 December 2016).

Po-Chi, C., Shih-Hsun, H., Ching-Cheng, C., & Ming-Miin, Y. (2013),"Efficiency measurements in multiactivity data envelopment analysis with shared inputs", China Agricultural Economic Review, Vol. 5 Iss 1 pp. 24 – 42, http://dx.doi.org/10.1108/17561371311294748, (accessed, 01 December 2016).

Pran, K. B. (2012),"Accounting development and international financial reporting standards in small island economies", Journal of Accounting in Emerging Economies, Vol. 2 Iss 1 pp. 4 – 29, http://dx.doi.org/10.1108/20421161211196102, (accessed, 01 December 2016).

Praveen, K. D., & Uma Rao, S.P. (2013),"Performance evaluation of socially responsible mutual funds using style analysis", Social Responsibility Journal, Vol. 9 Iss 1 pp. 109 – 123, http://dx.doi.org/10.1108/17471111311307840, (accessed, 01 December 2016).

Primož, P. (2014),"Efficiency levels of sub-national governments: a comparison of SFA and DEA estimations", The TQM Journal, Vol. 26 Iss 3 pp. 275 – 283, http://dx.doi.org/10.1108/TQM-12-2013-0127, (accessed, 01 December 2016).

Punita, S., Ratnesh, R. S., & Deepak, S. (2016),"Efficiency evaluation of the energy companies in CNX 500 Index of the NSE, India using data envelopment analysis", Benchmarking: An International Journal, Vol. 23 Iss 1 pp. 113 – 126, http://dx.doi.org/10.1108/BIJ-08-2014-0074 (accessed, 01 December 2016).

Punniyamoorthy, M., & Murali, R. (2008),"Balanced score for the balanced scorecard: a benchmarking tool", Benchmarking: An International Journal, Vol. 15 Iss 4 pp. 420 – 443, http://dx.doi.org/10.1108/14635770810887230, (accessed, 01 December 2016).

Purna, C., Parida, K., & Chandra, Pr. (2016),"Productivity and efficiency of labour intensive manufacturing industries in India", International Journal of Development Issues, Vol. 15 Iss 2 pp. 130 – 152, http://dx.doi.org/10.1108/IJDI-12-2015-0081, (accessed, 01 December 2016).

Qantas (2016) *Annual Report* (2007-2014). Available at: http://investor.qantas.com/investors/?page=annual-reports (Accessed: 20 April 2016).

Qian, Y., & Fujun, H. (2016),"A cross evaluation-based measure of super efficiency in DEA with interval data", Kybernetes, Vol. 45 Iss 4 pp. 666 – 679, http://dx.doi.org/10.1108/K-05-2014-0089 (accessed, 01 December 2016).

Rachita, G. (2015),"Trends of cost efficiency in response to financial deregulation", Benchmarking: An International Journal, Vol. 22 Iss 5 pp. 808 – 838, http://dx.doi.org/10.1108/BIJ-06-2013-0065, (accessed, 03 December 2016).

Rahat, M. & Kevin, B. (2016),"Influence of institutional pressures on performance measurement systems", Journal of Accounting & Organizational Change, Vol. 12 Iss 2 pp. 106 – 128, http://dx.doi.org/10.1108/JAOC-09-2014-0051, (accessed, 01 December 2016).

Rahim, H. (2016),"The mediating role of customer satisfaction: evidence from the airline industry", Asia Pacific Journal of Marketing and Logistics, Vol. 28 Iss 2 pp. 234 – 255, http://dx.doi.org/10.1108/APJML-01-2015-0001, (accessed, 01 December 2016).

Rakesh, A., Arun, M., & Varun, D. (2015),"Bank competition and efficiency: empirical evidence from Indian market", International Journal of Law and Management, Vol. 57 Iss 3 pp. 217 - 231, http://dx.doi.org/10.1108/IJLMA-03-2014-0029, (accessed, 01 December 2016).

Rama, K. J., & Jayanti, S.V. (2011),"Effects of airline bankruptcies: an event study", Journal of Services Marketing, Vol. 25 Iss 6 pp. 399 – 409, http://dx.doi.org/10.1108/08876041111160998 (accessed 01 December 2016).

Reinhard, L. (2016),"Arrival time optimization at hubs of network airlines", Aircraft Engineering and Aerospace Technology: An International Journal, Vol. 88 Iss 3 pp. 427 – 431, http://dx.doi.org/10.1108/AEAT-11-2013-0203, (accessed, 01 December 2016).

Reza, D., Arash, S., Mohammad, S., & Hadi, S. (2016),"Importance performance analysis of service quality dimensions for the customer groups segmented by DEA", International Journal of Quality & Reliability Management, Vol. 33 Iss 2 pp. 160 – 177, http://dx.doi.org/10.1108/IJQRM-02-2014-0022, (accessed, 01 December 2016).

Reza, F. S. & Majid, A. (2011),"A chance-constrained data envelopment analysis approach for strategy selection", Journal of Modelling in Management, Vol. 6 Iss 2 pp. 200 – 214, http://dx.doi.org/10.1108/17465661111149584, (accessed, 01 December 2016).

Rizal, E. H. (2010),"Marketing productivity and profitability of Indonesian public listed manufacturing firms", Benchmarking: An International Journal, Vol. 17 Iss 6 pp. 842 – 857, http://dx.doi.org/10.1108/14635771011089755, (accessed, 01 December 2016).

Roland, B., & Maurizio, M. (2013),"Shifting the paradigm of return on investment: a composite index to measure overall corporate performance", Corporate Governance, Vol. 13 Iss 5 pp. 498 – 510 http://dx.doi.org/10.1108/CG-06-2013-0081, (accessed, 03 December 2016).

Roma, M. D., & Ravi, S. (2009),"Assessing performance of management institutions", The TQM Journal, Vol. 21 Iss 1 pp. 20 – 33, http://dx.doi.org/10.1108/17542730910924727 (accessed, 01 December 2016).

Roma, M. D. & Sebastian, V.J. (2014),"Efficiency in the Indian iron and steel industry – an application of data envelopment analysis", Journal of Advances in Management Research, Vol. 11 Iss 1 pp. 4 – 19, http://dx.doi.org/10.1108/JAMR-01-2013-0005, (accessed, 01 December 2016).

Roma, M. D., & Ravi, S. (2008),"Benchmarking telecommunication service in India", Benchmarking: An International Journal, Vol. 15 Iss 5 pp. 584 – 598, http://dx.doi.org/10.1108/14635770810903169, (accessed, 01 December 2016).

Rosemary, R. F., & William, F. W. (2009),"Lean manufacturing, non-financial performance measures, and financial performance", International Journal of Operations & Production Management, Vol. 29 Iss 3 pp. 214 – 240, http://dx.doi.org/10.1108/01443570910938970, (accessed, 01 December 2016).

Rumki, M. (2010),"A stochastic approach to measure performance of the Indian electronics hardware industry after liberalisation", Journal of Manufacturing Technology Management, Vol. 21 Iss 5 pp. 539 – 555, http://dx.doi.org/10.1108/17410381011046959, (accessed, 01 December 2016).

Ruzita, J., Daing, N. I., & Yuserrie, Z. (2008),"The performance consequence of multiple performance measures usage", International Journal of Productivity and Performance Management, Vol. 57 Iss 2 pp. 119+ - 136, http://dx.doi.org/10.1108/17410400810847393, (accessed, 01 December 2016).

Ryan, B., Seong-Jong, J., Hsin-hui, I. H. W., & Jerry, W. L. (2015),"Assessing the comparative performance of banking branches", Benchmarking: An International Journal, Vol. 22 Iss 5 pp. 963 - 972, http://dx.doi.org/10.1108/BIJ-04-2013-0048, (accessed 01 December 2016).

Ryan, N. S., Merlin, S., & Jane, F. (2016),"Business models in the business-to-business and business-to-consumer worlds – what can each world learn from the other?", Journal of Business & Industrial Marketing, Vol. 31 Iss 8 pp. 943 – 954, http://dx.doi.org/10.1108/JBIM-10-2016-267 (accessed, 01 December 2016).

Ryanair (2016) *Annual Report* (2007-2014). Available at: http://investor.ryanair.com/results/ (Accessed: 20 April 2016).

Sachin, M., & Sanjay, S. (2016),"Total productive maintenance, total quality management and operational performance", Journal of Quality in Maintenance Engineering, Vol. 22 Iss 4 pp. 353 – 377 http://dx.doi.org/10.1108/JQME-10-2015-0048, (accessed, 03 December 2016).

Saleh, M. F. B., Ahmad, G., Charles, D., & Bothina, J. (2013),"The antecedents of travellers' e-satisfaction and intention to buy airline tickets online", Journal of Enterprise Information Management, Vol. 26 Iss 6 pp. 624 – 641, http://dx.doi.org/10.1108/JEIM-07-2013-0040, (accessed, 01 December 2016).

Salma, L., & Younes, B. (2015),"Banks' stability-efficiency within dual banking system: a stochastic frontier analysis", International Journal of Islamic and Middle Eastern Finance and Management, Vol. 8 Iss 4 pp. 472 – 490, http://dx.doi.org/10.1108/IMEFM-12-2014-0121 (accessed, 01 December 2016).

Salvatore, A., Francesco, C., & Luigi, M. (2015),"A DEA-based transport heliports' efficiencies evaluation", Aircraft Engineering and Aerospace Technology: An International Journal, Vol. 87 Iss 2 pp. 131 – 138, http://dx.doi.org/10.1108/AEAT-12-2013-0232, (accessed, 01 December 2016).

Sameer, K., Kevin, L. J., & Steven, T. L. (2009),"Performance improvement possibilities within the US airline industry", International Journal of Productivity and Performance Management, Vol. 58 Iss 7 pp. 694 – 717, http://dx.doi.org/10.1108/17410400910989485 (accessed, 01 December 2016).

Sami, K., & Juha-Matti, J. (2016),"Benchmarking construction industry, company and project performance by participants' evaluation", Benchmarking: An International Journal, Vol. 23 Iss 7 pp. 2092 – 2108, http://dx.doi.org/10.1108/BIJ-05-2015-0050, (accessed, 01 December 2016).

Sandeep, K. M., Shiv, P. Y., & Singh, S. P. (2015),"Slack based measure of efficiencies of public sector hospitals in Uttarakhand (India)", Benchmarking: An International Journal, Vol. 22 Iss 7 pp. 1229 – 1246, http://dx.doi.org/10.1108/BIJ-12-2013-0122 (accessed, 01 December 2016).

Sanjay, S. P., & Mukul, K. (2012),"Evaluation of irrigation efficiencies for water users' associations in a major irrigation project in India by DEA", Benchmarking: An International Journal, Vol. 19 Iss 2 pp. 193 – 218, http://dx.doi.org/10.1108/14635771211224536 (accessed, 01 December 2016).

Sanna, P., Minna, S., & Hannu, R. (2016),"Performance measurement system implementation in a turbulent operating environment", International Journal of Productivity and Performance Management, Vol. 65 Iss 7 pp. 947 – 958, http://dx.doi.org/10.1108/IJPPM-01-2015-0018 (accessed, 01 December 2016).

Santanu, M., & Surajit, G. D. (2014),"A DEA-investigation of efficiency of the Indian general insurance during recession", Journal of Advances in Management Research, Vol. 11 Iss 1 pp. 115 – 136, http://dx.doi.org/10.1108/JAMR-07-2012-0030, (accessed, 01 December 2016).

Sarah, N., &Tom, C. (2009),"Cultural sexism in the UK airline industry", Gender in Management: An International Journal, Vol. 24 Iss 1 pp. 32 – 45, http://dx.doi.org/10.1108/17542410910930734, (accessed, 01 December 2016).

Sarah, S., David, B.G., & John, M. (2010),"Developing environmental supply chain performance measures", Benchmarking: An International Journal, Vol. 17 Iss 3 pp. 320 – 339, http://dx.doi.org/10.1108/14635771011049326, (accessed, 01 December 2016).

SAS Group (2016) *Annual Report* (200 -2014). Available at: http://www.sasgroup.net/en/category/investor-relations/financial-reports/annual-reports/(Accessed: 18 April 2016).

Saunders, M., Lewis, P. & Thornhill, A (2007). Research Methods for Business Students. 4th ed. Essex: Pearson Education Limited. p102.

Saunila, M. (2014),"Innovation capability for SME success: perspectives of financial and operational performance", Journal of Advances in Management Research, Vol. 11 Iss 2 pp. 163 – 175 http://dx.doi.org/10.1108/JAMR-11-2013-0063, (accessed, 03 December 2016).

Saurabh, A., Rajesh, Kr. S., & Qasim, M. (2016),"Triple bottom line performance evaluation of reverse logistics", Competitiveness Review, Vol. 26 Iss 3 pp. 289 – 310, http://dx.doi.org/10.1108/CR-04-2015-0029, (Accessed, 01 December 2016).

Selin, Ö., & Jean-Pascal, G. (2011),"Productivity, scale effect and technological catch-up in Chinese regions", Journal of Chinese Economic and Foreign Trade Studies, Vol. 4 Iss 2 pp. 64 – 80, http://dx.doi.org/10.1108/17544401111143427, (accessed, 01 December 2016).

Seong-Jong, J. Don, N., & Philipp, A. S. (2011),"Benchmarking with data envelopment analysis: a return on asset perspective", Benchmarking: An International Journal, Vol. 18 Iss 4 pp. 529 – 542, http://dx.doi.org/10.1108/14635771111147623, (accessed, 01 December 2016).

Seong-Jong, J., & Karen, L. F. (2014),"Exploring comparative efficiency and determinants of efficiency for major world airlines", Benchmarking: An International Journal, Vol. 21 Iss 4 pp. 675 – 687, http://dx.doi.org/10.1108/BIJ-09-2012-0054, (accessed, 01 December 2016).

Seong-Jong, J., James, S. K. & Sue, H. (2013),"Measuring the longitudinal performance of 3PL branch operations", Benchmarking: An International Journal, Vol. 20 Iss 2 pp. 251 – 262, http://dx.doi.org/10.1108/14635771311307704, (accessed, 01 December 2016).

Seongseop (Sam), K., Kuo-Ching, W., Wan-Ting, J., &Yang (Young), G. (2016),"The best match-up of airline advertising endorsement and flight safety message", International Journal of Contemporary Hospitality Management, Vol. 28 Iss 11 pp. 2533 – 2552, http://dx.doi.org/10.1108/IJCHM-03-2015-0130, (accessed, 01 December 2016).

Seyed, H. R. H., Shide, S. H., & Hannan, A. M. (2016),"Fuzzy C-means based data envelopment analysis for mitigating the impact of units' heterogeneity", Kybernetes, Vol. 45 Iss 3 pp. 536 – 551, http://dx.doi.org/10.1108/K-07-2015-0176 (accessed, 01 December 2016).

Shabani, R., & Farzipoor, S. (2015),"Developing a novel data envelopment analysis model to determine prospective benchmarks of green supply chain in the presence of dual-role factor", Benchmarking: An International Journal, Vol. 22 Iss 4 pp. 711 – 730, http://dx.doi.org/10.1108/BIJ-12-2012-0087, (accessed, 01 December 2016).

Shrimal, P., & Michael, S. (2012),"On the cross-methodological validation of bank efficiency assessments", Studies in Economics and Finance, Vol. 29 Iss 1 pp. 26 – 42, http://dx.doi.org/10.1108/10867371211203837, (accessed, 01 December 2016).

Shwu-Ing, W., & Jui-Ho, C. (2012),"The performance evaluation and comparison based on enterprises passed or not passed with ISO accreditation", International Journal of Quality & Reliability Management, Vol. 29 Iss 3 pp. 295 – 319, http://dx.doi.org/10.1108/02656711211216153,(accessd, 01 December 2016).

Siddhant, M., Rachit, J., Narendra, M. G. & Sajeev, A. G. (2016),"Operational efficiency and service delivery performance", Benchmarking: An International Journal, Vol. 23 Iss 4 pp. 893 – 915, http://dx.doi.org/10.1108/BIJ-02-2014-0014, (accessed, 01 December 2016).

Singapore Air (2016) *Annual Report* (2007-2014). Available at: https://www.singaporeair.com/jsp/cms/en_UK/global_header/annualreport.jsp (Accessed: 16 April 2016).

Siobhan, T., Dawna, L. R., & Blaise, W. Jr, (2008),"Airline service quality", Managing Service Quality: An International Journal, Vol. 18 Iss 3 pp. 212 – 224, http://dx.doi.org/10.1108/09604520810871847, (accessed, 01 December 2016).

SkyWest (2016) *Annual Report* (2007-2014). Available at: http://inc.skywest.com/investor-relations/annual-reports/ (Accessed: 20 April 2016).

South African Airways (2016) *Annual Report* (2007-2014). Available at: http://www.flysaa.com/eg/en/footerlinks/aboutUs/financialResults.html (Accessed: 20 April 2016).

Southwest (2016) *Annual Report* (2007-2014). Available at: http://investors.southwest.com/financials/company-reports/annual-reports (Accessed: 16 April 2016).

Sprit Airlines (2016) *Annual Report* (2007-2014). Available at: http://ir.spirit.com/sec.cfm?DocType=Annual&Year=&FormatFilter (Accessed: 21 April 2016).

Srinidhi, S., & Ajay, K. M. (2013),"A conceptual model for demand forecasting and service positioning in the airline industry", Journal of Modelling in Management, Vol. 8 Iss 1 pp. 123 – 139, http://dx.doi.org/10.1108/17465661311312012, (accessed, 01 December 2016).

Stanley, N., Champika, L. L., & Akintola, A. (2016),"Performance measurement tool (PMT) to control maintenance-associated infections", Facilities, Vol. 34 Iss 13/14 pp. 766 – 787, http://dx.doi.org/10.1108/F-12-2014-0107, (accessed, 01 December 2016).

Štefan, B., & Laure, L. (2008),"Measures of farm business efficiency", Industrial Management & Data Systems, Vol. 108 Iss 2 pp. 258 – 270, http://dx.doi.org/10.1108/02635570810847617, (accessed, 01 December 2016).

Stephen, D. T. (2012),"The flexibility and benefits of operating a diverse fleet: an analysis using real options", Management Research Review, Vol. 35 Iss 6 pp. 462 – 472, http://dx.doi.org/10.1108/01409171211238244, (accessed, 01 December 2016).

Steven, W.D., Angappa, G., & Matthew, H. R. (2014),"Performance measures and metrics for the creative economy", Benchmarking: An International Journal, Vol. 21 Iss 1 pp. 46 – 61 http://dx.doi.org/10.1108/BIJ-03-2012-0017, (accessed, 01 December 2016).

Subhadip, S. (2015),"Assessment of performance using MPSS based DEA", Benchmarking: An International Journal, Vol. 22 Iss 4 pp. 624 – 642, http://dx.doi.org/10.1108/BIJ-02-2014-0012, (accessed, 01 December 2016).

Süleyman, Ç., Selçuk, P., & Hokey, M. (2015),"Evaluating the comparative efficiency of the postal services in OECD countries using context-dependent and measure-specific data envelopment analysis", Benchmarking: An International Journal, Vol. 22 Iss 5 pp. 839 – 856, http://dx.doi.org/10.1108/BIJ-10-2013-0098, (accessed, 01 December 2016).

Sundaram, N & Abdulrahman, A (2011), 'The exceptional performance strategies of Emirate Airlines', Competitiveness Review: *An International Business Journal*, Vol. 21, Iss 5, pp. 471 – 486.

Sunil, K., & Rachita, G. (2009),"Measuring efficiency, effectiveness and performance of Indian public sector banks", International Journal of Productivity and Performance Management, Vol. 59 Iss 1 pp. 51 – 74 http://dx.doi.org/10.1108/17410401011006112, (accessed, 01 December 2016).

Supannika, W. & Deepak, S. (2011),"Electricity industry reforms in Thailand: an analysis of productivity", International Journal of Energy Sector Management, Vol. 5 Iss 4 pp. 494 – 521 http://dx.doi.org/10.1108/17506221111186341, (accessed, 01 December 2016).

Suraya, A., Abdul, R., & Abdul, R., (2012),"The efficiency of Islamic and conventional commercial banks in Malaysia", International Journal of Islamic and Middle Eastern Finance and Management, Vol. 5 Iss 3 pp. 241 – 263, http://dx.doi.org/10.1108/17538391211255223, (accessed, 01 December 2016).

Susan, J. L., & Ilya, R. (2011),"Analyzing the efficiency of Russian firms", Journal of Economic Studies, Vol. 38 Iss 4 pp. 430 – 451, http://dx.doi.org/10.1108/01443581111160888, (accessed, 01 December 2016).

Susanne, W. (2014),"How to pick your staff? Using data envelopment analysis", Management Research Review, Vol. 37 Iss 9 pp. 815 – 832, http://dx.doi.org/10.1108/MRR-05-2013-0104 (accessed, 01 December 2016).

Sven, M. (2009),"Bundling management control innovations", Accounting, Auditing & Accountability Journal, Vol. 22 Iss 1 pp. 59 – 90, http://dx.doi.org/10.1108/09513570910923015, (accessed, 01 December 2016).

Syed, M. Q., &, Michael, D. (2014),"Corporate efficiency in the UK: a stochastic frontier analysis", International Journal of Productivity and Performance Management, Vol. 63 Iss 8 pp. 991 – 1011, http://dx.doi.org/10.1108/IJPPM-07-2013-0125, (accessed, 01 December 2016).

Sylvain, C., & Sebastian, H. (2014),"Empowering the regulators in the development of national performance measurements in food safety", British Food Journal, Vol. 116 Iss 2 pp. 317 – 336 http://dx.doi.org/10.1108/BFJ-05-2012-0124, (accessed, 01 December 2016).

Taeho, K. (2010),"Efficiency of trucks in logistics: technical efficiency and scale efficiency", Asian Journal on Quality, Vol. 11 Iss 1 pp. 89 – 96, http://dx.doi.org/10.1108/15982681011051859 (accessed, 01 December 2016).

Taiwen, F., Tongzheng, L., Linyan, S., & Dan, W. (2013),"External involvement and operational performance", Chinese Management Studies, Vol. 7 Iss 3 pp. 488 – 507, http://dx.doi.org/10.1108/CMS-Feb-2012-0023, (accessed, 03 December 2016).

Tamer, M. S., & Abdoulaye, K. (2013),"Efficiency analysis of GCC academic libraries: an application of data envelopment analysis", Performance Measurement and Metrics, Vol. 14 Iss 3 pp. 197 - 210, http://dx.doi.org/10.1108/PMM-07-2013-0023, (accessed,01 December 2016).

Tamer, M. S., & Yousef, M. H. (2013),"Efficiency analysis of UAE banks using data envelopment analysis", Journal of Economic and Administrative Sciences, Vol. 29 Iss 1 pp. 4 – 20, http://dx.doi.org/10.1108/10264111311319204, (accessed, 01 December 2016).

Tap Portugal (2016) *Annual Report* (2007-2014). Available at: http://www.tapportugal.com/Info/en/about-tap/tap-group/annual-reports (Accessed: 20 April 2016).

Tesfatsion, S. D. (2016),"Are the best African banks really the best? A Malmquist data envelopment analysis", Meditari Accountancy Research, Vol. 24 Iss 4 pp. 588 – 610, http://dx.doi.org/10.1108/MEDAR-02-2016-0016, (accessed, 01 December 2016).

Thanh, N., & David, T. (2016),"Stochastic cost frontier analysis – a sensitivity analysis on cost measures", Pacific Accounting Review, Vol. 28 Iss 4 pp. 401 – 410, http://dx.doi.org/10.1108/PAR-03-2016-0028, (accessed, 01 December 2016).

Theresa, D. (2013),"Governance and performance reporting in Scottish charities", Journal of Financial Reporting & Accounting, Vol. 11 Iss 2 pp. 112 – 130, http://dx.doi.org/10.1108/JFRA-11-2011-0015, (accessed, 01 December 2016).

Thomas Cook (2016) *Annual Report* (2007-2014). Available at: http://www.thomascook.in/pages/indus/tcportal/Annual_Reports.html (Accessed: 21 April 2016).

Thomas, L., Tazeeb, R., & Conor, O. (2011),"Strategic reorientation and business turnaround: the case of global legacy airlines", Journal of Strategy and Management, Vol. 4 Iss 3 pp. 215 – 237, http://dx.doi.org/10.1108/17554251111152252 (accessed, 01 December 2016).

Thomas, W., Júlia, M. B., & Catarina, F. I. (2015),"Measuring electric energy efficiency in Portuguese households", Management of Environmental Quality: An International Journal, Vol. 26 Iss 3 pp. 407 – 422, http://dx.doi.org/10.1108/MEQ-03-2014-0035 (accessed, 01 December 2016).

Tser-yieth, C., Chie-Bein, C., & Sin-Ying, P. (2008),"Firm operation performance analysis using data envelopment analysis and balanced scorecard", International Journal of Productivity and Performance Management, Vol. 57 Iss 7 pp. 523 – 539, http://dx.doi.org/10.1108/17410400810904010 (accessed, 01 December 2016).

Turkish Airlines (2016) *Annual Report* (2007-2014). Available at: http://investor.turkishairlines.com/en/financial-operational/annual-reports/1/2008 (Accessed: 16 April 2016).

Udayangani,K., Dilanthi, A., & Richard, H. (2011),"Structured approach to measure performance in construction research and development", International Journal of Productivity and Performance Management, Vol. 60 Iss 3 pp. 289 – 310, http://dx.doi.org/10.1108/17410401111112005, (Accessed, 01 December 2016).

United-Continental Holdings (2016) *Annual Report* (2007 -2014). Available at: http://ir.united.com/financial-performance/sec-filings (Accessed: 21 April 2016).

UTair Group (2016) *Annual Report* (2007-2014). Available at: https://www.utair.ru/en/about/corporate/investors/reports/annual-reports/ (Accessed: 21 April 2016).

Varun, M., Nauriyal, D.K., & Singh, S.P. (2014),"Technical efficiency analysis of the Indian drug and pharmaceutical industry ", Benchmarking: An International Journal, Vol. 21 Iss 5 pp. 734 – 755, http://dx.doi.org/10.1108/BIJ-10-2012-0070, (accessed, 01 December 2016).

Vasigh, B., Fleming, K. & Tracker, T. (2008), Introduction to Air Transport Economics, Ashgate, Aldershot.

Vedran, C., Martin, M., & Clemens, R. (2012),"Service specialization and operational performance in hospitals", International Journal of Operations & Production Management, Vol. 32 Iss 4 pp. 468 – 495, http://dx.doi.org/10.1108/01443571211223103, (accessed, 03 December 2016).

Vicky, R. (2007),"Interpreting the balanced scorecard: an investigation into performance analysis and bias", Measuring Business Excellence, Vol. 11 Iss 1 pp. 4 – 11, http://dx.doi.org/10.1108/13683040710740871, (accessed, 01 December 2016)

Vidyashankar, G., & Prakash, S. L. (2012),"Benchmarking educational development efficiencies of the Indian states: a DEA approach", International Journal of Educational Management, Vol. 26 Iss 1 pp. 99 – 130, http://dx.doi.org/10.1108/09513541211194400, (accessed, 01 December 2016).

Vincenzo, F., & Sandra, Z. (2016),"Measuring business performance in the airport context: a critical review of literature", International Journal of Productivity and Performance Management, Vol. 65 Iss 8 pp. 1137 – 1158, http://dx.doi.org/10.1108/IJPPM-06-2015-0090 (accessed, 01 December 2016).

Vineeta, N., Tripta, T, Sethi, V.K, & Singh, R.P. (2012),"Benchmarking of Indian mobile telecom operators using DEA with sensitivity analysis", Benchmarking: An International Journal, Vol. 19 Iss 2 pp. 219 – 238, http://dx.doi.org/10.1108/14635771211224545, (accessed, 01 December 2016).

Vinh, S. C., &Yu-Ying, K. (2009),"Bridge over troubled water or long and winding road?", Managing Service Quality: An International Journal, Vol. 19 Iss 1 pp. 106 – 134, http://dx.doi.org/10.1108/09604520910926836 (accessed, 01 December 2016).

Vinod, Y., & Milind, K. S. (2015),"An application of hybrid data envelopment analytical hierarchy process approach for supplier selection", Journal of Enterprise Information Management, Vol. 28 Iss 2 pp. 218 – 242, http://dx.doi.org/10.1108/JEIM-04-2014-0041, (accessed, 01 December 2016).

Virgin Australia (2016) *Annual Report* (2007-2014). Available at: http://www.virginaustralia.com/au/en/about-us/company-overview/investor-information/annual-reports/ (Accessed: 21 April 2016).

Volga-Dnepr Group Airlines (2016) *Annual Report* (2007-2014). Available at: http://www.volga-dnepr.com/en/investorrelations/annual_report/ (Accessed: 21 April 2016).

Vu, H. L. (2012),"Efficiency of rice farming households in Vietnam", International Journal of Development Issues, Vol. 11 Iss 1 pp. 60 – 73, http://dx.doi.org/10.1108/14468951211213868 (accessed, 01 December 2016).

Wann-Yih, W., & Ying-Kai, L. (2014),"A balanced scorecard envelopment approach to assess airlines' performance", Industrial Management & Data Systems, Vol. 114 Iss 1 pp. 123 – 143, http://dx.doi.org/10.1108/IMDS-03-2013-0135, (accessed, 02 December 2016).

Wantao, Y., & Ramakrishnan, R. (2016),"Environmental management practices and environmental performance", Industrial Management & Data Systems, Vol. 116 Iss 6 pp. 1201 – 1222, http://dx.doi.org/10.1108/IMDS-09-2015-0380, (accessed, 02 December 2016).

West Jet (2016) *Annual Report* (2007-2014). Available at: http://www.westjet.com/guest/en/media-investors/annual-reports.shtml (Accessed: 20 April 2016).

Wided, K., Adel, K., & Abdelwahed, O. (2007),"Corporate governance efficiency: an indexing approach using the stochastic frontier analysis", Corporate Governance: The international journal of business in society, Vol. 7 Iss 2 pp. 148 – 161, http://dx.doi.org/10.1108/14720700710739796, (accessed, 01 December 2016).

Will, S., & Linna, Y. (2014),"The balanced scorecard and the construction of a management control discourse", Journal of Accounting & Organizational Change, Vol. 10 Iss 4 pp. 466 – 485, http://dx.doi.org/10.1108/JAOC-10-2012-0098, (accessed, 01 December 2016).

Wolfgang, S., & Andreas, W. (2010),"Goodwill accounting and performance measurement", Managerial Finance, Vol. 36 Iss 9 pp. 768 – 784, http://dx.doi.org/10.1108/03074351011064645 (accessed, 01 December 2016).

Wu, Y., He, C., & Cao, X. (2013), "The impact of environmental variables on the efficiency of Chinese and other non-Chinese airlines", J. Air Transp. Manage. 29, 35-38. http://dx.doi.org/10.1016/j.jairtraman, (accessed, 04 February 2013).

Xiaotian, T., & Zhang, Y. W. (2014),"Production efficiency of Chinese banks: a revisit", Managerial Finance, Vol. 40 Iss 10 pp. 969 – 986, http://dx.doi.org/10.1108/MF-05-2013-0115, (accessed, 01 December 2016).

Yang, C., Atanu, C., & Sami, F. (2016),"Interplant coordination, supply chain integration, and operational performance of a plant in a manufacturing network: a mediation analysis", Supply Chain Management: An International Journal, Vol. 21 Iss 5 pp. 550 – 568, http://dx.doi.org/10.1108/SCM-10-2015-0391, (accessed, 03 December 2016).

Yan-Jie, Y., Jengfang, C., Qian, L. K., & Hsin, C. C. (2013),"Ownership structure and efficiency in Taiwanese electronics firms", Review of Accounting and Finance, Vol. 12 Iss 4 pp. 351 – 368, http://dx.doi.org/10.1108/RAF-07-2012-0063, (accessed, 01 December 2016).

Yat, H. C., Jing, L., Tracy, N.Y. C., & King, F. M. (2013),"Evaluating construction contractors' efficiency in Hong Kong using Data Envelopment Analysis Assurance Region model", Journal of Facilities Management, Vol. 11 Iss 1 pp. 52 – 68, http://dx.doi.org/10.1108/14725961311301466, (accessed, 01 December 2016).

Yilmaz, K. (2009),"The Balanced Scorecard: Implementation in Non-Profit Organizations", GRIN Verlag, San Francisco, CA.

Yiwen, B., Miao, H., & Hao, X. (2015),"Measuring efficiencies of parallel systems with shared inputs/ outputs using data envelopment analysis", Kybernetes, Vol. 44 Iss 3 pp. 336 – 352, http://dx.doi.org/10.1108/K-04-2014-0067, (accessed, 01 December 2016).

Yong, Q. C.,Huanqing, L., Wenxue, L., & Ning, Z.(2010),"Analysis of project delivery systems in Chinese construction industry with data envelopment analysis (DEA)", Engineering, Construction and Architectural Management, Vol. 17 Iss 6 pp. 598 – 614, http://dx.doi.org/10.1108/09699981011090215 (accessed, 01 December 2016).

Yongmei, H., Zhi, Z., & Wenyan, L. (2009),"Efficiency of primary schools in Beijing, China: an evaluation by data envelopment analysis", International Journal of Educational Management, Vol. 23 Iss 1 pp. 34 – 50, http://dx.doi.org/10.1108/09513540910926411, (accessed, 01 December 2016).

Younghee, N. (2011),"Evaluation of the resource utilization efficiency of university libraries using DEA techniques and a proposal of alternative evaluation variables", Library Hi Tech, Vol. 29 Iss 4 pp. 697 – 724, http://dx.doi.org/10.1108/07378831111189787, (accessed, 01 December 2016).

Yulia, T. (2016),"Are board characteristics relevant for banking efficiency? Evidence from the US", Corporate Governance, Vol. 16 Iss 4 pp. 655 – 679, http://dx.doi.org/10.1108/CG-09-2015-0124 (accessed, 01 December 2016).

Zhaobin, F., Ruohan, Z., Xiaotong, L., & Lin, P. (2016),"China's outward FDI efficiency along the Belt and Road", China Agricultural Economic Review, Vol. 8 Iss 3 pp. 455 – 479, http://dx.doi.org/10.1108/CAER-11-2015-0158, (accessed, 01 December 2016).

Appendix 1: Ethical Approval Letter

Graduate School of Business Leadership, University of South Africa, PO Box 392, Unisa, 0003, South Africa
Cnr Janadel and Alexandra Avenues, Midrand, 1685, Tel: +27 11 652 0000, Fax: +27 11 652 0299
E-mail: sbl@unisa.ac.za Website: www.unisa.ac.za/sbl

SCHOOL OF BUSINESS LEADERSHIP
RESEARCH ETHICS REVIEW COMMITTEE (GSBL CRERC)

11 November 2016

Ref #: 2016_SBl_DBL_037_SD
Name of applicant: Mr A Abebe
Student #: 78463122

Dear Mr Abebe

Decision: Ethics Approval

Student: Mr A Abebe, abeyiabebe@gmail.com, 251 911 398889

Supervisor: Dr GA Imiru, get_aiwo@yahoo.com, 251 911 429290

Project Title: Operational Performance Measurement of Airlines: An Integrated Comparative Approach in relation to Ethiopian Airline

Qualification: Doctorate in Business Leadership (DBL)

Thank you for applying for research ethics clearance, SBL Research Ethics Review Committee reviewed your application in compliance with the Unisa Policy on Research Ethics.

Outcome of the SBL Research Committee:
Approval is granted for the duration of the Project

The application was reviewed in compliance with the Unisa Policy on Research Ethics by the SBL Research Ethics Review Committee on the 09/11/2016.

The proposed research may now commence with the proviso that:

1) The researcher/s will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2) Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the SBL Research Ethics Review Committee.

45 years Building leaders who go beyond

SBL GRADUATE SCHOOL OF BUSINESS LEADERSHIP UNISA

Graduate School of Business Leadership, University of South Africa, PO Box 392, Unisa, 0003, South Africa
Cnr Janadel and Alexandra Avenues, Midrand, 1685, Tel: +27 11 652 0000, Fax: +27 11 652 0299
E-mail: sbl@unisa.ac.za Website: www.unisa.ac.za/sbl

3) An amended application could be requested if there are substantial changes from the existing proposal, especially if those changes affect any of the study-related risks for the research participants.
4) The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study.

Kind regards,

15/11/2016

Prof R Ramphal

Chairperson: SBL Research Ethics Committee

011 – 652 0363 or ramphrr@unisa.ac.za

16/11/2016

Dr R Mokate

CEO and Executive Director: Graduate School of Business Leadership

011- 652 0256/mokatrd@unisa.ac.za

45 years Building leaders who go beyond

SBL GRADUATE SCHOOL OF BUSINESS LEADERSHIP UNISA

Appendix 2: Annual Financial and Traffic Report for Year 2007

DMU	Op. Revenue	NI	ROA %	ROI%	Passenger	RPK	Energy	Capital	Labor	Material	Other Cost
1	660.573	48.942	10.130	4.190	5.200	3600.000	131.214	116.305	89.382	604.680	229.633
2	1758.246	144.092	5.600	10.990	9.305	20261.773	346.611	153.165	420.545	245.994	144.843
3	3807.800	313.400	9.220	10.640	10.205	27879.300	1023.100	53.200	555.200	999.500	315.100
4	3470.925	28.705	0.840	0.790	28.212	46070.000	768.695	67.905	426.667	2376.123	1.248
5	9908.906	399.297	3.600	4.220	33.000	31466.128	2376.239	1638.143	1916.442	1040.593	2494.446
6	6709.584	516.935	4.060	8.350	37.256	70025.800	2259.373	1030.533	684.303	591.212	1627.228
7	31572.898	1213.763	3.330	3.990	73.500	199510.000	5826.611	5002.839	9153.171	1807.645	8597.604
8	3294.072	170.131	4.734	4.460	12.500	26874.000	853.734	1262.510	679.754	602.771	419.554
9	360.573	31.509	7.770	9.580	3.265	3140.927	152.149	31.547	55.593	25.764	64.011
10	22833.000	356.000	1.400	1.640	175.213	310685.381	6011.000	3552.000	6132.000	1350.000	4702.000
11	12631.312	277.259	1.830	1.770	51.023	60709.000	2004.673	1819.910	1976.037	1233.258	8608.128
12	16990.592	608.236	2.670	3.780	33.068	112851.000	3863.499	3927.524	4555.768	1860.722	1906.740
13	9661.000	924.000	8.610	8.270	23.253	81801.000	3157.000	1149.000	1557.000	3545.000	1763.000
14	5586.833	46.521	0.520	0.830	39.161	57182.560	1985.639	1135.651	568.404	979.443	946.245
15	1027.264	161.820	18.700	19.470	5.861	4921.069	265.387	115.736	116.691	134.197	199.289
16	13358.000	314.000	0.970	2.410	52.498	136811.661	3416.000	4426.000	2887.000	906.000	1409.000
17	3595.795	304.718	6.050	9.070	372.301	36976.000	851.330	314.322	479.386	196.276	1518.989
18	3340.685	200.811	4.910	6.400	5.717	19436.282	962.189	1646.947	355.830	99.661	74.226
19	1932.450	44.826	2.440	2.370	3.533	15236.879	532.807	260.992	442.705	151.604	502.271
20	7943.802	843.153	8.160	8.130	17.544	77947.000	2049.141	1632.367	1095.824	3918.018	1672.221
21	733.350	13.913	1.730	1.800	2.096	7242.931	276.083	153.719	48.232	135.813	160.241
22	2983.778	139.713	4.760	5.640	8.653	20304.000	165.028	607.840	741.258	249.184	713.206
23	1554.914	6.589	0.590	0.430	144.016	6005.100	500.177	322.925	86.699	347.946	289.331
24	982.555	7.051	0.860	0.740	7.051	4928.440	291.636	143.361	222.558	147.043	143.009
25	1783.906	6.734	0.320	0.380	10.727	12307.000	585.124	416.647	226.145	194.997	340.456
26	2842.000	18.000	0.320	0.640	21.387	15995.649	929.000	451.000	648.000	106.000	690.000
27	858.277	59.825	5.300	7.480	2.601	7479.000	231.927	180.964	113.591	130.730	142.277
28	9392.400	11.400	0.070	0.130	22.834	55354.000	2804.281	1215.019	1397.375	336.979	3310.610
29	30679.338	2408.369	10.470	4.940	62.900	13569.000	5281.991	23919.484	8675.602	8358.135	2480.894
30	4253.134	235.858	8.060	5.920	14.213	40162.186	1429.076	789.387	619.304	417.365	729.097
31	721.052	14.431	3.630	2.150	6.900	6059.000	167.378	194.345	116.428	139.258	52.631
32	12600.262	562.897	3.450	4.700	34.075	97622.000	2791.729	2305.720	2789.972	2182.314	1922.367
33	1292.677	82.758	2.980	3.860	16.287	13808.174	296.573	398.114	226.521	130.237	1092.058
34	3060.955	596.071	7.560	24.180	39.329	43352.396	948.748	325.446	310.050	57.535	823.097
35	40155.000	94.099	1.300	1.310	31.381	33082.000	1117.653	1267.087	2499.997	465.171	1819.107
36	7527.417	795.349	4.610	10.200	18.346	89148.800	3262.551	2088.306	82.946	791.036	1573.180
37	3374.332	159.192	3.990	4.950	34.393	28788.682	1062.080	688.719	726.947	297.960	439.435
38	9861.000	645.000	3.850	7.000	88.713	44946.434	2690.000	857.000	3213.000	616.000	1840.000
39	2925.090	33.569	1.090	1.160	7.800	19135.000	577.088	440.856	666.419	438.196	777.344
40	3708.116	202.591	5.390	4.350	19.600	30251.000	896.586	664.877	775.769	1684.165	638.096
41	20143.000	403.000	1.660	2.100	93.812	209247.232	5003.000	4589.000	4261.000	2512.000	2786.000
42	1814.691	180.549	9.360	11.060	15.262	17563.000	409.037	287.807	358.169	159.884	417.320
43	19798.788	179.482	6.460	6.760	13.005	18888.152	469.040	318.668	380.269	149.064	1339.124

Note that all numbers are stated in million and US except the percentage

Appendix 3: Annual Financial and Traffic Report for Year 2008

DMU	Op. Revenue	NI	ROA %	ROI%	Passenger	RPK	Energy	Capital	Labor	Material	Other Cost
1	895.500	43.136	6.711	2.660	6.000	4400.000	216.550	163.353	109.501	832.834	301.566
2	4613.800	37.000	1.102	0.910	11.600	31100.000	1549.000	197.000	686.600	1270.700	380.900
3	35302.126	1122.864	2.500	3.280	74.800	207227.000	6693.262	5544.047	10274.128	2232.551	9464.554
4	3552.561	165.944	4.340	4.030	13.200	29349.000	854.076	1417.371	735.328	665.296	449.874
5	504.012	35.407	8.350	7.560	4.299	3863.497	229.640	46.745	72.007	41.465	78.748
6	13455.449	619.765	3.640	2.850	50.384	61219.000	2571.382	1069.929	2332.300	1394.329	14375.738
7	16073.144	1274.393	6.240	8.610	34.613	118395.000	3773.599	3621.186	3977.428	1794.066	1628.799
8	1288.789	118.659	10.140	11.800	6.485	4174.643	404.669	71.930	139.431	165.213	224.603
9	4338.812	1527.803	26.880	35.960	43.659	47690.000	1301.387	344.123	546.483	270.854	1786.354
10	4679.930	280.771	5.540	6.380	6.674	22691.457	1586.838	2115.745	402.024	143.573	150.977
11	10566.528	1366.876	10.790	10.190	21.229	94346.000	2996.254	2010.526	1501.777	4863.720	2048.546
12	927.661	51.182	5.390	5.260	2.505	8681.920	374.520	173.251	57.479	174.073	193.109
13	20004.578	69.031	5.120	3.580	10.400	17600.000	764.548	369.031	119.811	354.098	322.944
14	1210.865	28.586	3.080	2.500	7.848	4872.419	424.532	159.293	242.798	163.771	152.818
15	21550.810	16.349	0.080	0.100	55.273	92172.750	3987.606	1636.331	2628.129	1666.736	6846.662
16	980.415	62.728	5.039	6.830	2.762	7724.000	253.295	210.331	145.317	141.750	167.869
17	4.140	338.312	6.510	7.620	8.046	26951.600	1388.826	736.355	607.937	191.177	1515.096
18	36367.895	891.557	3.550	1.590	70.500	15463.000	7871.756	28176.994	9751.491	7928.851	2430.187
19	4513.952	73.727	2.440	1.680	13.760	36176.166	1960.939	683.927	653.659	344.184	749.507
20	1103.789	0.699	0.120	0.070	9.100	9074.000	355.682	186.865	192.679	210.939	74.757
21	13548.177	811.373	4.920	7.270	38.621	102466.000	3013.969	1687.759	2119.761	2165.529	2169.964
22	1479.755	84.580	2.610	6.060	18.918	15608.874	327.791	463.720	252.336	169.425	181.903
23	3972.917	571.972	6.180	16.820	50.900	55434.448	1158.477	578.254	417.733	83.020	1163.480
24	9018.966	201.802	1.080	2.420	19.120	91485.200	3552.283	1991.798	101.855	933.945	1744.970
25	3496.249	112.929	2.810	3.340	33.462	27516.973	1220.618	658.281	724.094	381.653	398.674
26	11023.000	178.000	1.240	1.640	88.529	45675.380	3713.000	1024.000	3340.000	721.000	2047.000
27	4709.109	872.292	14.410	21.630	22.600	34265.000	1423.943	108.003	907.011	661.056	933.388
28	1953.754	81.748	2.930	4.340	16.700	18764.000	493.082	277.709	448.569	171.612	491.995
29	2392.132	167.139	5.430	5.220	14.284	22093.115	753.708	316.456	421.367	179.156	1529.636

Note that all numbers are stated in million and US except the percentage

Appendix 4: Annual Financial and Traffic Report for Year 2009

DMU	Op. Revenue	NI	ROA %	ROI%	Passenger	RPK	Energy	Capital	Labor	Material	Other Cost
1	866.035	32.039	4.990	3.550	6.600	5400.000	148.942	200.611	125.113	132.098	297.013
2	3345.900	85.800	2.150	3.210	8.756	29900.000	725.400	53.100	538.900	1118.500	233.500
3	7523.592	703.132	4.450	9.730	41.279	75473.770	2117.727	1543.873	970.205	629.895	1962.544
4	2995.850	13.650	0.420	0.330	12.400	27112.000	109.655	1383.200	662.350	616.850	361.400
5	892.194	144.171	4.440	14.330	14.253	16890.000	264.211	517.405	87.141	254.892	111.837
6	557.940	76.331	15.280	15.850	5.328	4762.410	165.000	77.486	90.006	52.938	96.179
7	8587.000	623.000	6.030	5.780	24.558	89440.000	2224.000	1309.000	1618.000	3834.000	1791.000
8	489.885	68.464	9.220	14.320	8.756	7056.000	154.677	95.085	27.096	68.651	132.561
9	5707.805	28.789	0.270	0.440	44.043	60942.090	1794.041	1574.050	753.758	1359.704	1131.339
10	1256.076	249.087	11.530	24.710	7.182	4597.265	300.816	168.703	157.879	180.870	199.555
11	4159.278	111.047	1.940	2.630	45.164	50566.000	1258.950	110.735	547.438	252.040	2053.437
12	4892.214	245.258	4.700	5.280	6.820	23186.672	1476.100	2278.393	513.838	146.960	231.665
13	11779.863	267.277	1.910	1.640	22.731	101762.000	3932.339	2551.677	1595.751	6036.411	2142.734
14	1107.521	122.006	12.040	10.440	2.810	9389.000	512.475	187.059	65.765	277.666	126.092
15	1714.944	97.807	6.880	6.000	11.100	18000.000	478.526	413.353	159.468	264.091	314.397
16	1183.306	116.720	11.340	11.500	8.340	5063.211	243.909	145.503	272.623	187.446	165.808
17	3292.000	61.000	0.930	1.890	22.450	16131.137	945.000	578.000	776.000	149.000	783.000
18	3.519	233.032	4.040	6.060	5.675	29830.100	959.608	689.715	636.671	213.833	1348.891
19	3229.585	148.921	6.120	4.450	13.870	33455.303	995.939	663.728	596.306	422.614	666.803
20	1161.242	38.669	4.850	3.730	10.800	10602.000	226.136	307.513	209.219	219.642	75.433
21	11227.377	96.021	0.610	0.850	38.438	99176.000	2811.918	1956.321	2875.932	2212.376	1407.521
22	1642.218	36.385	0.820	2.270	18.784	16604.880	236.620	502.338	342.364	211.503	313.008
23	8973.514	788.599	4.630	8.800	18.293	16604.880	4406.749	1904.658	127.009	915.815	1607.111
24	2613.614	83.658	1.940	3.310	34.545	28075.373	390.739	650.858	698.326	436.039	353.994
25	3186.897	47.752	2.470	1.660	6.898	21935.000	1021.674	488.921	425.490	294.351	649.638
26	10350.000	99.000	0.690	0.970	86.310	46275.146	3044.000	965.000	3468.000	719.000	2055.000
27	2885.810	0.001	0.000	0.000	8.400	21076.000	498.778	443.324	701.561	385.100	857.045
28	4557.787	362.165	0.070	6.390	25.100	40130.000	987.259	865.272	913.470	2215.188	691.376
29	1998.470	86.013	2.810	2.990	14.039	22260.131	499.871	313.321	409.918	182.513	1474.315

Note that all numbers are stated in million and US except the percentage

Appendix 5: Annual Financial and Traffic Report for Year 2010

DMU	Op. Revenue	NI	ROA %	ROI%	Passenger	RPK	Energy	Capital	Labor	Material	Other Cost
1	1610.262	65.174	2.730	5.210	9.346	13895.000	352.632	202.916	342.945	216.628	137.079
2	4319.300	253.200	5.600	7.380	11.286	39200.000	943.000	159.500	686.500	1312.200	330.900
3	10466.429	103.830	1.020	1.000	32.000	32240.522	2573.426	2498.707	1829.151	928.646	2577.307
4	12184.345	1822.147	7.770	17.120	60.006	105695.000	3559.264	1678.155	1455.243	924.580	3033.595
5	2797.809	56.703	1.780	1.660	12.300	25829.000	649.319	1144.433	674.904	614.052	341.601
6	1225.919	329.586	8.020	38.890	16.055	18499.000	375.758	186.277	112.030	32.227	141.226
7	663.641	65.702	13.110	9.900	5.903	5466.237	243.671	141.342	108.000	60.579	110.049
8	11477.000	1825.000	15.550	13.620	26.796	96588.000	3625.000	1516.000	1776.000	4363.000	2124.000
9	645.176	153.538	13.860	28.120	10.461	8860.000	217.533	68.139	43.513	76.151	140.904
10	10901.637	780.554	5.110	7.430	64.930	93152.760	3191.394	1986.535	1320.655	2344.649	1657.045
11	1414.806	241.057	9.430	20.540	7.998	5230.578	354.427	228.535	178.845	195.947	215.995
12	31755.000	2217.000	5.130	7.120	119.266	310808.921	7594.000	10101.000	6751.000	2242.000	4436.000
13	4591.724	187.339	3.030	4.090	48.754	56128.000	11326.798	292.205	583.792	273.054	2303.044
14	5063.581	192.829	3.750	3.960	7.274	24731.000	1403.034	2459.051	603.345	178.097	227.225
15	1971.446	57.055	3.320	2.960	4.184	17400.000	584.260	260.766	473.611	154.958	452.903
16	11831.115	970.612	5.930	6.040	27.454	126273.000	3242.088	2611.530	1727.498	6276.984	2215.935
17	1267.027	122.498	10.210	9.170	3.150	10705.000	549.793	182.006	71.697	310.856	221.894
18	2149.925	56.738	3.771	2.680	12.700	18465.800	696.160	490.667	192.230	356.805	383.598
19	622.807	83.350	27.250	15.510	11.917	18632.000	162.359	52.041	142.353	54.756	126.027
20	1310.093	110.255	9.870	9.660	8.418	5385.873	322.999	151.456	297.567	186.135	183.848
21	22854.372	154.442	0.780	0.680	50.600	157323.000	6034.061	5814.753	5853.363	2335.168	2829.383
22	671.052	24.093	4.600	2.970	3.339	6219.000	147.184	176.836	142.550	153.207	191.200
23	3779.000	97.000	1.470	2.630	24.254	17575.513	1115.000	582.000	891.000	172.000	922.000
24	950.448	27.341	2.700	2.960	2.890	8071.000	252.838	168.961	165.912	162.942	172.455
25	10062.800	405.400	2.590	4.310	22.926	60528.000	2983.656	1963.249	1094.601	578.408	2781.071
26	4.391	420.925	6.200	9.040	6.302	23226.400	1161.927	809.436	793.264	234.863	1658.858
27	36195.139	1514.092	6.220	2.800	92.700	17845.000	6575.636	28579.641	10047.582	6869.711	1956.530
28	4030.641	73.700	1.910	1.870	15.708	38652.874	1361.275	715.616	673.243	455.407	745.047
29	1422.360	25.148	2.300	1.880	13.000	13774.000	346.220	381.586	255.363	258.193	94.898
30	12631.791	106.396	0.580	0.850	41.428	100727.000	3011.195	2460.870	3123.094	2453.532	1476.705
31	3958.231	404.420	4.040	11.380	66.500	72149.286	1184.118	566.559	443.763	113.921	1245.450
32	7441.988	205.031	1.240	2.610	16.480	82882.500	3076.926	1908.289	112.528	981.433	1779.475
33	2765.145	96.350	2.187	3.610	40.411	32545.597	340.074	662.699	764.933	487.466	413.623
34	3068.720	79.375	4.100	2.840	6.735	22413.000	703.311	439.774	559.452	390.455	702.355
35	12104.000	459.000	2.970	3.940	88.191	48506.505	3620.000	1345.000	3704.000	751.000	2225.000
36	781.265	72.481	15.240	10.230	6.952	10723.012	248.206	104.055	156.443	28.189	171.891
37	5588.998	190.072	2.690	2.770	29.119	47950.000	1434.938	916.438	1170.566	2489.340	860.470
38	23229.000	253.000	0.640	1.130	98.129	226638.913	6687.000	4914.000	4204.000	1115.000	5389.000
39	2735.115	19.537	0.550	0.720	18.600	26894.000	717.349	428.245	586.830	258.011	721.384
40	2531.953	87.525	2.530	2.440	15.174	25121.513	654.620	374.526	514.572	217.986	1823.575

Note that all numbers are stated in million and US except the percentage

Appendix 6: Annual Financial and Traffic Report for Year 2011

DMU	Op. Revenue	NI	ROA %	ROI%	Passenger	RPK	Energy	Capital	Labor	Material	Other Cost
1	1655.283	9.148	3.600	7.560	9.513	14051.000	370.975	126.692	334.770	240.533	136.704
2	5377.900	491.300	9.210	10.420	14.174	46077.400	1472.200	244.200	870.100	1708.400	417.700
3	15220.640	1092.357	4.020	7.720	69.687	123489.07	5367.444	2065.935	1897.766	1165.753	3644.600
4	3576.984	66.744	1.650	1.530	13.103	26996.000	893.216	1452.712	852.016	745.720	418.592
5	1469.657	380.247	8.360	28.850	17.987	21037.000	575.395	404.158	158.303	28.346	151.778
6	779.117	49.398	6.990	6.340	6.176	5640.577	330.657	128.520	119.856	81.228	118.856
7	17006.857	291.934	1.160	1.410	45.742	58413.000	3210.483	2760.224	3048.325	1629.718	10008.137
8	16014.329	1077.564	5.910	7.090	34.250	117348.00	5205.018	3056.304	3452.373	1686.900	1807.164
9	12616.000	727.000	5.660	4.870	27.581	101536.00	4984.000	1404.000	1894.000	4380.000	2255.000
10	784.013	83.735	7.260	10.880	11.933	10531.000	351.646	93.791	56.845	91.474	175.631
11	12744.992	707.826	3.990	5.780	68.725	100895.06	4520.745	2065.632	1340.161	2363.614	1957.676
12	13981.066	941.918	9.260	6.160	80.677	122344.29	5053.723	3287.124	2543.952	1485.416	2923.968
13	1830.921	310.425	20.420	20.420	8.723	6338.098	547.221	285.059	213.094	231.694	243.428
14	35115.000	1975.000	4.540	5.780	119.018	310162.10	9730.000	10441.000	6894.000	2486.000	4591.000
15	5535.342	360.791	5.040	6.900	54.509	61347.000	1470.426	389.655	710.358	287.030	2374.809
16	14764.774	1481.895	7.620	7.530	31.422	146134.00	4579.364	3094.474	2073.238	7325.349	2611.762
17	1493.349	74.315	3.930	4.330	3.730	13151.000	764.666	267.765	76.944	332.655	272.704
18	3096.328	64.226	3.960	2.120	17.074	24434.700	1137.745	576.795	238.607	554.507	524.448
19	822.981	40.890	7.690	5.200	14.334	22635.000	260.728	126.616	165.264	70.177	162.941
20	26199.872	889.952	2.810	3.490	51.687	168617.00	8126.627	5528.928	6205.613	2477.435	3136.480
21	2783.532	2.086	0.050	0.070	14.670	26972.000	939.885	805.171	288.924	283.608	545.838
22	4504.000	86.000	1.220	1.950	26.370	19078.931	1664.000	604.000	947.000	227.000	976.000
23	1043.244	43.001	4.500	4.300	3.137	8896.000	301.150	201.609	167.882	178.517	151.450
24	13311.300	320.197	4.190	0.010	60.283	96081.000	1750.052	1004.202	1012.503	318.407	2006.749
25	39972.956	5.565	0.020	0.010	100.600	19045.000	8730.781	31925.224	10736.802	7253.393	2396.931
26	1878.824	21.786	1.360	1.190	15.700	17421.000	551.858	534.875	330.042	302.158	114.276
27	15382.709	257.170	1.200	1.700	44.456	106759.00	3746.011	2937.319	3816.242	2935.253	1690.714
28	5049.135	557.429	4.660	12.360	72.100	85690.343	1706.926	679.571	523.207	130.628	1470.433
29	9338.751	913.899	4.680	9.690	16.647	84801.300	3639.767	2518.633	106.362	1048.741	2118.723
30	3115.729	107.358	5.510	3.790	8.053	22661.000	838.744	385.745	608.730	272.047	730.421
31	15658.000	178.000	0.990	1.150	103.974	60647.937	5644.000	1672.000	4371.000	955.000	2838.000
32	1071.186	76.448	10.250	13.010	8.518	12882.858	388.046	195.618	181.742	35.553	193.779
33	7031.518	11.022	0.120	0.130	32.649	58933.000	2381.139	1154.099	1331.431	2895.822	1082.116
34	37110.000	845.000	2.220	2.330	141.799	333917.37	12375.000	6523.000	7652.000	1744.000	7966.000
35	3378.330	70.025	1.770	2.000	18.600	29569.000	935.728	564.329	766.450	350.743	886.669
36	3104.689	150.307	4.280	3.510	16.041	27177.524	925.762	453.008	582.469	288.822	2036.999

Note that all numbers are stated in million and US except the percentage

Appendix 7: Annual Financial and Traffic Report for Year 2012

DMU	Op. Revenue	NI	ROA %	ROI%	Passenger	RPK	Energy	Capital	Labor	Material	Other Cost
1	1790.193	43.814	1.91	3.21	9.653	14523.000	460.699	184.908	342.754	239.415	139.212
2	8138.100	166.300	2.66	2.38	27.500	74617.200	2287.500	166.700	1241.800	2682.300	614.100
3	5539.892	8.754	0.31	0.14	33.346	48720.000	1450.123	99.213	627.989	4225.594	1.698
4	12120.036	131.000	1.45	1.09	34.900	34584.214	3561.011	2525.008	2109.006	963.003	2900.009
5	15979.430	780.925	2.63	5.14	72.416	129773.320	5647.520	2833.978	2162.786	1109.149	3445.072
6	3530.363	55.913	1.3	1.53	13.122	27013.000	959.963	1370.250	826.875	746.550	397.688
7	1601.912	332.625	6.13	25.21	19.679	22731.000	630.902	318.199	187.946	36.403	146.169
8	908.719	78.414	9.82	9.44	6.987	6514.056	378.195	111.393	133.295	73.897	133.525
9	17678.457	352.917	1.32	1.66	44.903	59940.000	3295.498	3109.083	3144.464	1654.882	10060.147
10	4269.656	38.257	0.89	0.9	23.093	29072.000	1305.396	705.061	644.901	562.194	1013.847
11	17155.515	158.451	0.85	0.92	37.580	126436.000	5881.710	3858.288	3715.681	1922.013	1888.739
12	12741.000	145.000	0.95	0.93	28.961	103837.000	5188.000	1488.000	2061.000	4542.000	2375.000
13	898.146	84.639	6.41	49.56	13.255	11533.000	416.128	100.484	72.084	104.236	204.818
14	13509.825	444.912	2.27	3.32	73.077	109112.680	4733.644	2499.701	1594.025	2447.805	2121.418
15	15769.670	599.639	5.34	3.45	86.485	135534.730	5926.819	3497.363	2953.347	1635.853	3360.448
16	2249.388	326.476	16.98	17.3	10.214	7768.179	725.763	306.689	247.405	309.303	297.704
17	36670.000	1009.000	2.27	2.44	119.146	310495.166	10150.000	16687.000	7266.000	2687.000	4518.000
18	6106.711	404.051	5.94	6.97	58.400	65227.000	1820.605	437.325	777.996	321.656	2438.564
19	16957.971	493.599	2.16	2.04	33.981	160446.000	6613.628	3704.307	2160.619	8785.681	2889.446
20	1873.053	40.666	2.01	2.00	4.640	16175.000	1056.087	230.231	86.839	361.273	298.353
21	3147.132	15.161	0.53	0.46	8.774	23563.000	861.240	629.067	564.695	334.577	798.411
22	3472.469	110.843	4.33	3.39	20.415	27342.100	1255.127	654.428	144.598	597.522	618.907
23	1962.353	52.237	2.8	2.87	9.484	7593.310	631.741	260.546	376.574	287.377	267.255
24	15515.905	2150.115	14.11	16.94	37.545	57049.000	2916.981	1588.602	2675.345	294.928	5214.435
25	4982.000	128.000	1.81	2.64	28.956	20859.540	1806.000	636.000	1044.000	338.000	1030.000
26	1322.617	20.349	2.14	1.56	3.644	9943.000	499.078	186.066	201.965	209.761	204.895
27	11875.300	239.400	1.12	1.98	24.283	68834.000	4220.560	2078.080	1513.923	766.611	3540.907

28	13271.101	10.959	0.05	0.1	64.677	103555.000	3434.569	1700.114	1908.915	537.466	3453.305
29	38719.202	1288.713	4.83	2.21	103.100	19551.000	9497.672	29536.320	10397.073	6859.858	2001.809
30	2209.266	78.455	3.83	3.94	17.700	20353.000	642.645	537.416	357.708	321.262	130.210
31	1377.400	51.300	1.4	2.6	20.100	16283.080	161.400	633.500	308.400	296.300	573.800
32	5556.883	720.035	6.23	14.63	75.800	94262.382	2047.550	671.595	533.216	133.625	1534.763
33	9647.382	317.154	1.8	3.15	17.155	87824.000	4638.538	1976.138	112.539	1131.860	2213.444
34	3534.372	51.157	1.2	1.5	58.804	48412.039	426.387	630.973	1171.689	659.869	524.845
35	17088.000	421.000	2.26	2.53	109.347	63937.215	6120.000	1584.000	4749.000	1132.000	3082.000
36	1318.388	108.460	11.79	8.96	10.423	15548.927	471.763	216.864	218.919	49.460	252.922
37	8198.595	641.865	6.15	6.64	39.045	74410.000	2867.251	1017.549	1371.700	2657.441	17467.909
38	4058.866	23.608	0.57	0.77	19.469	31100.000	1080.777	565.239	871.207	538.732	978.166
39	3427.419	242.393	6.47	5.24	17.423	29384.451	992.790	492.142	663.758	310.818	2163.678

Note that all numbers are stated in million and US except the percentage

Appendix 8: Annual Financial and Traffic Report for Year 2013

DMU	Op. Revenue	NI	ROA%	ROI%	Passenger	RPK	Energy	Capital	Labor	Material	Other Cost
1	1128.755	69.663	9.35	7.71	8.800	8400.000	263.478	233.604	97.982	90.976	217.897
2	1892.450	45.283	1.96	3.12	9.625	14807.000	474.474	205.277	368.371	259.498	142.976
3	9133.754	230.262	3.51	2.51	31.400	85300.000	2484.003	276.691	1423.606	2959.721	2018.237
4	12020.379	9.708	0.11	0.08	35.761	35295.836	3430.788	2751.232	2181.376	1211.552	2530.862
5	15958.409	587.580	1.76	3.82	77.677	141967.950	5481.255	2659.265	2279.417	1114.483	3836.409
6	3602.184	141.966	3.25	3.07	13.411	27733.000	939.158	1641.186	833.853	771.451	433.697
7	1622.940	114.970	2.03	7.51	21.853	26607.000	702.346	421.000	193.955	44.011	169.007
8	996.150	91.779	9.87	10.15	7.241	7129.416	385.558	141.449	158.627	72.818	145.919
9	15202.212	442.054	1.99	3.41	47.365	64878.000	3072.616	2561.610	1765.656	2151.362	3417.580
10	4609.604	248.821	4.81	5.71	24.625	31186.000	1325.763	662.368	674.951	589.444	1108.420
11	17857.869	439.371	2.36	2.5	39.960	131333.000	5871.316	3971.542	3732.312	2095.223	1921.664
12	12882.000	372.000	2.51	2.33	29.920	104571.000	4889.000	1687.000	2183.000	4871.000	2361.000
13	966.117	12.062	0.76	1.16	14.352	12927.000	459.984	190.554	64.305	114.460	209.639
14	14343.435	340.198	1.49	2.36	79.094	120461.130	4986.922	2396.668	2186.827	1882.388	2996.282
15	16002.737	446.564	2.37	2.41	91.791	148416.550	5770.904	4010.793	3417.918	1640.107	3709.728
16	2608.332	427.471	19.6	19.83	11.345	9032.318	783.092	413.983	276.156	343.597	338.385
17	37773.000	10540.000	20.17	38.7	120.389	313735.692	9397.000	2969.000	7720.000	2614.000	4533.000
18	6657.806	622.313	9.02	10.09	60.758	67573.000	1848.174	489.407	841.216	331.483	2656.555
19	2103.020	26.667	1.7	1.28	4.418	18086.000	690.922	236.113	507.910	175.342	466.358
20	21109.651	655.593	2.36	2.59	39.391	188618.000	7583.694	4108.889	245.820	9869.284	3475.077
21	2098.640	111.969	3.86	5.84	5.918	21358.000	907.532	332.298	228.463	164.469	283.446
22	3187.459	30.410	1.08	0.85	9.269	24776.000	916.147	893.705	510.328	318.706	929.161
23	3759.450	13.583	0.45	0.32	24.965	31950.000	1420.139	843.818	699.821	617.876	706.183
24	2155.865	51.854	2.4	2.56	9.936	8500.712	698.802	273.477	427.438	324.022	298.955
25	29200.219	229.849	0.71	0.79	67.224	186304.000	9798.256	6431.084	6599.953	3020.874	3450.864
26	13416.800	1703.569	12.41	15.65	38.942	59135.548	2524.290	1338.644	2323.798	311.908	4386.585
27	5441.000	168.000	2.29	3.19	30.463	22272.219	1899.000	678.000	1135.000	432.000	1129.000
28	39874.111	432.909	1.53	0.76	104.593	20594.000	5772.563	31882.557	11158.696	6870.771	1180.540

29	2649.832	54.255	2.06	2.11	20.700	26881.000	800.597	797.935	424.002	385.610	158.024
30	15340.522	389.735	2.02	2.51	48.276	110905.000	4093.185	3253.904	3710.203	3020.449	1451.860
31	1346.500	26.700	0.82	2.05	21.500	16556.610	46.400	462.300	342.100	251.600	197.300
32	6485.668	755.997	6.37	13.19	79.300	96323.751	2503.967	765.824	578.451	160.283	1721.145
33	12067.680	352.962	1.97	3.46	18.210	93765.600	4715.269	1976.138	118.453	1255.348	2141.269
34	3297.725	58.956	1.39	1.82	60.582	51222.089	193.513	664.520	1211.307	686.381	483.048
35	17699.000	754.000	3.9	4.45	108.076	64852.838	5763.000	1838.000	5035.000	1080.000	3229.000
36	1654.385	176.918	14.98	11.98	12.414	19309.751	551.746	307.757	262.150	60.143	295.671
37	9855.085	358.322	2.69	2.65	48.268	91997.000	3451.314	1605.453	1614.897	4074.998	2799.297
38	38279.000	571.000	1.55	1.51	139.209	330113.703	12345.000	6306.000	8625.000	1821.000	8675.000
39	3555.241	260.874	6.49	5.45	18.691	31522.197	1009.091	492.459	700.278	335.996	2250.874

Note that all numbers are stated in million and US except the percentage

Appendix 9: Annual Financial and Traffic Report for Year 2014

DMU	Op. Revenue	NI	ROA%	ROI%	Passenger	RPK	Energy	Capital	Labor	Material	Other Cost
1	1209.915	106.482	12.8	9.07	10.100	9600.000	308.880	300.299	133.315	132.372	298.743
2	12017.962	95.079	0.99	0.8	38.526	38294.593	3392.955	2673.073	2066.379	1280.395	2510.081
3	17194.222	695.829	2.05	4.22	83.010	154683.910	5609.238	3211.512	2519.069	1122.301	4036.273
4	4091.787	229.905	4.48	4.68	13.719	28078.000	983.678	1623.377	1010.004	859.073	433.485
5	1654.744	25.310	0.4	1.53	22.139	27273.000	688.767	5278.331	203.882	45.652	185.834
6	1137.046	86.303	6.96	8.21	8.154	7825.962	388.216	170.396	193.345	86.781	212.005
7	27141.000	2882.000	6.58	4.02	197.340	187673.357	10592.000	4052.000	8508.000	2051.000	7389.000
8	15124.136	178.409	0.82	1.37	49.004	68474.000	3458.855	2427.494	1583.572	2271.974	3274.542
9	4703.571	128.494	2.08	2.81	26.230	32602.000	1345.755	705.603	725.793	588.530	1209.450
10	19295.204	1155.835	5.23	6.37	41.516	138431.000	5787.409	4055.302	3987.796	2273.801	2035.060
11	13588.000	442.000	3.05	2.61	31.570	112257.000	5167.000	1831.000	2321.000	5138.000	2450.000
12	1171.192	19.223	1.12	1.53	16.870	16213.000	522.764	263.025	78.700	130.044	265.663
13	14644.858	575.986	2.14	3.93	83.811	127749.870	4910.254	3005.46	1830.100	1910.806	3013.575
14	17632.614	389.404	1.77	1.94	100.919	166629.180	6126.531	4399.547	3905.729	1753.940	3936.744
15	2705.068	361.669	15.43	16.23	11.681	9889.994	820.694	403.865	299.182	370.183	334.537
16	40362.000	659.000	1.22	1.68	129.210	326506.325	11166.000	12338.000	8120.000	2638.000	4939.000
17	7453.655	740.920	10.04	10.75	64.769	72933.000	2059.758	614.140	966.489	349.056	2901.114
18	23894.857	930.300	3.1	3.25	44.537	215353.000	8354.188	4779.461	278.518	11427.963	3817.852
19	2453.990	165.826	4.66	7.43	6.908	24726.000	1023.664	434.968	2631.681	198.637	312.231
20	2314.879	68.926	2.65	3.19	10.195	8652.049	678.253	379.002	447.446	348.399	304.951
21	33209.682	1651.428	4.24	5.23	77.334	202562.000	9857.529	6780.241	7549.152	3396.707	3974.624
22	12702.952	1407.969	10.12	12.85	39.438	60103.327	2676.979	1240.434	2222.578	388.699	4425.885
23	5817.000	401.000	5.12	7.4	32.078	23500.932	1912.000	558.000	1294.000	418.000	1234.000
24	39823.408	99.522	0.361	0.17	105.988	21060.000	6417.180	32489.298	11224.758	6808.634	2059.443
25	1375.400	64.300	1.84	4.9	22.600	18493.846	22.400	493.500	368.000	251.100	176.100
26	6683.501	693.735	5.93	11.58	81.700	103732.915	2671.304	781.712	615.179	154.060	1767.511
27	38006.000	139.326	3.16	2.53	29.408	34714.000	1228.573	1253.494	1402.293	401.800	1231.196
28	12030.248	334.930	1.87	3.4	18.628	95064.300	4500.008	1694.616	114.195	1346.664	2195.748
29	18605.000	1136.000	5.62	6.5	110.497	67144.272	5293.000	2448.000	5434.000	978.000	3316.000
30	1931.580	225.464	14.07	13.22	14.294	22783.215	612.909	375.650	313.988	73.956	329.613
31	11046.051	831.849	5.71	6.15	54.675	106787.000	3838.247	1248.322	1721.190	3554.074	3166.634
32	38901.000	1132.000	3.03	3	138.029	330744.431	11675.000	6598.000	8935.000	1779.000	8790.000
33	3600.817	257.127	6.11	5.28	19.872	33513.849	987.307	543.945	718.731	330.898	2293.878

Appendix 9: Foreign Currency Transaction into US Dollars (2007-2014)

Foreign Currency Transactions 1 US $=

Years

No	Airlines	Country	Currency	2014	2013	2012	2011	2010	2009	2008	2007
1	AEGEAN AIRLINES	**Greece**	Euro €	0.754	0.753	0.778	0.719	0.755	0.719	0.683	0.731
2	Aer Lingus Group Plc	Ireland	Euro €	0.754	0.753	0.778	0.719	0.755	0.719	0.683	0.731
3	Aeroflot	Russia	Russian Ruble	38.512	31.855	31.081	29.406	30.373	31.479	24.842	25.605
4	Air Berlin	Germany	Euro €	0.754	0.753	0.778	0.719	0.755	0.719	0.683	0.731
5	Air Canada	Canada	Canadian Dollar $	1.104	1.030	1.000	0.989	1.031	1.141	1.066	1.074
6	Air china	China	Chinese Yuan	6.158	6.152	6.310	6.466	6.770	6.831	6.953	7.613
7	Air France klm	France	Euro €	0.754	0.753	0.778	0.719	0.755	0.719	0.683	0.731
8	Air India	India	Indian Rupee	61.008	58.512	53.421	46.460	45.658	48.369	43.782	41.489
9	Air New Zealand	New Zealand	New Zealand $	1.140	1.282	1.270	1.214	1.446	1.538	1.314	1.299
10	Air Transat	Canada	Canadian Dollar	1.104	1.030	1.000	0.989	1.031	1.141	1.066	1.074
11	AirAsia	Malaysia	Malaysian Ringgit	3.273	3.150	3.088	3.059	3.220	3.512	3.331	3.440
12	Allegiant Air	USA	US$								
13	American Airlines	USA	US$								
14	ANA Group	Japan	Japanese Yen	105.858	97.590	79.843	79.830	87.807	93.589	103.496	117.789
15	Asian Airlines	South Korea	Korean Won	1053.582	1094.657	1126.438	1107.555	1156.534	1262.660	1097.183	929.436
16	Atlas Air Worldwide	USA	US$								
17	Avianca Holdings	Colombia	Cambodian Riel	3922.300	3902.900	3973.440	3998.010	4,129.23,3,998.01	4021.600	3819.400	3856.100
18	British Airways	UK	British Pound	0.607	0.640	0.631	0.624	0.647	0.641	0.545	0.500
19	Cathay Pacific Group	Hong Kong	Hong Kong Dollar	7.755	7.757	7.757	7.784	7.769	7.752	7.787	7.802
20	Cebu Pacific Air	Philippines	Philippine Peso	44.399	42.442	42.203	43.284	45.087	47.585	44.434	46.169
21	China Airlines	China	Chinese Yuan	6.158	6.152	6.310	6.466	6.770	6.831	6.953	7.613
22	China Eastern Airlines	China	Chinese Yuan	6.158	6.152	6.310	6.466	6.770	6.831	6.953	7.613
23	China Southern Air	China	Chinese Yuan	6.158	6.152	6.310	6.466	6.770	6.831	6.953	7.613
24	Copa Holdings	Panama	US$								
25	Delta airlines	USA	US$								

26	EasyJet PLc	UK	British Pound	0.607	0.640	0.631	0.624	0.647	0.641	0.545	0.500
27	Egyptair	Egypt	Egyptian Pound	7.079	6.873	6.069	5.944	5.635	5.544	5.441	5.645
28	El Al	Israel	Israeli New Shekel	3.577	3.610	3.856	3.577	3.734	3.903	3.583	4.112
29	Emirates Group	UAE	UAE Dirham	3.673	3.673	3.673	3.673	3.673	3.673	3.673	3.672
30	Ethiopian	Ethiopia	Ethiopian Birr (ETB)	18.980	18.344	18.053	16.580	13.272	11.028	9.917	9.392
31	Ethiad Airways	UAE	UAE Dirham	3.673	3.673	3.673	3.673	3.673	3.673	3.673	3.672
32	EVA AIR	Taiwan	Taiwanese New Dollar	71.819	29.710	29.574	33.369	31.495	32.945	31.527	32.861
33	FedEx	USA	US$								
34	Finnair	Finland	Euro €	0.754	0.753	0.778	0.719	0.755	0.719	0.683	0.731
35	Garuda Indonesia	Indonesia	Indonesian Rupiah	11849.580	10430.272	9370.124	8742.721	9086.051	10414.549	9698.079	9134.885
36	Grupo Aeromexico	Mexico	Mexican Peso	44.399	42.442	42.203	43.284	45.087	47.585	44.434	46.169
37	Hawaiian Airlines	USA	US$								
38	IAG	UK	British Pound	0.607	0.640	0.631	0.624	0.647	0.641	0.545	0.500
39	Japan Airlines	Japan	Japanese Yen	105.858	97.590	79.843	79.830	87.807	93.589	103.496	117.789
40	Jet Airways	India	Indian Rupee	61.008	58.512	53.421	46.460	45.658	48.369	43.782	41.489
41	Jet2	UK	British Pound	0.607	0.640	0.631	0.624	0.647	0.641	0.545	0.500
42	JetBlue Airways	USA	US$								
43	Kenya Airways	Kenya	Kenyan Shilling (KES)	85.145	84.086	81.578	82.278	74.431	77.295	61.679	68.500
44	Korean Air	South Korea	Korean Won	1053.582	1094.657	1126.438	1107.555	1156.534	1262.660	1097.183	929.436
45	LATAM Airlines	Chile	Chilean Peso	570.394	495.337	486.537	478.967	509.388	555.199	521.245	522.802
46	Lufthansa group	Germany	Euro €	0.754	0.753	0.778	0.719	0.755	0.719	0.683	0.731
47	Malaysia Airlines	Malaysia	Malaysian Ringgit ("RM")	3.273	3.150	3.088	3.059	3.220	3.512	3.331	3.440
48	Norwegian	Norway	Norway Kroner	6.304	5.880	5.820	5.606	6.045	6.294	5.641	5.861
49	Pakistan Int'l Airlines	Pakistan	Pakistani Rupee	236.988	101.693	133.765	86.314	85.183	81.792	70.416	60.696
50	Pegasus	Turkey	Turkish Lira	2.187	1.905	1.801	1.680	1.507	1.544	1.300	1.311
51	Qantas Group	Australia	Australian Dollar	1.109	1.037	0.966	0.968	1.090	1.281	1.195	1.195
52	Republic Airways Holdings	USA	US$								
53	Ryanair	Ireland	Euro €	0.754	0.753	0.778	0.719	0.755	0.719	0.683	0.731
54	SAS Group	Sweden	Swedish Krona	6.862	6.516	6.773	6.493	7.206	7.650	6.589	6.759

55	Shandong Airlines	China	Chinese Yuan	6.158	6.152	6.310	6.466	6.770	6.831	6.953	7.613
56	Singapore Airlines	Singapore	Singapore Dollar	1.267	1.251	1.250	1.257	1.363	1.454	1.415	1.507
57	SkyWest, Inc	USA	US$								
58	South African Airways	South Africa	South African Rand	10.843	9.644	8.214	7.256	7.320	8.419	8.246	7.050
59	Sprit airlines	USA	US$								
60	TAP Portugal	Portugal	Euro €	0.754	0.753	0.778	0.719	0.755	0.719	0.683	0.731
61	Thomas Cook Airlines	UK	British Pound	0.607	0.640	0.631	0.624	0.647	0.641	0.545	0.500
62	Turkish Airlines	Turkey	Turkish Lira	2.187	1.905	1.801	1.680	1.507	1.544	1.300	1.311
63	United-Continental Holdings	USA	US$								
64	UPS Airlines	USA	US$								
65	UTair Group	Russia	Russian Rouble	38.512	31.855	31.081	29.406	30.373	31.479	24.842	25.605
66	Virgin Australia	Australia	Australian Dollar	1.109	1.037	0.966	0.968	1.090	1.281	1.195	1.195
67	Volga-Dnepr Group	Russia	Russian Rouble	38.512	31.855	31.081	29.406	30.373	31.479	24.842	25.605
68	WestJet	Canada	Canadian Dollar	1.104	1.030	1.000	0.989	1.031	1.141	1.066	1.074

Appendix 10: Negative Net Income Airlines Excluded from the Sample Airlines Year 2014

	Airlines	Op Rev (US$)	NI (US$)
1	Aer Lingus	2,065,944,623	-127,122,805
2	Aeroflot	8,303,114,535	-445,209,859
3	Air Berlin	5,520,420,593	-376,669,000
4	**Air France klm**	33,057,237,109	-250,795,513
5	Air India	3,129,690,912	-1,029,314,549
6	Egyptair		-3,351,319,278
7	El Al	2,081,303,000	-28,060,000
8	Finnair	3,031,440,999	-109,474,232
9	Garuda Indonesia	3,933,530,272	-371,974,942
10	Jet Airways	2,903,486,271	-601,212,079
11	Kenya Airways	1,245,040,813	-39,720,477
12	Korean Air	10,834,924,000	-416,505,000
13	LATAM Airlines	12,093,501,000	-76,961
14	Norwegian	3,099,562,254	-169,730,379
15	Pakistan Int’l Airlines	480,108,483	-129,649,330
16	Qantas Group	13,837,287,488	-2,633,699,455
17	SkyWest, Inc	3,237,447,000	-24,154,000
18	South African Airways	2,791,207,687	-235,536,392
19	TAP Portugal	3,580,565,073	-107,416,116
20	Virgin Australia	3,863,840,803	-320,514,554

Appendix 11: Negative Net Income Airlines Excluded from the Sample Airlines Year 2013

	Airlines	Op Rev (US$)	NI (US$)
1	Air Berlin	5,506,709,426	-418,981,601
2	Air France klm	33,889,077,014	-2,414,198,355
3	Air India	2,746,790,198	-938,291,094
4	**American Airlines Group**	25,760,000,000	-1,526,000,000
5	Egyptair		-5,275,350,915
6	Jet Airways	2,974,273,868	-82,973,962
7	Kenya Airways	1,175,702,466	-93,523,409
8	Korean Air	11,227,810,000	-348,941,000
9	LATAM Airlines	12,924,537,000	-263,819
10	Pakistan Int'l Airlines	1,079,825,926	-443,200,750
11	SAS Group	42,182,000,000	-110,349,053
12	South African Airways	2,809,859,956	-121,112,865
13	TAP Portugal	3,544,312,757	-1,215,067
14	Virgin Australia	3,878,830,910	-94,636,220

Appendix 12: Negative Net Income Airlines Excluded from the Sample Airlines Year 2012

	Airlines	Op Rev (US$)	NI (US$)
1	Aegean Airlines Group	839,511,458	-13,486,463
2	Air France klm	32,934,770,319	-1,525,126,687
3	Air India	2,754,321,977	-1,415,130,277
4	Air Transat	3,714,230,143	-13,536,041
5	American Airlines Group	24,825,000,000	-1,926,000,000
6	Egyptair		-4,113,027
7	El Al	2,015,642,000	-18,198,000
8	IAG	28,706,610,110	-1,462,504,892
9	Jet Airways	2,840,294,098	-231,389,246
10	Malaysia Airlines	4,303,271,093	-430,738
11	Pakistan Int'l Airlines	728,428,913	-241,979,371
12	Qantas Group	16,281,022,627	-252,643,699
13	SAS Group		-145,422,613
14	South African Airways	2,905,053,534	-102,634,430
15	TAP Portugal	3,363,821,734	-32,654,671
16	United-Continental Holdings	37,152,000,000	-723,000,000

Appendix 13: Negative Net Income Airlines Excluded from the Sample Airlines Year 2011

	Airlines	Op Rev (US$)	NI (US$)
1	Aegean Airlines Group	929,583,062	-37,805,146
2	Air Berlin	5,880,782,265	-584,828,807
3	Air Canada	11,737,319,359	-251,687,265
4	**Air France klm**	33,892,292,540	-1,119,866,006
5	Air India	3,026,696,859	-1,477,654,224
6	Air Transat	3,693,603,606	-11,777,751
7	American Airlines Group	23,957,000,000	-1,965,000,000
8	Egyptair		-6,176,539
9	El Al	2,042,586,000	-49,836,000
10	Finnair	3,140,772,026	-121,724,566
11	Hawaiian Airlines	1,650,459,000	-2,649,000
12	Korean Air	10,236,100,000	-261,100,000
13	Malaysia Airlines	4,464,191,213	-2,521,325
14	Pakistan Int'l Airlines	1,350,311,670	-300,338,349
15	Republic Airways Holdings	1,514,400,000	-51,800,000
16	SAS Group		-259,834,513
17	SkyWest, Inc	3,654,923,000	-27,335,000
18	TAP Portugal	3,392,818,390	-100,444,329

Appendix 14: Negative Net Income Airlines Excluded from the Sample Airlines 2010

	Airlines	Op Rev (US$)	NI (US$)
1	Aegean Airlines Group	782,882,550	**-30,854,621**
2	Air Berlin	4,932,492,436	**-128,703,100**
3	**Air France klm**	27,810,011,286	**-2,065,152,310**
4	Air India	2,935,376,927	**-1,216,100,277**
5	American Airlines Group	22,151,000,000	**-469,000,000**
6	ANA Group	15,461,790,437	**-653,558,581**
7	British Airways	12,346,117,552	**-656,379,780**
8	Finnair	2,680,194,143	**-30,202,356**
9	Jet Airways	2,326,641,253	**-104,613,132**
10	Pakistan Int'l Airlines	1,350,311,670	**-300,338,349**
11	Republic Airways Holdings	2,653,651,000	**-13,846,000**
12	SAS Group	35,676,000,000	**-307,805,805**
13	TAP Portugal	3,067,287,669	**-70,094,634**

Appendix 15: Negative Net Income Airlines Excluded from the Sample Airlines Year 2009

	Airlines	Op Rev (US$)	NI (US$)
1	Aer Lingus	1,676,821,424	-180,935,944
2	Air Berlin	4,506,492,694	-13,167,575
3	Air Canada	8,532,257,259	-21,026,201
4	Air France klm	33,336,161,182	-1,132,066,550
5	Air India	3,078,726,263	-1,775,698,217
6	American Airlines Group	19,898,000,000	-1,474,000,000
7	ANA Group	13,125,015,006	-45,518,319
8	British Airways	14,024,383,587	-558,355,129
9	Delta airlines	28,063,000,000	-324,000,000
10	El Al	1,655,833,000	-76,300,000
11	Finnair	2,555,772,357	-141,716,931
12	Japan Airlines	20,848,223,620	-675,231,141
13	Jet Airways	2,436,876,463	-83,181,714
14	Kenya Airways	929,289,924	-52,823,940
15	Korean Air	8,045,300,000	-84,700,000
16	Lufthansa group	30,989,974,118	-30,596,393
17	Pakistan Int'l Airlines	1,262,346,769	-53,133,416
18	Ryanair	4,091,572,223	-235,314,079
19	SAS Group	39,696,000,000	-385,212,594
20	United-Continental Holdings	16,335,000,000	-651,000,000
21	Virgin Australia	2,057,025,268	-124,904,760

Appendix 16: Negative Net Income Airlines Excluded from the Sample Airlines Year 2008

	Airlines	Op Rev (US$)	NI (US$)
1	Aer Lingus	1,987,190,279	-157,815,760
2	Air Berlin	4,978,504,557	-109,825,422
3	Air Canada	10,397,940,303	-961,729,725
4	Air china	7,609,658,691	-1,347,238,307
5	Air India	3,677,442,790	-536,561,831
6	Air Transat	3,296,012,903	-46,923,966
7	AirAsia	857,138,311	-149,079,920
8	Cathay Pacific Group	11,100,000,000	-1,068,000,000
9	Cebu Pacific Air	442,952,734	-73,364,787
10	China Eastern Airlines	5,907,371,083	-2,204,867,733
11	Delta airlines	22,697,000,000	-8,922,000,000
12	El Al	2,096,326,000	-41,907,000
13	Finnair	3,312,374,190	-61,193,866
14	Jet Airways	2,165,602,116	-57,799,577
15	JetBlue Airways	3,392,000,000	-84,000,000
16	Korean Air	8,121,300,000	-1,544,700,000
17	Pakistan Int'l Airlines	1,090,585,213	-438,673,579
18	SAS Group	47,536,000,000	-959,356,580
19	South African Airways	2,698,991,016	-12,295,117
20	TAP Portugal	3,525,516,232	-414,304,432
21	United-Continental Holdings	20,194,000,000	-5,348,000,000

Appendix 17: Negative Net Income Airlines Excluded from the Sample Airlines Year 2007

	Airlines	Op Rev (US$)	NI (US$)
1	Japan Airlines	19,542,733,411	-138,103,120
2	Pakistan Int'l Airlines	1,161,208,830	-220,751,124
3	South African Airways	2,911,205,674	-125,248,227

Appendix I8: World Airline Ranking Financial

WORLD AIRLINE RANKINGS FINANCIAL

ANALYSIS BY **FLIGHTGLOBAL INSIGHT** DATA COMPILED BY **SILVA ISHAK** FLIGHTGLOBAL DATA RESEARCH

TOP AIRLINE GROUPS BY REVENUE

TOP AIRLINE GROUPS RANKED BY REVENUES 2014: 1 TO 50

Ranking 2014	(2013)	Group/Airline	Country	Revenues ($m)	Change (%) Local	In US$	Operating result ($m) 2014	2013	Operating margin (%) 2014	2013
1	(1)	American Airlines Group	USA	42,650		5.5	4,249	2,579	10.0	6.4
2	(4)	Delta Air Lines	USA	40,362		6.9	2,206	3,400	5.5	9.0
3	(2)	Lufthansa Group	Germany	39,558	-0.1	-0.9	1,258	929	3.2	2.3
4	(3)	United-Continental Holdings	USA	38,901		1.6	2,373	1,249	6.1	3.3
5	(5)	Air France-KLM Group	France	32,861	-2.4	-3.2	-170	173	-0.5	0.5
6	(6)	FedEx	USA	27,239		0.4	1,584	1,428	5.8	5.3
7	(7)	IAG	UK	26,587	8.6	7.7	1,356	701	5.1	2.8
8	(8)	Emirates Group	UAE	26,262	9.9	9.9	1,878	1,395	7.2	5.8
9	(9)	Southwest Airlines	USA	18,605		5.1	2,225	1,278	12.0	7.2
10	(11)	China Southern Air Holding	China	17,596	10.2	9.7	769	246	4.4	1.5
11	(12)	Air China	China	17,158	7.8	7.3	1,177	671	6.9	4.2
12	(13)	ANA Group	Japan	15,465	9.1	-1.0	826	657	5.3	4.2
13	(14)	China Eastern Airlines	China	15,211	3.2	2.7	982	257	6.5	1.7
14	(10)	Qantas Group	Australia	14,018	-3.5	-13.6	-3,444	202	-24.6	1.2
15	(17)	Cathay Pacific Group	Hong Kong	13,666	5.5	5.5	572	485	4.2	3.7
16	(15)	LATAM Airlines Group	Chile	12,471		-6.0	513	644	4.1	4.9
17	(16)	Japan Airlines	Japan	12,137	2.7	-6.9	1,622	1,660	13.4	12.7
18	(18)	Singapore Airlines Group	Singapore	12,027	2.1	-0.5	316	206	2.6	1.7
19	(19)	Air Canada	Canada	11,978	7.2	0.1	736	598	6.1	5.0
20	(21)	Turkish Airlines	Turkey	11,070	28.1	12.7	603	577	5.4	5.9
21	(20)	Korean Air	South Korea	11,064	-0.3	3.5	353	-16	3.2	-0.2
22	(23)	Qatar Airways Group	Qatar	9,388		11.6				
23	(22)	Aeroflot	Russia	8,092	9.9	-10.9	285	618	3.5	6.8
24	(28)	Etihad Airways	UAE	7,600		26.7	257	194	3.4	3.2
25	(26)	EasyJet	UK	7,516	6.3	13.1	965	776	12.8	11.7
26	(25)	Ryanair	Ireland	7,050	12.3	4.2	1,300	884	18.4	13.1
27	(24)	Thai Airways International	Thailand	5,877	-9.6	-14.3		-223		-3.2
28	(32)	Hainan Airlines Group	China	5,841	8.3	7.8	405	373	6.9	6.9
29	(31)	JetBlue Airways	USA	5,817		6.9	515	428	8.9	7.9
30	(29)	UPS Airlines	USA	5,814		0.3	328	337	5.6	5.8
31	(33)	Saudia [est]	Saudi Arabia	5,800		7.4				
32	(27)	SAS Group	Sweden	5,646	-9.9	-12.6	23	398	0.4	6.2
33	(34)	Asiana Airlines	South Korea	5,529	2.0	5.9	93	-10	1.7	-0.2
34	(30)	Air Berlin	Germany	5,484	0.3	-0.5	-387	-308	-7.1	-5.6
35	(35)	Alaska Air Group	USA	5,368		4.1	962	838	17.9	16.3
36	(37)	Virgin Group	UK	4,769	-3.7	1.2	24	-80	0.5	-1.7
37	(38)	Avianca Holdings	Colombia	4,702	9.4	2.0	285	385	6.1	8.3
38	(40)	China Airlines	Taiwan	4,599	6.1	3.8		-60		-1.3
39	(36)	Malaysia Airlines	Malaysia	4,465	-4.1	-7.4	-374	-93	-8.4	-1.9
40	(41)	Gol Transportes Aereos	Brazil	4,262	12.4	3.8	214	122	5.0	3.0
41	(39)	Alitalia [est]	Italy	4,200	-5.9	-6.7		-320		-7.1
42	(44)	Garuda Indonesia	Indonesia	3,934	17.5	4.7	-399	63	-10.1	1.7
43	(42)	Virgin Australia	Australia	3,932	7.1	-4.1	-345	-101	-8.8	-2.5
44	(43)	Air New Zealand Group	New Zealand	3,868	1.0	2.3	334	253	8.6	6.7
45	(45)	EVA Air	Taiwan	3,848	5.6	3.4	21	53	0.5	1.4
46	(47)	WestJet	Canada	3,589	8.6	1.4	429	386	12.0	10.9
47	(50)	Air India [est]	India	3,500	9.2	8.4		-349		-10.8
48	(55)	Jet Airways	India	3,307	14.5	13.6	-28	-320	-0.8	-11.0
49	(46)	TAP Portugal	Portugal	3,282	-7.5	4.3	-61	59	-1.6	1.7
50	(49)	SkyWest, Inc	USA	3,237		-1.8	25	153	0.8	4.6

NOTES: [est] Airline Business estimates used where full-year figures are unavailable to give an indication of the airline's revenue ranking. See P38 for methodology

TOP AIRLINE GROUPS RANKED BY REVENUES 2014: 51 TO 100

Ranking 2014	(2013)	Group/Airline	Country	Revenues $ million	Change (%) In US$	Op result ($m) 2014	Op margin (%) 2014	Op margin (%) 2013	Net result ($m) 2014	Net result ($m) 2013	Period to end:	Notes
51	(52)	**Grupo Aeromexico**	Mexico	3,211	3.7	126	3.9	6.0	59	84	Dec 14	
52	(53)	**Thomson Airways**	UK	3,179	4.1	503	15.8	11.7	467	301	Sep 14	
53	(56)	**Norwegian**	Norway	3,066	16.4	-221	-7.2	6.2	-165	54	Dec 14	
54	(51)	**Finnair**	Finland	3,011	-5.6	-96	-3.2	0.3	-109	30	Dec 14	
55	(48)	**Transaero Airlines**	Russia	2,969	-13.3	-7	-0.2	-11.3	-495	-514	Dec 14	
56	(58)	**Sichuan Airlines**	China	2,763	7.1				56	86	Dec 14	
57	(57)	**Copa Holdings**	Panama	2,722	4.4	538	19.8	19.8	371	428	Dec 14	
58	(54)	**South African Airways** [est]	South Africa	2,650	-10.7			-7.6		-251	Mar 15	*Airline Business* estimate
58	(59)	**Vietnam Airlines** [est]	Vietnam	2,650	3.2			0.3		7	Dec 14	*Airline Business* estimate
60	(64)	**Ethiopian Airlines**	Ethiopia	2,457	14.2	195	7.9	7.2	166	115	Jun 14	
61	(60)	**Azul** [est]	Brazil	2,450	2.0			7.4		29	Dec 14	*Airline Business* estimate
62	(66)	**IndiGo** [est]	India	2,400	14.3			9.5		200	Mar 15	*Airline Business* estimate
63	(67)	**Air Europa**	Spain	2,344	12.3	40	1.7	4.2	22	61	Oct 14	
64	(63)	**Hawaiian Airlines**	USA	2,315	7.4	245	10.6	6.2	69	52	Dec 14	
65	(61)	**Air Transat** [est]	Canada	2,300	-4.2						Oct 14	*Airline Business* estimate
66	(75)	**Philippine Airlines**	Philippines	2,270	30.2	53	2.3	-8.7	3	-299	Dec 14	
67	(68)	**Condor**	Germany	2,157	5.4	83	3.8	3.7			Sep 14	
68	(70)	**Cargolux**	Luxembourg	2,155	8.3	31	1.4	3.0	3	8	Dec 14	
69	(65)	**El Al**	Israel	2,081	-1.0	-4	-0.2	1.9	-28	27	Dec 14	
70	(73)	**Aer Lingus**	Ireland	2,052	8.3	95	4.6	4.3	-126	45	Dec 14	
71	(69)	**Aerolineas Argentinas** [est]	Argentina	2,000	-1.8			-12.3		-247	Dec 14	*Airline Business* estimate
72	(71)	**Egyptair** [est]	Egypt	1,950	-1.5						Jun 14	*Airline Business* estimate
73	(79)	**Spirit Airlines**	USA	1,932	16.8	355	18.4	17.1	226	177	Dec 14	
74	(74)	**Shangong Airlines**	China	1,875	0.8	33	1.8	2.4	47	64	Dec 14	
=75	(77)	**Thomas Cook Airlines** [est]	UK	1,800	7.0			6.6		124	Sep 14	*Airline Business* estimate
=75	(83)	**Royal Air Maroc**	Morocco	1,800	13.8	74	4.1	5.9			Oct 14	
77	(78)	**Atlas Air Worldwide**	USA	1,799	8.6	176	9.8	11.3	102	94	Dec 14	
78	(62)	**UTair Group**	Russia	1,796	-21.9	-251	-14.0	1.5	-564	10	Dec 14	
79	(72)	**S7 Airlines**	Russia	1,789	-8.7				22	22	Dec 14	
80	(76)	**AirAsia**	Malaysia	1,719	1.2	260	15.1	17.0	25	114	Dec 14	
81	(82)	**Lion Air** [est]	Indonesia	1,700	6.2						Dec 14	*Airline Business* estimate
82	(85)	**SunExpress**	Turkey	1,648	15.0						Dec 14	
83	(80)	**Volga-Dnepr Group**	Russia	1,606	-2.5	22	1.4	1.6	13	4	Dec 14	
=84	(84)	**Brussels Airlines** [est1]	Belgium	1,575	4.1	-12	-0.8	-2.5	-6	-29	Dec 14	Revenue is estimated
=84	(88)	**Frontier Airlines**	USA	1,575	16.8	210	13.3	3.8	129	77	Dec 14	US DOT
86	(87)	**Wizz Air**	Hungary	1,530	12.6	209	13.6	10.8	228	118	Mar 15	
87	(81)	**Jazz**	Canada	1,504	-6.9	125	8.3	7.4	58	60	Dec 14	
88	(86)	**Virgin America**	USA	1,490	4.6	96	6.5	5.7	60	10	Dec 14	
89	(90)	**Pegasus**	Turkey	1,444	16.0	148	10.3	10.8	65	46	Dec 14	
90	(89)	**Republic Airways Holdings**	USA	1,375	2.2	186	13.5	14.2	64	27	Dec 14	
91	(92)	**Monarch Airlines** [est]	UK	1,300	8.5			0.6		1	Oct 14	*Airline Business* estimate
92	(98)	**Tianjin Airlines**	China	1,245	18.2				41	34	Dec 14	
93	(91)	**Kenya Airways** [est]	Kenya	1,230	-0.1			-2.6		-39	Mar 15	*Airline Business estimate*
94	(93)	**Aegean Airlines Group***	Greece	1,202	6.4	140	11.6	9.0	106	70	Dec 14	2013 proforma
95	(102)	**Flydubai**	UAE	1,198	19.0				68	61	Dec 14	
96	(96)	**Spring Airlines**	China	1,182	11.0	87	7.3	6.7	143	119	Dec 14	
97	(109)	**Cebu Pacific Air**	Philippines	1,169	21.5	94	8.0	5.9	19	12	Dec 14	
98	(104)	**Allegiant Air**	USA	1,137	14.2	157	13.8	15.5	86	92	Dec 14	
=99	(99)	**Jet2** [est]	UK	1,125	9.8			4.0		26	Mar 15	*Airline Business* estimate
=99	(95)	**Pakistan Int'l Airlines**	Pakistan	1,125	4.5	-128	-11.4	-27.3	-304	-442	Dec 14	

NOTE: [est] *Airline Business* estimates have been used where full-year figures are unavailable to give an indication of the airline's revenue ranking. Volga Dnepr includes AirBridge Cargo and ATRAN; Republic sold Frontier Airlines to Indigo Partners in December 2013; Aegean includes Olympic Air on a pro-forma basis;

NOTES: Revenues are consolidated figures for groups, including contributions from subsidiaries and non-airline operations. However, for broad freight or travel operations, results have been given for the airline division only. All revenues are translated into US$ at the average annual rate for the given financial year. Where there has been strong movement between local currency and the US dollar there is a big difference in the change figure; Operating result is generally taken as the profit or loss from operations after normal expenses including depreciation, but before finance charges, exceptional items and tax. Net result is after all costs and exceptional items and contributions from subsidiaries. In some cases these may include sizeable gains or losses from exceptional items; Operating and net margins show profits or losses as a percentage of revenues allowing comparisons between the performance of different groups. However, differences in national accounting standards mean that direct comparisons should be handled with caution; Results are over the latest financial year to the end of the month shown. Returns from mid-year onwards have been included where there are no later figures; Most results have been taken from reports published by the airline groups. Other sources include returns to regulatory bodies, such as ICAO or national civil aviation bodies, press statements and other published reports. Estimates based on analysis of historical traffic, financial and fleet data, and regional trends have been made for carriers where no figures are available.