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Full Research Papers should contain original research not previously published elsewhere. They should normally be between 4,000 and 7,000 words although shorter or lengthier articles could be considered for publication if they are of merit. The first page of the papers should contain the title and the authors' affiliations, contact details and brief vitae (of about 50 words). Regarding the following pages, papers should generally have the following structure: a) title, abstract (of about 150 words) and six keywords, b) introduction, c) literature review, d) theoretical and/or empirical contribution, e) summary and conclusions, f) acknowledgements, g) references and h) appendices. Tables, figures and illustrations should be included within the text (not at the end), bear a title and be numbered consecutively. Regarding the referencing style, standard academic format should be consistently followed. Examples are given below:

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- Forsyth P. (2002a), 'Privatization and Regulation of Australian and New Zealand Airports', *Journal of Air Transport Management*, 8, 19-28.
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- Skycontrol (2007) *easyJet welcomes European Commission's decision to limit PSO abuse in Italy*. 23rd April. Available from: http://www.skycontrol.net/airlines/easyjet-welcomes-european-commissions-decision-to-limit-pso-abuse-in-italy/ (accessed on 22/08/2008).

Industry Perspectives are usually shorter than full research papers and should provide a practitioner's point of view on contemporary developments in the air transport industry. Contributors should explicitly specify whether their views are espoused by their organization or not.

Conference Reports should be between 1,000 and 1,500 words. They should provide factual information (e.g. conference venue, details of the conference organizers), present the various programme sessions and summarize the key research findings.

Book Reviews should be between 1,000 and 1,500 words. They should provide factual information (e.g. book publisher, number of pages and ISBN, price on the publisher's website) and critically discuss the contents of a book mainly in terms of its strengths and weaknesses.

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reducing services and products to remain competitive. The conclusion is that airline philanthropy is an expense rather than an investment. This paper contributes to the paucity of current literature on philanthropic motivations and airline CSER management.

We studied a methodology for flight trajectory optimization, and also the workloads of air traffic control officers (ATCOs). Case studies were conducted through simulations for flight trajectory optimization. The aircraft model was A320-200s, which is pre-dominantly utilized in Southeast Asia for short to medium range flights. Fuel savings were computed for selected routes and were compared with that of existing operations and flights simulations, which revealed significant fuel savings. The research also determined the coefficients of ATCOs' workloads and demonstrated dynamic sectorization in selected airspace of Southeast Asia. It was found that dynamic sectorization was more efficient than static sectorization in balancing the workloads of ATCOs, reducing the standard deviation by 50% and the balance of workloads among sectors by 12.9%.

With increased demand for air travel, airports have become economic engines of the regional development that connect aviation systems with other modes of transportation facilitating the movement of people and cargo. Originating air passengers account for the majority of passenger trips to and from an airport and have different ground access needs. Since the air transportation is interrelated to ground transportation, studying ground access mode choice of airport users is a crucial part of airport management and system planning. The purpose of this study is to identify Dubai International Airport (DXB) ground access mode characteristics and users located in the United Arab Emirates (UAE), which has not been studied previously. Although there are many different modes of transportation serving the airport, yet personal vehicles are the main mode used to arrive to the airport. Binary logistic regression models are developed to evaluate access mode choice for originating air travellers focusing on the mix between private vehicle and public transportation system (taxi, limousine, bus network, and Dubai metro) using data collected specifically for this study. A total of 1012 air travellers were interviewed and completed the questionnaire in December 2014. Models result showed that access mode choice is significantly affected by different socio-economic characteristics of travellers including income, nationality, household size, vehicle ownership; and different trip characteristics that include number of travellers and how often air travellers use public transportation in their community.

Airline involvement in sport sponsorship has grown over the last few years as sponsorship activity has proven effective as one method to reach a global audience. Aiding in this move

B. Conference Report

EDITORIAL

SELECTED PAPERS FROM THE 21st AIR TRANSPORT RESEARCH SOCIETY WORLD CONFERENCE, Antwerp, 2017

The 21st Air Transport Research Society World Conference (ATRS) was held in Antwerp, from July 5th to July 8th, 2017 and attracted up to 220 papers for presentations. This special issue of the Journal of Air Transport Studies collects six selected papers representing a variety of topics presented and discussed at the conference.

In the first paper, **Oluwaferanmi Oguntona, Kay O. Ploetner, Marcia Urban, Raoul Rothfeld,** and **Mirko Hornung** investigate the impacts of airline business models, market segments, and geographical regions on aircraft cabin configuration in terms of aircraft seat capacities and installed seats per cabin class. Using historical data covering the period of 2006-2016 for global fleet of scheduled aircraft, and airlines categorized into full-service network carrier (FSNC) and low-cost carrier (LCC), they find that the configuration and utilization of an aircraft cabin varies by flight distance and airline business model, and the cabin preferences of FSNC and LCC are different in different aircraft clusters.

Airline philanthropy is the topic of the second paper authored by **Deborah Ancell**. Built upon an extensive literature review about the corporate social responsibility (CSR) and thematic analysis, this paper attempts to determine whether the motivation for airlines' philanthropy is strategic investment or it is merely an expense. The dissection explores the contributions of the top 10 airlines (and in some cases, their passengers) in one financial year (2015-16) to various charitable endeavours based on the airlines' corporate social and environmental responsibility (CSER) reports. The three motivations of philanthropic activities include the prevention of unfavourable government intervention, product differentiation for sales increase, and cost reduction. The results, however, does not provide evidence in support of the accomplishment of any of these motivations. The author concludes that airline philanthropy is not an investment, but an expense only for the altruistic or egoistic interest of airline management.

The third paper collected in this issue is written by **Weiyang Sun, Wei-Chuen Wallace Ong and Zhao-Wei Zhong**. They present a methodology of optimizing flight trajectory for fuel savings, and conduct simulation using A320-200 aircraft on a route from Singapore to Cambodia. The simulation results validate the least amount of fuel consumption associated with the use of optimal flight trajectory. In addition, the authors also investigate the structural determinants of air traffic control officers (ATCO) workloads, and suggest that the adoption of dynamic sectorization is better than static sectorization in balancing the workloads of ATCOs and reducing the workload variation.

In the fourth paper, **Khaula A. Alkaabi** conducts a survey among 1,012 air travellers flying out of Dubai International Airport (DXB) in December 2014 about their choices between private vehicles and public transportation systems in accessing the DXB airport. Binary logistic regression models are estimated and the results suggest the access mode choice is significantly affected by various social-economic characteristics of travellers such as income, nationality, household size, and vehicle ownership and different trip characteristics including the group size of traveling and the frequency of travellers of using public transportation. However, variables such as age, trip purpose, cost, and time are found to have no significant effect on travellers' airport accessing mode choice. The author discusses policy implications from these results and suggests several measures that can be adopted by city planners and administration to help enhance travellers' use of public transportation in accessing the airport.

Airline sponsorships and sports are explored by **Blaise Waguespack** and **Scott Ambrose** in the fifth paper of this issue. The authors examine the role of one of the oldest marketing tactics, namely sponsorship, and how new technological approaches are being employed jointly with the increasing use of sports marketing by airlines around the world for the task of airline marketing. The airline examples they investigate provide prefatory evidence showing that the growing use of social media along with traditional media and event marketing activities can leverage the effectiveness of the sponsorship marketing employed by leading global airlines.

The last (but certainly not least) paper in this issue is by **Nobuaki Endo** and **Toshiya Ozaki**. The authors study the foreign direct investment (FDI) activities in the global airline industry, an important but understudied topic in the aviation literature. Using airline-country dyad data sampled among 90 top airlines in 2015 and the largest 90 economies in the world in 2014, the authors identify and estimate the determinants of FDI in the airline industry with a consideration focusing on intangible assets and resources an investing airline possesses and the institutional differences between home and hosting countries. The estimation results suggest that cross-border investment in the airline industry is deterred by government foreign ownership restriction, and institutional and cultural differences. On the other hand, the hypothesis that FDI will be more likely when an airline has greater intangible assets is moderately supported. Overall, the authors conclude that the Dunning's Eclectic Paradigm can also be applied in studying the FDI decisions made by airlines, just like in other international business settings.

We would like to extend our thanks to all these authors and all the reviewers for their hard work and contribution to this ATRS special issue of Journal of Air Transport Studies. We believe that these works are providing a valuable contribution to the aviation practitioners as well as encouraging further research on the respective topics.

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IMPACT OF AIRLINE BUSINESS MODELS, MARKET SEGMENTS AND GEOGRAPHICAL REGIONS ON AIRCRAFT CABIN CONFIGURATIONS

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ABSTRACT

Besides the significance of estimating aircraft seat capacity for airline operating cost and yield estimation as well as for the conceptual design of aircraft, airline fleet planning requires an understanding of aircraft cabin configuration. This paper presents the impact of airline business models, market segments in terms of flight distances, and geographical regions on aircraft cabin configuration, i.e. aircraft seat capacities and installed seats per cabin class. Using the historical databases of global low-cost carriers and airline flight schedules between 2000 and 2016, two ABM clusters – full-service network carriers (FSNCs) and low-cost carriers (LCCs) - were developed, while using seven already-developed passenger-aircraft clusters. Focusing on the jet commuter (JC), narrow-body (NB) and long-range (LR) aircraft clusters, studies were conducted on the historical development of aircraft cluster seat capacities at different abstraction levels: global, airline business model, intra- and inter-regional flight distances, as well as a combination of ABM and (inter)regional flights. Selected results were further analysed using statistical tests on the mean and regression analysis. The analysis results show that LCCs use aircraft that have less average scheduled and less average maximum possible seats than FSNCs. Specifically, FSNCs use significantly bigger aircraft types in LR cluster than LCCs, while LCCs use significantly bigger aircraft types in JC cluster than FSNCs. Furthermore, average cabin utilisation of aircraft clusters scheduled by LCCs are significantly higher than average cabin utilisation scheduled by FSNCs. With increasing distance, average cabin utilisation also significantly reduces.

KEYWORDS

Aircraft seat capacity, airline business model, aircraft cabin utilisation

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1. MOTIVATION

Over the past few decades, novel airline business models (ABMs) have been introduced to the air transport market in addition to that of the traditional full-service network carriers. One example is the low-cost business model on short-to-medium haul markets introduced by Southwest Airlines in 1971 in the US and later adopted in 1991 by Ryanair within Europe. In addition, long-haul low-cost carriers such as AirAsia X, Jetstar Airways and Norwegian Air Shuttle have recently increased their market share (Leigh Fisher, 2015), although similar services were offered mainly on the transatlantic routes by Icelandic Airlines in the 1960s and 1970s and then by Laker Airways. Other than business models targeting price-sensitive markets through cost leadership and the full-service network carrier business model, airline variations and specialisations currently exist.

A cluster analysis of selected low-cost and full-service network carriers resulted in seven clusters which further subdivide the two established ABMs: a point-to-point low-cost carrier, a hub-and-spoke low-cost carrier, a global hybrid carrier, a medium size network carrier, a global niche market network carrier, a high-quality network carrier and a large size network carrier (Klemm, 2015). Other studies have applied the cluster analysis methodology to specific markets (Heinz & O'Connell, 2013). For example, (Heinz and O'Connell, 2013) named the following airline clusters: full-service network carriers, established regional carriers, long-haul niche carriers, true low-cost carriers, emerging regional/low-cost carriers, emerging full-service network carriers, and small full-service carriers. It can be concluded that the two established ABMs, the low-cost carrier (LCC) and the full-service network carrier (FSNC), constitute a foundation on which more specific business model variations can be based. The former charter carrier business model has shifted towards the low-cost model (Bieger & Wittmer, 2006) which is why earlier studies considered it to a certain extent by analysing the low-cost carrier business model.

Nevertheless, irrespective of the business model chosen by an airline, the common unit of airline capacity is the available seat kilometre (ASK) or the available seat mile (ASM) and the available tonne kilometre (ATK) or the available tonne mile (ATM). Therefore, an evaluation of how aircraft cabins are configured is significant for many aspects of the aviation system, including airline operating cost and yield estimation, aircraft conceptual design and airline fleet planning.

1.1 Motivation for Airline Operating Cost and Yield Estimation

The offered products by an airline can be categorised into ground and on-board services, the latter mainly depending on the aircraft cabin with its installed cabin classes, offered seat configurations and other services such as infotainment, food and beverages. The main cabin classes were traditionally first class (F), business class (C) and economy class (Y), however, premium economy class (PY) has increasingly gained attention amongst both LCCs and FSNCs. The number of cabin classes, seats per cabin class and total installed seats offered by each ABM are essential for operating cost and yield estimations.

1.2 Motivation for Aircraft Conceptual Design

In the aircraft conceptual design phase, one of the first aircraft design parameters that needs to be fixed, is the design payload at the design range (Raymer, 1992). For a later refinement during the preliminary aircraft design phase, the number of cabin classes and number of installed seats per cabin class are essential information required for defining the fuselage cross-section and the overall length. Therefore, additional cabin information about design seat widths, seat pitches and additional cabin monuments (Nita & Scholz, 2010) is necessary. These vary with airline business models as well as for regional, short-haul and long-haul operations.

1.3 Motivation for Future Fleet Planning

To determine the future fleet needs of an airline, fleet planners consider the occupancy level (seat and freight load factors) as well as the level of competition on the markets they serve. Thus, with increasing competition in a certain market and airport capacity constraints, an airline would choose to increase the installed seats on its aircraft to retain its market share or claim a higher market share (Berster, Gelhausen, & Wilken, 2015). This will also occur when checking the break-even load factor of the planned aircraft (Clark, 2007).

Furthermore, a proper description of the installed seats and cargo weights of the modelled aircraft types is necessary for longer-term fleet planning and the evaluation of global emissions by airlines (IPCC, 1999). Therefore, this study evaluates the factors affecting aircraft cabin configuration (mainly installed seats, but also seats per cabin class as well as the level of cabin utilisation) and the impact of these factors by the use of empirical data.

2. REVIEW OF EXISTING STUDIES

The most common passenger metrics, fuel burn per seat-kilometre and range, used in aircraft performance evaluation are dependent on the aircraft payload configuration, i.e. the seat to cargo weight ratios (IPCC, 1999). According to IPCC (1999), this configuration varies among airlines and is dependent on market considerations.

Kownatzki (2011) also identified airline business models as a main reason for differences in the number of installed seats and configurations of the same aircraft type. Other factors identified as affecting the number of seats and seat class mix are geographic considerations, competition level, flight timing, and target customers. Airlines thus adopt both high and low-end options, depending on the market segment, flight timing and the target customers.

Airline business models differ in several characteristics. One of the most significant characteristics is the number of installed seats since it affects the unit costs for an airline (Doganis, 2002). The seat density in the fleets of low-cost carriers (LCCs) is about 15-20% higher (Stimac, Vince, & Vidovic, 2012) giving them an operational advantage compared with full-service network carriers (FSNCs) (Vidović, Štimac, & Vince, 2013). Miyoshi and Mason (2009) confirmed this in their analysis on the carbon emissions of different airlines and aircraft types. For the European short-haul market, they identified significant differences in the carbon emissions per passenger kilometre between FSNCs and LCCs and concluded that the latter achieved lower carbon emissions due to an operation of new aircraft types, exceedingly high load factors, and a high seat density (Miyoshi & Mason, 2009).

Besides the lower carbon emissions per passenger kilometre, a higher seat density provides a cost advantage for the operating airline (Gillen & Gados, 2008). Thus, airlines with a cost-leadership strategy, i.e. LCCs, addressing a price-sensitive target group of passengers operate their aircraft with more seats compared to airlines with other business models.

Market size as well as route distance have a positive effect on the size of an aircraft operated by the airline, which leads to the conclusion that the number of seats increases with an increase in the route distance (Givoni & Rietveld, 2009). Pai (2010) also identified a positive correlation between route distance and aircraft size, arguing that larger aircraft are needed as the distance between two endpoints increases. However, the study only investigated the US airline industry, focusing on determinants for aircraft size and frequency of flights such as market demographics, airport characteristics, airline characteristics, and route characteristics (Pai, 2010).

Although, Givoni and Rietveld (2010) confirmed the general behaviour of airlines in preferring small aircraft and high frequency to larger aircraft and lower frequency on short haul routes, they also highlighted the likelihood of full-service network carriers opting for higher seat densities on their large aircraft when operating them on short-haul hub-to-hub routes. They argued that this occurs due to the low demand for first-class seats on such routes. One example supporting this concept is that of British Airways, where the B767 aircraft fleet in 2016 had more installed seats (259) on its UK domestic routes than on its European routes (244 seats) and its long-haul routes (189 seats) (British Airways, 2016). In addition, to compensate for an increase in seats, a corresponding reduction in belly-freight carried on short to medium haul routes is observed. The changes in seat to cargo weight ratios over changing distances underscores the importance of air cargo in long haul airline operations compared to short haul operations (IPCC, 1999).

With respect to longer term fleet planning, the IPCC reported a 1% per year growth in aircraft size as the current trend (IPCC, 1999). However, this value could be misleading when used for all aircraft types irrespective of the seating capacity. It is equally important to identify the latest value of this variable nearly two decades after it was first determined.

Thus, although these studies have identified that airline business models and route characteristics determine aircraft seat capacities, their area of study was not based on flight connections within and between all world regions. Furthermore, they do not focus on LCCs from across the globe or on an overall majority of the global aircraft fleet.

Two databases are used in this research work. Information on aircraft cabin configurations is obtained from historical databases of scheduled aircraft flights, while airlines are categorised into two main groups - FSNCs and LCCs - by use of a carrier type database. Airlines not belonging to the LCC classification are considered as FSNCs. Although other ABM clusters exist as earlier explained, as there is no comprehensive global database of airlines belonging to these clusters, a simplification in which all airlines are classified into two ABM clusters is adopted.

2.1 Historical Database of Scheduled Aircraft Flights

To evaluate the historical development of scheduled aircraft cabin configurations, the Official Airline Guide (OAG) database is used covering information on scheduled flights for years 2000, 2004, 2008, 2012, 2014 and 2016 (OAG, 2000, 2004, 2008, 2012, 2014, 2016). The database was cleaned up by excluding code-share flights, surface transport trips, multi-stop flights and non-aircraft trips.

In selecting the aircraft to be investigated, the aircraft clustering methodology adopted by Randt (2016) was used. Randt developed this methodology for use in longer-term fleet planning studies (Randt, 2016; Randt, Jessberger, & Ploetner, 2015). In this methodology, the OAG database of 2008 (OAG, 2008) was analysed, then passenger aircraft types listed in the database with a minimum individual share of 0.1% ASK in the global provision of ASKs were selected. Similarly, freighter aircraft with a minimum individual share of 0.1% ATKs in the global provision of ATKs were selected. In total, 86 aircraft types were selected that contributed roughly 98% ASK and ATK of the global ASK and ATK in 2008. Furthermore, using a k-medoids-based clustering tool, the aircraft types were clustered based on available seat and freight capacity, available overall payload capacity, average flight distance flown, and type of propulsion. This resulted in seven clusters of passenger aircraft and two clusters of cargo aircraft. As this study is focussed on aircraft seats, the two clusters of cargo aircraft are excluded. The selected clusters and constituent aircraft types are shown in Table 1. Based on the OAG database, the selected aircraft types provided 87% and 86% of the total globally planned available seat-kilometres (ASK) in 2000 and 2016 respectively.

Also, based on the OAG classification of world regions, seven main regions were identified, these are: North America (NA1), Europe (EU1, EU2), Latin America (LA1, LA2, LA3, LA4), Africa (AF1, AF2, AF3, AF4), Middle East (ME1), Asia (AS1, AS2, AS3, AS4) and South West (SW1) (Giarratani, Hewings, & McCann, 2013). The South West region was merged into the Asian region. This is because, unlike the Middle East region, it is more of a destination region than a global aviation intersection. This results in six geographical regions. When considering single-leg flights within the regions as well as between region pairs, 21 route groups result. Thus, the classification of all flights globally into route groups used by Randt (2016) was adopted. This is shown in Figure 1. This classification is used in the definition of regions and route groups1, as later used in this study.

Figure 1. 21 Route groups evaluated, based on Randt (2016)

2.2 Historical Database of Low-Cost Carriers

For the evaluation of the historical operation of low-cost carriers (LCCs), a database of LCCs is adopted based on information provided by the International Civil Aviation Organisation (ICAO, 2014). The database was verified to ensure that the IATA codes are correct and further updated for the year 2016 using the ICAO's definition of a low-cost carrier as

"an air carrier that has a relatively low-cost structure in comparison with other comparable carriers and offers low fares and rates. Such an airline may be independent, the division or subsidiary of a major network airline or, in some instances, the ex-charter arm of an airline group" (ICAO, 2013 p.7).

[1] A route group refers to flights within a geographic region or between a pair of regions.

Table 1. Evaluated aircraft clusters and constituent specific aircraft names (Randt, 2016)

Aircraft Cluster Name	Constituent Aircraft OAG-Specific Aircraft Name
Long-range Combi (LRC)	Boeing (Douglas) MD-11 Passenger, Boeing747 (Mixed Configuration), Boeing 747-400 (Mixed Configuration)
Long-range heavy (LRH)	Airbus A380-800 Passenger, Boeing 747 (Passenger), Boeing 747-300/747-100/200 Sud (Pax), Boeing 747-400 (Passenger), Boeing 777-300 Passenger
Jet commuter (JC)	Airbus A318, Avro RJ100, Avro RJ85, Boeing 727 (Freighter), Boeing 737 (Freighter), Boeing 737-200 Passenger, Boeing 737-600 Passenger, Canadair Regional Jet, Canadair Regional Jet 200, Canadair Regional Jet 700, Canadair Regional Jet 900, Embraer 170, Embraer 175, Embraer 190, Embraer RJ 135/140/145, Embraer RJ 145, Fokker 100, Tupolev TU134
Turboprop commuter (TC)	ATR 72
Mid-range (MR)	Airbus A300-600 Passenger, Airbus A310 Passenger, Airbus A330, Airbus A330-300, Boeing 757 (Passenger), Boeing 757-200 (winglets) Passenger, Boeing 757-200 Passenger, Boeing 757-300 Passenger, Boeing 767-300 Passenger, Tupolev TU-204 /tu-214
Long-range (LR)	Airbus A330-200, Airbus A340, Airbus A340-200, Airbus A340-300, Airbus A340-500, Airbus A340-600, Boeing 767-400 Passenger, Boeing 777-200 Passenger, Boeing 777-200LR, Boeing 777-300ER, Ilyushin II-96 Passenger
Narrow-body (NB)	Airbus A318 /319/ 320 /321, Airbus A319, Airbus A320, Airbus A321, Boeing (Douglas) MD-80, Boeing (Douglas) MD-81, Boeing (Douglas) MD-82, Boeing (Douglas) MD-83, Boeing (Douglas) MD-88, Boeing (Douglas) MD-90, Boeing 717-200, Boeing 737 Passenger, Boeing 737-300 Passenger, Boeing 737-400 Passenger, Boeing 737-500 Passenger, Boeing 737-700 (winglets) Passenger, Boeing 737-700 Passenger, Boeing 737-800 Passenger, Boeing 737-900 Passenger, McD- Douglas DC9 30 /40 /50, Tupolev TU154

Table 2. Validation of LCC database

Year	LCC Global market share	
	Own values (% difference)	Published values
1997	n/a	6% seats (Airbus, 2008)
1998		n/a
1999		
2000	5% ASK, 37600 flights/week (31%), 8% seats	28640 flights/week (Magill, 2004)
2001	n/a	n/a
2002		
2003		7% ASK, 42490 flights/week (Boeing Commercial Airplanes, 2014; Magill, 2004)
2004	10% ASK, 70795 flights/week, 15% seats	n/a
2005	n/a	
2006		
2007		20% seats (Airbus, 2008)
2008	15% ASK, 109590 flights/week, 22% seats	n/a
2009	n/a	
2010		
2011		
2012	25% seats	
2013	n/a	26% seats, 16% ASK (Boeing Commercial Airplanes, 2014, Boeing Commercial Airplanes, 2015)
2014	20% ASK, 149979 flights/week, 28% seats	n/a
2015	n/a	28% seats (ACI, 2016; ICAO, 2015)
2016	28% seats (0%)	28% seats (ICAO, 2017)

In updating the database for 2016, airlines listed in the OAG 2016 database which were not included in previous OAG databases were identified and evaluated for compliance to the ICAO LCC definition. Sources consulted in updating the database include airline websites, Ishka (2017), and DLR (2016). Table 2 below shows the results of the validation check on global ASK, flights per week and percentage of total seats flown by LCCs globally, comparing own values with published values. The list of LCCs used in the analysis for the respective years is presented in the appendix.

3. PRELIMINARY ANALYSIS

In this section, representative clusters in the small, medium, and large aircraft categories, based on the highest total seats transported, (namely, JC, NB and LR aircraft clusters) are focused on. Similarly, where geographic world regions are discussed, the analysis covers intra-regional as well as inter-regional flights for the three biggest regions in terms of total departing seats on intra-regional flights in 2016. The regions are Asia, North America and Europe. Results for all aircraft clusters and route groups are presented in the appendix.

The historical development of seat capacities of the selected aircraft clusters is evaluated for both global and route group dimensions. In addition, the historical development of seat capacities of the aircraft clusters operated by the two ABM clusters is also investigated both for global and route group dimensions.

In computing average annual growth rates over the analysis period for use in longer-term fleet planning, values from each data point or analysis year were assumed to change linearly until the next available data point. Furthermore, in computing average differences in the number of aircraft installed seats over the analysis period, comparing ABMs, values from each data point were assumed to remain constant until the next available data point. To include the effect of flight frequencies, the average seats and average distances shown are weighted by flight frequency. Moreover, for each year and group of flights being analysed, a distinction is made between the average seat capacities scheduled, weighted by flight frequency, and the average maximum possible seat capacity for each aircraft cluster, also weighted by flight frequency. The former was determined from the number of seats on scheduled flights available from the OAG databases, weighted by flight frequency while the latter was analysed by determining the maximum seat capacity possible for each aircraft type analysed in the database and finding the average of these maximum possible values, weighted by flight frequency.

Sources consulted in determining the maximum seat capacity for each aircraft type include aircraft manufacturer websites2, Pitt & Norsworthy (2013), DVB Aviation Research (2015) and other sources3. The average maximum possible seat capacity was determined as a reference frame against which values of average scheduled seat capacity are compared, thus accounting for the differences in the mix of aircraft constituting an aircraft cluster for a given analysis year and group of flights. Moreover, given that one maximum possible seat capacity is given for a specific aircraft which was scheduled with a variety of installed seats depending on the airline, the average maximum possible seat capacity metric gives an insight into the prevailing or less prevailing constituent aircraft in each cluster per analysis year. Furthermore, using this metric makes it possible to estimate the aircraft cabin utilisation for each aircraft cluster. Aircraft cabin utilisation is here defined as the ratio, in percent, of the average scheduled seat capacity and the average maximum possible seat capacity for each aircraft cluster.

3.1. Historical Global Development of Aircraft Cluster Seat Capacities

Over the 17-year analysis period, aircraft cabin utilisation was found to grow at average annual growth rates of 0.4%, 0.6% and 0.5% for the JC, LR and NB aircraft clusters respectively. There was also an increase in the average number of installed seats on the three aircraft clusters. Average annual growth rates of 0.6%, 1.1%, and 0.3% were found for the JC, NB, and LR aircraft clusters respectively. Considering maximum possible seat capacity within the JC and NB clusters, there was a shift to larger dominant constituent aircraft types with larger maximum possible seat capacities since average maximum possible seat capacity increased at average annual growth rates of 0.2% and 0.5% respectively between 2000 and 2016. On the other hand, average maximum possible seat capacity for the LR cluster decreased at about 0.2% per year between 2000 and 2016. This development can be seen in Figure 2 below.

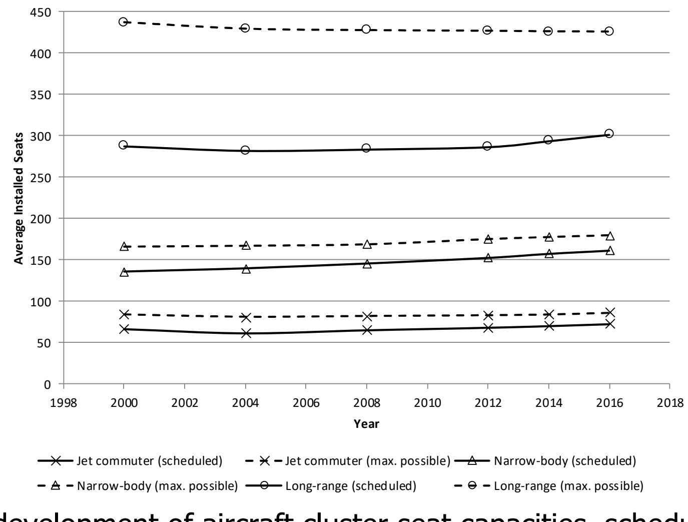

Figure 2. Global development of aircraft cluster seat capacities, scheduled and maximum possible

[2] For Airbus, Boeing, Bombardier, Embraer, Fokker, Ilyushin, and Tupolev aircraft
[3] www.airliners.net and www.angelwingsva.com

Therefore, the strong growth of the NB aircraft cluster average maximum possible seat capacity reflects the penetration of larger variants of the B737 and A320 family in the global fleet market. On the other hand, the decrease in the LR aircraft cluster average maximum possible seat capacity suggests a shift to, or prevalence of, constituent aircraft of the aircraft cluster with lower maximum possible seat capacities. For example, there could be less prevalence of the A340 and Boeing 777-300ER and more of the A330-200 and B777-200 aircraft. It is to be noted that although average maximum possible seat capacity of the LR aircraft reduced, the average distance flown by the aircraft cluster fleet increased over the analysis period.

3.2. Differences in Aircraft Seat Capacities Depending on Airline Business Models

In addition to determining the developments in average aircraft cluster seat capacity (scheduled and maximum possible) over time, these developments were also evaluated based on airline business models. Figure 3 presents the average maximum possible seat capacities of the three aircraft clusters as operated by the two ABM clusters over the analysis period. The results show that the average maximum possible seat capacities of NB and LR aircraft used by LCCs were 7% and 5% lower than those operated by FSNCs, whereas the maximum possible seat capacities of JC aircraft of LCCs are higher than those of FSNCs. This implies that globally, LCCs operated smaller constituent aircraft4 of the NB and LR aircraft clusters compared to FSNCs, whereas FSNCs operated smaller constituent aircraft of the JC cluster as compared to LCCs.

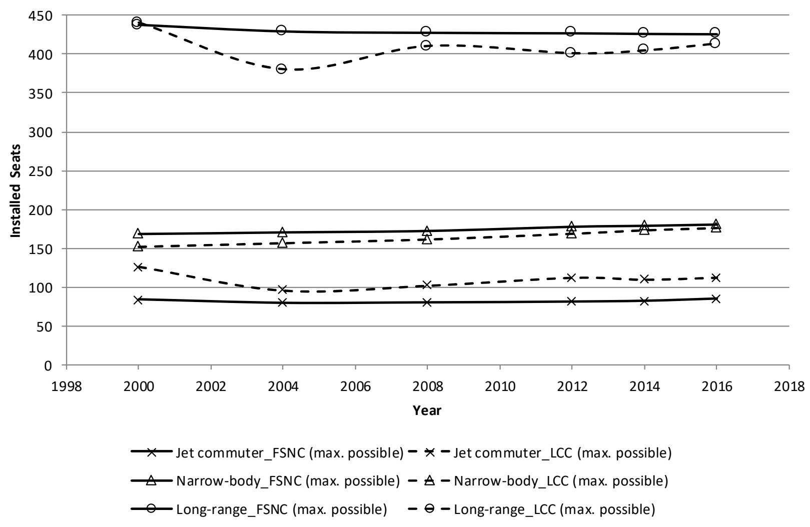

Figure 3. Global development of aircraft cluster average maximum possible seat capacities, FSNCs and LCCs

[4] (i.e. aircraft with lower maximum possible seat capacity)

In addition, Figures 4 and 5 present the historical development in seat capacities and aircraft cabin utilisation of the selected aircraft clusters as operated by FSNCs and LCCs, respectively, within the analysis period.

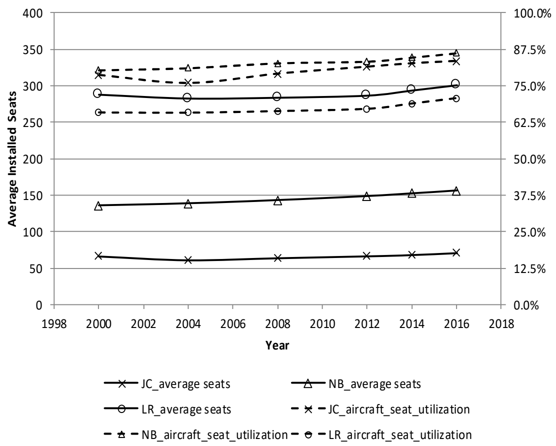

Figure 4. Global development of FSNC aircraft cluster seat capacities and cabin utilisation

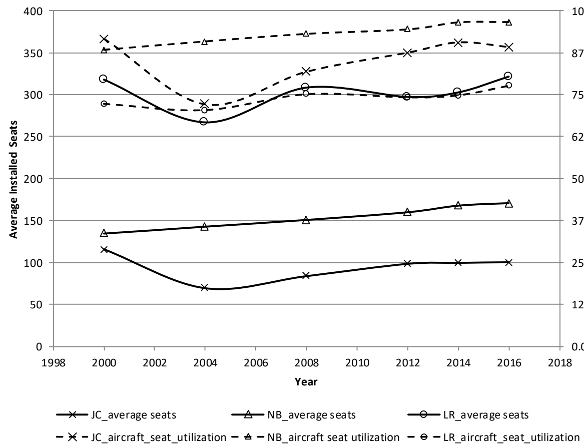

Figure 5. Global development of LCC aircraft cluster seat capacities and cabin utilisation

Therefore, although the average maximum possible seat capacities of NB and LR aircraft operated by LCCs were less than those operated by FSNCs, LCCs still installed more seats on their "smaller" aircraft than the number of seats installed by FSNCs on their "larger" NB and LR aircraft. Furthermore, LCCs operated JC aircraft that were larger on average (i.e. aircraft with greater maximum possible seat capacity) and installed more seats than FSNCs.

Considering installed seats per cabin class, for the JC and NB there was an increase in the share of first class and business class seats (F+C seats) of FSNCs, whereas the reverse was found for LCCs. The share of economy seats on these two aircraft clusters was about 92% and 99% for FSNCs and LCCs, respectively in 2016.

However, for the LR aircraft cluster, there was a growth in the share of premium seats for the two ABMs until 2008 after which the share of these seats slightly reduced for both business models. This is in agreement with a CAPA report that claimed a loss of share in premium traffic relative to economy traffic since the 2009 recession (CAPA, 2013). The share of economy seats in the LR aircraft cluster was about 87% and 94% for FSNCs and LCCs, respectively in 2016. This confirms the reduced focus of LCCs on business passengers in comparison with FSNCs over their operated routes. The development in the share of premium seats (F+C seats) and economy seats (Y seats) on LR aircraft operated by the two ABM clusters is presented in Figure 6.

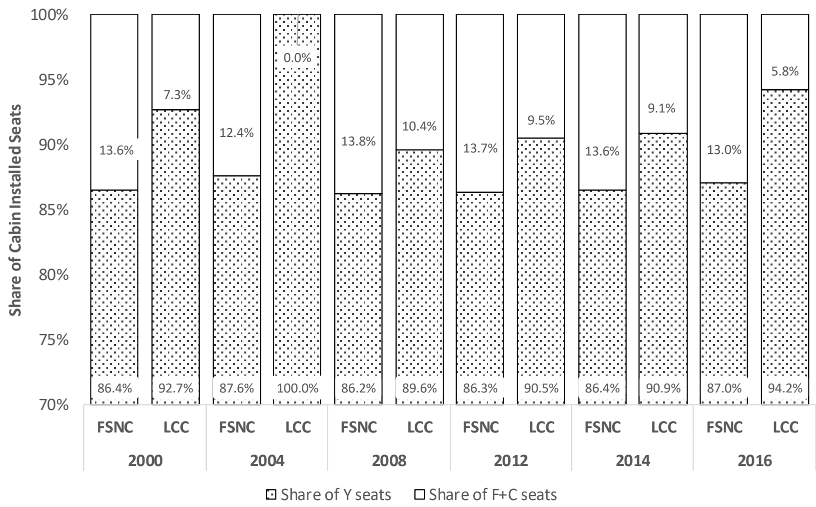

Figure 6. Globally installed seats per cabin class on LR aircraft by FSNCs and LCCs

3.3. Historical Development of Aircraft Cluster Seat Capacities between and within Geographical Regions and Airline Business Models

Frequency-weighted average scheduled and maximum possible seats of the evaluated aircraft clusters operating the selected inter-regional and intra-regional flights from 2000 to 2016 are shown in Appendices 8 and 9. The corresponding average annual growth rates in average installed seats are shown in Table 3.

Over the 17-year period, for the three aircraft clusters considered, the highest average annual growth rate in aircraft seat capacity was found on intra-European flights. However, the average maximum possible seat capacity did not increase accordingly. As a result, for the three aircraft clusters, the highest cabin utilisation on intra-regional flights was in Europe. (see Appendix 5).

In addition, the highest average scheduled seat capacities on aircraft belonging to the JC and NB aircraft clusters were found in Europe, while the highest scheduled seat capacity on aircraft belonging to the long-range aircraft cluster was found on flights in Asia. This reflects the contribution of high-density short haul routes within Asia. On the other hand, the lowest average annual growth rate summed up for the three clusters was on flights in Asia.

On inter-regional routes, where the long-range aircraft cluster is designed to operate, a growth in the average installed seats was also observed over the analysis period. The highest annual growth rate for the LR and NB aircraft cluster was on North Atlantic or North America-Europe routes with an average of 0.8%, while the lowest was on Trans Pacific or Asia-North America routes with an average of 0.5%. In addition, LR aircraft on Trans Pacific routes had more seats (average scheduled and maximum possible) than comparable aircraft on North Atlantic routes. These results correspond to historic and forecast trends in aircraft installed seats presented by the IPCC for these routes (IPCC, 1999). Focusing more on inter-regional flights using LR aircraft, Figure 7 below the development of average scheduled seats and average maximum possible installed seats for the LR aircraft cluster (both weighted by frequency) with distance flown (also weighted by frequency), when operating intra- and inter-regional flights for the Asian, North American and European geographical regions. The average number of scheduled seats, weighted by frequency, on LR aircraft was more when operating intra-regional flights than when operating inter-regional flights. However, the average maximum possible seat capacity was higher on inter-regional flights than on intra-regional flights. This result reflects the strategy identified previously in which airlines install more seats on their wide-body aircraft when flying shorter missions, whereas less seats are installed for longer-range missions to enable the transport of more belly-cargo. This correlation was not observed for the jet commuter and narrow-body clusters.

Table 3. Average annual growth rates in aircraft cluster seat capacity between 2000 and 2016, all airlines

Route Group	Aircraft Cluster	Average Annual Growth Rate 2000-2016 [%]	Average Annual Growth Rate 2008-2016 [%]
Intra North America	JC	0.7	1.1
	NB	0.8	1.4
	LR	0.4	0.3
Intra Europe	JC	1.4	2.4
	NB	1.2	1.3
	LR	1.0	0.8
Intra Asia	JC	-0.7	1.6
	NB	0.8	1.2
	LR	-0.4	0.5
North America-Europe	JC	-6.1	-6.1
	NB	1.1	7.3
	LR	0.5	0.5
Europe-Asia	JC	-1.1	-2.2
	NB	0.6	1.6
	LR	0.6	0.2
Asia-North America	JC	0	0
	NB	0.5	1.9
	LR	0.5	0.2

Analysing the developments in installed seats over time, geographic region, and airline business models, the development of average scheduled aircraft cluster seat operated by FSNCs and LCCs over time on intra-regional routes is presented in Appendices 10 to 13. In addition, Table 4 shows the development in aircraft cluster average seat capacities over the analysis period.

In 2016, LCCs had a market share of 41%, 32%, and 24% on European, North American and Asian regional flights, respectively. From Table 4, it can be seen that LCCs had different approaches to competing with FSNCs in terms of increasing the number of seats on their aircraft between 2000 and 2016 on the 3 intra-regional routes. For example, within North America, they operated the single-aisle cluster aircraft while at least matching the growth rate of the FSNCs. Within Europe, LCCs reduced growth in JC aircraft seats while ensuring slightly higher growth in NB cluster seats, while within Asia they doubled the growth rate of NB cluster seats compared to FSNCs. Where the LR cluster is concerned, LCCs maximised growth in average scheduled seats in Asia while no growth occurred in this cluster in the other two route groups.

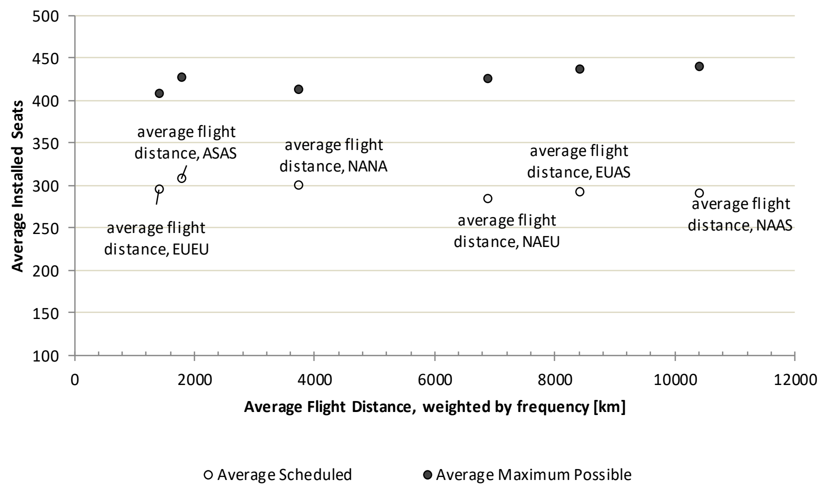

Figure 7. Development of average and maximum possible seat capacities with flight distance, for selected inter- and intra-regional flights using LR aircraft cluster in 2016

The historical development in the seat share of FSNCs and LCCs on intercontinental routes between the three regions is shown in Figure 8 while Table 5 shows the corresponding average annual growth rates on the route groups. From Figure 8, over the analysis period, LCCs had a lower but increasing market share on these inter-regional route groups, with the highest market share being on North Atlantic routes. In 2016, LCCs had a market share of 3.9%, 1.6%, and 0.4% on the North Atlantic, European-Asian and Trans Pacific routes respectively.

LCCs did not operate JC aircraft on the three inter-regional routes due to the payload-range limitation of the aircraft cluster. However, this aircraft cluster was operated by FSNCs on Europe-Asia routes. Furthermore, in the study of the differences in installed seats by the different ABMs on these inter-regional routes, the focus is on LR aircraft since the design characteristics of this aircraft cluster is most suitable for both ABMs operating on these three routes. Table 5 shows the average annual growth rates of average seat capacity of aircraft belonging to the LR cluster operated by the different ABMs on the observed route groups.

Similar to the observation made concerning intra-regional flights, LCCs operate their LR cluster aircraft with different configurations on the different inter-regional route groups. On the North

Atlantic market, LCCs grew their market share from 0.2% in 2000 to 3.9% in 2016. They also operated LR aircraft with about 14% more seats than LR aircraft operated by FSNCs, using constituent aircraft with 2% higher average maximum possible seat capacity.

Table 4. Average annual growth rates in aircraft cluster seat capacity of FSNCs and LCCs on regional routes, between 2000 and 2016

Route Group	Aircraft Cluster-ABM	Average Annual Growth Rate 2000-2016 [%]	Average Annual Growth Rate 2008-2016 [%]
Intra North America	JC-FSNC	0.5	1.1
	JC-LCC	0.6	2.4
	NB-FSNC	0.8	1.3
	NB-LCC	0.8	1.4
	LR-FSNC	0.4	0.3
	LR-LCC	0	0
Intra Europe	JC-FSNC	1.4	2.3
	JC-LCC	-0.3	3.0
	NB-FSNC	1.0	1.3
	NB-LCC	1.3	0.8
	LR-FSNC	1.0	0.8
	LR-LCC	0.0	-12.3
Intra Asia	JC-FSNC	-0.5	3.6
	JC-LCC	0	0
	NB-FSNC	0.6	1.0
	NB-LCC	1.2	1.3
	LR-FSNC	-0.5	0.5
	LR-LCC	4.2	4.5

On Europe-Asia inter-regional routes, LCCs increased their market share from 0.3% in 2000 to 1.6% in 2016. They operated LR aircraft with 3% less seats on average than FSNCs. They use constituent aircraft with about 5% less average maximum possible seats than those of LR aircraft operated by FSNCs. LCCs also increased the seat capacities of their LR aircraft by 1.8% as compared to FSNCs with average annual growth rates of 0.6%. In the Trans-Pacific market segment, LCCs operated LR aircraft at 35% higher seat capacity than LR aircraft operated by FSNCs, using constituent aircraft with equal average maximum possible seat capacity to those operated by FSNCs.

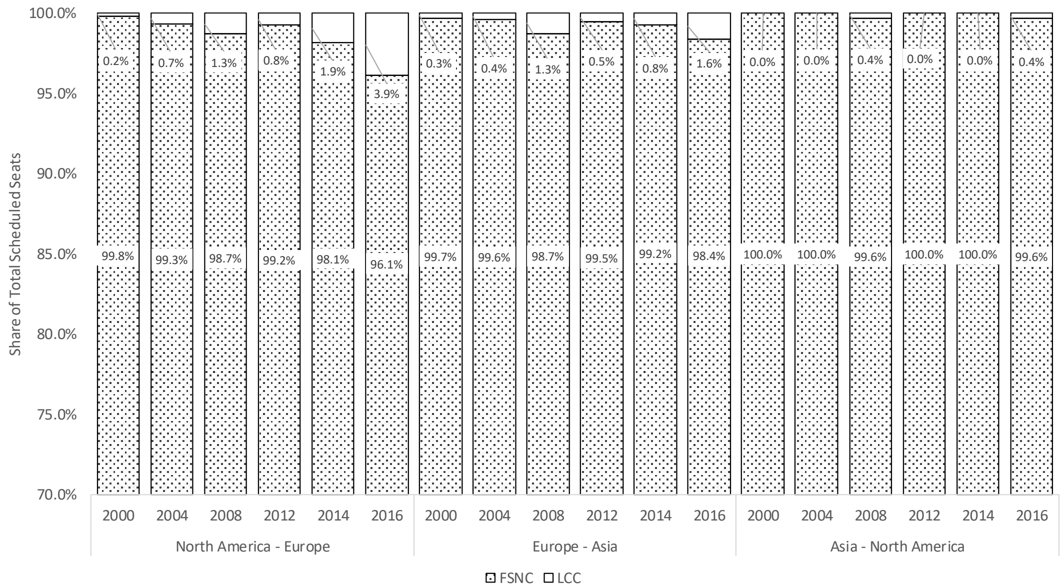

Figure 8. Historical development of inter-regional routes seat share, FSNCs and LCCs

Table 5. Average annual growth rates in LR aircraft seat capacity on inter-regional routes between 2000 and 2016, FSNCs and LCCs

Route Group	Aircraft Cluster_ABM	Average Annual Growth Rate 2000-2016 [%]	Average Annual Growth Rate 2008-2016 [%]
North America - Europe	LR_FSNC	0.5	0.5
	LR_LCC	0.4	0.4
Europe – Asia	LR_FSNC	0.6	0.3
	LR_LCC	1.8	3.7
Asia – North America	LR_FSNC	0.5	0.1
	LR_LCC	0	0

Therefore, in general, LCCs operated their LR aircraft with an average of 15% higher seat capacity than LR aircraft operated by FSNCs. They also used constituent aircraft with 1% less maximum possible seats than LR aircraft operated by FSNCs on these inter-regional routes. However, at a route group level, LCCs had different approaches to competing with FSNCs in terms of increasing the number of seats on their aircraft between the analysis period.

4. HYPOTHESIS-DRIVEN DATA ANALYSIS

In this section, selected results from the previous section are analysed using statistical tests on the mean. Statistical tests on the means are used to verify statistical significance while drawing conclusions regarding differences in means of average maximum possible seats and average scheduled seats of LCCs and FSNCs. The tests are conducted first for the ABMs generally, then by aircraft cluster. Furthermore, a regression analysis is carried out to determine the variables that significantly affect cabin utilisation of the aircraft clusters.

In carrying out this analysis, a unit of observation is defined as the average aircraft cluster flight per year, airline business model, and geographic route group. This means that averages of the seat capacities, maximum possible seat capacities, and flight distances are obtained for all scheduled flights by constituent aircraft types in each aircraft cluster, as well as between several specific airport pairs in each route group and between airlines in each ABM cluster.

Entries for an average aircraft cluster flight include average scheduled seats and average maximum possible seat capacities, average utilisation, aircraft operator ABM, and average distance per flight on the 21 identified route groups. In this case, average utilisation refers to the ratio between average scheduled seats and average maximum possible seat capacity of the aircraft cluster. The analysis covers all seven passenger aircraft clusters. Average aircraft cluster flight entries with flight distance exceeding the possible limit stipulated by payload-range diagrams of aircraft are deleted. Entries with missing or zero seat capacities are also deleted.

4.1. Difference in seat capacities of LCC and FSNC aircraft, general

First, a two-sample t-test of average scheduled seats and average maximum possible seats comparing LCCs with FSNCs, using unequal variances, is conducted. This is irrespective of aircraft cluster operated in the average flight. The results suggest that LCCs use aircraft with substantially less scheduled seats than FSNCs. This is only statistically provable up to 90% confidence interval. In addition, LCCs use aircraft that have less average maximum possible seats than FSNCs. These are summarised in Tables 6 and 7.

Table 6. Summary result: t-test of average scheduled seats

Group	Obs.	Mean	Std. Err.	Std. Dev.	[90% Conf. Interval]	
FSNC	645	226.704	4.248	107.882	219. 707	233.701
LCC	247	212.606	6.190	97.285	202.386	222.827
combined	892	222.80	3.522	105.19	217.001	228.599
diff		14.097	7.861		1.153	27.041
diff = mean (FSNC) – mean (LCC)					t = 1.793	
Ho: diff = 0					degrees of freedom = 890	

Ha: diff < 0   Ha: diff= 0   Ha: diff > 0

Pr (T < t) = 0.963   Pr (|T| > |t|) = 0.073   Pr (T > t) = 0.037

Table 7. Summary result: t-test of average maximum possible seat capacity

Group	Obs.	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
FSNC	645	343.243	7.124	180.937	329.253	357.233
LCC	247	270.928	9.290	146.008	252.629	289.226
combined	892	323.218	5.857	174.919	311.724	334.713
diff		72.315	12.870		47.057	97.573

diff = mean (FSNC) – mean (LCC) t = 5.619

Ho: diff = 0 degrees of freedom = 890

Ha: diff < 0	Ha: diff= 0	Ha: diff > 0
Pr(T < t) = 1.000	Pr (|T| > |t|) = 0.000	Pr (T > t) = 0.000

4.2 Difference in cabin utilisation and seat capacities of LCCs and FSNCs, by aircraft cluster

Two-sample t-tests of average maximum possible seats comparing LCCs with FSNCs, using equal variances, are conducted for each aircraft cluster. The results are summarised in Table 8 below.

Table 8. Summary result: t-test of maximum possible seats, LCCs and FSNCs

Aircraft Cluster	Mean maximum possible seats FSNC	Mean maximum possible seats LCC	Mean difference	*p* value mean (FSNC)-mean (LCC) =0	95% C.I.
TC	74	74	0	x	(0,0)
JC	91	106	-15.3	0.0000	(-22.3, -8.4)
NB	178	175	2.4	0.1416	(-0.2, 5.1)
MR	344	331	12.3	0.0777	(-1.4, 26.1)
LRC	457	410	47.5	x	x
LR	424	408	15.6	0.0074	(4.4, 26.9)
LRH	604	619	-15.2	0.0074	(-25.8, -4.5)
x: not available					

Although, LCCs are known to use significantly smaller (average maximum possible seat capacity) aircraft types than FSNCs, the results in Table 8 give more information into this relation by analysing the aircraft clusters individually. FSNCs use significantly bigger aircraft types than LCCs, in the LR cluster. This is probably because the latter try to minimise their landing costs, as part of their cost-minimization strategy. On the other hand, within a 95% CI, LCCs use significantly bigger aircraft types in JC clusters than FSNCs. LCCs could be said to also use bigger LRH aircraft than FSNC, but this cannot be statistically proven since only 16 observations are available to show this. Interestingly, given that the NB aircraft cluster embodies the main aircraft types of LCCs at least in Europe (EUROCONTROL, 2017), the results for this aircraft cluster are not significant. Although FSNCs have higher average maximum possible seats than LCCs, this difference is not statistically significant. As expected, LCCs have significantly more seats than FSNCs when using aircraft in clusters JC, NB, MR, and LR. These are also the main aircraft types in use by LCCs. The other clusters could be operated by LCCs, but only on rare occasions.

Evaluating the cabin utilisation behaviour of the two business models, LCCs have a significantly higher cabin utilisation than FSNCs for aircraft in the NB, MR, and LR clusters. A lower cabin utilisation by FSNCs hints towards the fact that they have a higher passenger comfort through a higher share of premium seats on aircraft in these clusters than LCCs.

Table 9. Summary result: t-test of mean cabin utilisation, LCCs and FSNCs

Aircraft Cluster	Mean cabin utilisation FSNC	Mean cabin utilisation LCC	Mean difference	p value mean (FSNC) - mean (LCC)=0	95% C.I.
TC	0.929	0.938	-0.008	0.439	(-0.03, 0.01)
JC	0.848	0.883	-0.035	0.101	(-0.08, 0.01)
NB	0.817	0.910	-0.093	0.000	(-0.11, -0.07)
MR	0.661	0.774	-0.113	0.000	(-0.13, -0.09)
LRC	0.611	0.707	-0.096	x	x
LR	0.666	0.742	-0.076	0.000	(-0.11, -0.05)
LRH	0.612	0.680	-0.067	0.001	(-0.10, -0.03)
x: not available					

4.3. Regression model of average cabin utilisation per aircraft cluster

Innovations in aircraft design like Cabin Flex (Saab Press Center, 2015) and in aircraft interior design like Space Flex (Dron, 2015) and Smart Cabin Reconfiguration (Rahner, 2017) are developed and advertised to offer flexibility in or optimization of aircraft cabin utilisation. This implies that in addition to the revenue and profit generated by use of their aircraft, fleet planners also evaluate their strategies in terms of cabin utilisation. However, there has been little or no work done in estimating the predictors of aircraft cabin utilisation, compared to aircraft seating capacity. To support our previous findings, a simple regression model is constructed. The model estimates the effect of two variables of interest (distance and ABM) on our dependent variable cluster cabin utilization. From the definition of cabin utilization, a value above unity cannot exist. Furthermore, the regression analysis assumes a lower bound of 0.5 for the dependent variable. Furthermore, effects of control variables (route groups and years of observation) are included. Based on literature findings (Boeing Commercial Airplanes, 2017; Givoni & Rietveld, 2009), these control variables also have an impact on aircraft cabin utilisation. The variables are defined in Table 10, while the descriptive statistics of the variables are shown in Table 11. Three models are estimated via the OLS estimator, using robust standard errors. More variables are added in each new model to test their effect on the identified regression relationship of the previous model. Table 12 shows the results of the regression models. The main linear equation can be written as:

$$cabin\ utilization = \beta_0 + \beta_1 \ln dist + \beta_2\ LCC$$

where $cabin\ utilization$ refers to the cabin utilization of an aircraft cluster; $dist$ stands for the average distance flown by an aircraft cluster; and LCC is a dummy which stands for the operator ABM being LCC. A log-linear relationship is assumed between distance and cabin utilization similar to the approach of Givoni & Rietveld (2009). The betas are coefficients of the predictors to be estimated.

Table 10. Description of variables

Variable	Definition	Source
Aircraft cluster	An aircraft cluster is a hypothetical aircraft type with properties such as average scheduled seats, maximum possible seat capacity, and flight distance averaged (flight frequency weighted) over corresponding properties of constituent aircraft types. An aircraft cluster observation can be differentiated from another, composed of either the same or another set of constituent aircraft types, based on other properties like operating airline's business model, the origin and destination region pair, and the year of observation	See Table 1
cabin utilization	Ratio of average maximum possible seat capacity and average scheduled seats of aircraft cluster	Own computation
distance	Average flight distance of aircraft cluster, in kilometers	OAG Scheduled flights database
LCC	Dummy, takes a unitary value when operator of cluster aircraft is LCC	ICAO LCC database
Average scheduled seats	Average scheduled seats of aircraft cluster	OAG Scheduled flights database
Average maximum possible seats	Average maximum possible seat capacity of aircraft cluster	Various sources, see appendix
Year of observation	All years of observation in scheduled flight database used	OAG Scheduled flights database
Route Group Index	Index identifying route group	Own assumption

Table 11. Descriptive statistics of the variables

Variable	Observations	Mean	Std. Dev.	Min.	Max.
Cabin utilisation	878	0.7521	0.1267	0.5328	1
Distance	878	7.7636	1.0297	5.0015	9.6472
LCC	878	0.2813	0.4499	0	1
Average scheduled seats	878	224.5579	104.3599	11.0502	480
Average maximum possible seats	878	321.724	174.5599	12.8030	635.6649
Year	878	2009.251	5.5690	2000	2016
Route Group index	878	11.2551	5.7358	1	21

Table 12. Estimation results of the regression analysis

	Model 1	Model 2	Model 3
Distance	-0.071***	-0.066***	-0.117***
LCC in comparison to FSNC		0.083***	0.083***
Constant term	1.301***	1.241***	1.508***
Year present in model	No	No	Yes
Route Group Index present in model	No	No	Yes
N	878	878	878
R^2	0.330	0.415	0.568
rmse	0.104	0.097	0.085

* p<0.05, ** p<0.01, *** p<0.001

Model 1 depicts the influence of flight distance on cabin utilisation. The results show that distance has a negative impact on cabin utilisation. Thus, with increasing distance, cabin utilisation diminishes significantly. This hints towards the fact that with higher travel distance, passenger comfort, in terms of increased seat pitch, improves (Schmidt, 2018) and number of premium seats increases.

In Model 2, the effect of airline business models is added. The regression results show that cabin utilisation significantly increases when an aircraft cluster flight is operated by an LCC, as compared to an FSNC. This suggests that flights by LCCs offer significantly less legroom and passenger comfort. This outcome is in line with the theory on cabin utilisation of LCCs (Kremser, Guenzkofer, Sedlmeier, Sabbah, & Bengler, 2012).

Finally, we include two control variables (year and route group index) in Model 3 to test whether the coefficients of our variables of interest adhere to the same tendency. As expected, the control variables do not change the impact direction of the variables of interest. Furthermore, the significance of the variables of interest does not change when checking for the control variables. In addition, a better fit of the estimator (suggested by a higher R^2 and lower root-mean-square error value) was achieved by testing for the control variables.

A higher cabin utilisation implies more scheduled seats nearing the maximum possible seats per aircraft cluster. This also implies less passenger comfort, for example, when more rows of seats are added to the same aircraft. The results of the regression models therefore suggest that passenger comfort improves with increasing distance and on FSNC flights. Thus, there is a need for more innovative solutions for flexible adjustment of number of installed seats based on demand for short to medium haul flights, especially those operated by LCCs.

5. CONCLUSION

Aircraft cabin configuration is defined in terms of the average scheduled seats, average maximum possible seats, seats per cabin class, and average cabin utilisation of aircraft clusters. Examining the factors to which the configuration of an aircraft cabin is sensitive has been identified as useful in airline operating cost and yield estimation, aircraft conceptual design, and airline fleet planning. Studies have been conducted on the factors influencing aircraft seat capacities. However, none has been conducted analysing aircraft cabin utilisation using data on flights operated by LCCs and FSNCs, averaged within and between global geographical regions and using a clear majority of the global passenger aircraft fleet.

From the study, it is clear that the utilisation of an aircraft's cabin significantly depends on the scheduled flight distance as well as the operating airline's business model. Globally, LCCs had a low preference for premium class seats, especially on their short-haul routes. This study has also given insight into the trend in the average scheduled and maximum possible seats of aircraft, not only globally, but also within and between world regions. The results further suggest that there is no significant difference in aircraft types in the NB aircraft cluster used by LCCs and FSNCs. If this trend continues with the promised middle of market aircraft, a potential market for the aircraft would exist in both business models. By contrast, FSNCs show a greater preference for larger aircraft types in the twin-aisle LR aircraft cluster.

Further research is needed in determining the utilisation of available cargo capacity of aircraft operated on short-haul missions as compared to longer range missions. Also, a more rigorous regression analysis could be performed by using actual, instead of average, flight data and incorporating variables specific to the cities or countries of each specific airport pair. This will enable the investigation of more predictors in greater geographic detail so that more robust conclusions can be drawn.

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Appendix

Appendix 1: Low-Cost Carriers evaluated in study

Year	Low Cost Carriers IATA Codes
2000	ZA, Z2, YX, XQ, WS, WN, VQ, VA, VA, U2, TZ, TV, TV, SY, SJ, SH, SG, RE, QZ, PE, PC, P9, NK, NJ, NB, N7, LF, KF, JT, JR, JN, IT, IG, HV, HD, GO, G4, FR, FL, FF, F9, DY, DS, DI, DH, DG, DE, C6, BV, BL, BE, BC, B7, B6, AK, 8Q, 6A, 5J, 5D, 0B
2004	ZE, ZB, Z4, Z2, YX, Y2, XQ, X3, WW, WS, WO, WN, W6, VY, VQ, VF, VE, VA, VA, UO, U5, U2, TZ, TW, TV, TR, T6, SY, SX, ST, SJ, SH, SG, SG, RE, QZ, QG, PE, PC, PA, OX, O6, NZ, NK, NE, NB, MN, LS, LQ, LF, KK, KI, KF, JT, JR, JQ, JN, IX, IV, IT, IG, HV, HQ, HG, HD, HC, H2, GX, G9, G4, G3, FR, FL, FD, F9, F7, DY, DS, DJ, DI, DH, DG, DE, DD, C6, C0, BV, BL, BE, BC, B7, B6, AK, 9X, 9C, 8Q, 8I, 8A, 7G, 6A, 5P, 5J, 5D, 4U, 4P, 3L, 3K, 3J, 2L, 0B
2008	ZS, ZG, ZE, ZB, Z4, Z2, YX, YV, Y4, Y2, XY, XW, XQ, XG, X3, WW, WU, WS, WO, WN, WH, WG, W6, VY, VX, VF, VE, VB, VA, V5, UO, U5, U2, TZ, TW, TT, TR, TO, T6, SY, SX, SJ, SG, RE, QZ, QS, QG, QA, PE, PC, PA, O8, O6, NZ, NM, NK, NE, NB, MN, MJ, LZ, LS, LQ, LJ, LF, KK, KI, KF, JT, JR, JQ, JN, JE, J9, IX, IV, IT, IG, HV, HG, HD, HC, H2, G9, G8, G4, G3, FZ, FR, FL, FD, F9, F7, DY, DS, DJ, DG, DE, DD, D7, C6, C4, C0, BV, BL, BE, BC, B6, AK, AD, 9X, 9C, 8Z, 8Q, 8J, 8I, 8A, 7H, 7G, 7C, 6E, 6A, 5P, 5K, 5J, 4U, 4O, 3L, 3K, 2P, 2L, 0B
2012	ZE, ZB, Z2, YV, Y4, XY, XQ, X3, WW, WU, WS, WN, WH, WG, W6, VY, VX, VJ, VF, VE, VB, VA, V7, UO, U5, U2, TW, TT, TR, TO, T6, SY, SG, RI, RE, QZ, QS, QG, PQ, PC, PA, OD, NZ, NM, NK, MN, MM, MJ, LZ, LS, LQ, LJ, KK, KF, JW, JT, JQ, JE, J9, IX, IV, IG, HV, HG, HD, HC, H2, GK, G9, G8, G4, G3, FZ, FR, FN, FL, FD, FC, F9, E5, DY, DS, DJ, DG, DE, DD, DC, D7, C6, BV, BL, BE, BC, B6, AK, AD, 9C, 8Q, 8J, 7H, 7G, 7C, 6E, 5P, 5K, 5J, 4U, 4O, 3O, 3L, 3K, 2P, 2L, 0B
2014	ZE, ZB, Z2, YV, Y5, Y4, XY, XQ, X3, WW, WU, WS, WN, WG, W6, VY, VX, VJ, VF, VE, VB, VA, V7, UO, U2, TW, TT, TR, TO, SY, SL, SG, RI, RE, QZ, QS, QG, PQ, PC, PA, OD, NZ, NK, MN, MM, MJ, LS, LQ, LJ, KK, KF, JX, JW, JT, JQ, JE, J9, IX, IG, HV, HG, HD, H2, GK, G9, G8, G4, G3, FZ, FR, FN, FL, FD, FC, F9, E5, DY, DS, DJ, DG, DE, DD, DC, D7, C6, BV, BL, BE, BC, B6, AK, AD, 9C, 8Q, 7H, 7G, 7C, 6E, 5P, 5K, 5J, 4U, 4O, 3O, 3L, 3K, 2P, 2L, 0B
2016	E5, JX, 3O, MN, JE, FN, JQ, TT, VA, 9C, UO, IX, G8, 6E, SG, QG, QZ, JT, RI, HD, GK, MM, BC, LQ, 7G, JW, AK, D7, OD, Y5, NZ, PA, Z2, 5J, 2P, PQ, DG, DJ, 3K, TR, VF, ZE, 7C, LJ, TW, MJ, DD, FD, SL, BL, VJ, 3L, HG, QS, KF, TO, DE, 4U, X3, 5P, W6, WW, RE, FR, BV, IG, HV, DY, 5K, 0B, V7, VY, DC, DS, 2L, KK, 7H, 8Q, PC, XQ, WU, U2, BE, LS, ZB, AD, G3, H2, VE, FC, 4O, VB, Y4, J9, XY, G9, FZ, C6, WG, WS, FL, G4, F9, YV, B6, WN, NK, SY, VX, BF, RS, TZ, V6, 2D, 5F, 6F, 6J, 7B, 8W, AJA, AQ, CO, D8, DP, E2, RN, RY, TRJ, VNE, VU, VZ, XW, 2B, 9P, FT, GM, GY, OR

Appendix 2: Historical Development of Aircraft Cluster Average Seat Capacity, all airlines

A/C	2000	2004	2008	2012	2014	2016	Average Annual Growth Rate 2000-2016 [% p.a.]	Average Annual Growth Rate 2008-2016 [% p.a.]
LRC	273	277	261	255	326	291	0.7	1.5
LRH	389	383	372	366	347	374	-0.2	0.0
JC	66	61	65	68	70	72	0.6	1.4
TC	67	68	68	69	68	69	0.2	0.1
MR	207	217	219	227	237	250	1.2	1.5
LR	288	282	284	287	294	302	0.3	0.7
NB	135	139	146	153	158	162	1.1	1.3

Appendix 3: Historical Development of Aircraft Cluster Average Seat Capacity, FSNC

A/C	2000	2004	2008	2012	2014	2016	Average Annual Growth Rate 2000-2016 [%]	Average Annual Growth Rate 2008-2016 [%]
LRC	273	277	261	255	326	291	0.7	1.5
LRH	389	382	372	366	347	374	-0.2	0.1
JC	66	61	64	66	68	71	0.5	1.3
TC	67	68	68	69	68	69	0.2	0.1
MR	207	217	219	227	235	247	1.1	1.4
LR	288	282	284	287	294	301	0.3	0.7
NB	136	138	143	149	152	156	0.9	1.1

Appendix 4: Historical Development of Aircraft Cluster Average Seat Capacity, LCC

A/C	2000	2004	2008	2012	2014	2016	Average Annual Growth Rate 2000-2016 [%]	Average Annual Growth Rate 2008-2016 [%]
LRC	290							
LRH	480	407	376	360	346	336	-2.1	-1.4
JC	115	69	84	98	99	100	0.0	2.7
TC		67	67	70	69	69	0.2	0.3
MR	205	226	246	253	294	309	2.7	2.9
LR	318	267	308	297	302	321	0.2	0.9
NB	135	143	151	160	168	171	1.5	1.6

Appendix 5: Historical Development of Aircraft Cabin utilisation for all Airlines on Intra- and Inter-Regional Flights

Route Group	A/C	2000	2004	2008	2012	2014	2016
Intra North America	JC	73%	70%	74%	77%	78%	79%
	NB	83%	83%	85%	87%	88%	89%
	LR	65%	67%	71%	64%	73%	72%
Intra Europe	JC	81%	85%	89%	92%	93%	93%
	NB	79%	84%	89%	90%	92%	94%
	LR	60%	66%	65%	71%	72%	73%
Intra-Asia	JC	96%	81%	82%	86%	87%	91%
	NB	83%	84%	86%	86%	88%	89%
	LR	74%	72%	68%	71%	71%	72%
North America-Europe	JC			82%	24%	29%	24%
	NB	88%	66%	54%	68%	85%	83%
	LR	61%	60%	64%	63%	65%	67%
Europe-Asia	JC	89%	92%	94%	91%	89%	86%
	NB	80%	81%	81%	84%	84%	87%
	LR	62%	66%	66%	64%	64%	67%
Asia-North America	JC						
	NB	91%	91%	84%	86%	78%	82%
	LR	60%	64%	65%	63%	62%	66%

Appendix 6: Historical Development of Aircraft Cabin utilisation for all FSNCs and LCCs on Intra-Regional Flights

			2000	2004	2008	2012	2014	2016
FSNC	Intra North America	JC	73%	70%	73%	76%	78%	78%
		NB	82%	80%	81%	82%	84%	86%
		LR	65%	67%	71%	64%	73%	72%
	Intra Europe	JC	81%	84%	89%	92%	92%	93%
		NB	79%	81%	84%	84%	88%	89%
		LR	60%	66%	65%	71%	71%	73%
	Intra-Asia	JC	96%	81%	78%	86%	87%	91%
		NB	83%	84%	84%	83%	84%	85%
		LR	74%	72%	68%	71%	71%	72%
LCC	Intra North America	JC	92%	66%	79%	86%	88%	88%
		NB	89%	90%	91%	92%	93%	93%
		LR						
	Intra Europe	JC	89%	86%	93%	88%	96%	99%
		NB	86%	93%	98%	98%	99%	99%
		LR	67%	70%			94%	71%
	Intra-Asia	JC		88%	96%			88%
		NB	89%	90%	93%	95%	99%	99%
		LR		70%	76%	73%	65%	91%

Appendix 7: Historical Development of Aircraft Cabin utilisation for all FSNCs and LCCs on Inter-Regional Flights

			2000	2004	2008	2012	2014	2016
FSNC	North America-Europe	LR	61%	60%	64%	63%	65%	67%
	Europe-Asia	LR	62%	66%	66%	64%	64%	67%
	Asia-North America	LR	60%	64%	65%	63%	62%	66%
LCC	North America-Europe	LR			71%	69%	73%	73%
	Europe-Asia	LR		70%		65%	58%	80%
	Asia-North America	LR						89%

Appendix 8: Historical Development of Aircraft Seat Capacities for all Airlines on Intra-Regional Flights

		2000	2004	2008	2012	2014	2016
Intra North America	LRC	272	272	42			
	LRH	371	344	383	68	80	374
	JC	58	54	58	60	61	64
	TC	65	66	65	72	72	72
	MR	186	196	193	188	191	199
	LR	286	276	298	260	297	299
	NB	132	133	135	141	146	151
Intra Europe	LRC	281	275	0		409	
	LRH	380	391	378	365	389	406
	JC	73	74	76	83	88	91
	TC	67	69	69	69	65	69
	MR	208	215	217	220	233	238
	LR	252	274	277	284	290	295
	NB	139	146	153	159	165	169
Intra Middle East	LRC				270	446	450
	LRH	390	383	381	375	385	388
	JC	101	103	87	86	85	83
	TC	72	71	68	67	65	66
	MR	211	232	222	241	260	266
	LR	266	260	261	273	289	307
	NB	130	136	143	153	149	151
Intra Africa	LRC	272	256	285	95		
	LRH	375	369	372	390	416	368
	JC	67	90	82	69	74	72
	TC	69	70	69	62	69	69
	MR	211	225	220	237	236	243
	LR	259	266	270	279	278	285
	NB	128	133	139	141	144	148
Intra Latin America	LRC	282	281	294	204		
	LRH	412	387	339	394	375	405
	JC	88	87	78	80	87	86
	TC	65	65	65	70	69	69
	MR	197	205	201	204	213	226
	LR	263	258	259	260	285	296
	NB	129	135	142	152	156	158
Intra Asia	LRC	274	276	260	274	272	265
	LRH	388	379	368	371	360	383
	JC	92	74	71	75	69	79
	TC	70	70	70	70	70	70
	MR	238	240	245	255	267	276
	LR	330	317	295	304	307	308
	NB	145	145	150	156	161	165

Appendix 9: Historical Development of Aircraft Seat Capacities for all Airlines on Inter-Regional Flights

Route Group	A/C	2000	2004	2008	2012	2014	2016
North America-Europe	LRC	264	278	243	273	280	274
	LRH	403	394	351	371	350	348
	JC			66	32	38	32
	TC						
	MR	213	220	221	229	230	233
	LR	265	263	275	269	275	284
	NB	147	108	93	127	131	155
Europe-Asia	LRC	269	277	257	273	305	274
	LRH	391	382	372	373	339	385
	JC	75	70	75	60	61	62
	TC			72	69	71	70
	MR	214	209	213	244	256	261
	LR	265	282	287	281	279	292
	NB	144	144	139	145	149	158
Asia-North America	LRC	278	270	288	270	264	264
	LRH	382	372	382	338	296	354
	JC			0			
	TC				72		
	MR	198	214	242	231	243	249
	LR	266	282	287	276	275	290
	NB	164	164	151	120	108	157
North America-Latin America	LRC	252	281		0	0	0
	LRH	367	355	384	342	357	371
	JC	44	43	54	63	63	71
	TC	64	64	64	72		
	MR	190	207	204	197	199	204
	LR	266	240	254	248	260	275
	NB	140	139	143	146	150	156
North America-Middle East	LRC	371					
	LRH	430	438	433	373	363	401
	JC				109		
	TC						
	MR	213	212	213	238	236	222
	LR	283	284	308	302	309	323
	NB	144					165
North America-Africa	LRC						
	LRH	366	362	447	358	359	369
	JC						
	TC						
	MR	225	236	223	224	231	237
	LR	319	304	291	271	280	293
	NB						120
Europe- Africa	LRC	274	269	282	150	6	16
	LRH	381	389	345	407	391	363
	JC	84	109	104	99	104	97
	TC	70	72	72	69	70	70
	MR	219	236	237	255	248	262
	LR	262	265	278	278	282	284
	NB	144	149	153	159	161	162
Latin America-Europe	LRC	283	278	268	287	303	274
	LRH	422	409	400	410	398	406
	JC				100		
	TC						
	MR	227	235	247	246	275	288
	LR	258	272	281	285	306	309
	NB	150	132	122	149	156	159
Africa-Middle East	LRC				240	444	450
	LRH	377	371	376	369	375	363

	JC	117	121	78	83	74	62
	TC						
	MR	225	235	231	271	266	271
	LR	272	266	274	281	302	325
	NB	136	144	144	150	151	155
	LRC	288	279	270			
	LRH	278	392	359	383	294	296
Latin America-Africa	JC						
	TC						
	MR		223	188	186	229	228
	LR	235	245	251	272	244	241
	NB				174	166	165
	LRC	288					
	LRH	356	392	373	353	360	334
Africa-Asia	JC						
	TC						
	MR	196	205	211	224	235	256
	LR	286	292	288	282	294	304
	NB		136		154	163	146
	LRC						
	LRH						
Latin America-Asia	JC				85	103	50
	TC						
	MR			205	174		
	LR			277	268	270	273
	NB					180	
	LRC	279	263	294	288	423	450
	LRH	416	386	364	367	348	332
Europe-Middle East	JC	83	93	89	87	81	91
	TC			72	71	72	72
	MR	218	211	222	250	250	252
	LR	256	258	271	287	300	308
	NB	145	143	148	154	157	161
	LRC	290	270	273	270	448	450
	LRH	400	391	380	376	366	387
Asia-Middle East	JC	11	92	81	116	95	98
	TC	72					
	MR	224	228	223	238	263	288
	LR	298	268	282	299	312	327
	NB	133	141	157	161	165	172

Appendix 10: Historical Development of Aircraft Seat Capacities for FSNC Intra-Regional Flights

Route Group	A/C	2000	2004	2008	2012	2014	2016
Intra North America	LRC	272.4	271.8	42.2			
	LRH	362.9	344.4	382.9	67.6	80.4	373.6
	JC	57.2	53.5	56.6	58.5	59.7	61.8
	TC	65.0	65.6	65.2	72.0	72.0	71.5
	MR	185.8	195.0	192.4	188.4	190.9	199.4
	LR	285.8	275.6	297.6	260.5	297.0	298.7
	NB	131.7	131.5	135.6	143.5	147.0	150.4
Intra Europe	LRC	281.2	274.8	0.0		409.1	
	LRH	379.8	390.9	377.9	365.2	389.0	406.2
	JC	73.4	72.9	76.3	82.4	88.2	91.2
	TC	66.9	68.9	69.3	68.3	64.2	69.1
	MR	209.9	211.6	210.1	219.2	227.8	231.3
	LR	251.7	273.9	277.2	283.6	288.9	295.8
	NB	138.4	142.0	145.2	150.2	156.1	161.0
Intra Middle East	LRC				270.0	445.6	450.0
	LRH	390.0	383.0	380.9	373.9	385.5	387.7
	JC	101.3	103.0	87.0	85.6	85.0	83.0
	TC	72.0	71.0	68.0	67.3	64.7	66.4
	MR	210.7	231.9	222.2	241.2	259.6	266.0
	LR	265.6	259.6	261.4	273.1	288.9	307.2
	NB	129.6	135.8	141.8	148.3	142.9	144.7
Intra Africa	LRC	272.2	256.2	285.0	95.0		
	LRH	375.3	368.7	371.9	390.0	416.0	368.4
	JC	66.6	90.8	81.5	68.8	73.6	72.9
	TC	68.8	69.8	69.2	62.5	68.9	69.0
	MR	211.1	224.9	219.3	237.6	235.3	243.2
	LR	259.1	265.8	270.4	279.1	277.7	285.3
	NB	127.6	132.1	136.7	137.8	139.3	142.7
Intra Latin America	LRC	282.3	281.2	294.0	203.8		
	LRH	412.3	386.9	339.1	394.4	374.8	405.3
	JC	88.0	86.7	81.5	77.9	83.8	83.0
	TC	64.8	64.9	65.2	69.3	70.3	68.7
	MR	196.5	204.3	199.9	204.1	211.1	224.2
	LR	261.7	258.2	259.4	259.8	285.5	297.5
	NB	129.6	134.7	140.8	149.3	152.0	154.2
Intra Asia	LRC	273.6	275.8	260.1	274.0	272.2	264.5
	LRH	387.5	377.9	368.4	371.0	359.6	383.1
	JC	92.0	73.6	61.4	75.3	69.2	79.0
	TC	70.0	69.9	69.7	70.3	69.2	69.5
	MR	237.2	240.8	245.5	253.6	263.6	272.5
	LR	330.4	316.7	295.0	304.3	306.7	306.2
	NB	144.7	145.1	147.4	150.7	154.5	159.0

Appendix 11: Historical Development of Aircraft Seat Capacities for FSNC Inter-Regional Flights

Route Group	A/C	2000	2004	2008	2012	2014	2016
North America-Europe	LRC	264	278	243	273	280	274
	LRH	403	394	351	371	351	348
	JC			66	32	38	32
	TC						
	MR	213	220	221	229	230	232
	LR	265	263	275	269	275	284
	NB	147	108	93	127	129	116
Europe-Asia	LRC	269	277	257	273	305	274
	LRH	391	382	372	373	339	385
	JC	75	70	75	60	61	62
	TC			72	69	71	70
	MR	212	207	212	243	256	261
	LR	265	282	287	281	280	292
	NB	144	144	140	145	149	157
Asia-North America	LRC	278	270	288	270	264	264
	LRH	382	372	382	338	296	354
	JC			0			
	TC				72		
	MR	198	214	242	231	243	249
	LR	266	282	287	276	275	289
	NB	164	164	151	120	108	157
North America-Latin America	LRC	252	281		0	0	0
	LRH	352	355	384	342	357	371
	JC	44	43	52	55	57	66
	TC	64	64	64	72		
	MR	190	207	204	197	199	203
	LR	266	240	254	248	260	276
	NB	142	139	142	144	148	153
North America-Middle East	LRC	371					
	LRH	424	438	433	373	363	401
	JC				109		
	TC						
	MR	213	212	213	238	236	222
	LR	283	284	308	302	309	323
	NB	144					165
North America-Africa	LRC						
	LRH	366	362	447	358	359	369
	JC						
	TC						
	MR	225	236	223	224	231	237
	LR	319	304	291	271	280	293
	NB						120
Europe- Africa	LRC	274	269	282	150	6	16
	LRH	381	389	345	407	391	363
	JC	84	109	104	99	104	97
	TC	70	72	72	69	70	70
	MR	219	236	235	256	246	262
	LR	262	265	278	278	282	284
	NB	144	148	149	155	155	156
Latin America-Europe	LRC	283	278	268	287	303	274
	LRH	422	409	400	410	398	406
	JC				100		
	TC						
	MR	220	232	245	251	278	296
	LR	257	272	281	285	306	310
	NB	150	132	122	149	156	159
Africa-Middle East	LRC				240	444	450
	LRH	377	371	376	369	375	363

	JC	117	121	78	80	74	62
	TC						
	MR	225	235	231	271	266	271
	LR	272	266	274	281	302	325
	NB	136	144	143	146	148	152
	LRC	288	279	270			
	LRH	278	392	359	383	294	296
	JC						
Latin America-Africa	TC						
	MR		223	188	186	229	228
	LR	235	245	251	272	244	241
	NB				189	166	165
	LRC	288					
	LRH	356	392	373	353	360	334
	JC						
Africa-Asia	TC						
	MR	196	205	211	224	235	251
	LR	286	292	288	282	294	304
	NB		136		154	162	148
	LRC						
	LRH						
	JC				85	103	50
Latin America-Asia	TC						
	MR			205	174		
	LR			277	268	270	273
	NB						
	LRC	279	263	294	288	423	450
	LRH	414	386	364	367	348	332
	JC	83	93	89	85	81	91
Europe-Middle East	TC			72	71	72	72
	MR	218	211	221	251	250	252
	LR	256	258	271	287	300	308
	NB	145	143	148	151	152	156
	LRC	290	270	273	270	448	450
	LRH	400	391	380	373	364	387
	JC	11	92	81	116	95	98
Asia-Middle East	TC	72					
	MR	224	228	223	237	251	276
	LR	298	268	282	299	312	327
	NB	133	141	151	156	158	165

Appendix 12: Historical Development of Aircraft Seat Capacities for LCC Intra-Regional Flights

Route Group	A/C	2000	2004	2008	2012	2014	2016
Intra North America	LRC						
	LRH	480					
	JC	120	61	86	97	103	103
	TC						
	MR	192	217	224	221	222	225
	LR						
	NB	132	136	135	138	145	151
Intra Europe	LRC	290					
	LRH						
	JC	98	90	71	88	90	89
	TC		72	66	71	69	68
	MR	190	241	250	222	251	262
	LR	295	267			359	270
	NB	146	157	167	174	176	178
Intra Middle East	LRC						
	LRH				420	400	
	JC				98		
	TC						
	MR				210	315	346
	LR						
	NB		150	150	173	166	167
Intra Africa	LRC						
	LRH						
	JC		81	118	50	73	56
	TC						
	MR	214	242	259	214	261	259
	LR						
	NB	150	156	166	169	177	176
Intra Latin America	LRC						
	LRH						
	JC			66	105	105	106
	TC				72	68	70
	MR	267	232	225	214	259	263
	LR	332	267			272	267
	NB	114	136	145	157	164	165
Intra Asia	LRC						
	LRH		436		420		420
	JC		115	125			97
	TC			66	66	72	72
	MR	268	221	243	305	330	352
	LR		267	307	278	275	402
	NB	151	149	164	172	180	181

Appendix 13: Historical Development of Aircraft Seat Capacities for LCC Inter-Regional Flights

Route Group	A/C	2000	2004	2008	2012	2014	2016
North America-Europe	LRC						
	LRH	480	392	379	338	332	332
	JC						
	TC						
	MR	269	264	251	220	256	273
	LR			313	304	314	323
	NB					136	170
Europe-Asia	LRC						
	LRH			371	338		
	JC						
	TC						
	MR	269	243	266	253	236	255
	LR		267		285	257	320
	NB			121	180	185	184
Asia-North America	LRC						
	LRH			359			
	JC						
	TC						
	MR						
	LR						390
	NB						
North America-Latin America	LRC						
	LRH	480					
	JC			95	100	100	100
	TC						
	MR	222	226	200	210		220
	LR					272	267
	NB	112	139	148	151	156	161
North America-Middle East	LRC						
	LRH	480					
	JC						
	TC						
	MR						
	LR						
	NB						
North America-Africa	LRC						
	LRH						
	JC						
	TC						
	MR						
	LR						
	NB						
Europe- Africa	LRC						
	LRH					420	
	JC			91	100	112	
	TC						
	MR	215	243	262	234	262	263
	LR	311	267			358	287
	NB	151	181	172	176	180	181
Latin America-Europe	LRC						
	LRH						
	JC						
	TC						
	MR	257	248	258	214	260	261
	LR	325	267				275
	NB						
Africa-Middle East	LRC						
	LRH						

	JC				98		
	TC						
	MR			265	210	321	310
	LR						
	NB		150	155	163	164	165
	LRC						
	LRH						
Latin America-Africa	JC						
	TC						
	MR						
	LR						
	NB				150		
	LRC						
	LRH						
	JC						
Africa-Asia	TC						
	MR						377
	LR						
	NB					176	122
	LRC						
	LRH						
Latin America-Asia	JC						
	TC						
	MR						
	LR						
	NB					180	
	LRC						
	LRH	480					
Europe-Middle East	JC			90	98	111	
	TC						
	MR	216	234	266	215	309	267
	LR						356
	NB			163	177	176	177
	LRC						
	LRH				420	397	420
Asia-Middle East	JC				98		
	TC						
	MR	217	233	267	323	392	387
	LR						
	NB		150	172	173	175	180

Appendix 14: Maximum Possible Seat Capacity per Aircraft Type

Aircraft Cluster	SPECIFICACFT (OAG)	SPECIFICACFTNAME (OAG)	Maximum Possible Seats per Aircraft
LRC	M11	Boeing (Douglas) MD-11 Passenger	410
LRC	74M	Boeing 747 (Mixed Configuration)	264
LRC	74E	Boeing 747-400 (Mixed Configuration)	264
LRH	380	Airbus A380-800 Passenger	853
LRH	747	Boeing 747 (Passenger)	624
LRH	743	Boeing 747-300 /747-100 /200 Sud (Pax)	624
LRH	744	Boeing 747-400 (Passenger)	624
LRH	773	Boeing 777-300 Passenger	550
JC	318	Airbus A318	132
JC	AR1	Avro RJ100	112
JC	AR8	Avro RJ85	100
JC	72F	Boeing 727 (Freighter)	0
JC	73F	Boeing 737 (Freighter)	0
JC	732	Boeing 737-200 Passenger	130
JC	736	Boeing 737-600 Passenger	130
JC	CRJ	Canadair Regional Jet	90
JC	CR2	Canadair Regional Jet 200	50
JC	CR7	Canadair Regional Jet 700	78
JC	CR9	Canadair Regional Jet 900	90
JC	E70	Embraer 170	78
JC	E75	Embraer 175	88
JC	E90	Embraer 190	114
JC	ERJ	Embraer RJ 135 /140 /145	50
JC	ER4	Embraer RJ145	50
JC	100	Fokker 100	109
JC	TU3	Tupolev TU134	76
TC	AT7	ATR 72	70
MR	AB6	Airbus A300-600 Passenger	345
MR	310	Airbus A310 Passenger	265
MR	313	Airbus A310-300 Passenger	265
MR	330	Airbus A330	440
MR	333	Airbus A330-300	440
MR	757	Boeing 757 (Passenger)	280
MR	75W	Boeing 757-200 (winglets) Passenger	228
MR	752	Boeing 757-200 Passenger	228
MR	753	Boeing 757-300 Passenger	280
MR	767	Boeing 767 Passenger	350
MR	762	Boeing 767-200 Passenger	255
MR	763	Boeing 767-300 Passenger	350
MR	T20	Tupolev TU-204 /tu-214	210
LR	332	Airbus A330-200	380
LR	340	Airbus A340	440
LR	342	Airbus A340-200	300
LR	343	Airbus A340-300	440
LR	345	Airbus A340-500	375
LR	346	Airbus A340-600	475
LR	764	Boeing 767-400 Passenger	375
LR	777	Boeing 777 Passenger	451

LR	772	Boeing 777-200 Passenger	440
LR	77L	Boeing 777-200LR	375
LR	77W	Boeing 777-300ER Passenger	451
LR	IL9	Ilyushin II-96 Passenger	300
NB	32S	Airbus A318/ 319 /320 /321	220
NB	319	Airbus A319	156
NB	320	Airbus A320	180
NB	321	Airbus A321	220
NB	M80	Boeing (Douglas) MD-80	172
NB	M81	Boeing (Douglas) MD-81	172
NB	M82	Boeing (Douglas) MD-82	172
NB	M83	Boeing (Douglas) MD-83	172
NB	M88	Boeing (Douglas) MD-88	172
NB	M90	Boeing (Douglas) MD-90	172
NB	717	Boeing 717-200	117
NB	737	Boeing 737 Passenger	189
NB	733	Boeing 737-300 Passenger	149
NB	734	Boeing 737-400 Passenger	168
NB	735	Boeing 737-500 Passenger	132
NB	73W	Boeing 737-700 (winglets) Passenger	149
NB	73G	Boeing 737-700 Passenger	149
NB	73H	Boeing 737-800 (winglets) Passenger	189
NB	738	Boeing 737-800 Passenger	189
NB	739	Boeing 737-900 Passenger	189
NB	D9S	McD-Douglas DC9 30 /40 /50	139
NB	TU5	Tupolev TU154	180

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AIRLINE PHILANTHROPY – INVESTMENT OR EXPENSE?

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ABSTRACT
Airlines are corporately socially and environmentally responsible (CSER). Unlike predecessor 'CSR', CSER acknowledges the importance of the environment. CSER-managed airlines obey the law, service customers safely, manage employees fairly, reward owners appropriately, pay suppliers promptly and mitigate environmental impacts. Unlike philanthropy (i.e. CSERplus), airlines' CSER-management is underpinned by economics – the optimal allocation of resources. External pressures push airlines to go beyond economically-viable, strategic investments to make philanthropic donations which are voluntary, discretionary contributions purportedly to further their interests. If the CSERplus philanthropic contributions are non-strategic they could increase costs without any benefit. Husted and Salazar (2006) determined three motivations for corporate entities to engage in strategic CSERplus (philanthropic) activities: either to (a) prevent unfavourable government intervention (b) create product differentiation to increase sales or (c) trigger cost reductions. Content and theme analysis of the top 10 airlines' CSER reports indicated that none of the three motivations applied to their philanthropic contributions. Philanthropy appeared to support the altruistic or egoistic interests of managers rather than the airlines. There were no success measures. In fact, philanthropic donations appeared to increase costs at a time when many airlines were reducing services and products to remain competitive. The conclusion is that airline philanthropy is an expense rather than an investment. This paper contributes to the paucity of current literature on philanthropic motivations and airline CSER management.

KEYWORDS
corporate social and environmental responsibility; CSER; CSR; philanthropy; costs

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1. INTRODUCTION

According to the airline trade body, the International Air Transport Association (IATA), air transport "drives economic and social progress" (IATA, 2016) as it connects trade with "people, countries and cultures" while (among other benefits) paying taxes and wages, promoting social inclusion, delivering emergency aid and contributing philanthropy. Although airlines trumpet their philanthropy in their annual financial and corporate social responsibility (CSR) reports there is little examination as to the motives which drive such donations. This is significant because any contribution should be derived from profits which could have been diverted from provision of dividends for owners, rewards for employees, reduced customers' prices or improved suppliers' terms (among other possibilities). This paper (comprising a review of literature with context and thematic analysis) will attempt to determine whether the motivation for airlines' philanthropy is strategic investment or whether it is merely an expense. This dissection will explore the contributions of 10 airlines (and in some cases, their passengers) in one financial year (2015-16) to various charitable endeavours. One of the key findings was the identification of possible 'genteel extortion'. Another finding included the potential negative effects on competitiveness and the absence of identifiable, measurable and strategically justifiable outcomes for donations of all types (money, goods or services). This paper represents a contribution to the lack of literature on the theoretical dimension of airlines' philanthropic motivations. It also contributes to airlines' CSR management indicating the necessity for philanthropic measurement to ensure that such contributions are effectively and efficiently focussed for the benefit of the business and not the managers.

1.1 Corporate Social Responsibility (CSR)

Focusing on corporate responsibilities of all types leads to identifying the characteristics of well-managed organisations. These include competitive advantage derived from lower costs, reduced risks, strategic financial management and increased loyalty from employees, investors and customers (sources: many authors including Porter and Kramer, 2006; Brammer and Millington, 2008; Lynes and Andrachuk, 2008; Martinez and Bosque, 2008; Nikbin *et al.,* 2016). In past decades, the all-encompassing term 'corporate social responsibility' (CSR) has become a mantra. It has two fundamental concepts: stakeholders and licensing.

1.2 Stakeholders

The concept of 'stakeholder' makes an entity responsible to more of society and any industry is now considered responsible for and to its multitude of stakeholders. This concept "allows each stakeholder – including the managers – to elevate pursuit of his own interests over both the ostensible organisational objective and the interests of other stakeholders" (Sternberg, 2009: 7). Such elevation can be triggered by egoism (utility derived from one's own consumption) or altruism (utility derived from the consumption of others as well as one's own) (Husted and Salazar, 2006). Aside from altruism, an individual's contribution to charity has many motives including "guilt, sympathy, an ethic for duty, a taste for fairness, or a desire for recognition" (Andreoni, 1988: 57).

Stakeholders can be primary (essential to the organisation) or secondary (influencing or affecting the firm but not transacting with it) (Clarkson, 1995). Airlines' primary stakeholders include the owners, employees, customers, suppliers and regulatory bodies. Secondary include non-governmental organisations (NGOs) and other public interest groups such as communities affected by their operations. In a 'grey' area between the two are their competitors with which they sometimes have to transact. Airlines touch many groups and individuals in a 'principal-agency' relationship i.e. where the owners (as principals) appoint managers as their agents to act on their behalf. As agents, managers are encouraged to consider operational impacts on those parties with an interest in the airline i.e. the 'stakeholders' which the World Business Council for Sustainable Development (WBCSD) (a CEO-led global advocacy association for social and environmental concerns) describes as "society at large" (WBCSD, 1999: 3). However, the wider 'stakeholder doctrine' damages the principal-agency relationship (Ancell, 2017), weakens accountability, suffers from practical defects which undermine its justification and attracts "the promoters of worthy causes who (unrealistically) believe they would be the beneficiaries if organisational (and particularly business) assets were diverted from their owners" (Sternberg, 2009:7–8). Many of these 'promoters' target airlines to be contributors to their causes and persuade agent-managers to behave like principals (i.e. owners). They also decide what they believe will be in the public good however it is not clear how unelected private individuals decide what is in the interest of wider society (Friedman, 1982).

1.3 Licensing

Licensing is a means by which governments can protect consumers and in the CSR context, the implicit 'licence to operate' "is what organisations receive when they become accountable to society through the stakeholders" (Ancell, 2017: 32-33). This 'licence' is awarded by stakeholders including national, multi-national and supra-national governments (NMSGs), NGOs, customers and suppliers. It is retained by virtue of commercial organisations adhering to legislation and regulations. However, it can be argued that the implicit 'issue' of such a licence actually undermines free society because in free society, what is not prohibited by law is actually permissible (Sternberg, 2009). Such a 'licence' could even pose a threat to operations i.e. business must submit to society or it could be prevented from trading (another form of 'genteel extortion'). It could therefore be argued that any 'licence' (issued under the guise of CSR) is actually "inimical to liberty" (Sternberg, 2009: 8).

2. ESTABLISHING CSR

2.1 Defining CSR

CSR has multiple similar definitions from many recognisable sources. The European Commission (2002: 3) (an institution of the European Union (EU) which proposes legislation, implements decisions, upholds EU treaties and manages day-to-day EU business) decided that CSR was a "… concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a *voluntary* basis" *[emphasis added].* CSR is also perceived as a grouping of corporate activities aimed to "further some social good *beyond the interests of the firm and that which is required by law*"*[emphasis added]* (McWilliams and Siegel, 2001: 117) or as "a commitment to improve community well-being through *discretionary* business practices and *contributions [emphasis added]* of corporate resources" (Kotler and Lee, 2005). CSR's impacts are on the "triple bottom line" of "people, planet and profit" and reflect how a commercial entity "… acts *voluntarily [emphasis added]* to ensure the most beneficial outcomes for all its stakeholders … [including]… the wider communities which businesses serve" (Coles *et al.,* 2013: 71).

CSR is also an important element of the work programme of the United Nations (UN) through the UN Conference on Trade and Development (UNCTAD) "…which seeks to bring together key stakeholders that can promote responsible international investment practices and contribute to sustainable development around the world." (UNCTAD, 2013). Furthermore, "CSR is best conceptualised at the level of the individual business as means of delivering higher aspirations for, and collective action necessary to achieve, sustainable development" (Coles *et al.,* 2013 citing Plume, 2001). Unfortunately, the idea of 'sustainable development' is often confused with CSR. 'Sustainable development' evolved from the 1992 UN Sustainable Development (UNSD) Conference in Rio de Janeiro which delivered a global plan, Agenda 21. The plan encompassed land, forests, population and worldwide human activities and required developed world commercial organisations to 'voluntarily' contribute to developing nations. This was endorsed by the WBCSD which defines CSR as "…the continuing commitment by business to behave ethically and contribute to [developing world] economic development while improving the quality of life of the workforce and their families as well as the local community and society at large" (WBCSD, 1999: 3).

Such *'voluntary'*, '*discretionary' 'contributions'* beyond that *'which is required by law'* is not the generally recognised definition of CSR and yet this is how its definers appear to have intended. CSR requires contributions by managers to causes which might have neither direct relevance nor resonation with either the business or its owners. The managers are merely passing on their own conception of what is in the public interest. This '*contribution*' which "… is not considered a duty or social responsibility of business… but something that is merely desirable or beyond what duty requires…" (Schwartz and Carroll, 2003*:* 505-506) was the ultimate purpose when various NMSGs and NGOs invented CSR. Such contributions are philanthropic. Many philanthropic projects ultimately provide public goods for which there is no market and where managers (having decided on their concept of desirable public goods) allow private enterprises to replace governments in provision. This undermines the efficiency of markets. It is governments' role to provide where there is no market for private enterprise to fulfil.

2.2 Claimed benefits of CSR

Corporately responsible behaviour benefits airlines; airlines' accidents are expensive. However, illustrating the muddled definitions which have characterised CSR are claims that the initiatives enhance a firm's competitive advantage "to the extent that they influence the decisions of the firm's stakeholders in its favour … In other words, one or multiple stakeholders will prefer the firm over its competitors specifically because of the firm's engagement in such CSR initiatives…" (Carroll and Shabana, 2010: 98-99). However, if CSR comprises contributions which take the organisation beyond that which it is legally required to do, it is possible these actions could be misinterpreted as 'bribery' or even "genteel extortion" (Ancell, 2017: 31) particularly if employed to minimise the effects of an untoward event or to prevent disruption. Philanthropy should not be used as a tool to offset unfavourable corporate occurrences. Some writers claim that "funding CSR activity is a popular technique for building a strong CSR reputation" (Nikbin *et al*., 2016: 358) which is purported to allow a firm to charge higher prices. The philanthropy-based, price benefits of a "strong CSR reputation" are unclear. In the highly-competitive aviation marketplace, price is the customers' first consideration accompanied by expectations of matched, price-based quality (Wittman, 2014). Whether passengers would willingly pay more if they were aware of the airlines' *'voluntary', 'discretionary'* CSR *'contributions'* is unknown. However, because of competition, passengers who are unhappy with market-based price or quality usually have many choices. The market will rule.

3. REDEFINING CSR

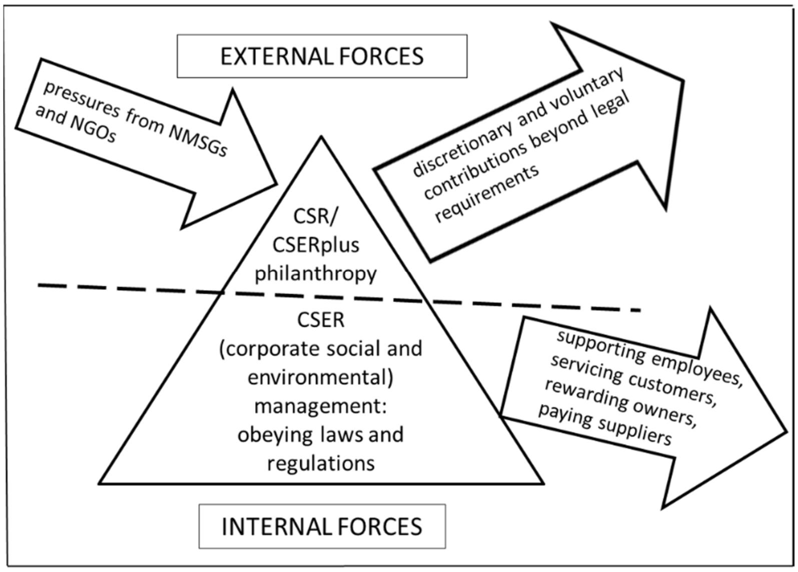
The "airline industry's adoption of CSR is still relatively slow" (Kuo *et al.*, 2016: 184). This is understandable if CSR equates to "*discretionary business practices", "contributions to economic development*" or "*voluntary*" "*discretionary*" spending beyond that *"which is required by law"* which will not contribute to corporate profitability. Economically sustainable entities' social and environmental behaviours are underpinned by economics marked by allocative and productive efficiency. Therefore 'CSR' – now more accurately identified as 'philanthropy' – is insufficient to describe all the dimensions of corporate interaction that some writers intended. In order to differentiate CSR's responsible economic, social and environmental management from CSR as philanthropy, it is therefore more appropriate to redefine 'CSR' as 'corporate social and *environmental* responsibility' i.e. 'CSER' (Ancell, 2017: xi). CSER organisations ensure consistent, reliable and safe product quality, reward owners, pay suppliers promptly, strive for healthy employee relations and safe workplaces, recruit diverse workforces, exhibit strong financial stewardship, protect the environment, compete fairly and operate legally. These organisational characteristics are sustained by law and supported by regulations. Consequently, any philanthropic contribution would be *voluntary, discretionary* and not integral to CSER management practices. The airline industry is heavily regulated and as such must operate within laws applicable in all destinations. In response to pressures from many NGOs, developed world NMSGs produce an ever-increasing quantity of laws and regulations affecting the multiple CSR dimensions. This means there is less discretion for corporate organisations to act other than within the bounds of the law i.e. 'responsibly'. If an airline does not exercise regulatory compliance it will be fined and could ultimately fail because passengers and freight forwarders will lose confidence and avoid it. Again, the market will rule.

However, if an entity behaves responsibly in all CSER dimensions it will most likely exhibit strong financial performance which could allow it to indulge in '*voluntary', 'discretionary'* CSR *'contributions'*. This philanthropy is 'CSR/CSERplus'. In summary: two elements have emerged: CSER (management) and CSR/CSERplus (philanthropy). Introducing these clarified abbreviations makes a clear distinction between behaviours which keep airlines economically, socially and environmentally viable (i.e. CSER) – and those which under pressure from NMSGs and NGOs are *voluntary, discretionary contributions beyond legal requirements* (i.e. CSR/CSERplus). Definitions matter.

3.1 CSER and CSR/CSERplus

NMSGs and NGOs do not recognise CSER-management as 'business as usual'. They push for corporate entities to deliver increased *voluntary, discretionary contributions beyond legal requirements* to society and the environment (i.e. CSR/CSERplus-philanthropy) which fulfil the definitions of earlier authors (WBCSD, 1999; McWilliams and Siegel, 2001; European Commission, 2002; Schwartz and Carroll, 2003; Kotler and Lee, 2005; UNCTAD, 2013; Coles *et al.,* 2013) (Figure 1).

Figure 1: the CSER and CSR/CSERplus model



3.2 Advocates' pressures

With the increased awareness of world problems and the fact that business has from time to time included many bad actors (notably in financial institutions e.g. the investment industry) commercial entities (including airlines) have been asked to solve many of the world's social and environmental problems by donating owners' funds or employees' rewards.

The NMSGs and NGOs want airlines' *voluntary, discretionary contributions beyond legal requirements* to fund their social or environmental aims and yet any spending which does not contribute to profits cannot be sustainable in the long run (Vogel, 2005; Inoue and Lee, 2011). Without profits there would be no long term, sustainable, viable entity to act responsibly. Larger firms which are more profitable and which spend more on advertising, research and development are "expected to make donations at a higher rate" (Brammer and Millington, 2008: 1335). Where airline customers, employees or investors perceive little or no economic value from CSR activities, any such spending might even be counterproductive (Seo, Moon and Lee, 2015) and since "CSR activities are often costly while providing little or no direct benefit, the additional costs of CSR can serve business negatively" (*ibid*: 131).

The UN, through the UN Framework Convention on Climate Change (UNFCCC), argues that the drive for economic success in the developed world has triggered anthropogenic-caused global warming (AGW) (UN Intergovernmental Panel on Climate Change (IPCC), 2013). AGW has merged social and environmental interests into a cause which was clearly espoused by the UNFCCC Executive Secretary who noted that "…the fight against climate change is a process…" and, in echoes of Agenda 21, would only be achieved by "…the necessary transformation of the world economy…" (UN Regional Information Centre (UNRIC), 2015). Furthermore the UN believes that it should be able to change the capitalist economic model to redistribute wealth and thereby create more equitable societies. This requires *voluntary, discretionary contributions beyond legal requirements* from developed nations to developing nations – monies which will be derived from purchasers of their goods and services (i.e. in the market) and taxpayers. To assist this goal many NMSGs have adopted the various UN climate change protocols with which the airline industry has had to comply by passing on environmental taxes to passengers. One such scheme is the EU's Environmental Trading Scheme which demonises and monetises carbon dioxide (CO_2) and other gases. It initially included aviation from 2012 (EU, 2016) and purportedly would have been competition-neutral. In addition, airlines offer passengers the opportunity to voluntarily offset and monetise their emissions. Passengers' donations are despatched to various charities often using an intermediate financial institution. Administration costs of these schemes is an airline cost.

The UN's stance is in contrast to the frequently-quoted writings of Friedman (2007) who believed that the social responsibility of business was to increase profits which would filter into the national economy. All wealth is created by business so it is to business that non-commercial organisations such as NMSGs or NGOs turn for resources. Redistribution of corporate earnings into charitable causes (i.e. CSR/CSERplus) is neither economically productive nor allocatively efficient. It can also undermine owners' wishes if chosen by managers without consultation (another breach of the principal-agency relationship). Alternative responses to these external pressures comprise reacting by resisting (invoking "the trade-off between socially responsible behaviour and profitability" (McWilliams and Siegel, 2000: 607)), defending (by doing what is required), accommodating (by being slightly progressive) or proactively lead the industry (as innovators) (Carroll, 1979). Any of these options could lead to a less than optimal allocation of airlines' resources when airlines are offering "relatively identical products and services in similar price ranges" (Lee, Seo and Sharma, 2013: 23). They are innovating continuously pushing through barriers to attain competitive advantage while lowering costs.

3.2.1 Profits vs costs

The importance of profits cannot be underestimated in a market economy. However, profits are generally perceived to be of two types: 'good' profits (which are made without exploiting customers, employees or suppliers) and 'bad' profits (which come from exploitative behaviours) (Dowling, 2008). There is some argument that CSR/CSERplus donations could offset any 'bad' profits. However, as signs of 'good' profitability, airlines seek ethical awards (awarded by self-appointed 'ethical expert' NGOs) to illustrate their favourable CSR/CSERplus characteristics while cutting costs which can negatively impact on customers' perceptions. One such example is the full service carriers (FSCs) charging customers for selected items which were previously complimentary (e.g. meals) while continuing philanthropic programmes. This trade-off – complimentary passenger meals or philanthropy – is not transparent because the costs of both are not disclosed. FSCs are under pressure from low cost carriers (LCCs) to continue profitability in highly competitive conditions with the often conflicting goals of lowering costs and prices while improving services.

3.2.2 Advocacy vs research

Airlines are pressured to voluntarily provide philanthropic contributions. This is evidenced by researchers who surveyed airline passengers seeking confirmation that "this airline company tries to help the poor" (Iklhanizadeh and Karatepe, 2017: 14), "prioritises areas in CSR practices", "donates money to charitable organisations" and "encourages employees to engage in voluntary social events" (Kucukusta, Guillet and Chan, 2017: 460). Although such leading statements are more advocacy than research they do serve to reinforce CSR/CSERplus philanthropy while simultaneously providing misleading conclusions which can be used to sway NMSGs and NGOs. Although CSR/CSERplus can be expressed as an activity "in terms of purchasing or non-purchasing behaviour … [or] … expressed as opinions in surveys or other forms of market research" (Devinney *et al.,* 2006: 32), self-defined, 'socially-responsible' consumers' actions do not always match their espoused behaviours i.e. "consumers are not willing to put their money where their mouths are…" (*ibid:* 32). Their "morals stop at the pocket book. People may say they care but they will always buy the cheaper brand" (*ibid:* 32). That being the case, many consumers might not be represented by the NMSGs and NGOs which pressure airlines to donate to their causes. However, there has to "be a clear [psychological] connection between social features and functional features" because "socially-conscious consumers will not sacrifice functional features for socially acceptable ones" (*ibid*: 36) e.g. FSC's cutting costs by reducing passengers' legroom vs *voluntary, discretionary contributions beyond legal requirements*.

3.2.3 CSR/CSERplus motivation

The CSR/CSERplus expectations of airlines has been fuelled by many NGOs and charities often purposefully formed to deal with both existing and new social and environmental challenges. However, such responsibilities displaced onto commercial entities are more correctly the domain of governments' spending of citizens' taxes in accordance with the will of their electorates (Friedman, 2007).

There are three motivations for corporate entities to engage in strategic CSR/CSERplus which could also increase the value of the firm (Husted and Salazar, 2006):

(a) preventing unfavourable government intervention (such as proposing an emissions tax)

(b) seeking an opportunity to differentiate products (to increase sales) or

(c) enabling cost reductions (to maintain competitiveness).

However, despite *voluntary, discretionary contributions*, airlines did not succeed in preventing environmental taxes (such as EU ETS) and furthermore, alignment with charities is not known to have increased seat or freight sales which could be the only economically beneficial effect if a "strong CSR reputation" (Nikbin *et al.*, 2016: 358) is to be corporately rewarding.

Typically firms "…have a portfolio of [CSR/CSERplus] projects, some of which may be coerced [i.e. 'genteel extortion'], others altruistic, and still others strategic in nature" (Husted and Salazar, 2006: 87). The CSERplus costs are borne by owners (through lower dividends), employees (from reduced rewards), customers (by increased prices) or suppliers (by unfavourable terms) (Friedman, 2007; Ancell, 2017). The pursuit of CSR/CSERplus philanthropy has also been attributed to altruistic or egoistic managers pursuing their own interests instead of value for the business owners (Husted and Salazar, 2006; Friedman, 2007; Ancell, 2017) because such "… an opportunistic and self-serving manager may use … CSR … to increase his or her personal social status" (Fang, Huang and Huang, 2010: 120). This egoism (Husted and Salazar, 2006) is also another manifestation of the principal-agency problem.

3.2.4 Advertising and cause-related marketing

However, some "philanthropy can also be perceived as a form of sponsorship" (Ancell , 2017: 167). Many airlines broadcast their generosity because "…many of the benefits of being socially responsible are contingent upon awareness of firm behaviour among stakeholder groups…" (Brammer and Millington, 2008: 1330). One means of advertising is to invoke cause-related marketing (CRM) whereupon a charity (with expertise) and a company (with resources) could join forces to solve social or environmental problems. In theory this should create business value for the company which can then use it as a vehicle to increase sales with perhaps a percentage going to the aligned charity. Such support is commercially-motivated, strategic philanthropy and is clearly perceived as a strength (Scholten, 2008) by the airlines which broadcast it in their CSER or CSR/CSERplus reports. While CRM might bring "financial benefits through increased revenues or reduced costs" (Brammer and Millington, 2008: 1330) it is estimated that 30-50% of US companies have no measures of return on such investment including "cost per reach" and "sales related to sponsorship spend" (Jacobs, Jain and Surana, 2014). "Advertising plays an important role in capturing the value of CSR actions" (McWilliams and Siegel, 2001: 1488). Furthermore, CRM's influence on consumers' choice "is found to depend on the perceived motivation underlying the company's CRM efforts as well as whether consumers must trade-off company sponsorship of causes for lower performance or higher price" (Barone, Miyazaki and Taylor, 2000: 248) e.g. airlines pursuing philanthropy while simultaneously reducing much-prized passenger legroom by installing an extra row of seats to increase corporate revenue.

3.2.5 CSER and financial performance

Despite the foregoing, price is the greatest determinant of passenger choice (IATA, 2015) so airlines (particularly international carriers) must be extremely cost-conscious in order to remain competitive. There is no 'one size fits all' model for CSER-managed airlines therefore decisions ranging from investments through to philanthropy will vary with each carrier. The CSR literature appears focussed on whether those firms actively pursuing the CSR ideals behave ethically and create social value (McWilliams and Siegel, 2001; Fang *et al.,* 2010; Carroll and Shabana, 2010). Unfortunately, claims of CSR links to successful corporate financial performance are not consistent (McWilliams and Siegel, 2000). From these uncertainties, a new financial industry has evolved: socially responsible investment. Socially responsible investors (SRIs) are the self-appointed arbiters of ethical social and environmental concerns and yet "socially responsible investment funds perform no better than non-socially screened funds and many relatively responsible companies have not been financially successful" (Vogel, 2005: 19). SRIs believe that there is a strong correlation between social and financial performance and that CSR/CSERplus is "simply the right thing to do" (Carroll and Shabana, 2010: 92).

Some authors write of a relationship that is insignificantly positive (Mwangi and Jerotich, 2013), positively correlated (Lee, 2008) or neutral (McWilliams and Siegel, 2001) while others claim that the CSR/CSERplus dimensions "had a differential effect on both short term and future profitability" (Inoue and Lee, 2011: 790). Scholten (2008) in the attempt to decide "causality between corporate financial performance and corporate social performance" noted that "it appears that financial performance (both risk and return) in general terms precedes social performance (both strengths and concerns) much more often than the other way around." (*ibid*: 52). In other words, organisations must make profits before they can make *voluntary, discretionary contributions beyond those which are legally required.*

Costs of CSER-managed companies are included in corporate annual accounts. However, the costs of CSR/CSERplus activities are often difficult to monetise without inside knowledge because their measures are not consistent (including "staff volunteering hours", "donations in kind", "complimentary or reduced price seats or freight"; plus unidentified administrative costs for passenger "cash collections" and "student work experience"). Furthermore, the costs of administering the philanthropic disbursements are obscured in the CSER operating costs rather than the clarified CSR/CSERplus philanthropic totals.

3.2.6 CSERplus costs and benefits

Measuring the CSERplus programmes' costs and benefits and private and social returns can be difficult particularly because public social goods are not traded in markets (McWilliams and Siegel, 2011). Furthermore, "Firms in environmentally damaging industries such as mining, and those in consumer oriented sectors such as retailing, give significantly more heavily to charity than other firms, while firms in newer, cleaner industries such as the IT and electronic equipment sectors give significantly less heavily …" (Brammer and Millington, 2008: 1335). It could be argued that airlines fit into the former category.

3.2.7 Reputation

Airlines compete on their customer service reflected in their reputations. They do not compete on their *voluntary, discretionary contributions*. Annual awards such as those conferred by world airline ranking Top 100 Airlines (Skytrax, 2016) are much sought after by carriers as these are based on the successful fulfilment of customers' requirements on ground and on board (Table 1). It would appear that philanthropy is not included in the criteria by which passengers judge an airline (Table 1).

3.2.8 Reporting

NGOs, NMSGs and advocates of CSR encourage (and in some jurisdictions (e.g. EU) mandate) corporations to annually report their social and environmental successes as an adjunct to their financial statements. The annual repackaging of on-going operational highlights results in a CSER-management report of successful decision-making and how economic stewardship of resources has contributed to the viability of the airline (Ancell, 2017). CSR/CSERplus reports are a form of advertising with a cascading readership: government and owners (1st equal), customers (3rd) and employees (4th equal with managers) (Kuo *et al.,* 2016: 190). NGOs ranked 9th *(ibid).* However, commercially successful entities put their employees first because customers are influenced by employees' satisfaction which ultimately influences profits (Yee, Yeung and Cheng, 2008).

Table 1: Skytrax airline ranking criteria (Skytrax, 2016)

Ground/airport	Onboard: product	Onboard: staff service
Airline web site	Cabin seat comfort	Assistance during boarding
Online booking	Cabin cleanliness	Friendliness and hospitality
Online check-in	Toilet cleanliness	Service attentiveness/efficiency
Airport ticket counters	Cabin lighting / ambience	Consistency of service
Waiting times at check-in	Cabin temperatures	Staff language skills
Quality of check-in service	Cabin comfort amenities	Meal service efficiency
Self check-in	Reading materials	Cabin presence thru flight
Boarding procedures	Airline magazine	PA announcements
Pre-boarding procedures	Inflight entertainment	Assisting families
Friendliness of ground staff	Audio / movie programming	Problem solving skills
Efficiency of ground staff	AVOD options	Staff attitudes
Airline lounge product facilities	Cabin WiFi and connectivity	Staff grooming
Airline lounge staff service efficiency	Quality of meals	
Airline lounge staff Hospitality	Quantity of food	
Transfer services	Meal choices	
Arrival services	Selection of drinks / pay bar	
Baggage delivery		

Claims are that airlines publish CSR/CSERplus reports for reasons including burnishing reputation, government transparency, brand value, and employee and stakeholder communication (Kuo *et al.,* 2016). There are however, barriers to reporting including time-consuming preparation, confrontation of adverse sensitive information and data and potential to undermine corporate confidentiality (Kuo *et al.,* 2016). Despite this firms are urged to be transparent in their reportage so that CSR/CSERplus stakeholders can determine the non-financial strengths and weaknesses of the firm. Such disclosures can also assist competitors. Other barriers to full disclosure include cost, doubting the potential advantages, lack of competitor equivalent disclosure or customers' concerns, possibility that it might damage the company's reputation or attract unwanted attention to topics which might need improvement with all the financial and legal complications that such disclosure could involve (Kuo *et al.,* 2016).

Despite the foregoing, "Most scholars note CSR reporting's benefits as a competitive advantage" (Kuo *et al.,* 2016: 184). There is, however, a difference between the worlds of 'scholarship' and commerce and it is often difficult to differentiate research from advocacy. The number of customers who read annual CSR/CSERplus reports is not known and yet it is with them that "competitive advantage" would be most valuable. CSR/CSERplus reports are often colourful, comprehensive and complex delving deeply into an organisation's CSER management and CSR/CSERplus philanthropy. Given the detail they would be an expensive output and potentially a productively and allocatively inefficient use of corporate resources.

3.2.9 Measures of strengths and concern

Currently, a "lack of consistency due to different measurement frameworks and reporting structures" (Cowper-Smith and de Grosbois, 2011: 60) makes inter-firm achievements incomparable. SRIs urge transparency and full disclosure and call for these reports to be comparable by standardising formats such as those advocated by NGOs e.g. the Global Reporting Initiative, International Integrated Reporting Council or the US Sustainability Accounting Standards Board. However, there is no single best method of categorising and assessing airlines' responses to SRI's views on CSR/CSERplus strengths and concerns except perhaps obtaining memberships of CSR indices (such as FTSE4Good, Hang Seng Corporate Sustainability Index or Dow Jones Sustainability Index). Criteria are variable depending on who is making the judgement (Table 2) about what is in the interests of society (Friedman, 1982).

SRIs show concern for the industries which they determine are socially or environmentally unethical (e.g. military contracting or nuclear power (Kinder, Lydenburg, Domini (KLD) n.d.). This filtering tends towards bias. (Some SRIs even ignore 'economic prosperity' as a measure of strength or concern.) Lee *et al.,* (2013: 20) categorised airline CSR data into operation-related (OR) and non-operation-related (non-OR) i.e. two levels of CSR. OR-CSR categories include "improvements to product quality, employee relationships or treatment, and corporate governance" (*ibid*: 21). These are, in fact, the basic behaviours of any well-managed, CSER business. Non-OR items are "those CSR activities that firms ought to engage as ethical or responsible, societal citizens, despite a lack of direct implications for a firm's operations…. human rights, develop community relationships, support environmental issues and encourage diversity" (*ibid*: 21). This is actually CSR/CSERplus. These voluntary (non-OR) behaviours actually include some which could be OR especially if they require fulfilment under regulations (e.g. some environmental issues). Other authors have proposed different criteria. Schwartz and Carroll (2003) proposed a Venn-diagram with a three-dimensional framework: economic, legal and ethical rings which absorbed the philanthropic activities at the triple intersection. Becchetti and Ciciretti (2006) detailed the non-financial criteria which a commercial data provider could use to monitor the CSR performance of various US company stocks. Their categories covered strengths and concerns in the following: community, corporate governance, diversity, employee relations, environment, human rights and products. Cowper-Smith and de Grosbois (2011) included economic prosperity as well as social concerns. Inoue and Lee (2011) used five measures based on the KLD categories to determine how each would affect financial performance for tourism industries. The philanthropic areas included charitable and innovative giving, support for education, housing and volunteer programmes (in company time) and benefitting economically disadvantaged consumers. For CSER-managed airlines (operating within regulations) measures of success include social (zero accidents), environmental (no fines for breaches) and economic (profitable).

Table 2: variable criteria of CSER and CSR/CSERplus strengths and concerns

Measure	KLD (1990)	Lee *et al.*, (2013)	Schwartz and Carroll (2003)	Becchetti and Ciciretti (2009)	Cowper-Smith and de Grosbois (2011)	Inoue and Lee (2011)
economic prosperity			x		x	
employee relations	x	x (OR)		x	x	x
product quality (including safety)	x	x (OR)		x		x
community relations	x	x(NON-OR)		x	x	x
environmental issues	x	x(NON-OR)		x	x	x
diversity issues	x	x(NON-OR)		x	x	x
corporate governance		x(OR)		x		
human rights		x(NON-OR)		x		
nuclear power	x					
excessive executive compensation	x					
quality programmes	x					
military contracting	x					
legal/economic/pure/ ethical			x			
ethical/economic/legal/pure			x			

4. METHODOLOGY

This research was not to assess the worthiness of airlines' CSERplus programmes but simply to determine whether there was an expressed motivation to satisfy any of the three Husted and Salazar (2006) categories. Airlines differ greatly in the quantity of documents, data and information provided. Determining the value and purpose of airlines' *voluntary, discretionary contributions* began with a literature search of the annual sustainability/CSR/CSERplus reports of top 10 airlines (Skytrax, 2016). Content analysis ("the accepted method of investigating texts" (Joffe and Yardley, 2004: 56)) was extended to thematic analysis in the search for specific patterns in the data of interest. Thematic analysis offers "an accessible and theoretically flexible approach to analysing qualitative data" (Braun and Clarke, 2006: 77).

This involved "… establishing categories and then counting the number of instances in which they are used in a text…" (*ibid*). Codes 1 to 3 were allocated to each of Husted and Salazar's (2006) motivations (Table 3) to be treated as 'themes'. The code "0" was allocated if none of the motivations was discernible. The conclusions would be drawn from the raw information itself (inductive coding) (*ibid*).

Table 3: codes for Husted and Salazar's motivations

Husted's and Salazar's motivations	Code
no mention of any motivation	0
prevent government intervention	1
product differentiation to increase sales	2
cost reductions	3

When assessing methodological quality it is appropriate to consider the clarity of the research question, whether the method proposed was the most appropriate and if the sample strategy would provide generalisable or transferable conclusions. Thematic content analysis fulfilled these requirements.

The airlines chosen were the top 10 from a population of 100 airlines surveyed by Skytrax World's Top 100 Airlines – 2016 (Skytrax, 2016) (Table 4).

Table 4: Reports for Skytrax top 10 airlines 2016

Skytrax ranking	Airline	Separate sustainability/CSR/CSERplus report and its title	CSR/CSERplus report incorporated into Annual Report and accounts	Number of pages
1	Emirates	--	x	179
2	Qatar Airways	x (Sustainability Report)	--	68
3	Singapore Airlines	x (Sustainability Report)	--	46
4	Cathay Pacific	x (Sustainable Development Report)	--	93
5	ANA		x	150
6	Etihad	x	--	28
7	Turkish Airlines	x (Sustainability Report)	--	84
8	EVA Air	x (CSR report)	--	125
9	Qantas	x (Annual Review)	--	43
10	Lufthansa	x (Sustainability Report)	--	124

Skytrax Awards recognise the quality and delivery consistency of products and services as voted for by international airline customers using CSER market-based, performance criteria (Table 1). The criteria omit any mention of airlines' CSR/CSERplus philanthropic programmes presumably because they are not considered important for customers whose choice is primarily price-determined (IATA, 2015). CSR/CSERplus comprise a minor part of any product's relevant attributes (McWilliams and Siegel, 2011). These airlines all produced CSER management and sustainability/CSR/CSERplus reports. However some airlines included those reports within the annual financial statements (e.g. Emirates, ANA) while others produced separate CSR/CSERplus reports (e.g. Qatar, Singapore). The examination of these airlines' CSR/CSERplus contributions excluded programmes which supported good business practice (e.g. by following the law or working to productively and allocatively efficient practices) therefore, by elimination, the research analysed a cross section of CSR/CSERplus programmes which were *voluntary, discretionary contributions beyond those which are required by law*. These programmes were assessed for their purpose according to the Husted and Salazar (2006) criteria (Table 5).

TABLE 5: SUMMARY OF FINDINGS

SKY-TRAX RANK-ING	AIRLINE AND THEIR CSR/CSERplus CONTRIBUTIONS i.e. PHILANTHROPY INCLUDE: (NB: * denotes donated by passengers)	COST OF CSR/CSERplus PROGRAMME (NB: 'not found' indicates the monetised amounts were not available in the report consulted)	OPERATING PROFIT/ (LOSS) 2015-16	PURPOSE • no discernible strategic motivation =0 • prevent government intervention =1 • product differentiation =2 • cost reductions =3
1	***Emirates:*** • multiple education projects (Africa and Asia) • anti-poaching rhino orphanage	AED2 million shared (matched fund)	AEDm 9,391	 0 0
2	***Qatar Airways:*** • wildlife and animal welfare	 not found	QARm 3,048	 0
3	***Singapore Airlines:*** • community engagement ○ multiple Singapore community projects ○ rainforest ○ children's causes and arts ○ national programmes in many destinations ○ humanitarian relief (particularly Nepal) ○ medical charities ○ staff volunteering ○ staff support (e.g. music, sport, nutrition, education) ○ charity flight ○ USA charity support	 $5m Singapore to JY Pillay Global-Asia Programme not found not found not found not found not found not found not found not found business class tickets $US16,000	$m 681.2	 0 0 0 0 0 0 0 0 0 0
4	***Cathay Pacific (and Dragonair):*** • food donation • English on air (metrics available) • staff volunteering • charity sweaters *(passenger donated)	$HK22m not found not found 1300 hours 1 million miles	$USm 854	 0 0 0 0

	• wheelchair bank • conservation* • disadvantaged children*	$HK12m (cumulative since 1999) $HK9.5m $HK11.3		0 0 0
5	***ANA:*** • UNESCO programmes in education, science and culture including replacing thatched roofs • hearty baths provided by employee volunteers • free flights for rescuers for Japanese earthquake • support for UN's Sustainable Development Goals • biodiversity preservation • blind football and other para sports • tourism initiatives	 not found not found not found not found not found 2000 volunteers (hours unspecified) not found not found	¥78.1 bn	 0 0 0 0 0 0 0 0
6	***Etihad:*** • staff volunteering • passenger donations* (Nepal Earthquake relief) • charitable ticketing • multiple education projects (Africa and Asia) • creative arts • international leadership programme • surgical support and earthquake repairs for Nepal • staff volunteering • charitable passenger support • bags from banners • carpets from uniforms • composting	 not found 21 million miles (since 2014); 30 million for Nepal 300 tickets for 2014 not found not found not found not found not found converting loyalty miles to cash not found not found not found	US$ 103 million (2015)	 0 0 0 0 0 0 0 0 0 0 0 0 0
7	***Turkish Airlines:*** • Turkish Red Crescent • solar power in Africa • assorted African projects • tents for Nepal earthquake • tree planting	 not found 10 projects 100 projects 1000 tents 500,000 trees	$USm 1,069 (2015)	 0 0 0 0 0

8	***EVA Air:*** • charitable activities • athletic sponsorships • local communities • education (staff volunteering) • arts and culture • emergency aid • medical subsidy • disaster relief • funeral/burial financial assistance	 1.32% of net income=$85m ***(donation amount NT$62.4m))*** $62.4m $13.2m $7m $1.9m=717 hours 12 free tickets + 84 special fares not specified not specified not specified not specified	NT$6.44 bn (New Taiwan $)	 0 0 0 0 0 0 0 0 0
9	***Qantas (Australia):*** • community investment • proportion of Aboriginal and Torres Strait Islander investment • UNICEF donations * • World Vision*	 >$AU3.3m $AU22.5m $AU1.4m $AU1.6m	$AU 1.53bn	 0 0 0 0
10	***Lufthansa:*** • humanitarian, refugee aid • orchestra support • football • air crash bereavement endowment • protection of logo-inspired crane • staff volunteering • on board collections*	 €1m not found not found €15million not found not found €363,000	€1,776m	 0 0 0 0 0 0 0

5. FINDINGS AND DISCUSSION

5.1 Reporting

The reports examined (Table 4) had many of the strengths and concerns identified by the SRIs (Table 2). The exceptions were 'military contracting', 'nuclear power' and 'excessive executive compensation'. The reports varied from highly detailed including monetised values of the direct contributions through to those which conveyed the minimum of information. Report titles were inconsistent: "corporate social responsibility", "sustainability" with one even titled "sustainable development" which did not fit with the definition from UNSD's Agenda 21. Many reports were glossy, colourful and extremely comprehensive with some containing as many as 179 pictorially- and photographically-illustrated pages (Emirates) through to a scant 28 (Etihad).

5.2 Profits and contributions

The top 10 airlines were profitable for the 2015-16 financial year surveyed (Table 5) which enabled philanthropy (Scholten, 2008). The airlines all made philanthropic contributions confirming the suspicion that financial performance preceded social performance (*ibid*). These profits could perhaps be classified as 'good' profits (Dowling, 2008). The proportion of spend to profits was not calculable owing to lack of comparable metrics so it is not possible to assess whether or not the airlines' contributions were 'generous' or by what standard generosity should be assessed.

5.3 Motivations

The programmes could not be specifically aligned with the Husted and Salazar (2006) motivation criteria. Uniquely, one programme could possibly have delivered the recommended psychological links (Devinney *et al.,* 2006) between social and functional CSR/CSERplus programmes – the Lufthansa bereavement endowment for the families of one of their crashed aircraft – but this was not explicit. The programmes were also reconsidered using Carroll's (1979) strategic corporate criteria (reactive, accommodative, defensive and proactive). Again none were found to contribute directly to allocative or productive airline efficiency.

It would appear that airline philanthropy is applied primarily to social or environmental problems (e.g. education, arts, culture and humanitarian aid) (Table 5). Some were closer to CRM such as Lufthansa's contribution to the successful football industry for which there was no metric such as 'cost per reach' or 'sales related to sponsorship spend' (Jacobs *et al.,* 2014).

CRM in this instance was clearly a form of sponsorship and any strategic contribution to *preventing government intervention, lowering costs or increasing sales* was not obvious. It might however, have supported the altruism or egoism of the managers (Husted and Salazar, 2006). Some environmental programmes included in this analysis were beyond CSER-regulated requirements and were CSR/CSERplus philanthropy such as Emirates' anti-poaching rhino orphanage or Qatar Airways' wildlife and animal welfare. Again, the strategic links were not expressed.

Local community projects featured widely (as recommended by UNCTAD, 2013; WBCSD, 1999; Kotler and Lee, 2005; Becchetti and Ciciretti, 2009; Lee *et al.,* 2013) e.g. Singapore, ANA, Qantas, Eva Air. Programme themes ranged from children's medical, wheelchair banks, humanitarian relief through to rainforest support. All the programmes selected fulfilled the aspiration for *voluntary, discretionary contributions* (WBCSD, 1999; European Commission, 2002; Coles *et al.,* 2014) which took the airlines beyond their *legal requirements* (McWilliams and Siegel, 2001; Kotler and Lee, 2005).

5.4 Success measurement

Philanthropy weaves through areas for which there are no recognised markets (McWilliams and Siegel, 2011) and measurement is often ignored as it is sometimes difficult to justify *voluntary, discretionary contributions* if they have to be accurately measured and fully disclosed. Few airlines disclosed the full values of their CSERplus programmes (column 3, Table 5) and often the values were hidden by metrics which external stakeholders could not monetise for comparative purposes (including "staff volunteering hours", "customer loyalty miles", "reduced price or complimentary tickets"). Consequently it was not possible to determine proportionality of contribution as a percentage of profits.

Since there were no success measures it was not possible to assess whether these contributions furthered airlines' strategic interests. Only Cathay Pacific would appear to have some measures of successful outcomes (for their "English on Air" programme for local youth).

The challenge of finding comparable metrics as requested by the SRIs was unresolved. It may be that by obscuring metrics and avoiding monetising the airlines can overstate or burnish their philanthropic actions. The target readership for the reports (government and owners (1st equal), customers (3rd) and employees and managers 4th equal with NGOs at 9th (Kuo *et al.,* 2016: 190)) does not chime with the customer service ranking for airline profitability i.e.

employees (Yee *et al.,* 2008) and customers 1st. Without the customers there is no economically sustainable airline therefore they should be the primary stakeholders for such reports and yet by excluding CSR/CSERplus projects from the Skytrax criteria, the link between customer and airline philanthropy is incomplete. In terms of profitability every action taken by an airline is to service customers competitively. While customers might unknowingly be targeted as report readers, what they know and value are the Skytrax criteria – not *voluntary, discretionary contributions*.

5.5 Stakeholder targetting

It was not immediately apparent which primary stakeholder groups (Clarkson, 1995) were to be influenced by these CSERplus philanthropic contributions. This leads to the conclusion that these donations were to influence a secondary group and were possibly examples of 'genteel extortion' (Ancell, 2017) in order to maintain the airlines' implicit 'licence to operate' (Sternberg, 2009), provide altruistic or egoistic benefit for the managers (Husted and Salazar, 2006) – or to assuage some of their guilt, show sympathy or fairness, confirm an ethic for duty or simply to fulfil a desire for personal recognition (Andreoni, 1988). The secondary grouping could also have included the SRI community since none of the CSR/CSERplus programmes prevented government intervention (the primary target of such reports (Kuo *et al.,* 2016)) while any failure of CSER management activity identified by their regulated and monitored performance metrics would have alerted regulators to any discrepancies. The lack of identifiable strategic corporate purpose for CSERplus philanthropic contributions tends to indicate altruism and egoism (Husted and Salazar, 2006) possibly to placate stakeholders to retain the implicit 'licence to operate' (Sternberg, 2009) (i.e. genteel extortion). The winning stakeholders from such contributions are the NGOs which benefit from such largesse and possibly the managers (undermining the principal-agency relationship).

To the frustration of the SRIs, many of the real costs of CSR/CSERplus are incomparable and hidden including the costs of administering CSR/CSERplus programmes and the annual reworking and production of CSER management and CSR/CSERplus philanthropy reports. The information and data available supporting some of the CSR/CSERplus programmes was minimal – often no more than advertising (McWilliams and Siegel, 2001). The exception was Eva Air (2015) which attempted to monetise its CSR/CSERplus spending. Now that CSR/CSERplus is an integral part of airlines' activities, repealing it could be easily misinterpreted by those who attempt 'genteel extortion'. If *voluntary, discretionary CSR/CSERplus contributions* do not qualify as economically allocatively or productively efficient then they are by default unsustainable (Vogel, 2005; Inoue and Lee, 2011), altruistic or egoistic (Husted and Salazar, 2006) and awarded at the behest of managers using their concept of what is in the public good (Friedman, 1982). The managers' role is to grow the airlines on behalf of the owners. If customers believe there is minimal value from CSR/CSERplus philanthropic activities (especially if services and products are being reduced) then the spending might be counter-productive (Seo *et al.,* 2015), and actually serve the airline negatively *(ibid).* This might explain the opaqueness of the costs – too much transparency might actually harm the airline as it could highlight waste. This could undermine any aspirational competitive advantage (Kuo *et al.*, 2016) which might have been gained from the annual CSER management or CSR/CSERplus philanthropic reports.

Since the values of contributions were impossible to total, it was not feasible to assess whether the airlines fitted somewhere between the older environmentally damaging industries (e.g. mining) which make larger donations to charity than the newer, purportedly cleaner industries (e.g. IT) which actually give less to charity (Brammer and Millington, 2008). It was also not possible to determine the impact on the price of airline tickets since the full costs of administering these programmes was not identifiable. Few customers' *voluntary, discretionary contributions* to offset negative emissions were noted which implies passengers did not want to voluntarily increase their fares (i.e. their morals stopped at their pocket book (Devinney *et al.,* 2006)).

5.6 Transparency

There is a balance between disclosure and secrecy. An excess of disclosure would undermine competitiveness and yet the opaqueness in these reports is not in accordance with the openness and transparency required by NMSGs, NGOs and SRIs. Transparency would benefit if the CSR/CSERplus contributions were categorised as 'philanthropy' and the full monetised costs were published. Historically, CSR campaigns have not been known to increase sales (Devinney *et al.,* 2006) and any philanthropic gesture should show a "clear connection between social features and functional features" by providing "a psychological connection" (*ibid*: 36). It was challenging to find any psychological connections between the social and functional features of all of the CSR/CSERplus programmes (apart from possibly the Lufthansa bereavement project).

5.7 Competition

These *voluntary, discretionary contributions* were innovative in that none seemed to be duplicated. In theory these donations should contribute to differentiating airlines and improve competitiveness leading to increased sales. However, it was not possible to discern who, in the primary stakeholder group, would have benefitted from the CSR/CSERplus philanthropic contributions or from reading the CSER management reports.

6. CONCLUSION

CSER-management is legislated, regulated best practice which makes airlines profitable. CSR/CSERplus-philanthropy is the *voluntary, discretionary contribution beyond legal requirements.* It is CSER management practices – not CSR/CSERplus philanthropy – which make airlines economically sustainable and enables philanthropy.

This study was a one-year snapshot of some worthy CSR/CSERplus philanthropy and any alignment to business investment was not apparent. An economically-sustainable airline is one which is productively and allocatively efficient with minimal wastes of all types. However, if *philanthropy* is neither transparently motivated nor measured and does not (a) prevent unfavourable government intervention (b) create product differentiation to increase sales or (c) trigger cost reductions, it is not strategic and could be considered a by-product of managerial egoism or altruism. It is therefore an expense and an increase in costs. If (under pressure from NMSGs or NGOs) the strategic justification for philanthropy is to retain the 'licence to operate', then the CSR/CSERplus contributions could be considered as 'genteel extortion'. Furthermore without justification for their philanthropy managers are breaching the principal-agency relationship and by increasing costs, could be sacrificing owners' dividends, employees' or suppliers' rewards and/or customers' products and services.

The CSR/CSERplus contributions examined in these 10 airlines did not appear to be functionally linked to increased sales (i.e. as investments) since philanthropy is not considered a criterion for membership of a customer satisfaction survey (remembering that customers' morality stops at their pocket books). Lack of transparency enabled full costs to be understated and often hidden behind non-monetised metrics. This could have been intentional especially if the contributions were made to support altruistic or egoistic managers who decide what is (in their view) best for the social good. Although the proportion of contributions disclosed in relation to profits appeared small, its comparison with costs reductions obtained from cutting customers' products and services would have been useful.

Primary stakeholders (critical to the airline) who benefit from airlines' CSR/CSERplus philanthropy are not identified. Recipients would appear to be secondary stakeholders – those who are not essential to the organisation and who do not transact with it. When costs are tightly controlled in order to maintain competitiveness and fund innovation for resilience, competitiveness and growth, any *voluntary, discretionary contributions beyond legal requirements* warrant disclosure of the selection rationale – especially if cost reductions directly affect passengers' comfort and expectations. In the absence of identifiable, measurable and strategically justifiable outcomes, CSR/CSERplus philanthropy could negatively affect competitiveness because as an expense, it only increases costs.

LIMITATIONS

It is recognised that there might have been justifiable strategies for these programmes of which report readers would be unaware.

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STUDIES OF FLIGHT TRAJECTORY OPTIMIZATION AND THE WORKLOADS OF AIR TRAFFIC CONTROL OFFICERS

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ABSTRACT

We studied a methodology for flight trajectory optimization, and also the workloads of air traffic control officers (ATCOs). Case studies were conducted through simulations for flight trajectory optimization. The aircraft model was A320-200s, which is pre-dominantly utilized in Southeast Asia for short to medium range flights. Fuel savings were computed for selected routes, and were compared with that of existing operations and flights simulations, which revealed significant fuel savings. The research also determined the coefficients of ATCOs' workloads and demonstrated dynamic sectorization in selected airspace of Southeast Asia. It was found that dynamic sectorization was more efficient than static sectorization in balancing the workloads of ATCOs, reducing the standard deviation by 50% and the balance of workloads among sectors by 12.9%.

KEYWORDS

Balance of Workloads, Controller Workload, Dynamic Sectorization, Flight Trajectory Optimization, Fuel Savings

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1. INTRODUCTION

Because of developing economies and emerging markets in Asia Pacific, compared to other regions, this region has faster air transport growths (Tee and Zhong, 2018). One study reported in this paper is an introductory step forward for Southeast Asia, due to the limited studies in air traffic management in this region until recent years (Zhong *et al.*, 2017). Experimental constants and multipliers used in conventional algorithms governing trajectory-based optimization might not be possible for the computation of the modified algorithm in this paper. This was overcome, which yielded a good approximation, as shown by the results of the study presented in section 2. For selected routes in Southeast Asia, significant fuel savings could be computed compared with existing operations and flights simulations.

Air traffic control officers (ATCOs) ensure the safety of aircraft and smooth traffic flow, and one major factor that determines their workloads is the sectorization of airspace (Kopardekar *et al.*, 2007). A larger sector results in increased ATCOs' workloads due to increased aircraft entry rates and time to monitor conflicts. ATCOs' routine workloads are also affected by the way the airspace sectors are partitioned (Trong *et al.*, 2016). With an increasing demand for air travel in Southeast Asia (Phyoe *et al.*, 2016; Raheja and Zhong, 2018), it is even more important to ensure that ATCOs are not overloaded (Majumdar and Ochieng, 2002). The growth in air traffic volumes has resulted in an increasing strain on air transport systems, and the airspace capacity is closely related to ATCOs' workloads (Zhong *et al.*, 2016). Unexpected poor weather conditions such as heavy storms or ashes from volcano eruptions may lead to airport closures and changes in flight paths (Sheth *et al.*, 2013; Xie and Zhong, 2016a; Lim and Zhong, 2018).

The current method to manage the increasing demand is to divide the airspace into more sectors, so that ATCO workloads can be manageable. However, small sectors result in more resource fragmentation. There is a size limit for a very small sector to be further subdivided (Foo and Zhong, 2017). One approach to address this issue is dynamically sectorizing the airspace and keeping the ATCO workloads manageable (Foo and Zhong, 2018).

With a decrease in workloads of ATCOs for monitoring and control, they can better handle strategic control problems and manage traffic under bad weather conditions (Amin *et al.*, 2013; Xie and Zhong, 2016b). Thus, in the second part of this work, various values of the coefficients were used to study how they affected the imbalance of workloads and the standard deviation in static and dynamic sectorization. Lastly, as dynamic sectorization has not been implemented in Southeast Asia, this work also examined if the application of dynamic sectorization to selected airspace of Southeast Asia could better balance the workloads of ATCOs and lower the standard deviation throughout various times of the day, as detailed in section 3.

2. STUDY OF FLIGHT TRAJECTORY OPTIMIZATION

The foundation begins with the derivation of the atmospheric properties, which contributes to subsequent aerodynamic calculations and lateral optimization in the relevant altitude wind fields. The input of the weather conditions is automated from a weather model built. The only necessary user input would be the beginning flight altitude for the cruising phase. Subsequently through the application of an aircraft model constructed from Base of Aircraft Database (BADA), the aerodynamic properties are derived. The computation leads to an altitude optimization, which then is coupled with the lateral optimization in an iterative process until results converge. The number of the iterative process is based on the user's input of waypoints. At least 7 waypoints are used for convergence (Sun, 2016).

The cost function (Equation 1) proposed by Ng et al. (2012) is adopted.

$$J = \int_{t_i}^{t_f} [C_t + C_f F(m, h, V)]\, dt \qquad (1)$$

C_t represents the cost coefficient of time, one of the key considerations for airliners in terms of operational functionality. The cost coefficient of fuel, C_f, is the key consideration of this study. As the aircraft model under study is A320-200s, which has turbofan engines, the important relationship of altitude, Mach number and velocity of a turbofan is accounted for (Roth and Mavris, 2001; Turgut *et al.*, 2009):

- Specific Fuel Consumption (SFC) is near constant with altitude.
- SFC increases with an increase in free stream velocity.
- SFC increases with an increase in Mach number.

The optimization form proposed by Ng et al., is the derivative of fuel consumed with respect to altitude changes resulting in Equation 2 (Ng *et al.*, 2012):

$$\frac{df}{dh} = \frac{C_{fcr}}{1000}(D.\frac{dSFC}{dh} + SFC.\frac{dD}{dh}) \qquad (2)$$

Referring to Equation 2, changes of SFC with altitude are set to be zero ($\frac{dSFC}{dh} = 0$), as per discussed using the turbofan's performance characteristic, and only the latter term is to be considered (Ng *et al.*, 2011; Ng *et al.*, 2012).

A reduction in drag with respect to altitude would be the key premise for consideration in lateral optimization. Therefore, through cross-product, this key relationship can be obtained as shown in Equation 3 (Sun, 2016).

$$\frac{dD}{dh} = \frac{dD}{d\rho} \cdot \frac{d\rho}{dh} \tag{3}$$

$\frac{d\rho}{dh}$ is not zero, as density changes with altitude based on the ISA model adopted (which can be found in the later part of this section). Therefore, $\frac{dD}{d\rho} = 0$ for $\frac{dD}{dh} = 0$ (Ng *et al.*, 2011; Ng *et al.*, 2012). This would result in the focus being on $\frac{dD}{d\rho}$, which produces Equation 4 (Sun, 2016):

$$\frac{dD}{d\rho} = \frac{1}{2}\rho V^2 S(C_{Do} + KC_L^2) \tag{4}$$

A modification done was replacing the experimental constants used in Ng's original equation, which were obtained through a pre-existing dataset. Replacing this limitation with an empirical formula, the Oswald's efficiency (referring to *K* in Equation 4) for large commercial transport aircraft was calculated and found to be in the range of 0.83-0.85 (Nita and Scholz, 2012).

The range for consideration is only at steady level flight, in which cruising occurs (n=1). This would result in the governing aerodynamic equations (Equations 5 to 8) (Sun, 2016).

$$L = W = mg \tag{5}$$

$$C_L = \frac{2mg}{SV^2\rho} - C_{Lo} \tag{6}$$

$$\frac{dD}{d\rho} = \frac{1}{2}\rho V^2 S(C_{Do} + \frac{1}{\pi eAR} \cdot \left(\frac{2mg}{SV^2\rho} - C_{Lo}\right)^2) \tag{7}$$

$$\frac{dD}{d\rho} = \frac{1}{2}(V^2 SC_{Do} + \frac{1}{\pi eAR}C_{Lo}^2 SV^2 - \frac{1}{\pi eAR} \cdot \frac{4m^2g^2}{SV^2\rho^2}) = 0 \tag{8}$$

The papers from (Ng *et al.*, 2011; Ng *et al.*, 2012) showed a relationship, which is expressed in Equation 9:

$$\frac{4m^2g^2K}{C_{Do}} \cdot \frac{1}{S^2V^4} = \rho^2 \tag{9}$$

Another modification made by Sun (2016) alters Equation 9 into Equation 10:

$$\frac{4m^2g^2K}{C_{Do} + \frac{1}{e\pi AR}C_{Lo}^2} \cdot \frac{1}{S^2V^4} = \rho^2 \tag{10}$$

Sun (2016) has added the additional constant that accounts for the zero lift coefficients. This is not prominent for symmetrical airfoils. However, as the exact nature of commercial airlines airfoils is unknown, it is more reasonable to assume a non-symmetrical general case.

A third modification was made by Sun (2016) on the initial condition provided by Ng et al. (refer to Equation 2). This modification was necessary because of the difference in atmospheric models adopted. Sun has adopted the ISA model presented by Cavcar (2000), and the ideal gas model has been applied to Equation 11 (Sun, 2016).

$$\frac{df}{dh} = \frac{C_{fcr}}{1000}\left(SFC. \frac{dD}{d\rho} . \frac{P}{RT}\right) = 0 \tag{11}$$

C_{fcr}, SFC and $\frac{d\rho}{dh}$ are all not zero. Therefore, $\frac{dD}{d\rho} = 0$ for $\frac{df}{dh} = 0$.

This produces the altitude optimization equation that was presented by Ng et al. The equation has been modified by Sun (2016) to include the lift coefficient at zero angle of attack, and thus is a generalized equation applicable to even non-symmetric airfoils.

It has been found through experimental results as presented by Ng et al. in Equation 12, that fuel consumption is a logarithmic function of the square of density, which is co-related to the minimum drag to altitude ratio found in the above equations (Ng *et al.*, 2011; Ng *et al.*, 2012).

$$f = \ln(\rho^2) \tag{12}$$

The fuel consumption model presented has been modified to Equation 13 (Sun, 2016) by substituting Equation 10 into Equation 12.

$$f = \ln\left(\frac{4m^2g^2K}{C_{Do} + \frac{1}{e\pi AR}C_{Lo}^2} \cdot \frac{1}{S^2V^4}\right) \tag{13}$$

Equation 13 is a generalized equation, which can be used for any airfoil available, symmetrical or non-symmetrical. Therefore, the optimum altitude is found using Equation 14 or 15.

At or below Tropopause (11,000 m) (Ng *et al.*, 2012):

$$h_{optimum} = \left(1 - e^{\frac{-fK_TR}{2(g+K_TR)\rho_o^2}}\right).(\frac{1000T_o}{6.5}) \quad (14)$$

Where K_T refers to the temperature gradient associated with that at or below Tropopause.

Above Tropopause (11,000 m) (Ng *et al.*, 2012):

$$h_{optimum} = \frac{-fRT_{trop}}{2g\rho_{trop}^2} + 11000 \quad (15)$$

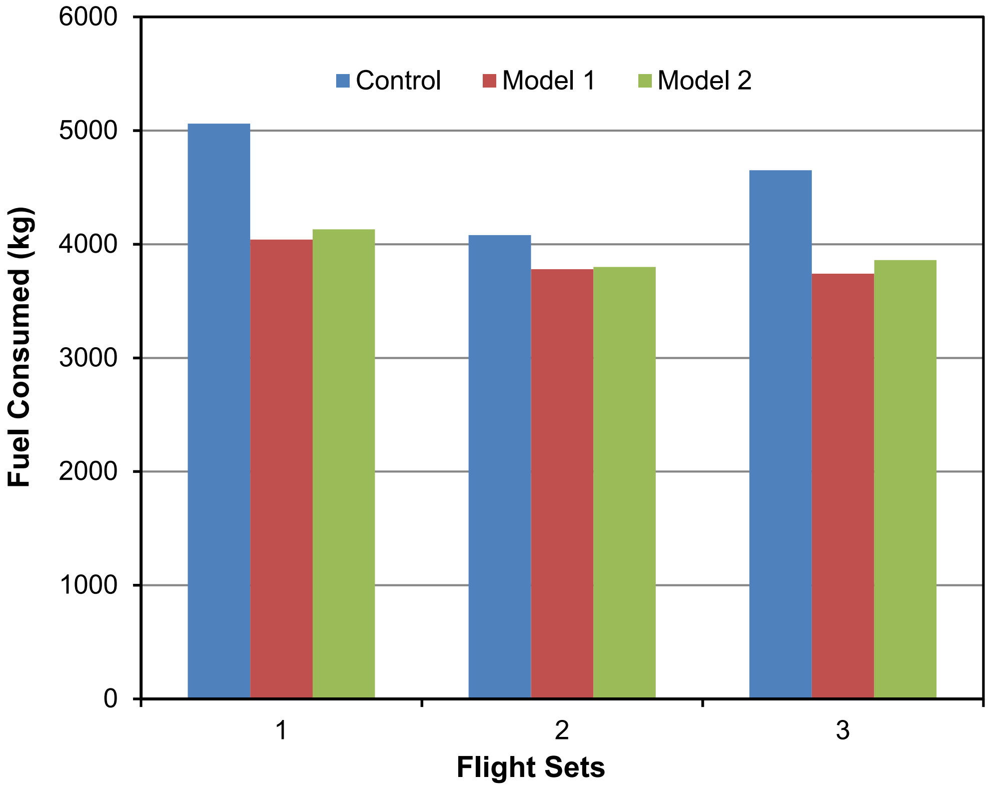
A flight simulator group from Singapore Virtual Airlines Group and Singapore vACC helped to conduct the simulations (Sun, 2016). Different pilots piloted the flights from Singapore to Cambodia, to ensure that regardless of the human element involved, the System Optimization could still provide a flight route to achieve minimum fuel consumed. The simulations used Microsoft Flight Simulator X, with weather condition inputs taken from Active Sky Next for FSX. Three flights flew under actual current flight routes being flown by airline operators (termed Control). Three flights flew using trajectory solutions with the modified method (termed Model 1) (Sun, 2016). Three flights flew using trajectory solutions with the original method (termed Model 2) (Ng *et al.*, 2012). The aircraft model used was an A320-200 at the maximum take-off weight with a 180-pax capacity.

The trajectory solution produced by Model 1 represents a closer approximation to the altitude flown in the simulation studies, resulting in a better prediction in fuel savings. A higher altitude results in a lower atmospheric density, which reduces drag and thus indirectly contributes to better fuel savings. The variation of the simulated flight altitude is a natural occurrence due to wind gust experienced.

Control flight 1, experiment flight 1 (Model 1) and experiment flight 1 (Model 2) correspond to the same pilot; the only deviation is in terms of route taken. This is the same for flight sets 2 and 3. Maximum take-off weight was set at 77,000 kg. The fuel to be uploaded in respect to the payload accommodated was not specified, providing the pilots with the freedom to decide the amount of fuel to be uploaded. This was done so as to mimic real-life situations, providing the pilots with the flexibility of fuel-onboard (FOB). As it was conducted only on A320s, the variation in fuel-onboard only affected the range of the aircraft and not the overall fuel efficiency (Airbus, 2005). As such, the only requirement imposed for the decision of FOB for the simulator pilots was being sufficient to arrive at the destination and maintain an emergency reserve for any holding if applicable.

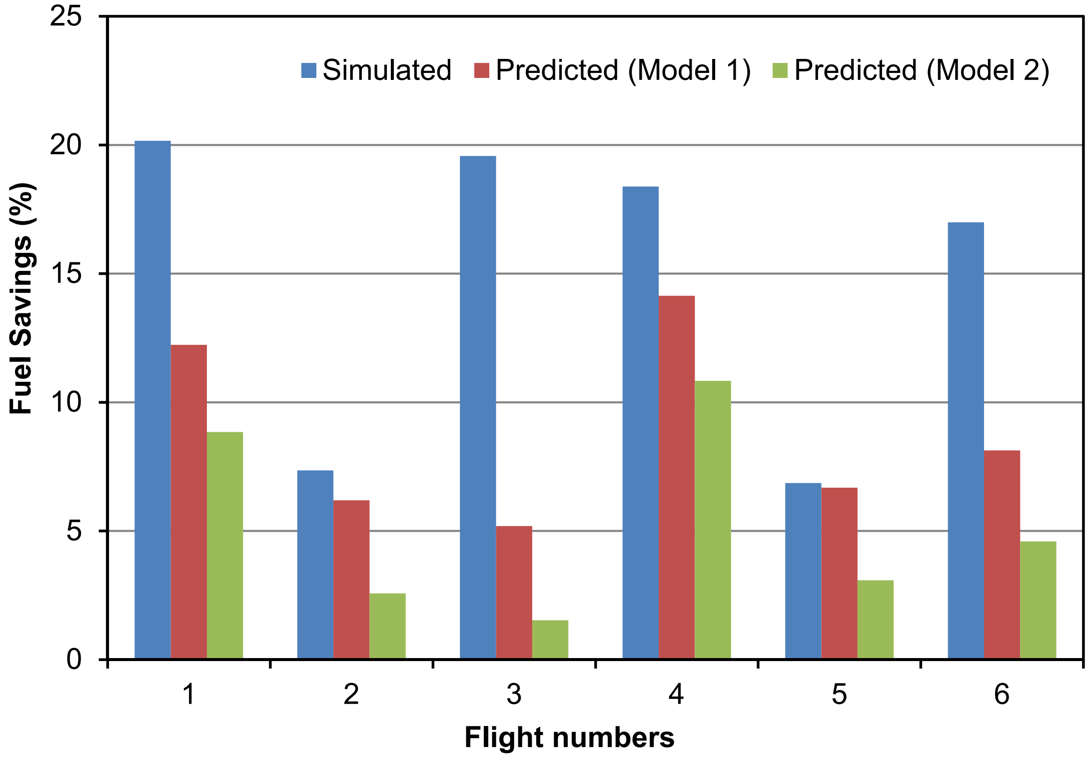
In all three cases shown in Figure 1, Model 1 trajectory solution resulted in the least fuel consumed. It yielded 300-1020 kg fuel savings per flight. Flight route trajectories created by Model 2 yielded 280-930 kg fuel savings.

Figure 1: Simulated fule consumed



In Figure 2, the predicted fuel savings calculated with the algorithms are compared with the simulated flight fuel savings. Model 1, compared with the simulated flights, yields a better prediction. The improvement reduces the gap between the predicted and simulated results.

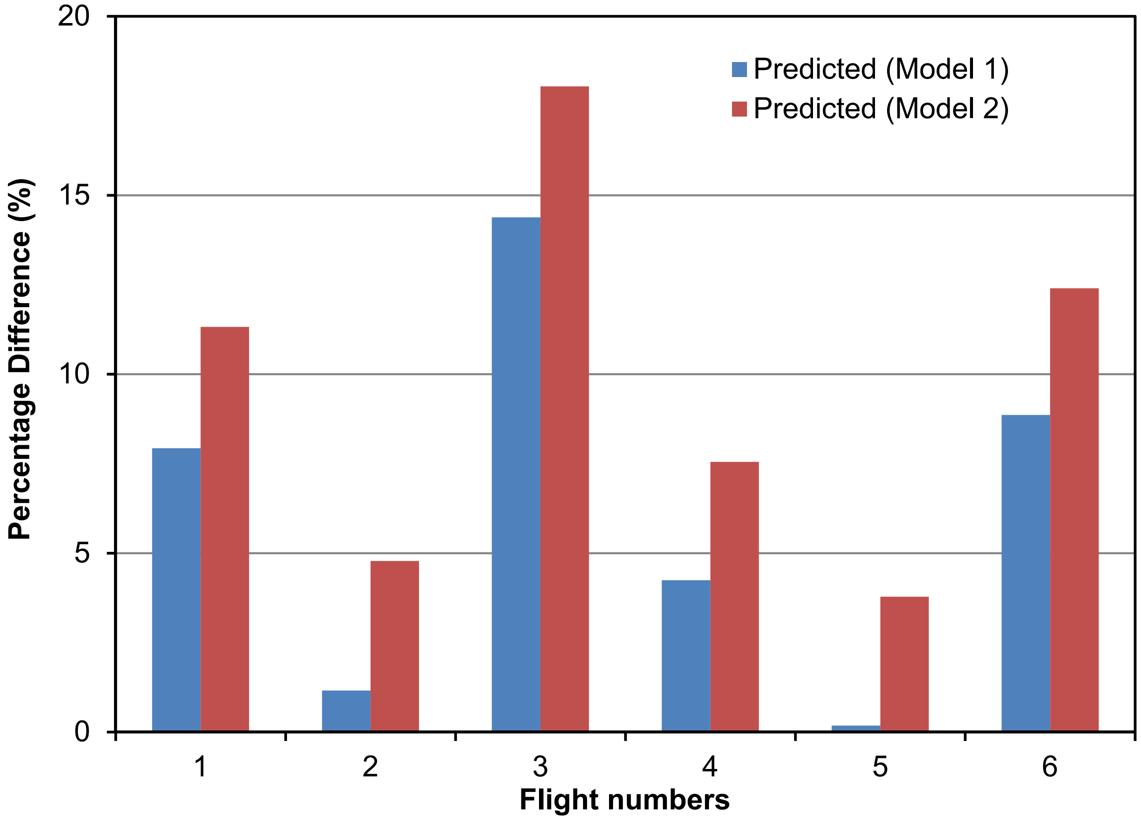
Figure 2: Predicted fuel savings compared with the simulated flight fuel savings



The differences between predicted and simulated fuel savings are shown in Figure 3. Model 1 provides a better prediction, and the differences in all 6 flights are 0.18-8.85%. In the case of Model 2, the differences are 3.78–18.04%. The modifications done for Model 1 can reduce the difference between simulated and predicted results. The ability of the algorithm to predict fuel consumed would help pilots utilizing a program to determine how much fuel to upload, reducing excess weight from excess fuel uploaded. A reduction in weight would lead to greater fuel savings in return.

As flights from Singapore to Cambodia occur on a daily basis, the fuel savings multiplied over a time period can result in a significant amount. Based on ICAO Carbon Emission methodology, an aircraft with a passenger capacity of 180, flying from Singapore to Cambodia, produces 21207.6 kg of carbon emission per flight (International Civil Aviation Organization, 2014; Sun, 2016). A reduction in fuel consumed over the course of a year would lead to a significant amount of reduction in carbon emission.

Figure 3: Differences between predicted and simulated fuel savings



3. STUDY OF ATCO WORKLOADS

In this study, the state of equipment is treated as a constant, as the study is conducted with the comparison in the same country's airspace and the states of equipment in the various control centers are assumed to be similar (Ong, 2016). The workload experienced by ATCOs would only be affected by the situation in the airspace.

Therefore, the total workload experienced by ATCOs would be the combination of the following three components (Wang *et al.*, 2010): (1) Monitoring workload, $WL_{monitoring}$ – This is the workload for monitoring flights in a sector and checking the trajectories of the aircraft in the sector. Monitoring workload depends on the air traffic and is proportionate to the number of flights within the sector throughout certain duration. (2) Coordination workload, $WL_{coordination}$ – This is the workload for coordinating during takeover or handover of flights to or from adjacent sectors. This can be information exchange between two controllers of adjacent sectors or between the controller and a pilot. (3) Conflict resolution workload, $WL_{conflict}$ – This is the workload to monitor two or more aircraft crossing a waypoint in opposite directions. This workload is proportional to the number of crossing aircraft.

The total workload of an ATCO is therefore (Li *et al.*, 2009):

$$WL_{total} = \alpha WL_{monitoring} + \beta WL_{coordination} + \gamma WL_{conflict} \quad (16)$$

$$\alpha \geq 0, \beta \geq 0, \gamma \geq 0.$$

Where α is the monitoring coefficient, β is the coordination coefficient, and γ is the conflict resolution coefficient. The coefficients $\alpha,\ \beta$ and γ are from the empirical study of air traffic workloads. However, because of the lack of data from relevant authorities, we assume the monitoring coefficient α to be 0.1. β and γ are plotted against the imbalance to find the optimal value where the change of imbalance is less than 0.5%. In this article, the unit of WL_{total} would be based on the number of flights within the sector. Upon calculation of WL_{total}, the weight matrix W is then created as follows (Von Luxburg, 2007).

$$W = (w_{ij})_{\ i,j=1,\dots,n}. \quad (17)$$

If $w_{ij} = 0$, there are no flights over the flight route, and this means $a_{ij} = 0$.

After the sectorization of the airspace, we determine the performance of the sectorization by comparing two properties, the coefficient of sector workload balancing and the standard deviation. To determine if the workloads of the various sectors are balanced, we compare the imbalance of workloads among the sectors, c_{bal}, which is defined as (Li *et al.*, 2010)

$$c_{bal} = \frac{WL_{max} - WL_{min}}{WL_{max}} \times 100\%. \quad (18)$$

Where WL_{max} is the maximum sector workload and WL_{min} is the minimum sector workload. Hence, c_{bal} is the maximum difference among the sector workloads. The smaller this value is, the more balanced the sector workloads are.

The standard deviation percentage, σ, is defined as (Savai *et al.*, 2010)

$$\sigma = \frac{\sqrt{\frac{1}{N}\sum_{i=1}^{N}(WL_i - \mu)^{2}}}{Average\ Workload} \times 100\%. \quad (19)$$

Where μ is the mean of the workloads of all the sectors. The standard deviation percentage, σ measures how the workloads of the sectors deviate from the mean workload. The smaller this value is, the more balanced the sector workloads are.

The demand for air travel in Vietnam has been increasing in recent years. ATCOs in Hanoi FIR have to deal with an average of 30 to 35 flights per hour (Thanh Nien News, 2016). In this section, we do not consider military airports and flights, due to the lack of such flight information. Hanoi FIR is located north of Ho Chi Minh FIR and has three active airports, two international airports with larger traffic and one domestic airport. To ensure that proper measures can be taken to sectorize the airspace efficiently, it is important to get the optimal coefficients. In 2015, Hanoi FIR was sectorized into three sectors (Vietnam Aeronautical Information Centre, 2015).

The numbers of flights across various air routes were collected from FlightStats and matched to the numbering system of the nodes. Some of the air routes have zero flight and are not recorded (FlightStats, 2016).

Using the numbers of flights in Hanoi FIR for the whole day and the actual sectorization, we could find the imbalance of sectors, c_{bal} with the various values of β and γ. The optimal value, where the change of imbalance was less than 0.5%, was then noted (Ong, 2016). The numbers of flights were then used to analyze how the imbalance of workloads among the sectors and standard deviation changed, as the coefficient of coordination, β and coefficient of conflict resolution, γ changed. Figure 4 shows how the dynamic sectorization (Ong, 2016) of Hanoi FIR changes throughout the day based on the optimal coefficients achieved.

The imbalance of the sector workload and the standard deviations for the dynamic and actual sectorization with the optimal coefficients and other coefficients are then plotted in Figs. 5 and 6 respectively. The average values of c_{bal} and σ are tabulated in Table 1.

In Figs. 5 and 6, the red lines represent the imbalance of workload among the sectors and the standard deviations with the coefficients of $\beta = 0.31$ and $\gamma = 0.55$. The green lines are drawn with the coefficients of $\beta = 0.1$ and $\gamma = 0.1$ and the blue lines are drawn with the coefficients of $\beta = 2$ and $\gamma = 2$. The thicker lines represent the readings from the dynamic sectorization, while the thinner lines represent the readings from the actual sectorization (in 2015) of Hanoi FIR.

Figure 4: Dynamic sectorization of Hanoi FIR

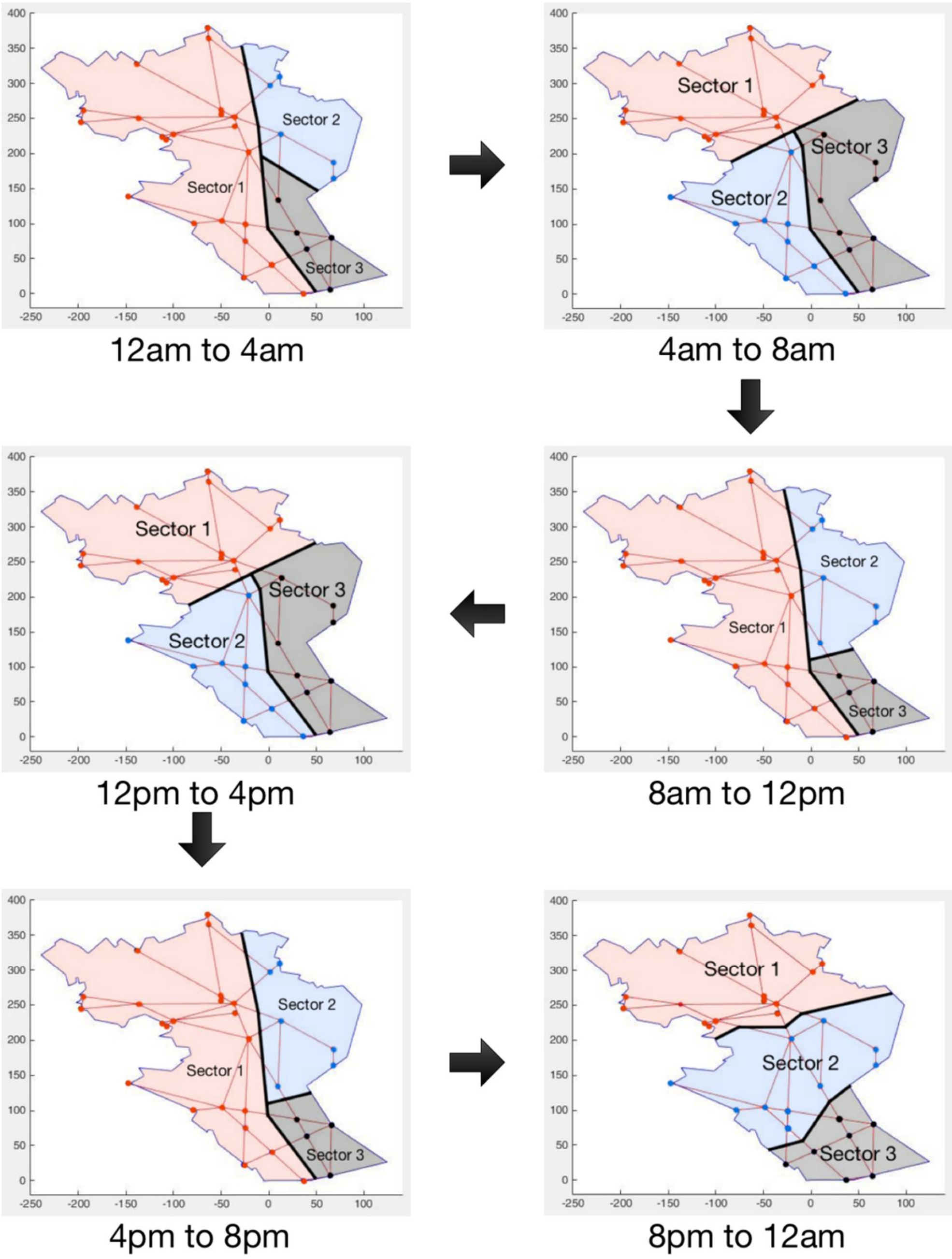


Figure 5: Graph of c_{bal} for both dynamic and actual sectorization

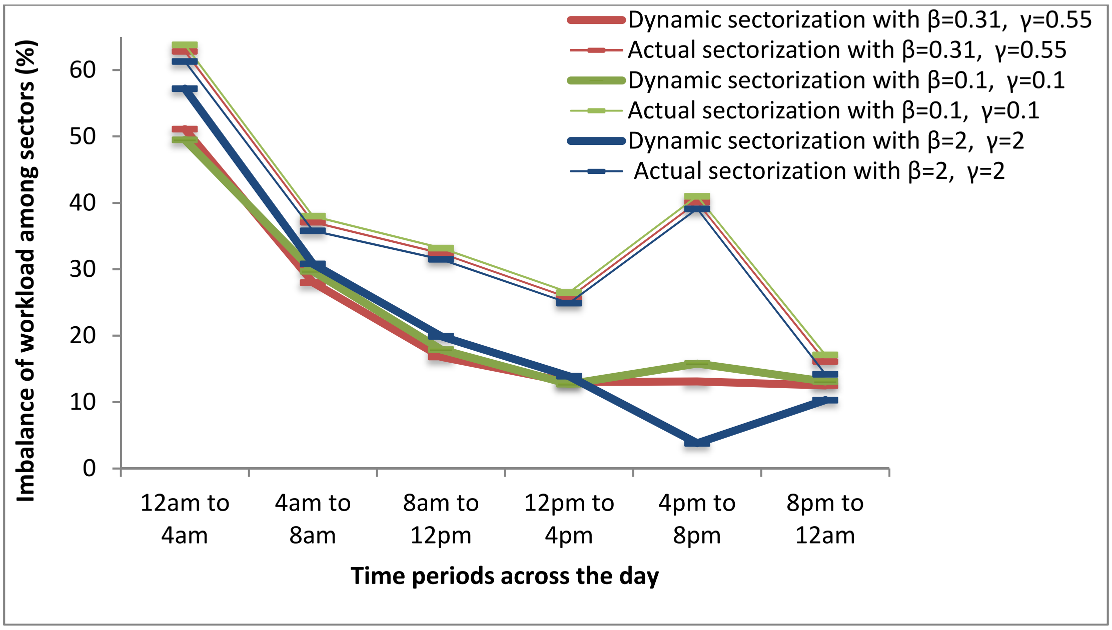


Figure 6: Graph of σ for both dynamic and actual sectorization

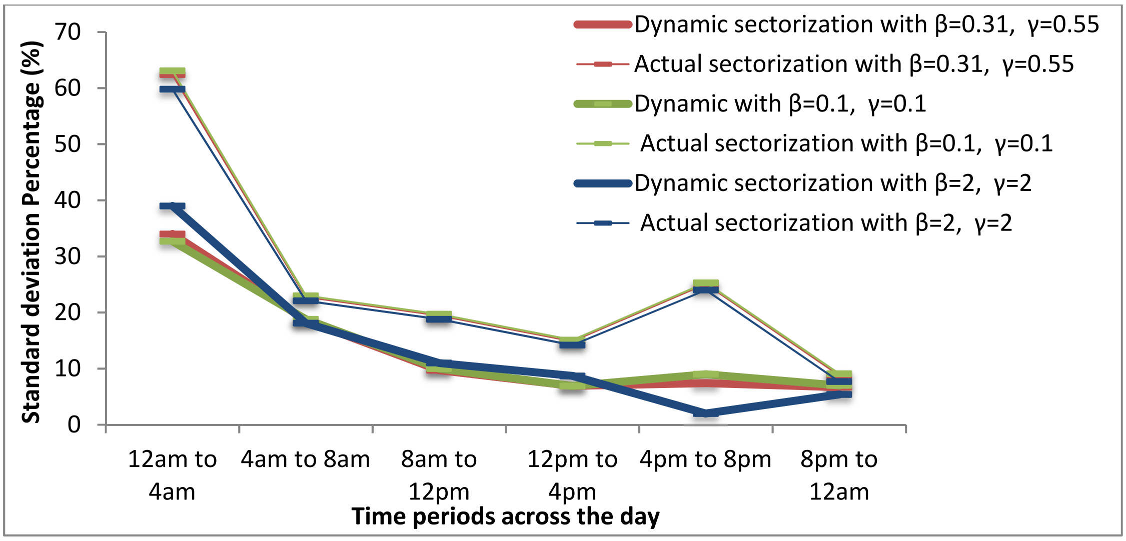


Table 1: Average values of c_{bal} and σ

	Dynamic sectorization with $\beta = 0.31$ and $\gamma = 0.55$	**Dynamic sectorization with $\beta = 0.1$ and $\gamma = 0.1$**	**Dynamic sectorization with $\beta = 2$ and $\gamma = 2$**	**Actual sectorization with $\beta = 0.31$ and $\gamma = 0.55$**	**Actual sectorization with $\beta = 0.1$ and $\gamma = 0.1$**	**Actual sectorization with $\beta = 2$ and $\gamma = 2$**
Average c_{bal} (%)	22.4	23.1	22.7	35.7	36.6	34.5
Average σ (%)	13.9	14.1	14.0	25.6	25.9	24.4

From Figs. 5 and 6 and Table 1, we note that c_{bal} and σ are constantly lower for dynamic sectorization than that for the actual sectorization with the 3 groups of values of coefficients. Average c_{bal} is improved by 13.3% and σ is improved by 8 flights for the results with the coefficients of $\beta = 0.31$ and $\gamma = 0.55$. c_{bal} is improved by 13.5% and σ is improved by 3 flights for the results with the coefficients of $\beta = 0.1$ and $\gamma = 0.1$. c_{bal} is improved by 11.8% and σ is improved by 30 flights for the results with the coefficients of $\beta = 2$ and $\gamma = 2$. Comparing c_{bal} and σ for the actual sectorization with the various coefficients, we see that average c_{bal} is the highest at 36.6% when $\beta = 0.1$ and $\gamma = 0.1$, 35.7% when $\beta = 0.31$ and $\gamma = 0.55$ and the lowest at 34.5% when $\beta = 2$ and $\gamma = 2$. Based on the results for the actual sectorization, it seemed that the higher the coefficients, the more efficient the sectorization would be. However, when we take into account the average σ, we see that when $\beta = 2$ and $\gamma = 2$, σ is significantly higher at 60 flights, compared to 15 flights and 6 flights when $\beta = 0.31$ and $\gamma = 0.55$ and $\beta = 0.1$ and $\gamma = 0.1$ respectively. When comparing the c_{bal} and σ for dynamic sectorization with the various coefficients, we see that average c_{bal} is the lowest at 22.4% when $\beta = 0.31$ and $\gamma = 0.55$, 22.7% when $\beta = 2$ and $\gamma = 2$ and the highest at 23.1% when $\beta = 0.1$ and $\gamma = 0.1$ (Ong, 2016). Hence, the results show the importance of determining the optimal coefficients of coordination and conflict resolution with the assumed value of the coefficient of monitoring. Using the optimal coefficients would result in a more balanced workload among the sectors for the dynamic sectorization. The dynamic sectorization is better than actual sectorization for balancing the workload among sectors throughout the day, with an improvement of an average of 12.9% in the imbalance of workload among the sectors and 50% in the standard deviation.

As discussed in section 1, dynamic sectorization has not been implemented in Southeast Asia. Besides dynamic sectorization, other methods such as direct route airspace in this region can be also researched. In the direct route environment, there was a reduction in the ATCO's workload, because of fewer conflicts and lesser time spent in the sector (Aneeka and Zhong, 2018). Researchers in universities can be solution providers but are usually not decision makers for air transport systems. The implementation of these advanced approaches needs the support and approval from the decision makers. The research on air transport management in this region is still not enough. One challenge in this region might be the difficulty in finding collaborators in the aviation industry. However, the stakeholders can be expected to be even more supportive to researches, after more solutions to real-world problems are published (Zhong, 2018).

4. SUMMARY

We studied flight trajectory optimization. Fuel savings were computed for selected routes and were compared with that of existing operations and flights simulations. The results obtained from the trajectories solutions provided by Model 1 resulted in a range of 300-1020 kg of fuel reduced per flight. For dynamic sectorization of Hanoi FIR, using the optimal coefficients resulted in the lowest imbalance of workload among the sectors, proving the importance of determining the optimal coefficients. Dynamic sectorization of airspace is consistently more advantageous than actual and static sectorization in terms of improving imbalance of workload among sectors and standard deviation.

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MODELLING TRAVELLER'S GROUND ACCESS MODE CHOICE OF DUBAI INTERNATIONAL AIRPORT, UNITED ARAB EMIRATES

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ABSTRACT

With increased demand for air travel, airports have become economic engines of the regional development that connect aviation systems with other modes of transportation facilitating the movement of people and cargo. Originating air passengers account for the majority of passenger trips to and from an airport and have different ground access needs. Since the air transportation is interrelated to ground transportation, studying ground access mode choice of airport users is a crucial part of airport management and system planning. The purpose of this study is to identify Dubai International Airport (DXB) ground access mode characteristics and users located in the United Arab Emirates (UAE), which has not been studied previously. Although there are many different modes of transportation serving the airport, yet personal vehicles are the main mode used to arrive to the airport. Binary logistic regression models are developed to evaluate access mode choice for originating air travelers focusing on the mix between private vehicle and public transportation system (taxi, limousine, bus network, and Dubai metro) using data collected specifically for this study. A total of 1012 air travelers were interviewed and completed the questionnaire in December 2014. Models result showed that access mode choice is significantly affected by different socio-economic characteristics of travelers including income, nationality, household size, vehicle ownership; and different trip characteristics that include number of travelers and how often air travelers use public transportation in their community.

KEYWORDS

Dubai International Airport, ground access mode, Binary logistic regression model, air passengers, car, public transportation

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1. INTRODUCTION

As per the statistics of Dubai airport authority, there was an 11.4% average growth rate of passengers in every year till 2014 and authority is expected 104 million passengers on 2020. With rapid development of Dubai's economy and associated growth in personal income, the ability of residents to travel abroad is increasing significantly, also the high number of immigrants in the country made the airport as a major transit hub for the passengers. As a result, travel demand and aviation activities at DXB are increasing, partly creating road congestion that might negatively impact airport users' travel time. Attracting the passengers to the public transportation is the one of the major challenge of Dubai government. Traffic jams are frequently occurring at Dubai streets, which cause to delay the passenger to reach the destination. In order to better manage ground traffic and further improve accessibility to DXB, it is crucial to identify the access mode choice for each air traveler since this group makes the majority of trips to and from the airport. The major aim of the study is to find the factors influencing ground access modes choice, characteristics of the passengers who use ground transportation to reach the airport and the share of each ground access mode.

Dubai's aviation sector contributes a total of US$6.2 billion to Dubai's GDP based on 2010 estimates (Oxford Economics, June 2011). By 2020, the economic contribution of Dubai's aviation sector is anticipated to grow to 32% of Dubai's' GDP with US$45.4 billion (Oxford Economics, June 2011). Understanding the travel behavior of airport users will guide Dubai government through the planning process to achieve an effective and sustainable transport system diminishing traffic congestion and car dependency.

Although there are several studies related to ground access mode choice, there was no study empirically investigating DXB ground access mode choice and the factors influencing modes choice to DXB. Therefore, this study focuses on understanding the modal preferences, demographic characteristics, and trip characteristics of DXB users. In order to develop an effective ground access to the airport, we must first understand the factors shaping the current modes choice by the air travelers; and this study will enable us to achieve this understanding. And it was observed from the analysis of model that socio-economic factors that include monthly income (MI), nationality (N), household size (HS), employment status (ES) are significant factors at 0.05 and age, travel time, travel cost, and trip purpose was found not to be significant indicators in the model. Due to that most of the travelers use their own vehicles as their main mode of transportation to reach the airport.

2. LITERATURE REVIEW

Airports are vital resource for contemporary living as they form an essential part of moving people and shipping goods around the world (Alkaabi et al., 2013; Alkaabi and Debbage, 2011 and 2007). Moreover, airports connect air travelers with other modes of transportation and hence can be seen as a node that is connected to ground travel and both can affect each other (Alhussein, 2011). Ground traffic problems such as traffic congestion can have a negative impact on the management of air traffic; therefore, airport administrators and authorities are more often facing problems related to ground traffic at and around their airports. According to Alhussein (2011) and Jou et al. (2011), managing ground traffic is important for travelers and airport administrators, where the quality of ground access to an airport can influence the demand for airport air services.

Several studies have investigated ground transportation use at large airports and synthesized strategies for improving the quality of public transportation access to airports (Akar, 2013; Choo et al., 2013; ACRP, 2008a, 2008b; Budd et al., 2011a, 2011b; de

Neufville, 2006; Reynolds-Feighan and Button, 1999; Alkaabi, 2017). One of the earliest studies in this field was made by Ellis et al. (1974). They developed statistical models for air passenger airport ground access mode choice. In their study, they used travel time as a measure of airport accessibility. Other studies considered in modeling ground access mode choice additional factors such as the number of ground transportation service available and the proportion of airport users who decide to choose different ground transportation modes. For example, Harvey (1986) showed that air passengers were highly sensitive to travel time, particularly with increasing flight length. In addition, he showed that the number of pieces of luggage carried by travelers is another variable that played an important role in mode choice. Clark and Lam (1990) and; Pels et al. (2003) elaborate on that work and found that trip purpose, travel cost, origin residential area, and party size also plays a significant role in mode choice. Sangho et al. (2007) added income, age, occupation, and gender variables to those variables used previously in other studies. They studied ground access mode choice for two domestic airports in Korea, Daegu Airport and Gimpo Airport, and their model demonstrated that this array of variables were significantly different across airport access mode.

Mamdoohi et al. (2012) studied the behavior of air travelers in accessing Imam Khomeini International Airport (IKIA). They found that airport access mode choice is significantly affected by trip purpose, private car ownership, travel time, and monthly income. In addition, they found that business travelers tend to pay more to use private transport to access IKIA than non-business air travelers. Alhussein (2011) investigate the King Khaled International Airport access mode characteristics and users, and found that variables such as number of luggage, nationality and income, and travel access time significantly affect mode choice. Psaraki and Abacoumkin (2002) investigate the travel distance to determine the market segment for an access service. They found that the use of the private cars and taxis are the main mode for traveling to Athens International Airport; however, due to its higher cost the use of the taxis decreased in relation to increasing distance between trip origin and the airport.

Foote et al. (2007) focused on factors affecting the use of rail transit when they examined mode choice at two major airports in Chicago, Illinois. They found that the most important factors affecting transit use by actual rail users are cost, time and being close by. They found that less than 8% of the departing air travelers accessed Midway and O'Hare airports. Mandle et al. (2000) concluded that 10% to 15% is the maximum market share of public transport at airports in the United States. Sobienaik, et al. (1979) studied the access mode choice at Ottawa-Hull and vicinity in Canada and found that walking time and luggage handling are the significant variables for mode choice. Choo et al. (2013) found that variables such as travel time, gender, income, age, trip purpose, and occupation are significantly affect mode choice in Korea. Hess et al. (2007) found that the most significant variables are air fare, frequency flyer benefits, and access time.

Tsamboulas and Nikoleris (2008) conducted a survey to investigate willingness to pay to save time on trips to the Athens International Airport. Their findings show that the majority of air travelers are not willing to reduce their travel time to the airport by paying any amount of money. Their findings are based on that air travelers chose the modes that offer high level of services, and because they arrive early to the airport and thus have a lot of time to spend in the airport prior to their departure. Nevertheless, the study finds that business air passengers and those who travel to the airport utilizing their own cars or take a taxi are more willing to pay to reduce their travel time. They also found that air travelers are more willing to pay if the distance from the airport increases.

Hess and Polak (2005) added choice of airline and airport, and found a complex set of connections between several factors, including in-vehicle access time and flight frequency. Jou et al. (2011) investigated air travelers' choice of mode for access to the Taoyuan International Airport in Taiwan. They found that in-vehicle travel time and travel cost are significant factors affecting ground access choice. Gupta et al. (2008) also considered the time factor in mode choice decision in their modeling of ground access mode choice for the New York City metropolitan region. They concluded that access cost and time, and travelers' socioeconomic characteristics are vital factors affecting the resulting mode choice when they studied the ground access mode choice for the New York City metropolitan region. They found that this factor is more significant for groups of passengers, in addition for frequent versus less frequent travelers (i.e., business and non-business travelers).

Tam et al. (2008) took the time variable on another dimension. Their study was the notion of a "safety margin" in mode choice to Hong Kong International Airport (HKIA). Their investigation revealed that business air travelers place a significantly higher value on both safety margin and travel time for their ground access to HKIA. They found that the dominant modes of access to the airport are rail services and buses, suggesting these services have been able to provide service regularity that meets safety margin concern of most air travelers. Koster et al. (2010:1) study the variability in estimates of the cost of access travel time for Dutch air Travelers. They found business travelers and non-business travelers are similar regarding costs allocated for access travel time observing "the costs of access travel time variability for business travelers are between 3–36% of total access travel cost, and for non-business travelers between 3–30%". Alkaabi (2017) has investigated access mode choice of airport employees to DXB and their willingness to car sharing, as well as has discussed the factors that influence them to use public transportation for commuting to their work at the airport. The study revealed that DXB employees were mostly sensitive to their income, nationality, employment status, car parking permit, and parking compensation in making mode choices; and that they are less interested to car share.

In summary, previous studies provide several and important observations and insights about the models used to analyze, and the factors that affect travelers' mode choice that are the starting point for the current study.

First, identifying explanatory variables is a critical process in developing airport ground access mode choice. Two main groups of factors were utilized in most of these studies. The first group of factors is the travelers' socioeconomic characteristics. As shown in the table, many scholars include factors such as gender, age, household average income, traveled party size, and level of education and occupation type. The second group of factors is related to the trip characteristics such as travel time and cost, walking distance, auto access, access time, and flight frequency. Many of these factors are utilized in this study to investigate the mode choice of DXB.

Second, most of these studies utilized discreet choice model such as binary logistic model, nested model, and multinomial logistic regression models among others. However, no specific recommendation or judgment about which model is more appropriate. Each model is utilized based on the number of modal choice analyzed in the study and the selected appropriate explanatory variables.

3. DUBAI INTERNATIONAL AIRPORT

Dubai International Airport (DXB), located east of Dubai Emirate at Al Garhoud district as shown in Figure (1), is currently the MENA region's busiest aviation hub, with a 15.2% increase in passenger traffic between 2012 and 2013 (from 57.6 million to over 66.4 million passengers) ranking it tenth among worldwide airports (ACI, 2014). As the largest cargo hub in the region, it also handled over 2.4 million tons in 2013, more than all other GCC airports combined (ACI, 2014). DXB is linked to three access transportation modes including: private cars, taxis and limousines, and public transit services (bus and metro). The airport is linked to the city by intra-city roads including Road D89 and Road 91, and is connected to the other emirates through highway E311 (Mohammed Bin Zayed Road) and highway E11 (Al Ittihad Road). DXB is also served by the government owned Dubai Taxi Agency providing 24-hour service at all terminals. Dubai Metro operates two lines through or near the airport. Passengers can directly access Terminal 1 and Terminal 3 through the Red Line stations with daily services run from 6 am to 11 pm, except Friday from 1 pm to 12am. Passengers can be also connected to Terminal 2 through the Green Line station near the Airport Free Zone. Dubai airport buses, operated by Roads and Transportation Authority (RTA), are available daily for passengers at every terminal connecting them to the city center and over 80 hotels (RTA, n.d.). Despite the government efforts toward public transport services, the core issue for the current study is the decision made by travelers between private cars and public transportation.

Dubai is planned to be the leading tourism and business hub in the Middle East for attracting substantial numbers of visitors and business investors to the region. As a result, Dubai government has capitalized the airport annual passenger capacity from 60 million to 75 million passengers by January 2013 (Hofmann, 2012) and developed its national carrier fleet – Emirates Airlines – to cope up with continuous demand for air services. By November 2013, DXB handled more than 60 million passengers, a 47.4% increase from 2009 with 40.9 million passengers (CAPA, n.d.). The recent Dubai successful bid to host World Expo 2020 is expected to revitalize the local economy and attract additional overseas tourists, generating further traffic movement at DXB and Dubai streets network. To better manage ground traffic at and around DXB, Dubai government needs to focus further on improving ground accessibility to the airport and extending airport connectivity to the rest of the Emirates.

Different modes of transportation from different cities in the country serve Dubai Airport. Table 1 shows the origin/destination of these modes as well as the cost of using each mode, the time required to arrive to the airport by each mode from its origin, and the distance traveled to arrive to the airport. The table shows that buses are the cheapest mode of transportation that can travelers use from other cities than Dubai to arrive to the airport, however it takes more time than the other modes. Within Dubai Emirate, Metro Dubai and Dubai buses are considered the cheapest modes to arrive to the airport; however, the metro is the fastest mode that can be used to arrive to the airport while the buses are the slower modes as shown in the table. On the other hand, Dubai Taxi and Uber services are more convenient and faster despite their higher riding costs.

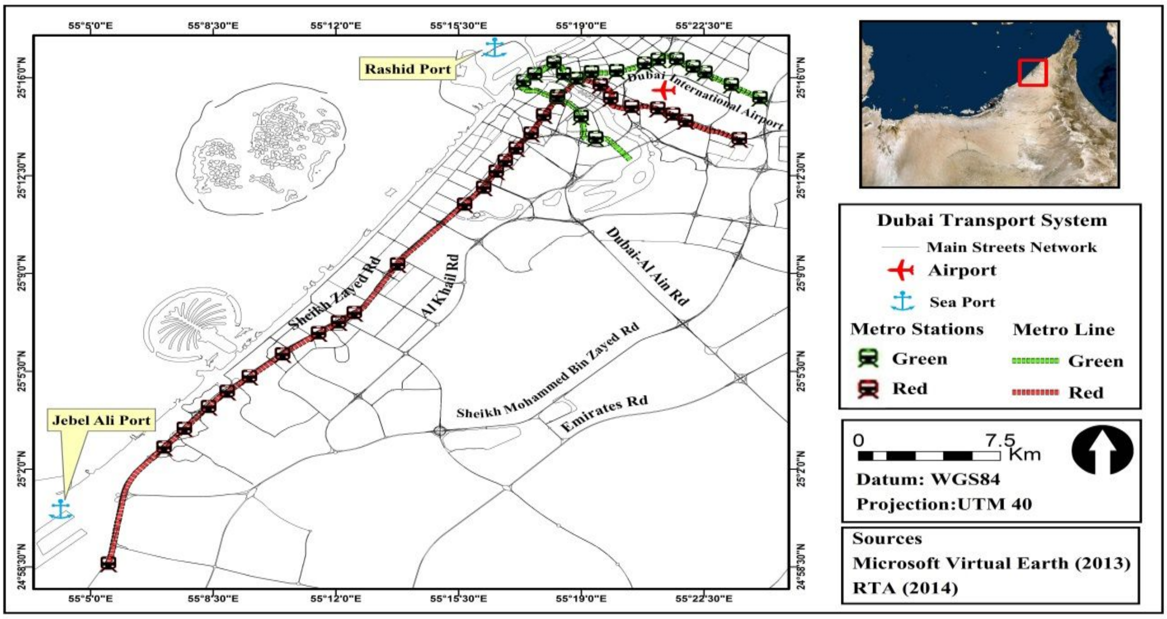

Figure 1: Locations of Dubai Transport Systems (Dubai International Airport, Dubai Metro, Main Streets Network, Sea Ports)

Table 1: Cost, time, and distance required for different modes of transportation serve DXB from different cities in the UAE

Origin (Emirate)	Starting Point	Destination	Mode of Transport	Cost (AED)	Time	Distance
Ras Al Khaima	Khazam	Terminal 1	Taxi	160	1 hr.	92.8 km
			Bus	25	2 h	92.8 km
			Private Car	400	1:15 h	92.8 km
Ajman	Mohyat District	Terminal 1	Taxi	95	25 min	26.5 km
			Private Limousine	140-200	30 min	
Al Ain	Al Ain Bus Station	Terminal 1	Taxi	400	1:30 h	145 km
			Bus	20	2 h	
Fujairah	Fujairah Bus Station	Terminal 1	Taxi	180	1:30 h	107 km
			Bus	25	2:15 h	
Abu Dhabi	Al Khaldiy Bus Station	Terminal 1	Taxi	400	1:26 h	130 km
			Bus	15-20	2:30 h	
	Yas Mall		Mini Van	375	1:11 h	119 km
Sharjah	Rolla Bus Station	Terminal 1	Taxi	70	30 min	26 km
			Bus	15	1:30 h	
	Dasman		Uber	55-65	24 min	17.77 km
Dubai	Burj Khalifa	Terminal 1	Dubai Metro	5	24 min	14.2 km

	Palm Deira			3	21 min	6.55 km
	ADCB Station			5	14 min	7.65 km
	Emirates Exchange			7.5	50 min	55.8 km
	Burj Khalifa		Taxi	27.9	16.82 min	14.2 km
	Palm Deira			23.7	20.70 min	12.1 km
	ADCB Station			19.2	13.32 min	9.8 km
	Emirates Exchange			89.8	34.25 min	45.8 km
	Burj Khalifa		Uber	44-55	15 min	14.18 km
	Palm Deira			47-59	18 min	15.18 km
	ADCB Station			35-43	11 min	9.82 km
	Emirates Exchange			196-255	35 min	47.22 km
	Burj Khalifa		Bus	5	35 min	18.86 km
	Palm Deira			5	47 min	6.95 km
	ADCB Station			5	38 min	8.04 km
	Emirates Exchange			7.5	1:48 h	57.79 km

Sources: Data were retrieved by the author from the following: Uber, Wojhati, Careem, Dubai Airport, Al Hamrah Taxi, RTA, Sharjah Transportation, Ajman Taxi, Cars Taxi Fujairah, Al Ghazal Taxi, Google Earth.

4. DATA COLLECTION

In order to understand departing air travelers' travel behavior of ground access to DXB, a revealed preference (RP) face-to-face interview survey was designed and conducted by the author exclusively for this research at DXB in Dubai. Departing travelers, whose air journey origin was DXB, were targeted by the interview survey while connecting flight passengers were omitted. Departing travelers use ground access modes to arrive in the airport and encounter greater arrival time pressures to meet scheduled flight times, and the uncertainty of travel time to arrive in the airport.

The distribution method of the RP questionnaire survey was semi-random on departing air travelers, in the three terminals of DXB, sitting in the boarding waiting area. The RP survey collects information about traveler's actual choices to perform and utilize statistical models of travel mode choice. In the RP questionnaire survey, we asked the respondents about their current mode choice to arrive to DXB and the factors driving them to do that, in addition to different socio-economic characteristics of the travelers. The selection of survey participants was based on a systematic approach meaning that the first traveler sitting in the first row in the boarding waiting area was first given the questionnaire, and then the sixth traveler was selected, and so on. Travelers were selected from different nationalities and have different socio-economic characteristics and are residing inside the country and traveling outside. Six undergraduate students were trained to do the questionnaire and were distributed on the three terminals in the airport and were supervised by an assistant professor from the university during the survey period.

The questionnaire is comprehensive and requires 10 to 15 minutes for completion; therefore, seated air travelers at the boarding gates were interviewed to ensure the greater likelihood of a comprehensive response. A total of 1012 air travelers were interviewed and completed the questionnaire. The questionnaire survey was conducted in three days (28-30 December, 2014), and the sample size represents 0.03% of total departures on December. The survey was designed to satisfy the requirements for the development of a ground access mode choice behavior model and to explore the significant aspects, which affect the selection of ground access mode to travel to DXB. Since air travelers at DXB are from different nationalities, the questionnaire was designed and written in both English and Arabic languages. The questionnaire survey contains 36 questions divided into three parts. The first part was designed to collect information about the travelers' trip characteristics, while the second part was designed to collect general information regarding the selection of particular mode of transportation that traveler used to travel to/from the airport, and the third part consists of questions to collect general information about travelers' socioeconomic characteristics. As per the Dubai Statistics Center data, 70 million passengers used the Dubai airport among this 35.1 million departed and 34.9 million passengers arrived in Dubai. And it was observed that August, December, and January months were the peak time of passengers in Dubai airport

5. DEMOGRAPHIC CHARACTERISTICS

The analysis of the data revels that among the study sample, only 4.6% were UAE nationals and the rest are expatriates where Arab travelers (from the GCC and other Arabic countries) comprise a large proportion of the travelers (32.3%) and the rest are from other parts of the world. As shown in Table (2), 91.2% are residents of the UAE; 58.2% of the respondents were male; about 80% of the total respondents were aged between 25 and 44 years where the largest age group of travelers was between 35 and 44 years old; 95% of the travelers do not have disability; more than 98% finished high school; 84.6% of them are working where 67.6% are full time and the majority were in professional/manager (41.1%) followed by general office occupations (14.8%). In terms of income, 33.6% had monthly income ranges between AED10,000 and AED14,999, showing a distinctive difference from other monthly incomes which exhibit percentages ranging from 2.1% to 16.2%.

Table 2: Key socioeconomic characteristics of the sample

Total Number of Respondents			**1012**		
Nationality	**Total**	**1009**	**Number of vehicles**	**Total**	**1004**
	UAE	4.6%		None	22.5%
	GCC	12.1%		1	35.8%
	Europe	23.0%		2	30.7%
	North American	5.5%		3 or more	11%
	African	8.2%	**Household size**	**Total**	**999**
	Arab (excluding GCC)	20.2%		1	17.6%

	India	9.8%		2	19.5%
	Pakistan	4.9%		3	17.0%
	Filipino	10.2%		4	32.6%
	Other	1.6%		5 or more	13.2%
Age	**Total**	**1007**	**Employment statues**	**Total**	987
	18-24	2.3%		Full time worker	67.6%
	25-34	30.3%		Part-time worker	16.8%
	35-44	51.4%		Not employed	15.6%
	45-54	15%	**Education**	**Total**	**977**
	55-64	0.9%		Did not finish high school	1.8%
	65+	0.1%		Finished high school	4%
Gender	**Total**	**994**		College	23%
	Male	58.2%		University	56%
	Female	41.8%		Higher Education (Master, PhD)	15%
Disable	**Total**	995	**Occupation**	**Total**	1**005**
	Yes	5.0%		Not Working	15.6%
	No	95.0%		General Office	14.8%
Monthly household income (AED)	**Total**	**850**		Professional/Manager	41.1%
	Less than 5000	2.1%		Sales/Services	9.1%
	5,000-9,999	16.2%		Manufacturing	8.5%
	10,000-14,999	33.6%		Other	10.9%
	15,000-19,999	12.7%	**Resident or Visitor**	**Total**	**997**
	20,000-24,999	3.9%		Residents	91.2%
	25,000-29,999	8.6%		Visitors	8.8%
	30,000-34,000	14.0%			
	35,000 or more	8.8%			

6. ACCESS AND TRANSPORTATION CHARACTERISTICS

The majority of respondents (74.4%) travel to Dubai airport are from Dubai and only 8.7%, 8.3%, and 8.5% of travelers are from Abu Dhabi, Sharjah, and other Emirates respectively as shown in Table (3). This indicates that the majority of airport users have the choice to use different mode of transportation to travel to the airport. About 77.5% of the respondents reported that they own at least one car which explains the high rate of using personal vehicles as the primary mode to travel to DXB. More than 50% of the respondents used their own cars to travel to the airport compared to 43.3% used taxis to arrive to the airport. The data reveals that the majority of the respondents are traveling in parties of two or more. Only 16.8% of the respondents were sole travelers. However, using the bus system or Dubai Metro accounted only for 3.8% of the sample. Dubai Metro provides service within the Dubai city limits hence those who want to use the metro services reach the airport must use either of a bus, taxi or their private car and then travel to DXB. This process is time consuming and costly in terms of time and money. This also applies on those who are traveling to the airport from inside the City of Dubai. The table shows that 56.3% used the same mode of transportation to arrive to DXB during the past 12 months. As for trip purpose, about 65.5% of respondents were traveling for holiday and leisure and about 23.5% were traveling to visit friend or family and only 9.9% of the respondents were traveling for business purposes. In terms of using the airport parking, most of those who used the car to travel to the airport used the airport short term car park. However, only 20.6% of them were reimbursed fully or partially the parking cost. Large and small business are pillars of Dubai economy and these types of trips are reimbursed. Cross-tabulating parking reimbursement with trip purpose and parking period reveals that short-term business trips are reimbursed in higher percentage compared to other types of trips, followed by long-term business trips. 22.9% of the respondents travelled with one luggage and 21.9% of them carried two bags and the rest traveled with three pieces of luggage or more. Finally, a considerable percentage of the respondents (32.5%) indicated that the primary factor of using their mode of transportation was journey time followed by parking charges (22.2%).

Table 3: Key trip characteristics of the sample

Total number of respondents		**1012**			
Trip Origin	**Total**	**997**	**Number of vehicles owned**	**Total**	**1004**
	Abu Dhabi	8.7%		None	22.5%
	Dubai	74.4%		1	35.8%
	Sharjah	8.3%		2	30.7%
	Other Emirates	8.5%		3 or more	11%
Parking charges	**Total**	**987**	**Number of persons traveling**	**Total**	**1007**
	Reimbursed in full	16.3%		1	16.8%
	Reimbursed partially	4.3%		2	23.7%
	None	79.4%		3	23.9%
Primary factor influencing the choice of ground access mode	**Total**	**998**		4	18.2%
	Cost	11.7%		5 or more	18.4%
	Journey time	32.5%	**Airport access mode**	**Total**	**1010**
	parking charges	22.2%		Car	51.6%
	luggage amount	8%		Taxi	43.3%
	public transport availability	4.2%		Limousine	0.6%
	nature of party	1.9%		Bus	2.2%
	Others	19.4		Dubai Metro	1.6%
Number of luggage	**Total**	**1006**		Other	0.8%
	1	22.9%	**Purpose of the trip**	**Total**	1005

	2	21.9%		Holiday/leisure	65.5%
	3	16.5%		Visit relatives/friends	23.5%
	4	13.7%		Business	9.9%
	5	10.2%		Other	1.2%
	6	6.8%	**Using the same mode to travel to DXB**	**Total**	**994**
	7 or more	8.1%		Yes	56.3%
				No	43.7%

7. DESCRIPTIVE ANALYSIS

This section explores if key variables such as income, age, trip purpose, travel time, travel cost, and other explanatory variables affect ground access mode choice. Chi-square test was conducted to examine statistical difference among access modes related to socio-economic characteristics of travelers and trip characteristics. Airport access modes were classified into two different groups car and public transportation (combing taxi, limousine, bus, and metro) and excluding other modes due to insufficient sample size. To ensure reliability in performing the Chi-square test, some categories in the key variables are combined together so each cell in the cross-tabulation table have an expected count of five or more. Table 4 provides a cross-tabulation for access mode distribution by key variables related to both traveler and trip characteristics.

The table 4 shows that number of luggage is not a significant key variable that determine ground access mode to DXB. About 45% of travelers carried one or two bags in their journey and this percentage is same across all access modes. On the other hand, there are a strong association between the size of the party and the mode choice at .05 level (*P*-value = .001). The data shows that 1.6% of travelers who use the metro to arrive to DXB are solo travelers, while more than 51% of those who use their private cars. In terms of trip origin, there is a significant association between access mode and the origin of the trip. The use of the car increases as the distance increases from DXB. The data shows that around 75% of trip is originating from Dubai, 8.7 % from Abu Dhabi and 8.5% from Sharjah. Only 2.2 percentage of passengers use bus as their mode of transportation to reach the airport. Around 48% of passengers depend on the public transportation (combing taxi, limousine, bus, and metro) to reach the airport. And the data shows that the journey time is the one of the major reason for choosing the mode of transportation and followed by the parking charges.

Table 4: Chi-square test analyses of key variables by airport access mode

	X^2-value	***P*-value**
Trip Characteristics		
Number of luggage	5.192	0.519
Number of people traveling	16.419	0.003
Trip origin	35.382	0.000
Traveling class	9.986	0.007

Trip purpose	12.814	0.005
Number of times traveled during the last 12 months	18.611	0.001
Place to park the car	35.732	0.000
Reimbursing parking fees	33.182	0.000
Primary factor influencing the choice of mode	54.489	0.000
How often traveler use public transportation	205.530	0.000
Socio-Economic Characteristics		
Nationality	75.088	0.000
Age	34.191	0.000
Gender	1.707	0.191
Occupation	83.741	0.000
Income	52.580	0.000
Number of vehicles owned	83.537	0.000
Household size	142.768	0.000
Employment status	63.318	0.000
Education	25.131	0.000

Also, the data reveals that there are statistical differences in ground access mode in terms of trip purpose distribution. Private cars are mostly used in traveling to DXB regardless the purpose of the trip and particularly to visit friends or family members. On the other hand, most of those who use taxis or limousine to arrive to the airport travel for holiday or leisure purposes. The same implies on travelers who use the metro and bus system where more than 50% of those who use these systems travel for holiday or leisure purposes followed by business trips (22%). Among those who used cars to travel to the airport, about 50% of respondents parked in the airport short term car park and only 10% parked in the airport long term car park. Parking charges was found to be a key factor that prevents many respondents to use their own cars particularly the long-term parking charges. At DXB, parking charges cost per day range between 100AED (≈30USD) to 240AED (≈65USD) which is more expensive than using other modes of transportation. Other key factors that determine the mode choice is the travel time and travel cost. The analyses shows that travel time and travel cost are important factors that would trigger some travelers to use their cars or taxi/limousine and avoid using the bus system or the metro.

In terms of the socio-economic characteristics and its influence on mode choice, the inspection of the entries in Table 4 shows that there is a strong association (sig = 0.000) between mode choice and nationality, age, occupation, income, car ownership, Household size, employment status, and education. The analysis shows that most of the UAE nationals use their own car to travel to the airport and the Europeans are the least. This may due to high level of income of UAE nationals and at the same time the culture of using car in their daily lives. Europeans are more pronounced to use public transportation as the analysis show that 30% of Europeans use taxis and limousines and 35% of them use the bus system or the metro to travel to Dubai airport. In terms of age, the table shows that age is a significant factor in mode choice. The majority of respondents who use the car are in the 24 to 44 age group. Income is another key factor that influences mode choice. The entries of the table reveal that as the income increases the use of cars increases and the use of public transportation decreases. In addition, the data reveals that those who finished university, works full-time, professionals/managers, and own 2 cars are more willing to use cars in their journey to the airport.

8. ACCESS MODE CHOICE MODELING

8.1. Model Specification

Considering the current state of the transportation system in Dubai and the corresponding plans and programs, two alternative airport access modes were identified for accessing DXB, namely private car and public transportation (taxi, limousine, Dubai Metro, and bus system). Therefore, Binary Logit model is utilized for developing airport access mode choice model. Binary logit models were used with SPSS Software Version 22 and R statistical software due to their capabilities to characterize complicated factors of travel decisions of individuals. In addition, binary logit model has been widely used as a discrete choice model for airport access mode choice studies because it predicts the possibility of the occurrence of a specific event, based on the independent variables (see for example Alhussein, 2011, Mamdoohi, 2012). The use of this technique deepens the understanding of the mode choice behavior of travelers for ground airport access.

Extensive evaluation of the explanatory variables was taken place to design the mode choice model and to ensure the efficiency of the whole model. Explanatory variables for the model have been assessed to identify the variables which have most effectively augmented the data for mode access choice. Some of the variables (i.e., income, age, vehicle ownership) included in this study are considered substantial in modeling access mode choice. Other specific explanatory variables (such as nationality) that are predicted to have an impact on access mode choice are exclusively used in this study to deal with specific research problems. Overall, the explanatory variables used to model access choice mode are age (A), nationality (N), monthly income (MI), employment status (ES), Household size (HS), vehicle ownership (VO), number of travelers (NT), trip purpose (TP), travel time (TT), Travel Cost (TC), and how often travelers use public transportation (PT). These explanatory variables were found to have significant impacts on mode choice as shown in Table (5).

A binary logit model has been designed for two options mainly private cars and public transportation to compare the use of these travel modes as access modes to the airport. In order to compare the application of these travel modes and determine the factors that might impact the selection of certain mode. The dependent variable in this model is "1" for car use and "0" for public transportation use. Dummy variables have been created for the categorical variables in this model, for example: UAE Nationals has coded as "1" and other nationalities have been coded as "0" because of all the depended variables in the model is "0" for personal vehicle use and "1" for public transport use (i.e. from our survey it was observed that UAE nationals are Major percentage of personal vehicle users in Dubai, around 80% of UAE Nationals uses their own vehicles to reach airport). The insignificant explanatory variables in Table (5) were dropped from the model as well as other explanatory variables that does not affect directly on selecting a specific mode such as reimbursing parking fees that is not applicable in case of selecting public transportation.

A binary logit models are estimated and calibrated to examine the impact of traveler socio-economic characteristics and trip characteristics on travelers' access mode choice to DXB. The logit model is used mainly to predict a categorical variable from a set of predictor variables and it is based the random utility theory. This theory assumes that a utility value affects the decision of a traveler to select an alternative that achieves the highest utility. Therefore, the probability of selecting a particular alternative depends upon the utility gained from that alternative. In this study, the probability of selecting a specific mode (*i*) to travel to DXB is equal to the probability that the utility of this mode (*i*) is equal to or greater than the utility associated with alternative mode (*j*). Therefore, the traveler will select the mode of transportation that yields the maximum utility. In this study, the utility comprises of traveler socio-economic characteristics, trip and mode attributes. Mathematically, the utility can be represented as in Equation 1:

$$U_{in} = f(X_{in}, S_{in}) \quad (1)$$

Where, U_{in} is the utility obtained by air passenger (*n*) selecting mode (*i*). This equation indicates that the utility U_{in} is a function (f) of the attribute value of mode (*i*) in terms of traveler (*n*) which is expressed as X_{in}. S_{in} is the characteristic value of air passenger (*n*) selecting mode (*i*). Hence U_{in} is considered to be random and cannot be measured with certainty (McFadden, 1974; Lerman, 1984; Ben Akiva and Lerman, 1985); therefore, it is rewritten as a sum of observed (V_{in}) that relates to the access mode and the traveler, and unobserved or random (ε_{in}) components as shown in Equation 2:

$$U_{in} = V_{in} + \varepsilon_{in} = \beta_n X_{in} + \varepsilon_{in} \quad (2)$$

Where β_n is a vector of estimated parameters with regards to variable X_{in}. Based on that and for this study, the binary logit model is governed by the following equations:

$$U_{1n} = \beta_n X_{1n} + \varepsilon_{1n} \quad (3)$$

$$U_{2n} = \beta_n X_{2n} + \varepsilon_{2n} \quad (4)$$

Therefore, traveler (*n*) select mode (*i*) if the modes utility is greater than or equal to the other mode's (*j*) utility as expressed in equation 5:

$$U_{in} \geq U_{jn} \quad (5)$$

Therefore, the probability of mode (*i*) to be selected is expressed in equation 6:

$$P_{in} = \text{Prob}\,(U_{in} > U_{jn}) = \text{Prob}[(V_{in} + \varepsilon_{in}) > (V_{jn} + \varepsilon_{jn})],\ i \neq j \text{ where } j=1,2,\ldots J$$
$$= \text{Prob}\,[\varepsilon_{jn} < (V_{jn} - V_{in} + \varepsilon_{in})] \quad (6)$$

To formulate a binary logit model, the probability can be expressed as in equation 7:

$$P_{n1} = \frac{\exp(\beta X_{1n})}{\exp(\beta X_{1n}) + \exp(\beta X_{2n})} = \frac{1}{1+\exp(\beta X_{2n} - \beta X_{1n})} = \frac{1}{1+\exp(\Delta U)} \quad (7)$$

Where:

P_{n1}: is the probability that traveler n selects first mode;

βX_{n1}: is the utility function that traveler n selects first mode;

βX_{n2}: is the utility function that traveler n selects second mode;

$\Delta U = \beta X_{2n} - \beta X_{1n} = \sum (a_i - b_i) Z_i$, where Z_i is the ith variable; a_i is the coefficient of the ith variable in βX_{n1}; bi is the coefficient of the ith variable in βX_{n2}.

8.1. Model Results and Discussion

This section focuses on modeling DXB ground access mode choice using binary logit model. The explanatory variables used in this model consist of socio-economic variables (income, age, employment status, nationality, Household size, and vehicle ownership) and trip variables (travel cost and time, trip purpose, how often travelers use public transportation, number of travelers). All explanatory variables in the model are considered key variables affecting mode choice and were statistically significant at *P* = 0.05 level as shown in Table (4). The model was calibrated to examine the behavior of air travelers in accessing DXB. Table (5) shows the results of the model for using private cars and public transportation as two different main groups of access mode choice to DXB. In general, the model shows that socio-economic factors that include monthly income (MI), nationality (N), Household size (HS), employment status (ES) are significant factors at 0.05. On the other hand, trip variables that include how often travelers use public transportation and number of travelers are significant at 0.05 level. Age, travel time, travel cost, and trip purpose was found not to be significant indicators in the model. This finding coincides and contradicts with other findings found in the literature. For example, Alhussein (2011) found that number of luggage, income level, travel access time, and nationality had affected airport access mode choice in King Khaled International Airport (KKIA). Gupta et al. (2008) found that income, age, and gender are significant in airport access mode choice in New York City. Other scholars (see for example: Akar, 2013; Jou et al., 2011; and Choo et al., 2013) found that travel time, travel cost are the main factors influencing traveler's mode choice selection. In this study, travel time, travel cost was found not to be significant indicator due to that most of the travelers use their own vehicles as their main mode of transportation to reach the airport, and hence the other advantages of using the own vehicles such as privacy and comfortability of the cars may considered a primary factor of not looking at the cost of the travel. In addition, cars can be considered as a fast mode of transportation to reach the airport far area where the public transportation is away from the origin of journey. The calibrated model for the sample data is as follows:

$$\text{Ln}\ (P_{car}/P_{public\ \ transportation}) = 4.915 + 0.753VO + 0.909HS + 0.866MI + 0.086N + 1.950NT - 0.601PT + 1.151ES$$

Table 5: Model parameter estimates

	β	Std. error	Wald	df	Sig.	Exp(β)	95% CI for EXP(β)	
							Lower	Upper
Number of vehicles owned	.753	.281	7.199	1	.007	20123	1.225	3.679
Household size	.909	.461	3.879	1	.049	2.482	1.004	6.132
Income	.866	.0358	5.859	1	.016	2.378	1.179	4.794
Nationality	.086	.042	4.135	1	.042	1.089	1.003	1.183
Number of travelers	1.950	.310	39.619	1	.000	7.027	3.829	12.896
Trip purpose	-.109	.094	1.346	1	.246	.897	.746	1.078
Travel cost	-.183	.229	.635	1	.425	.833	.532	1.305
Travel Time	.052	.183	.082	1	.774	1.054	.737	1.507
Age	.069	.126	.295	1	.587	1.071	.836	1.372
Employment	1.152	.400	8.308	1	.004	3.164	1.446	6.923
Using public transportation	-.601	.069	75.783	1	.000	.548	.479	.628

Constant	4.915	.695	49.953	1	.000	136.266		
Hosmer and Lemeshow Test shows that Chi-square-6.353, df- 8 and Sig-.608. Which indicates that the model fits the data as the significant value is greater than 0.05								
Model Summary								
-2 Log likelihood-785.577a, Cox & Snell R Square- 0.333 and Nagelkerke R Square- 0. .444								
The literature suggests that values of 0.2 to 0.4 for R2 represent an excellent fit (McFadden, 1979).								

Table (6) indicates that the model is good in predicting the overall choice with 76.8% which indicate that the 76.8% of the variation of the dependent variable can be explained by the explanatory variables. Based on the outcomes' calculation of the classification matrices of predicted vs. observed outcomes, the model was found to accurately and correctly classify 76.4% of the car users and 77.1% of the public transportation users as shown in the table.

Table 6: Model Prediction

Observed		Predicted		
		Mode		Percentage Correct
		Car	Public transportation	
Mode	Car	298	92	76.4
	Public transportation	94	317	77.1
Overall Percentage				76.8

In this study, some of the socio-economic variables such as income, number of vehicles owned, Household size, nationality, and employment status have substantially contributed to explain the access mode choice. On the other hand, age have no significant contribution to explain the access mode choice. The coefficient for income were positive, which implies that increase in income results in increase in using personal vehicles over public transportation to reach the DXB. The results of the logit model shows that an increase for one unit increase in income value, while holding other variables constant, will result in increase of the preference for using car by 0.866 units. Figure (2a) shows the differences between various income groups based on the model and it clearly indicates that the increase of income reduces the probability of selecting public transportation. However, surprisingly the figure shows that the travelers whose monthly income is greater than AED 35,000 are willing to use public transportation more than other groups. This is due to that this category use limousines more than other group.

The model results show that nationality explains significantly access mode choice behavior. The nationality had a statically significant p-value (p = .042) contributing to the explanation of access mode choice. Nationality has a positive sign and hence a positive impact upon choosing car mode over public transportation. Figure (2b) shows that being a United Arab Emirates national would decrease the probability of preferring public transportation to travel to DXB. On the other hand, being European increases the most the probability of using public transportation. In addition, the probability of selecting public transportation increases for nationalities other than being Emirates.

Vehicle ownership is another explanatory variable that was found to explain significantly access mode choice. The positive sign of the coefficient implies that as the number of owned cars increases the probability of selecting public transportation decreases. However, Figure (2c) shows that those who do not own a car are less likely to use public transportation. The interpretation of this finding is that those travelers use the car as passengers to travel to the DXB. In terms of the Household size and its impact on access mode choice, the model shows that as the number of persons increases the probability of selecting car increases. Figure (2d) shows that if the household consists of one person, the probability of choosing public transportation increases and this probability decreases to almost the same degree as the household size increases.

How often travelers are using public transportation is obviously a major factor affecting access mode choice. As expected, travelers who use public transportation as their main mode of transportation are more likely to use this system to travel to DXB. Figure (3a) clearly shows that those who use public transportation in their daily commuting are more likely to use public transportation to travel to DXB. The estimated coefficient of the number of travelers also was found to explain significantly the access mode choice (see figure (3b)). Holding other variables constant, the increase in the number of travelers is expected to increase the probability of preferring cars to travel to DXB by 1.950. The number of travelers is identified to be considerable and inversely impact the choice of choosing public transportation as the access mode to DXB. The probability of selecting public transportation decreases as the number of travelers (i.e., family or group trip) increases because the number of traveler's coefficient had a positive sign. It has been hypothesized that, when air passengers travel as a group to the airport they will select car mode over public transportation because of the superiority of the car mode in terms of privacy and comfort and the car mode gets more economical as the size of the travelers rises. Trip purpose, travel time, travel cost, and age were not found to have any significant contribution to explanation of access mode choice (see Table (6) and Figures (2f, 3c, d)) therefore they were eliminated from the model.

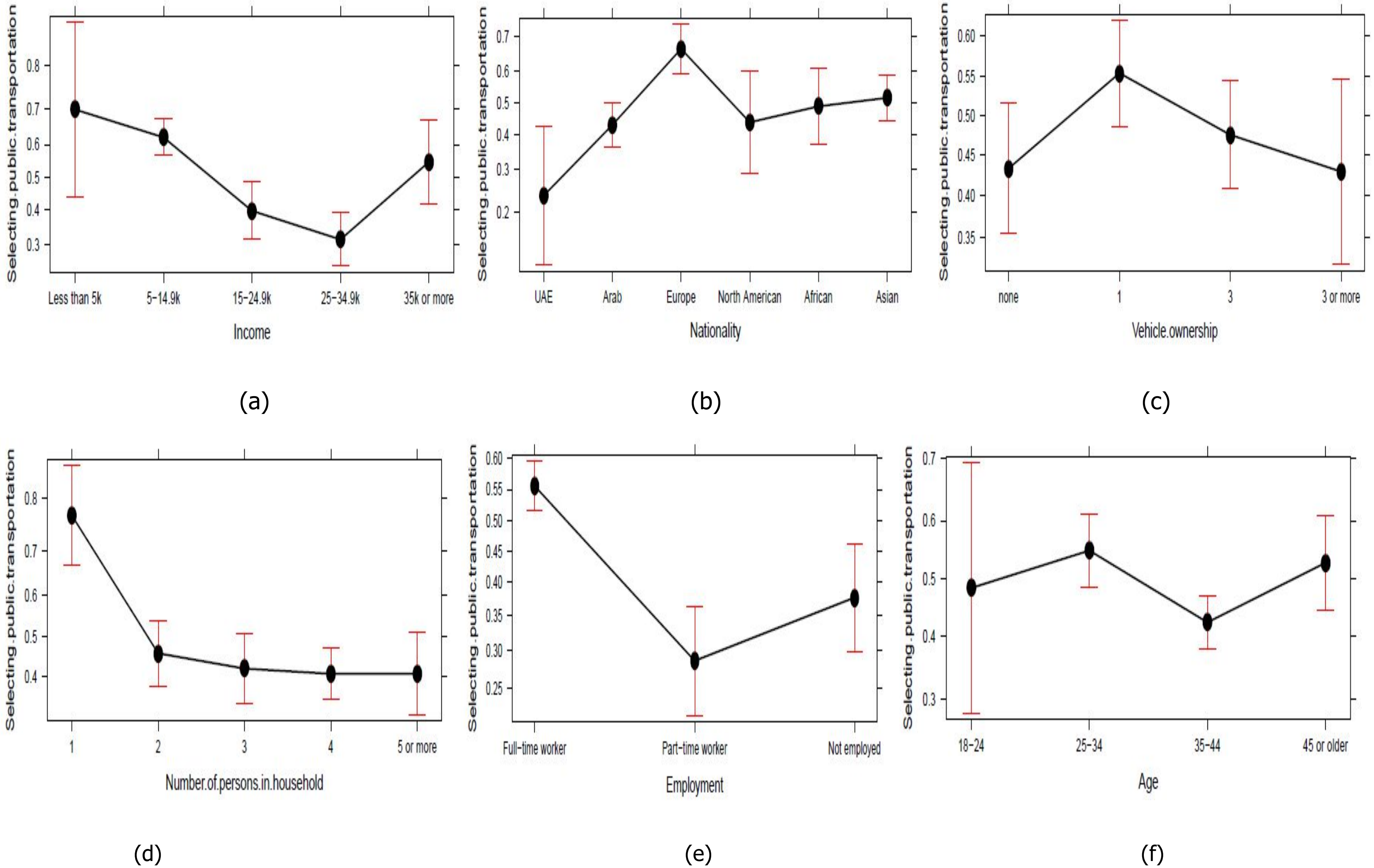

Figure 2: Probability of selecting access mode choice in terms of: a) Monthly income, b) nationality, c) vehicle ownership, d) Household size, e) employment, f) Age.

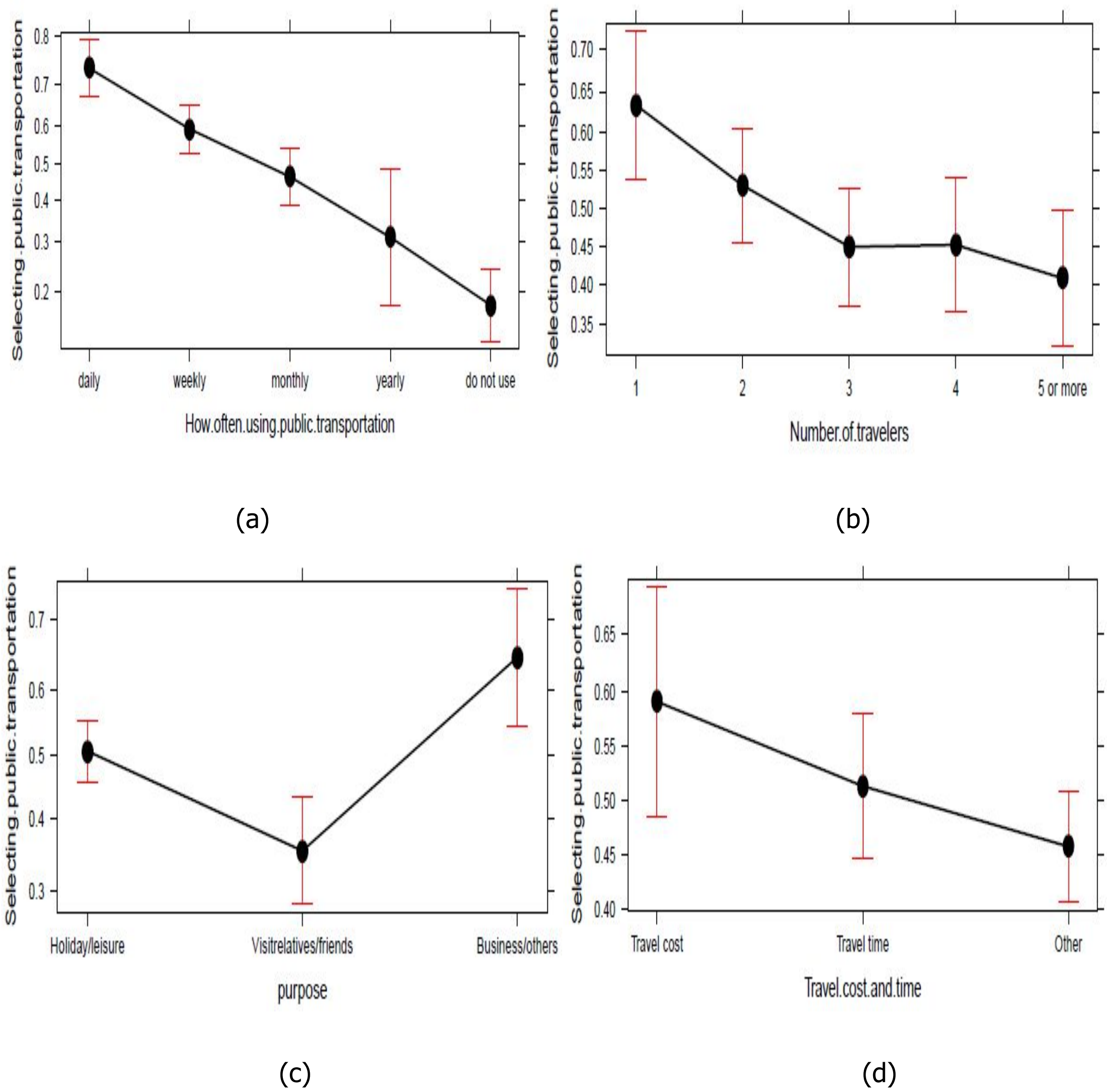

Figure 3: Probability of selecting access mode choice in terms of: a) how often travelers use public transportation, b) number of travelers, c) trip purpose, and d) travel cost and time

9. CONCLUSION AND RECOMMENDATIONS

The main objective of this study was to explore access mode choice to DXB Travelers and trip characteristics, as well as access mode service to DXB were identified. Chi-square test was conducted to determine if some of the key socio-economic explanatory variables and trip explanatory variables are statistically different across access modes at DXB. Binary logistic models were proposed for two choice sets mainly private vehicles and public transportation considering the key explanatory variables. The model was calibrated and used to estimate effective explanatory variables. Model's result showed that access mode choice is significantly affected by different socio-economic characteristics of travelers including income, nationality, household size, vehicle ownership; and different trip characteristics that include number of travelers and how often air travelers use public transportation in their community. Variables such as age, trip purpose, and trip cost and time were found to have no impact on access mode choice. From these results it is very clear that the passengers are more concentrated on the comfort of travel instead of the travel time and travel cost. The authority can provide airport buses particularly for the air passengers which will help to attract the passengers to use public transportation. Authorities should take initiatives for the public awareness to use the public transportation for achieving a sustainable and smart transportation system of the city.

The model is beneficial to the planners because it is receptive to number of variables that affect access mode choice. Understanding the travel behavior of airport users should guide Dubai government through the planning process to achieve an effective and sustainable transport system diminishing traffic congestion and car dependency such as encouraging carpooling, park and ride, and increase bus trips or frequencies to the airport.

Dubai is a populated city that is supported to some extent with public transport, a city with hot climate during most of the year, and a high concentration of private cars. Most of the travelers to the airport depend on their vehicles to arrive to the airport as discussed earlier in this study. Therefore, there is a need to reduce the dependence and reliance on car use to travel to the airport. One way to do that is by encouraging travelers to use public transport more often. Metro Dubai appears to be a promising mean to carry more passengers to the airport since it is faster than other modes, and at the same time the cost of using this mode is cheaper. However, this mode does not cover the whole city. Transport authority must consider this point for the future expansion of the metro service in the city. So that it can help to shift the mode choices of passengers from personal vehicles to public transport.

The results of this study are beneficial to policy makers in different ways. First, public transit passengers originating outside and inside Dubai City should be promoted for accessing the airport by extending the Metro services within the city or to the other cities, and with the help of certain incentives. The aim is to promote public transit to be the main and preferred mode of transportation for Dubai airport access. These incentives can include increasing the public transit frequencies to the airport during peak- and off-peak periods and overnight. Second, giving the high percentage of travelers using their own cars to arrive to the airport, the transport authority in the city should consider establishing a loyalty program to attract more travelers onto public transportation. In addition, the transport authorities can build park and ride facilities and reimburse portion of the parking fees for those who use these facilities to park their cars and take public transportation to the airport. This reimbursement strategy may encourage those who do not use public transportation from inside Dubai City to use this system, and attract those who live outside the city by parking in these facilities and hence use public transportation.

We recommend further investigation and extension of the current approach by determining the effect of travel seasons on airport ground access mode choice. In winter season, Dubai encounters some active tourism activities particularly from outside the country, while in the summer many of the residents in the city and nearby cities flew to different destinations around the globe. This can contribute in providing more information to transport operators in the city to improve their individual services and increase their share of the airport ground access market. In addition, more research should be conducted on business travelers as the timing of the survey was at the end of December where many travelers from different nationalities travel for leisure purposes or to visit their families in their original countries. Finally, the results show that 20.6% of travelers who use their own cars to arrive to the airport reimbursed fully or partially for the parking cost. This high percentage needs exploring. Reimbursing parking cost encourages travelers to use their own cars.

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AIRLINE SPONSORSHIPS AND SPORTS – AN EXPLORATORY REVIEW OF MAJOR AIRLINE ENGAGEMENT

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ABSTRACT

Airline involvement in sport sponsorship has grown over the last few years as sponsorship activity has proven effective as one method to reach a global audience. Aiding in this move to the use of sponsorship is the growing role of social media networks that can be utilized with traditional media and event marketing activities to leverage the impact of the sponsorship. However, the extent of involvement in sports, the leading area of sponsorship activity, and across other events by the world's major air carriers varies greatly. This review examines the reported sponsorships engagements in sports by leading global airlines at the airline's web site.

KEYWORDS

Airline Marketing, Sports Marketing, Sponsorship programs

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1. INTRODUCTION

Airline marketing as a subject has faced numerous criticisms and difficulties (Das and Reisel, 1997; Bhargava, 2006; Gianatasio, 2016) through the years. Due to the structural and competitive constraints of a mature industry, along with a consumer base chasing whatever the lowest fares may be for a flight, questions have arisen about the efficiency and effectiveness of airline marketing programs. Often these concerns are raised as critics note about the easy copying of themes used in airline marketing, especially airline advertisements; i.e., the over-reliance of pictures of either the newest first class seat or photos of far-away tropic or urban landscape depending on the airline's network and routes being advertised. Recent literature concerning trends in airline marketing focuses on the increasing use of technology-driven approaches, away from large-scale advertising based programs (Bhargav, 2006; Franko, 2018). This review examines the role of one of the oldest marketing tactics – sponsorship – and how new technological approaches are being utilized in conjunction with the growing sub-discipline of sports marketing by airlines across the globe as these airlines seek to strengthen their brands.

2. SPONSORSHIP AND SPORTS MARKETING

In many marketing management textbooks, the role of sponsorship within the promotion - communication mix is often noted as one of the tools of public relations (Peter and Donnelly, 2015; Lamb, Hair and McDaniel; 2017) and may only be discussed in terms of event sponsorship (Grewal and Levy, 2018). Sponsorship may also be introduced as a marketing tactic when discussing the role of sales promotions and trade shows (Kotler and Keller, 2006). When trying to define exactly what sponsorship may entail, the American Marketing Association (AMA) web site presents two definitions of the term; one is from a leading marketing consulting firm in the field, IEG (see http://www.sponsorship.com/).

> Sponsorship (1): Advertising that seeks to establish a deeper association and integration between an advertiser and a publisher, often involving coordinated beyond-the-banner placements.
>
> Sponsorship (2): A cash and/or in-kind fee paid to a property (typically sports, entertainment, non-profit event or organization) in return for access to the exploitable commercial potential associated with that property. Source: IEG
> *Source: https://www.ama.org/resources/Pages/Dictionary.aspx*

This inability to reach a concise definition of the term and the role of sponsorship in the promotion - communication mix is not new. In reviewing the strategic role sponsorship may play in the promotion - communication mix, Dolphin (2003) found the lack of an agreed upon definition of the concept common but that most of the definitions do agree sponsorship is a paid activity for access and association to an event, organization, person or charitable cause. Unlike the AMA, most of the research reviewed by Dolphin (2003) clearly notes differences between sponsorship and advertising. While advertising may be one outcome of the sponsorship, and be used in supporting the sponsorship activity, sponsorship may not always be tied to advertising and have different strategic goals than advertising.

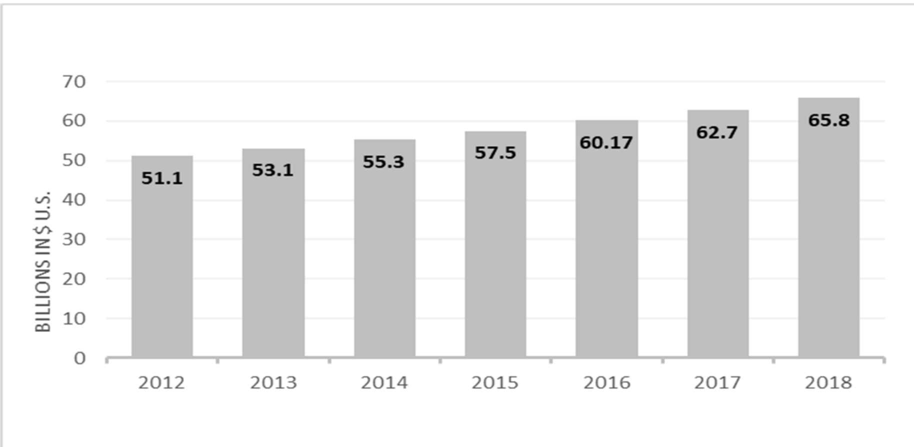
The inability to find a commonly accepted definition between the research on sponsorship and in marketing texts may in fact relate to the different goals sponsorship may fulfill. There are many reasons marketers may become involved in sponsorship, listed are some of the following:

Identify with a target market	Build brand awareness local and globally
Identify with a life style	Create / reinforce brand perceptions & associations
Enhance corporate image	Express commitment a community
Entertain key clients & customers	Support merchandising opportunities
Stimulate sales	Employee reward and moral building

(Source: derived from Dolphin, 2003; Kotler and Keller, 2006)

As shown herein, sponsorship may be used to meet a variety of possible corporate, marketing, promotional and internal human resource goals. Figure One displays how global spending on sponsorships have increased yearly, including projections for 2018, demonstrating how sponsorship spending is increasing by over 4% per year (IEG, 2016a; IEG 2018):

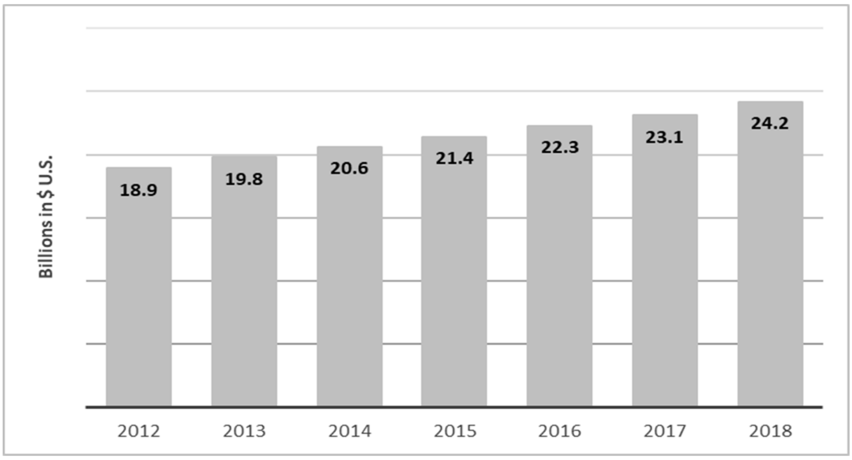
Figure 1: Global Sponsorship Spending



Source: IEG, 2016a; IEG 2018

By far, the greatest amount of spending currently occurs in the North American region (IEG, 2016a; IEG 2018). Figure Two displays the growth in spending in North America, also averaging over 4% per year.

Figure 2: North American Sponsorship Spending



Source: IEG, 2016a; IEG 2018

Examining spending trends in other global regions, excluding North America, Table One displays how spending is increasing, especially in the Asia Pacific region (IEG, 2016a; IEG 2018).

Table 1: Sponsorship Spending by Global Region (In Billions $ U.S.)

	2014	2015	2016	2017	2018	Avg. Growth Percentage
Europe	14.8	15.3	16	16.7	17.6	4.43 %
Asia Pacific	13.3	14	14.8	15.7	16.6	5.70 %
Central/South America	4.2	4.3	4.4	4.5	4.6	2.30 %
All Other Countries	2.4	2.5	2.6	2.7	2.8	3.93 %

Source: IEG, 2016a; IEG 2018

While sponsorships by category are not reported globally, the data available from North America clearly demonstrates that sponsorship related to sport is by far the leading category (IEG2016A, IEG, 2018). Table Two shows the spending pattern for North America by category or property type and the growth percentage over the years. An examination of the spending projections for 2018 easily reflects how sports sponsorship dominates in the overall percentage of dollars by category type. Specifically, the percentage values by category in 2018 are 70% for Sports, 10% for Entertainment, 9% for Causes, 4% for Arts, 4% for Festivals and Fairs, and 3% for Associations and Memberships.

Table 2: North America Sponsorship Spending by Category (In Billions $ U.S.)

	2014	2015	2016	2017	2018	Avg. Growth Percentage
Sports	14.35	14.99	15.7	16.26	17.05	4.41%
Entertainment	2.05	2.13	2.22	2.29	2.4	4.02%
Causes	1.85	1.92	1.99	2.05	2.14	3.71%
Arts	.923	.939	.962	.993	1.03	2.78%
Festival, Fairs and Annual Events	.847	.860	.878	.903	.936	2.53%
Associations and Membership Organizations	.574	.591	.604	.616	.635	2.56%

Source: IEG, 2016a; IEG 2018

With the growth in sponsorship spending, the research effort of trying to develop the value of sponsorship has increased. As sport sponsorship has lead in the spending by type of sponsorship, much of the research is found in sports related journals. As a starting point research in the past has focused on the biggest global sporting event, the Olympics (Tripodi and Hirons, 2009; Cho; et al.; 2011; Ellis, Parent and Seguin, 2016) or on sponsorship in auto racing focusing on the two major racing series, Formula One and NASCAR (DeGaris, Kwak and McDaniel, 2017; Jensen and Cobbs, 2014; Rotthoff, Depken, and Groothuis, 2014). In a recent publication, Grohs (2015) found 44 studies that focused on sponsorship and the effects on the sponsors brand image from 1995 to 2014 with the Olympics, auto racing and football (soccer) being the most consistent sponsorship areas across the studies. Also of note, while the sports involved are identified by league for most of the 44 studies, the sponsoring firms, if named in the articles, are not identified by Grohs (2015).

3. AIRLINE SPONSORSHIP

While a historical review of airline sponsorship was not undertaken for this study, sponsorship has long been used by airlines. In the past the aviation literature on sponsorship might be covered as Nelms (1996) did in a report on Delta becoming the official airline of the 1996 Atlanta Summer Olympic games. The article reads much like a case study of the airline strategy in acquiring the sponsorship as being the official carrier and the operational aspects the games would have on the airline's main hub in Atlanta. As with many sponsorship articles, the sponsorship focus for Delta is on building the carriers brand awareness globally. Relatively few such articles appeared in the past with an airlines focus. With the growth in sponsorship and firms such as IEG (www.sponsorship.com), SportBusiness (www.sportbusiness.com), and Nielson Research, who recently launched a separate sports sponsorship reporting service, Nielsen Sports (www.nielsensports.com) now regularly reporting on sponsorships, it would be hard to not find a story on some airline sponsorship deal being signed almost on a daily basis.

The other way sponsorship as a tool of the airline promotional mix was known in the past was for the traditional public relations tasks of community involvement and corporate social responsibility response (Dasburg, 1998). Airline management needed to be ready to respond to the request for services and assistance from the communities the airline served and have long recognized the need to have a strategy to deal with this request and get the stories to the public about the activities engaged. In the US, it is not uncommon in fact for the sponsorship links on the web site to focus more on the charitable aspects of the firm and how the airline responds to charitable requests. An example of this would be the American Airlines web page "let good take flight" (https://www.aa.com/i18n/customer-service/about-us/let-good-take-flight/let-good-take-flight.jsp) which highlights the various non-profit and community-based organizations the airline and its employees participate currently along with links to how to engage the airline in a program.

Academic research on the use of sponsorships by airlines is rather lacking. As noted, Grohs (2016) did not directly identify whom the sponsors were in the article found in his research on brand image. Additionally, in an earlier review of sponsorship research Cornwell and Maignan (1998) also do not identify the sponsors in the 78 articles referenced in the review and in the table presented provide no clear airline sponsor identity. One of the few articles found directly referencing the role of sponsorship by an airline is a case study of Turkish Airlines (Atas, Morris and Bat, 2015) during the late 2000s to 2013. The case study interviewed three members of the Turkish Airlines marketing staff who provide their views on the selection of the sponsorship and accompanying advertising and other promotion tactics of the airline at that time. While stating their belief in the tactics used, there is no empirical evidence presented to support the claims.

Another academic article found noted sponsorship only by example as the article's focus is more on the brand messaging strategies used in social media communications (Coursaris, Osch, and Balogh, 2016). The article examines how three firms, Delta Air Lines, Wal-Mart and McDonalds utilize Facebook in two selected periods in 2012 post content on the firms' Facebook pages. The article proposes a typology of social media communication strategies and then reviews the messages posted during the time periods used to derive the typology. Within the article, four sub-categories, Promotion, Awareness, Fundraisers and Event are identified to contain posts that deal with the content of sponsorships. Due to the manner in which the data was presented only examples of the sub-categories were shown. Totaling the Delta percentages from the main data table, the four sub-categories that may have sponsorship content posted by Delta are less than 2% of the total messages across the three firms in the study.

4. TACTICAL EXAMPLES OF SPONSORSHIPS BY AIRLINES

With the growth of the international airline industry, more and more firms have striven to market across the globe the active promotion of sponsorship activities, especially across country borders. While local or domestic related sponsorships are still common, catering to the events and demographics of an airlines home market, international and cross border sponsorships are more common. As satellite and digital communications have grown with the world of digital tools and apps now offered by sports networks such as ESPN and NBC Sports, more sports are global in their reach. While the Olympics and the FIFA World Cup are clearly global sporting events, now some leagues and series across sports are challenging for global dominance.

In the past some airline consultants suggested that airlines not become involved in dangerous sports like racing (Shaw, 2011, page 296). However, over the past 20 years F1 has become known as the world's most watched racing series and most successful in garnering sponsorship dollars, surpassing FIFA (Sylt, 2015). Airlines are now the major sponsor of F1 Grand Prix races such as the Singapore Airlines Singapore Grand Prix (http://www.singaporegp.sg), the F1 Etihad Airways Abu Dhabi Grand Prix and the F1 Gulf Air Bahrain Grand Prix (https://www.formula1.com/en/championship/races/2017.html). If not named as a title sponsor, airline involvement in F1 can still be seen by the numerous advertisements around the track by being a "Global Partner of F1" as Emirates is currently signed to be through 2018 (Paul, 2013).

Another major sport airlines have especially become active in sponsoring is football clubs. Most noticeably is the English Premier League, the most watched soccer league globally (Total Sportek, 2017). Airlines have become the major sponsor on the soccer kit (the uniform shirt) as Emirates has with Arsenal and Etihad with Manchester City. Overall, for the EU soccer leagues, UAE firms are noted for spending the most in 2015/2016 at $183 million as Emirates has deals additionally with Real Madrid and Paris Saint-German (Badenhausen, 2016). While not part of the Emirates spending, Qatar Airlines cannot be forgotten in the world of global soccer sponsorship. Qatar renewed their shirt deal sponsorship with Barcelona for 2016/2017 for 33.5 million EU (Marsden, 2016). In the future, while no longer being the shirt sponsor, Barcelona and Qatar just signed a new sponsor deal for 50 million Euros per year to be the official club carrier and receive other marketing rights (Nicholson, 2017a). Additionally, Qatar has just signed to become the world sponsor of FIFA, replacing Emirates going forward immediately through 2022 when the World Cup will be held in Doha, Qatar (Nicholson, 2017b). As noted with Qatar's changing agreement with Barcelona, if not on the shirt, the other way airlines are becoming involved with teams is by becoming an official partner of the team. In the English Premier League sponsorship arrangements exists between Delta with Chelsea, Malaysia Airlines with Liverpool, South African Airlines with Sunderland and Aeroflot with Manchester United. In comments by Emirates founding CEO, Sir Maurice Flanagan, the airline's investment in sponsorships, especially football is made clear. "Advertising never produces the same exposure for the money as the rights sponsorship, especially on TV," stated Sir Maurice (Halligan, 2015). Sir Maurice believes that the rights deal struck between Emirates and the Arsenal Football Club, which includes not just the shirt, but naming rights for the club's stadium, was the best deal the airline made as Emirates began its sponsorship strategy (Halligan, 2015). Examining the web sites of the world's leading airlines it is easy to see the role sponsorship has in the communication and marketing tactics of the airline. Many of the leading global carriers have dedicated sponsorship pages across the sport and other cultural activities the airline is engaged in. For this exploratory review an examination of the Top 50 airlines as presented in the "World Airline Rankings - 2016" published by Flight Airline Business (2016; page 11) was conducted in the spring of 2017. Of the Top 50 airlines, sixteen of the airlines (32%) have dedicated web pages on the airline's web site to present the sports sponsorships involved with at this time.

Table 3: Airlines with sports dedicated sponsorship pages

Emirates Airline	Southwest Airlines
Lufthansa	Air France
Ryanair	Turkish Airlines
Etihad Airways	Qantas
Aeroflot	Korean Air
JetBlue Airways	Malaysia Airlines
China Airlines	Swiss
Avianca	EVA Air

In terms of the individual sport, the three sports most sponsored by the airlines are football (soccer) by 16 airlines; basketball by 14 airlines; and golf by 13 airlines. Besides the individual sports, 16 airlines either on the web sites sponsorship page or in the airlines press releases presented sponsorship involvement in the Olympic movement, often by being the countries' official airline for the national Olympic team. While not the focus of this review, it is of note that in the area of corporate social responsibility, focusing on either charitable and / or environmental - sustainability issues, 30 of the 50 airlines (60%) had dedicated pages on these areas on the airline's web site. Therefore, while spending is heavily focused towards sports sponsorship activities found based on the existent data, due to the regulatory and social climate, airlines now focus more attention on the web site on the air carriers corporate and sustainability efforts.

One public source does provide an overview of the leading US airlines and the sponsorship activities engaged in by the carriers. Examining US airlines data from 2015 (IEG, 2016b), Table Four shows the amount spent by US airlines across the major categories and with whom the largest deals are.

Table 4: The five biggest spenders among the U.S. Airlines for Sponsorships in 2015

Spending Categories

	Est Total Millions	Sports	Arts	Entertainment	Cause	Festivals	Other
United	$35-$40	45%	24%	18%	8%	4%	1%
Delta	$25-$30	58%	15%	4%	17%	6%	
American	$20-$25	26%	30%	4%	26%	12%	1%
Southwest	$10-$15	57%	3%	0	29%	11%	
JetBlue	$5-$10	60%	3%	0	30%	7%	

Source: *http://www.sponsorship.com/iegsr/2016/07/25/Sponsor-Profiles--The-Five-Biggest-Spenders-In-The.aspx*

Top Sponsorship Deals in 2015 for U.S.Airlines

United: Chicago Bears, PGA Tour, San Francisco 49ers, United Center - Chicago, U.S. Olympic Committee

Delta: Los Angeles Lakers, Madison Square Garden, New York Mets, New York Yankees

American: AA Arena - Miami, AA Arena - Dallas, Dallas Cowboys, Los Angeles Clippers, Race for the Cure

Southwest: Denver Nuggets, Phoenix Suns, Texas Rangers

JetBlue: Boston Red Sox, Boston Bruins, New England Patriots, University of Southern California

The table clearly shows the commitment to sports sponsorships among the US airlines. Most of the top deals are clearly with teams that either are in an airline hub city or focused on key cities for the airline network and growth. Examining the web sites of the US airlines above, it is of note that only Southwest and JetBlue clearly identify sponsorship partners on their web sites on a dedicated page, while Delta promotes the airline's sponsorships in the recently revised Delta NewsHub (https://news.delta.com).

5. SPONSORSHIP ACTIVATION AND LEVERAGE

Besides the spending for the rights, for the sponsorship to be effective the firm must engage in activation and leveraging of the sponsorship. Leveraging encompasses all sponsorship marketing communication while activation relates to those activities and messages for audiences to interact and become involved with the sponsor (Weeks, Cornwell, Drennan, 2008). It is through the various forms of leverage and activation that many of the goals for sponsorship, such as creating positive perceptions, brand image building, and for some low involvement purchases increasing the likelihood of purchase, are accomplished (Carrillat and d'Astous, 2013; Herrmann, et. al.; 2016). Table Five presents the many ways a sponsorship can be leveraged across promotional and distribution networks (O'Reilly and Horning, 2013). The table demonstrates that depending upon the marketing strategy and tactics to be utilized, sponsorships can be utilized to do outreach in variety of means, both traditional broadcast and person to person or across social networks.

While rates for spending beyond the rights acquired may vary by the activity selected, these spending categories typically include traditional media uses such as advertising and public relations with a focus on the need to track dollars and show a marketing return. Activation activities such as having on-site hospitality, web sites and social media utilization are more often being engaged. As the range for leverage spending can be anywhere up to 7 times right fees (O'Reilly and Horning, 2013), the spending must be able to demonstrate its value.

As has occurred in much of the marketing field, the addition of social media networks and digital communication tools has influenced the tactical applications of sponsorship. Research into sponsorship leverage has demonstrated the benefits of traditional promotional and communication tools, such as advertising, for meeting firm goals and engaging the audience (Carrillat and d'Astous, 2013). The additional aspect that the sponsorship and leveraged activities possess today is the ability to measure the responses and track data from the social media networks utilized (Rashid, et. al., 2017). Concepts such as big data and data analytics of traveler's behavior (Kahn, 2016) have become topics of concern. Sponsorships and the associated additional promotion and media tactics that can be leveraged can build data and relay to the airline aspects such as trip purpose, other transport modes utilized and other socio-cultural and demographic data.

Table 5: Sponsorship Activation Methods

Advertising (TV, Radio, Magazine, Newspaper, Brochures, Outdoor)	Digital / Social / Mobile Media
Public relations / Media Coverage	On-Line campaigns (Websites, Blogs)
Signage / Logo Placement / Banners / PA Announcements / Logo on Scoreboard or Uniforms	On-Site Hospitality / Events / Client Entertainment / VIP Passes
In-Store Displays / Point of Sale Promotions / Coupons	Off Site Events
Samples / Product-Event Integration / Product Demonstrations / Event-Based Distribution	Sponsorship Tie-In Promotions
On-Pack Signage / Company Vehicle Signage Licensing / Merchandising	Direct Marketing / Business to Business Communications
Giveaways / Contests / Sweepstakes / Games / Memorabilia / Premiums	Internal Marketing / Employee Programs
Player Sponsorships / Meet and Greets / Product Use	New Product / Services
On-Site Personnel / research / Consumer Interaction	Cause Related Tie-ins

Source: O'Reilly, N and Horning, D. (2013; page 427)

Some forms of social media are easier to track than others. Micro blogs, such as Twitter, are perhaps the easiest to track as hashtags can be created that are tied to events and locations. Studies have already appeared tracking twitter use during sporting events (Jensen, Limbu and Spong, 2015) and using both visual analytics and the use of hashtags found the ratio of hashtags between the teams and sponsors involved in the event. Of note this was only the third research article found where an airline, Qatar Airways in this article, was identified as a sponsoring firm for Barcelona.

Social networks that utilize photographs (e.g., Instagram) or selfies (e.g., Snapchat, WeChat) and now live streaming (Facebook, Periscope) video taken by travelers may note the location and the purpose of the trip. Bowles (2016) found when examining the Instagram posts by member schools of the Southeastern Conference in the NCAA in the U.S. that 174 of the 1,599 images or videos posted (15%) clearly had a promotional focus including both sales promotion and sponsorship content. As other "theme" categories in the study including Fans and Landmark (stadiums and arenas), other common sponsorship content is likely present and can be analyzed. Monitoring systems now allows firms to scan the backgrounds details to see the nature of the event and the demographics of the participants at the event (MacMillan and Dwoskin, 2014). Whereas in the past some sponsorships may have been difficult to measure the associated value (Shaw, 2004), the social network and analytical systems today allow specific measurements to be determined. With the ability to leverage the airlines web site and social media platforms, such as Facebook, Twitter, Instagram and WeChat, airlines are well positioned to offer contests and sweepstakes, travel prizes and create hashtags to engage with targeted customers on the social media platforms. With the data that may come from a sponsorship, targeted messages can be sent to find the right customer that may react positively to an offer from the airline (Yardley, 2016).

6. CONCLUSIONS AND FUTURE RESEARCH

As the amount of public data on the spending by airlines is limited and not all sponsorship announcements include the total amount to be spent, including activation and leveraging activities, the exact amount being spent is difficult to determine. While internal budgets within the airline should be able to report the exact amount that leveraging and activation activities are costing, only general rules of thumb appear in much of the marketing literature. Whether such rules of thumb as guidance are correct for the strategic and marketing goals undertaken with the sponsorship are always debatable.

Another concern is the amount of 'fit' or congruence between airlines and the sponsored events. As a majority of sponsorship dollars are going to sporting events, there is research suggesting that transportation services and sports are not seen as very related or providing a good fit for the sponsorship (Gupta and Yousaf, 2015). To overcome the incongruence that may exist, firms may have to spend more and engage in multiple leveraging activities targeted towards the consumers (fans) of the participating teams in the event to build a positive attitude towards the sponsorship and the brand (Mazodier and Quester, 2014). Therefore, for airline sponsorships to meet the goals of the firm, additional spending beyond the rules of thumb that appears in much of the marketing literature may need to be engaged in to overcome the incongruence that may exist between the event and the sponsorship.

With the increase in the use of social media and influencers in sponsorship activities, research on the success and failures of sponsorship leveraging and activation needs to continue. Reports on social media usage show the rapid acceptance of the technologies and digital platforms among younger age groups. This only means more focus on how to engage with potential new fliers through the interaction of sponsorship, sales promotion and marketing communications is needed. Marketers like the use of social media as the networks allow firms to get personal data as never before and allows the ability to provide metrics that in the past were unavailable. Many social media platforms have dedicated pages, forums, or channels that allow targeting of the consumers engaged in the sponsored activity or event that can aid leveraging opportunities that can assist in overcoming any fit issues. The number of likes, friends, followers and reactions to past messages and posts can be found. However, caution must be taken to make sure these metrics are legitimate. With the spread of bots, fake accounts and the use of hashtags that can be the target for spammer and bots (Valdes, 2018), the ability to derive meaningful metrics must be undertaken. More data and personalization are becoming possible, but whether the sponsorship is really engaged with a person, not a bot or fake account is now a concern.

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WHAT DRIVES AIRLINES TO MAKE A CROSS-BORDER INVESTMENT? FIRM-LEVEL FACTORS AND INSTITUTIONAL FACTORS

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ABSTRACT

The purpose of this research is to identify the determinants of cross-border investment in the airline industry, focusing on the intangible assets and resources which airlines possess and the institutional differences between home and host countries. The empirical results indicate that airlines have fewer incentives for making foreign investment in other airlines in institutionally different countries and culturally different countries. Furthermore, government restriction on foreign ownership in the host country may discourage airlines to pursue investment in such country. The results weakly support a hypothesis that the more intangible assets airlines possess, the more they may be induced to make FDI. We interpreted the results as follows: the FDI decision of the airline industry may be accounted for by Dunning's Eclectic Paradigm model just as other industries may be; the institutional difference may have an overwhelming impact on airlines for their FDI decisions; and further studies may be necessary in scrutinizing the role of intangible assets of airlines.

KEYWORDS

Foreign direct investment; Institutional difference; Foreign ownership restriction; Intangible assets; LCCs; Eclectic Paradigm

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1. INTRODUCTION

Cross-border investments by the airline industry have increased in recent years. Major full-service European airlines, such as British Airways (UK), Air France (France) and Lufthansa (Germany), have initiated mergers and acquisitions with airlines in foreign countries. These airlines have been consolidated into major airline groups. Furthermore, airlines such as Virgin Group (UK), LATAM (Brazil and Chile), Qantas (Australia), Singapore (Singapore), Air Asia (Malaysia) and Etihad (UAE) have created subsidiaries of their brands in foreign countries.

These and a few other airlines are more actively involved in and exert greater control over the foreign airlines. What drives airlines to expand internationally by way of investing in a foreign country? What firm- and country-level factors may play a key role for an airline to decide on such investments?

The factors and incentives for a firm to decide on foreign direct investment (FDI) have been among the major research topics in international business (IB) studies. IB studies are the leading academic discipline that explores the questions of why, when and how a firm becomes international (Buckley, 2002). Many studies focusing on both the manufacturing and services industries have examined and identified such factors as monopoly power, intangible assets, rivalry relationship, transaction costs, and location conditions, among others. However, past research has largely ignored FDI by the airline industry. With the notable exceptions of Albers et al. (2010), Ramón-Rodríguez et al. (2011), Franco-Arroyave et al. (2014), and Endo (2017), only a limited number of studies have examined major factors for airlines to invest in foreign countries.

The purpose of our research is to identify the firm-level and country-level determinants of FDI by the airline industry, focusing on both the intangible assets that airlines possess and the institutional difference between the home and host countries that they are constrained with. Specifically, it develops hypotheses regarding the impact of intangible assets and institutional difference on FDI decisions based upon IB studies. This research is one of the first studies that examines both intangible assets and institutional difference as determinants for FDI in airlines based upon the statistical regression analysis.

2. TREND OF FDI IN AIRLINES

FDI refers to the firm behaviour in which a firm establishes another firm in a foreign country, known as a foreign subsidiary. By doing so, a firm may transfer its people, capital, management know-how, technology and skills to run business in a foreign market, usually by producing and/or marketing, distributing and selling products and services to foreign clients. A parent firm may establish a foreign subsidiary by acquiring an existing firm in a foreign country (M&A) or by incorporating a firm from scratch (Green-field investment). To be considered FDI, the investment ratio of a parent firm in a foreign subsidiary should be 10% or greater.

Since the end of WW-II, trade has become liberalized under the multilateral trade framework, the GATT/WTO system, along with additional regional free trade agreements such as EEA, NAFTA, and TPP. On the contrary, cross-border investment is still regulated by a network of bilateral investment treaties between home and host countries. Furthermore, FDI is often subject to a host of domestic regulations such as safety standards and labour regulations that apply equally to both domestic and foreign firms. It may also be subject to local contents requirements and foreign ownership restrictions that apply specifically to foreign-owned firms.

Because the liberalization of trade has progressed steadily and multilaterally while that of FDI has not, trade and FDI have often been considered a substitute relationship (Caves and Jones, 1985). A firm may internationalize by pursuing a trade instead of FDI as it may face more difficulty internationalizing through FDI. However, in recent years, FDI has become the most important driving force for a firm to internationalize. Even if a firm may want to export, it may need to set up a foreign subsidiary to undertake distribution, sales, marketing, and after-market activities. In other words, trade and FDI may be a complementary relationship. Furthermore, a firm may also pursue FDI to establish production capabilities in a foreign country. Accordingly, the amount of FDI flow has far surpassed that of trade (Hill, 2014).

The airline industry is one of a few industries that are left behind this trend. Most bilateral frameworks and domestic regulations establish a rule to restrict FDI in the airline industries. Their goal is that substantial ownership and effective control of airlines operating international air transport services belong to the nationals of the contracting countries. This rule is referred to as the nationality clause.

As such, the scope of internationalization of air transport services has remained limited, and internationalization for many airlines means to transport passengers and cargo from their home countries to foreign destinations (Third Freedom) and back (Fourth Freedom). For a few airlines, it also means to transport passengers and cargo between two foreign locations, either by exercising a so-called Fifth Freedom (i.e., two foreign locations are served by a multi-stop flight originating in one's home country) or a Sixth Freedom (i.e., two foreign locations are served by flights connected through one's home country). However, until recently, few airlines freely transport passengers and cargo between two foreign locations, be they internationally or domestically without involving one's own country by exercising so-called Seventh, Eighth and Ninth Freedoms (ICAO, https://www.icao.int/Pages/freedomsAir.aspx).

Under these restrictive conditions, airlines typically internationalize by establishing foreign branch offices in place of incorporating foreign subsidiary through FDI. A foreign branch office is considered an extension of a home-country organization, most frequently used when the size of the operation is small and the level of strategic, managerial and operational complexity is low (Cerutti et al.,2007). They show stark contrast with many multinational enterprises that internationalize operations by undertaking FDI to set up foreign subsidiaries. These foreign subsidiaries are legally separate entities, even if they are owned and controlled by their parent firms. They are given strategic flexibilities and delegated managerial responsibilities even if they are carefully coordinated with those of their parent firms.

Recently, some countries and regions have reviewed the nationality clause and implemented more liberal revisions to it. As notable examples, the rule of the principal place of business as a substitute for substantial ownership has been adopted in a bilateral framework between Australia and other countries, in a multilateral open-skies agreement comprising the US and seven other countries, and in a multilateral agreement among Pacific island countries (Hocking, 2011; Endo, 2017).

The EU's single market for aviation and its extension, called the European Common Aviation Area (ECAA), and the Australia-New Zealand Single Airline Area (ANZSAA) introduced the common airline operating certificate. They allow nationality over multiple countries and free cross-border investment among countries within these areas. Furthermore, as a substitute provision to effective control, effective regulatory control over airlines by the designated country has been proposed in the ICAO and World Economic Forum (Chang et al., 2004; Endo, 2017). Several governments have responded positively to the proposal and incorporated the effective regulatory control clause into their bilateral agreements. Notable examples include those by Brazil and Colombia.

Regarding a domestic regulation restricting foreign ownership, the most common upper limit of such ownership is 49%. Regulations in the US, Japan, Egypt, Saudi Arabia, and a few other countries stipulate that a level of foreign ownership must be less than 33%. However, along with the recent liberalization trend, several countries have removed the upper limit and now allow up to 100% of foreign ownership, marking a new era of internationalization in the airline industry.

As noted, such airlines as Singapore Airlines (Singapore), LAN (Chile), Virgin Atlantic (UK) and Qantas (Australia) have actively pursued the cross-border investment. They have established their own brand airlines and served routes between two points outside of their home countries. More recently, Etihad (UAE), Qatar (Qatar), AirAsia (Malaysia), Delta (US) and Hainan (China) are rapidly emerging as major sources of such investments. The most common recipients of FDI by these airlines are Europe, Asia, Australia, and South America.[1]

These airlines may represent a breakthrough in the internationalization of the airline industry. By establishing foreign subsidiaries, they may access to a much larger foreign market than the markets that their branch operations have been serving. Equally important, they may be able to undertake a far broader scope of business activities than those activities that airlines with foreign branch operations may pursue by deploying their resources and capabilities that may constitute competitiveness.

It may be obvious that the liberalization of some of the bilateral treaties and the domestic regulations have prompted these front-runners to pursue FDI and have moved their internationalization strategies to the next level. However, are other airlines following suit? Which airlines may more likely pursue FDI in going their internationalization strategies beyond the current level? Likewise, which airlines may more likely continue using branch operations? What may be key driving forces that may make airlines explore a new level of internationalization by pursuing FDI?

3. LITERATURE REVIEW

Past research in different schools of thought has identified various incentives for firms to pursue FDI. They include international economics, the industrial organization approach, the transaction cost theory, the institutional approach, the Eclectic Paradigm, and the resource-

[1]Some countries set conditions for 100% of foreign ownership in airlines. For example, Australia allows up to 100% only as regards airlines operating domestic services. India imposes 49% cap on the ownership of foreign airlines.

based view, among others. Early research by Hymer (1976) uncovers that, if a firm possesses monopoly power, it may be able to exercise such monopolistic power by investing in a foreign market because the market is imperfectly competitive. According to Caves (1971, 1982), a firm possessing transferrable advantages has the desire to use them more effectively overseas, which laid down the economics foundation for the resource-based view.

Knickerbocker (1973) explores the relationship between FDI and the competitive nature of firms in an oligopolistic industry. He identifies the strategic follow-the-leader behaviour as an incentive for FDI. Vernon (1966) expands the Ricardian comparative advantage model to observe different location advantages. He concludes that firms from capital- and technologies-intensive countries pursue FDI in the capital- and technologies-scarce countries at the final stage of the product life cycle in which the product has become standardized, transferring technologies has become easier, and other production factors including labour and materials are abundant and less expensive in such countries. Finally, the transaction cost theory begins by assuming that the market is incomplete, and information and knowledge are uncertain. Therefore, it is economically rational for an organization to perform certain transactions internally rather than through the market (Rugman and Verbeke, 2003).

Dunning has integrated these various approaches into the "Eclectic Paradigm" (Dunning, 2000; Dunning, 1998). According to this view, a firm may select foreign production through FDI rather than through licensing if all the three, not just one or two, advantages exist. The three advantages are an "ownership-specific" advantage based on transferable advantages that a firm possesses, an "internalization" advantage of the incomplete market, and a "location-specific" advantage due to gaining resources that are related to a specific location and that are worth associating with the transferable advantages. Dunning not only integrates all the key approaches on FDI under one platform but also highlights substantial barriers for a firm to endeavour FDI – unless a firm recognizes that all the three advantages exist, it may not be successful in pursuing FDI.

Since the Eclectic Paradigm was introduced, it has become a dominant approach to examining the internationalization strategies of a firm. Many types of research have employed the approach to analyse determinants of FDI in the internationalization of a firm (Ferreira et al., 2011). Those researches have also highlighted difficulties in operationalization, especially in examining the ownership advantage and the location advantage (Narula, 2010).

As for the ownership advantage, such traditional performance indicators as revenues and profits to demonstrate firm-level capabilities, ex-post, have become supplemented by a series of "intangible assets" that the resource-based view scholars have introduced. These assets comprise technological know-how, patents, trade-marks, trade-secrets, management skills, brands, and goodwill, among others. They are unique to each firm and constitute a source of competitive advantage of a firm (Barney, 1991; Peteraf, 1993; Grant, 1996; Delios and Beamish, 2001).

A firm that possesses abundant intangible assets may have an incentive to pursue either one of the following two strategies. One is to license them to other firms if a market is perfect, under which such assets may be easily traded between firms and at the same time such a transaction may be well-protected so that a firm may not need to worry about a free-riding problem. Another is to internalize intangible assets by transferring them to foreign subsidiaries through FDI and try to fully exploit them to establish the ownership advantage in foreign markets (Ferreira et al., 2011).

Since few markets are perfectly competitive, firms with a rich pool of intangible assets may face difficulties in licensing them to other firms. This is so because intangible assets typically have high specificity which may not be immediately and directly applicable to other firms (Anderson and Gatignon, 1986; Endo et al., 2014). Furthermore, as Coase's theorem may indicate, a firm may face difficulty in pricing these types of assets appropriately or enforcing transaction in the market because of a high market transaction cost due to specificity and information asymmetry (Caves, 1971; Grant, 1987; Lu and Beamish, 2004). Accordingly, they may thus be more inclined to choose FDI over licensing in entering foreign markets.

The airline industry is no exception. This imperfect market condition may lead to uncertainty when airlines explore opportunities to undertake a market transaction of the intangible asset with other airlines. They may be faced with such difficulties as information asymmetry, opportunistic behaviour, and difficulty in calculating their values through market transactions. Accordingly, they tend to pursue forms of alliances, such as franchising or simple flight cooperation even if they have decided not to undertake FDI to fully transfer intangible assets internally to their foreign subsidiaries (Bouquet et al., 2004; Endo, 2010).

This observation is linked to another one about the market. Markets around the world are not only far from perfect but also different from each other. Traditionally, studies of international economics have focused on factor endowments as the single source of differences among countries that define the pattern of trade and hence, the location advantage of national economies. However, in the last three decades, institutional studies have accumulated knowledge about national differences beyond factor endowments and their impacts on the location advantage of national economies and the internationalization strategy of a firm.

These studies have uncovered that markets are institutions and they are institutionalized by both formal institutions such as legal and political institutions and informal institutions such as cultures and social norms (North, 1990; Jackson and Deeg, 2008). Institutions and institutional differences among countries have thus become among the most important measures used to address the magnitude of national differences (Ando, 2012; Endo et al., 2014).

A firm investing abroad must crucially understand differences between its home and host countries not only in factor endowments but also in institutional dimensions. An institution may define utilities of its members including firms and customers, set their behaviour and impact their performance. As Brouthers (2002), Endo and Ozaki (2009), Jackson and Deeg (2008) and Meyer (2001) note, the institution of the host country and its difference from the home country may result in "restrictions, costs or hazards for MNEs" (Jackson and Deeg, 2008: 542).

A firm that conducts business in a foreign country is in a disadvantageous position compared to the local firm and cannot avoid encountering additional costs that the local firm does not (Eden and Miller, 2004; Nachum, 2003). This situation is conceptualized as the liability of foreignness. A previous study notes that the higher the level of institutional difference is, the greater the additional costs of conducting business abroad are (Eden and Miller, 2004; Nachum, 2003; Gaur and Lu, 2007).

Such costs are often divided into three scopes of hazard: unfamiliarity hazards, discriminatory hazards, and relational hazards (Eden and Miller, 2004). Unfamiliarity hazards arise because a foreign firm does not have enough knowledge and experience in the host country (Eden and Miller, 2004, Gaur and Lu, 2007; Caves, 1971). Discriminatory hazards reflect the discriminatory and differential treatment of foreign firms by governments, consumers or the public in the host country (Eden and Miller, 2004). Relational hazards follow the uncertainties in managing both internal and external relationships at a distance, and these hazards result in higher administrative costs (Eden and Miller, 2004; Gaur and Lu, 2007; Endo et al., 2011).

There are studies by Albers et al. (2010), Ramón-Rodríguez et al. (2011), Franco-Arroyave et al. (2014), and Endo (2017) that explore internationalization of the airline industry through FDI from the viewpoints of the aforementioned FDI theories. But other than them, few studies have examined FDI activities in the airline industry. These studies that examined the FDI of the airline industry highlight that insights from the FDI theories are relevant to the airline industry. For example, Albers et al. (2010) explain that the three advantages of Dunning (2000) influence FDI in LCCs. In particular, the ownership advantage stemming from capital and ownership structure is important. Franco-Arroyave et al. (2014) note that, in the case of Avianca, the South American airline, its advantage relying on economies of scale, monopoly power, and avoidance of competition motivated the airline to pursue FDI in its neighbouring countries. Endo (2017) focuses on the relationship between institutional difference and FDI through the country level analysis and points out the negative impact of such difference on the bilateral (country-country combination) FDI movement in the airline industry.

However, these studies do not necessarily go into lengths of the theoretical relevance of the Eclectic Model to FDI activities in the airline industry. This is so especially in the level of the ownership advantage and the location advantage based on the analysis of intangible assets and institutional difference. Albers et al. (2010) may be one of the few exceptions that does suggest the importance of intangible assets of airlines in their FDI.

Furthermore, the institutional dimension has been ignored as a factor affecting the decision of airlines in FDI. They show a stark contrast with the studies examining FDI in other industries. Many of them support the idea that the negative relationship exists between FDI and the institutional difference in the manufacturing industry and such services industries as finance, shipping, and tourism. (Buch and DeLong, 2004; Buch and Lipponer, 2007: Gaur and Lu, 2007: Nachum, 2003: Ando, 2012: Endo et al., 2014). The literature thus indicates that, at least in the industries other than the airline, institutional differences have been identified as a key factor that undermines both the ownership advantage and the locational advantage for firms to undertake FDI.

4. HYPOTHESIS DEVELOPMENT

4.1 Intangible assets

As mentioned, the resources and capabilities of a firm constitute a key foundation of its competitive advantage (Barney, 1991; Peteraf, 1993; Grant, 1996; Delios and Beamish, 2001). According to Barney (1991), a firm generates skills and knowledge and accumulates them as time passes. If they are valuable, rare, difficult to imitate and well-organized for mobilization and execution, they may contribute to sustained competitive advantage.

A firm that is rich in resources and capabilities has a strong motivation to take full advantage of them. By expanding foreign operations through FDI, firms may be able to use these resources and capabilities across countries and markets and thereby achieve economies of scale, scope, and learning, which contribute to augmented production efficiencies (Hitt et al., 1997; Endo and Ozaki, 2011).

As examined in the preceding literature review section, there were once difficulties to operationalize firm-level resources and capabilities in analysing the ownership advantage of the Eclectic Paradigm model. Traditionally, such performance indicators as revenues and profits were employed to demonstrate firm-level capabilities ex-post. However, in recent years, they have become supplemented by "intangible assets" that the resource-based view scholars have introduced (Barney, 1991; Peteraf, 1993; Grant, 1996; Delios and Beamish, 2001).

In airlines, intangible assets as capabilities contributing to competitiveness of a firm may be present in a wide variety of areas, including technologies, specialized skills, leadership and know-how for developing and offering competitive and attractive products and services, branding them as distinct and differentiated products and services, and efficiently and effectively managing airlines to deliver those products and services, among others. Furthermore, intangible assets may include organizational structure related to capital and ownership (Albers et al., 2010; Endo, 2010; Endo, 2017).

These assets shape a firm's competitive advantage regarding knowledge and organizational capability. Accordingly, airlines that possess such assets at a substantial level to make them feel confident about the ownership advantage may have the incentive to utilize them in foreign markets by pursuing FDI if host countries have location advantages, such as a host-country having a large market and a lower level of factor prices. This is so because the internalization advantage usually exists in many markets for the airline industry, as examined in the preceding literature review, and there are few incentives for an airline to license them to other airlines.

Hypothesis 1:

Airlines with a higher level of intangible assets have more incentives to invest in other airlines of a foreign country.

4.2 Institutional difference

As examined in the literature review section, North (1990) highlighted that the institution defines the strategic options and corresponding utilities from which actors, including firms and individuals, may choose. Actors from a foreign institution (e.g., a foreign country) may pursue a different strategy under a similar situation, place different priorities on the same set of strategic options relative to a similar situation, or even provide different meanings for a similar situation. As a result, a less transparent institution and a large institutional difference between host and home countries may significantly impact FDI decisions.

As scholars such as Jackson and Deeg (2008), Peng (2004), and Endo et al. (2014) note, a firm may encounter the risk and uncertainty of conducting business in a foreign country whose institutions differ from those of the home country, leading to increased transaction costs of pursuing FDI. The firm is thus discouraged from fully committing itself to its foreign subsidiary in transferring intangible assets.

We argue that institutional difference between the home and host countries is a critically important factor that affects the ownership advantage and the location advantage of airlines in pursuing FDI. If the institutional difference is wide between the two countries, it may substantially undermine the ownership advantage and the location advantage of airlines, resulting in reducing the incentive for them to pursue FDI in entering into a foreign market.

As discussed in the literature review section, there are two forms of institutions, one being formal and the other being informal. Formal institutions define a wide spectrum of business activities including the scope of business, the governance structure, market regulations, supply chain, competitive relations, and employee relations, among others. For example, in airline industry, some governments may continue to maintain regulations both in breadth and depth, including business licensing regulations, antitrust law, foreign capital ownership restrictions, labour-related regulations, and safety and service quality regulations, among others, while other governments may have liberalized some, or many, of these regulations (Walulik, 2017). If a home country has a set of more liberalized regulations while a host country has a set of stricter regulations, the difference of formal institutions is identified to be wide.

The institutional difference may also exist in informal institutions and affect a wide spectrum of business activities including customer preference, interfirm relations, and employee relations. For example, in some societies, a casual and friendly manner may be considered a good airline service while in other societies, such a manner may be considered rude. In some societies, customers may put strong affinity to national brands of airlines while in other societies, they may put more importance on price and quality rather than to nationality (Havel and Sanchez, 2011; Clark, 2010). In some societies, employee relations may be more vertical and hostile, while in other societies, they may be more egalitarian and cooperative (Hall and Soskice, 2001).

They highlight that airlines may be faced with more difficulties adapting to local regulations, employee relations, customer preferences and other dimensions of national differences if institutional differences between home and host countries may be wide. Accordingly, the following hypothesis may be proposed:

Hypothesis 2:

Airlines have less incentive to undertake FDI in a foreign country whose institution is more different from that of the home country.

5. METHODOLOGY

To test these hypotheses, we examine airlines undertaking FDI in foreign (host) countries. Similar to Buch and Lipponer (2007), the data is the airline-host country combination, comprising of observations of the investment by airlines directing at foreign countries, as Table 1 shows. The sampling process is as follows. We choose airlines, excluding charter airlines and regional airlines, which the Airline Business magazine ranks in the top 90 regarding revenue passenger kilometre in 2015. We select the top 90 countries in the world (including Taiwan as a separate entity) as host countries (recipient countries of foreign investment) based on GDP of 2014. We delete those observations that do not have information about the variables.

The dependent variable is an investment decision by airlines directing at foreign countries. The data for foreign investment where airlines have more than 10% ownership in foreign airlines in 2015 and the first half of 2016, shown in Table 1, is collected from the Alliance Survey of the September 2016 edition of the Airline Business magazine, the annual reports of airlines, magazines and newspapers.

We realize that FDI by airlines directed to foreign airlines is not a commonplace phenomenon. The total number of FDI in the airline industry is around 80, of which around 20 cases have missing information in some of the independent variables so that we may need to eliminate them from the examination. Because of the limited number of positive data, we aim at analysing the yes/no decision (i.e., what makes an airline to undertake/not-undertake FDI) rather than the in-degree decision (i.e., what makes an airline to undertake what level of FDI).

Table 1 - Foreign investments by airlines ranked in top 90 in terms of traffic: airlines having more than 10% stock ownership shares in foreign airlines

Investing airlines/ Home country	Recipient countries of foreign investment (Invested Airlines)
AirAsia/Malaysia	India(AirAsia), Indonesia(AirAsia, AirAsia X), Philippines(AirAsia), Thai(AirAsia, AirAsia X)
airberlin/Germany	Austria(Niki), Swiss(Belair)
Air France/France	Netherlands(KLM)
KLM/Netherland	France(Air France,Transavia),Kenya(Kenya)
Azul/Brazil	TAP(Portugal)
Avianca/Colombia	Costa Rica(Avianca), Ecuador(Avianca), El Salvador(Avianca)*, Guatemala(Avianca), Honduras(Avianca)*, Peru(Avianca)
Copa/Panama	Colombia(Copa)
Delta/US	UK(Virgin)
easyJet/UK	Swiss(easyJet)
Etihad/UAE	Australia(Virgin)*, Germany(airberin)*, India(Jet)*, Italy(Alitalia)*, Serbia(Serbia)*, Seychelles(Seychelles)*, Swiss(Darwin)*
Hainan/China	Australia(Virgin), Brazil(Azul), France(Aigle Azur), Portugal(TAP)
IAG:BA/UK	France(OpenSkies), Ireland(Aer Lingus),Spain(Iberia, Vueling), South Africa(Comair)
Iberia/Spain	UK(BA)
Korean/Korea	Czech(Czech)
LAN/Chile	Argentina(LAN), Brazil(TAM), Colombia(LAN), Ecuador(LAN)#, Peru(LAN)
TAM/Brazil	Chile(LAN), Paraguay(TAM)*
Lion/Indonesia	Malaysia(Malindo)*, Thai(Lion) *
Lufthansa/Germany	Austria(Austria), Belgium(Brussel), Italy(Dolomiti), Switzerland(Swiss), Turkey(SunExpress), US (JetBlue)
Air New Zealand/ New Zealand	Australia(Virgin)
Norwegian/Norway	Ireland(Norwegian)#, UK(Norwegian)#
Qantas/Australia	Fiji(Fiji)*, Japan(Jetstar), Singapore(Jetstar), Vietnam(Jetstar)
Qatar/Qatar	Brazil(TAM),Chile(LAN), Ireland(Aer Lingus), Italy(Meridiana) Spain(Iberia,Vueling), UK(BA)
Singapore/Singapore	Australia(Virgin), India(Vistara)#, Taiwan(Tiger)#
Spring/China	Japan(Spring)
Virgin/UK	Australia(Virgin), Samoa(Virgin)*,US(Virgin)
Volaris/Mexico	Costa Rica(Volaris)#

Note: Investing airlines-host country combination observations marked by * are not included in the statistical analysis because information for some independent variables is missing or because the observations are not from top 90 countries in terms of GDP. Investing airlines-host country combination observations marked by # are not included in the statistical regression analysis when the dependent variable is operationalized by the secondary measure in the form of (1+RPKs) for robustness check because the information for such measure is missing in several FDI cases. Source: Alliance Survey of the September 2016 edition of the Airline Business magazine, annual reports of airlines, magazines and newspapers.

As such, the dependent variable is operationalized by the binary dummy variable (FDI dummy) which takes the value of 1 when airlines invest in other airlines of a foreign country and have more than 10% stock ownership shares and which takes the value of zero when airlines do not make an investment in airlines of a foreign country or do not have more than 10% stock ownership shares there though they invest in foreign airlines. Since the dependent variable takes either the value of zero or one, OLS bears the risk of biased estimates (Greene, 2012; Maddala, 1992). Accordingly, we employ the logit method to analyse the impact on the binary dummy dependent variable.

In addition to the binary dummy variable as the primary measure for the dependent variable, we introduce the number of revenue passenger kilometres (RPKs) in 2014 or 2015 as the secondary measure to check the robustness of the estimation results. If airlines invest in foreign airlines and have more than 10% stock ownership shares there, the dependent variable is evaluated by RPKs. If airlines do not make an investment in foreign airlines or do not have more than 10% stock ownership shares even if they invest in such airlines, the variable takes the value of zero.

We take the logarithm of the secondary measure in the form of (1+RPKs) to avoid the problem caused by the secondary measure taking the value of zero. Since the dependent variable operationalized by the secondary measure is cornered at the value of zero and non-negative and partly continuous, the Tobit model analysis is an appropriate statistical technique.

The secondary measure is more suitable to operationalize the incentive for FDI because it can capture more information about the decision process in FDI. We may be able to analyse the decision not only of whether airlines invest in foreign airlines but also to what degree they invest and commit. However, as we noted, the information is missing in several FDI cases. The Tobit model is critically dependent on the two assumptions, i.e., the normal distribution in error terms and heteroscedasticity (Greene, 2012; Mandala, 1992). In this respect, our data may not perfectly satisfy the two assumptions. Accordingly, we designate the binary dummy variable as the primary measure to focus on the estimation result of the variable.

We have two types of independent variables, the firm-level variable for airlines making FDI and the country-level variable of both home and host (foreign) countries. We offer the definitions and operationalization of the firm-level variable as follows. Regarding the variable for intangible assets that airlines may possess, the most commonly used measure in analysing the internationalization of a firm in the services sector is the advertising intensity ratio, as expressed by dividing advertising expenses by operating revenues. However, only a small number of airlines disclose these data. The training and education intensity ratio may be another well-established measure, but again, the data is not readily available for the airline industry.

Accordingly, in place of these measures, we use the percentage of intangible assets to total assets in the balance sheet (b/s intangible assets). This measure was introduced by Nachum (2003) in the analysis of the financial industry. Intangible assets reported in the financial statements of airlines include airport slots, trademarks, and goodwill, among others.

We also use such commonly used measures as the profitability (the percentage of operating incomes to operating revenues) and the load factor as proxies for intangible assets. The relevance and the limit of these measures have been examined in the preceding literature review section. Airlines possessing more intangible assets may be able to perform better, achieving higher ratios of these measures. The expected sign of the coefficient for the three measures of the intangible assets is positive. Employing the three different measures serves for checking the robustness of estimation results.

Other firm-level variables include the percentage of debt of airlines that have made FDI, expressed by dividing the debt by total assets (debt ratio), and the operational size of airlines as measured by the logarithm of RPKs (operation size). The expected sign of the coefficient for the two variables is negative and positive respectively. The information on such variables as b/s intangible assets, debt ratio, and profitability in 2014 or 2015 are collected from the ICAO database as main source as well as the Airline Business magazine and the annual reports of airlines as a secondary source. The data source of load factor and RPKs is the Airline Business magazine, the ICAO database, and the IATA publication.

Regarding the country-level variable, we use the World Bank's Governance Indicators to evaluate the institutional difference. They take scores from +2.5 to -2.5 in the following six fields: accountability, political stability, government effectiveness, quality of regulation, the legal system, and corruption control. The higher the score of such Indicators may be, the more transparent the institution of the country concerned may be.

Any dataset may have strengths and weaknesses. We selected the World Bank's Governance Indicators for the following reasons. First, they focus on the formal legal and regulatory institutions, which should have paramount importance for the airline industry. Second, they integrate such factors associated with informal institutions as accountability, stability, effectiveness, quality of regulation and corruption that may affect the formal legal and regulatory institutions. And finally, the Indicators have been widely tested and used by the IB scholars in conducting empirical studies to examine the impact of institutional difference on a firm FDI strategy. In short, not only the dataset is reliable, but also it measures the fields that are immediately relevant to the country-level factors of our study.

Regarding the operationalization of the institutional difference variable, in each field, we calculate the squares of the difference in the score of the relevant two countries (home and host countries) and divide the squares by the variance of the score among all the countries. We then calculate the average values of the six fields. The expected sign for the institutional difference variable is negative. We also add a binary dummy variable for a common language, which is one of the surrogate variables for capturing the difference between the institution in the cultural and normative aspects of the home and the host countries. The dummy variable takes a value of 1 if home and host countries use the same official language. The expected sign of the coefficient for the common language variable is positive.

We include the foreign stock ownership percentage cap set by the host country when foreign airlines invest in firms operating air transport services (foreign ownership cap)[2]. The cap variable may take a positive sign. Airlines may have more incentives for investing in a host country where such cap is high. The information for the variable is collected from the World Bank database and Walulik (2016). We incorporate economic factors of home and host countries, measured by the logarithm of GDP of such countries, collected from the World Bank database. The expected sign is negative and positive respectively.

6. ESTIMATION RESULTS

Tables 2 shows descriptive statistics as well as correlation coefficients between variables. The correlation coefficients are not high in most cases. Also, variance inflation factors (VIFs) are less than 10. Accordingly, any serious problem of multicollinearity is not observed. We use the White heteroscedasticity-consistent standard errors to cope with the problem of heteroscedasticity.

[2] Only few countries (e.g. Australia) set different caps for locally licensed domestic operators and international operators. In this case, we choose the foreign stock ownership percentage cap regarding when foreign airlines invest in firms operating domestic air transport services.

Table 2 - Descriptive statistics of variables and their correlation coefficients

		1	2	3	4	5	6	7	8	9	10	11
1	FDI dummy	1										
2	b/s intangible assets	0.026	1									
3	load factor	0.009	0.100	1								
4	profitability	-0.014	-0.070	0.280	1							
5	debt ratio	-0.038	0.285	-0.109	-0.176	1						
6	operation size	0.015	0.302	0.106	0.093	-0.048	1					
7	institutional difference	-0.042	0.017	0.053	-0.053	-0.030	0.050	1				
8	common language	0.135	0.068	0.047	0.065	0.020	0.017	-0.004	1			
9	foreign ownership cap	0.041	0.029	0.089	-0.022	0.060	0.002	-0.086	0.060	1		
10	home country GDP	-0.030	0.328	0.250	0.008	0.161	0.470	0.017	0.039	-0.042	1	
11	host country GDP	0.059	-0.005	-0.003	-0.001	-0.002	-0.007	-0.055	0.062	-0.307	-0.015	1
	mean	0.016	4.918	81.303	3.870	84.728	10.946	1.841	0.072	62.030	14.226	12.830
	SD	0.124	6.547	4.574	7.444	21.709	0.805	1.916	0.259	29.058	1.459	1.376

Table 3 shows the estimation results. Model 1a includes only the b/s intangible assets percentage of the three measures of the intangible assets. Models 2a and 3a add load factor and profitability respectively. Models 1b, 2b, and 3b exclude the common language dummy variable from Models 1a, 2a, and 3a.

The coefficients of the b/s intangible assets percentage are positive as predicted. They are statistically significant ($p<0.05$). The load factor meets the sign condition in models 3a and 3b. However, it is not statistically significant. The profitability shows the unexpected negative sign. We observe that these results weakly support Hypothesis 1. Regarding the other firm-level factors, the debt ratio has the expected signs, and its coefficient is statistically significant ($p<0.01$). The operation size satisfies the positive sign condition, but it is not statistically significant.

The two institutional variables take the expected signs in their coefficients which are statistically significant. The institutional difference meets the sign condition and works statistically significantly ($p<0.05$). The coefficient of the common language dummy variable is positive as expected and highly statistically significant ($p<0.01$). These results imply that if the institutional difference is larger between the home and host countries, airlines of the home country have fewer incentives in investing in other airlines of the host country. We observe that these results support Hypothesis 2.

The foreign ownership cap variable shows the expected positive sign, which is statistically significant ($p<0.01$). The results demonstrate that airlines have more incentive to undertake FDI in a host country where the foreign stock ownership regulation is more liberalized. Home country GDP and host country GDP take expected signs. The coefficient of host country GDP variable is highly statistically significant (p<0.01).

Table 3 - Estimation results: Dependent variables is FDI dummy

	model 1a	model 1b	model 2a	model 2b	model 3a	model 3b
constant	-8.781***	-9.566***	-7.700**	-9.106***	-9.189***	-10.59***
	(2.782)	(2.869)	(3.071)	(3.135)	(3.461)	(3.611)
b/s intangible assets	0.039**	0.051**	0.041**	0.051**	0.041**	0.052**
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.021)
load factor			-0.016	-0.006	0.007	0.015
			(0.026)	(0.023)	(0.029)	(0.027)
profitability					-0.037**	-0.035*
					(0.016)	(0.019)
debt ratio	-0.017***	-0.020***	-0.018***	-0.020***	-0.021***	-0.024***
	(0.006)	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)
operation size	0.207	0.203	0.212	0.203	0.277	0.267
	(0.172)	(0.174)	(0.176)	(0.172)	(0.188)	(0.188)
institutional difference	-0.186**	-0.190**	-0.186**	-0.191**	-0.195**	-0.197**
	(0.082)	(0.089)	(0.082)	(0.090)	(0.081)	(0.088)
common language	1.890***		1.903***		1.953***	
	(0.293)		(0.296)		(0.301)	
foreign ownership cap	0.018***	0.020***	0.018***	0.020***	0.018***	0.020***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
home country GDP	-0.233**	-0.181*	-0.227**	-0.178*	-0.277**	-0.215*
	(0.105)	(0.105)	(0.102)	(0.101)	(0.118)	(0.112)
host country GDP	0.424***	0.460***	0.433***	0.462***	0.425***	0.456***
	(0.108)	(0.104)	(0.109)	(0.105)	(0.109)	(0.105)
Log likelihood	-257.00	-273.88	-256.84	-273.85	-254.36	-272.04
Chi-Square	83.63	49.88	83.96	49.94	88.90	53.56
Positive observations	58	58	58	58	58	58
Observations	3716	3716	3716	3716	3716	3716

We have checked the robustness of these estimation results by employing different measures for two major independent variables, the intangible assets, and the institutional difference. As pointed out, the results are not consistent among the three measures for the intangible assets, while the results are consistent between the two institutional difference measures.

Additionally, as mentioned, we performed the Tobit model analysis for the log (1+RPKs) as the alternative measure of the dependent variable. Table 4 shows the coefficient estimates based upon such analyses. Focusing on the two major independent variables, their results are consistent with those presented in Table 3 except for the b/s intangible assets percentage, which meets the sign condition but is not statistically significant when the common language dummy is included in models 1a, 2a and 3a in Table 4.

Table 4 - Estimation results for robustness check: Dependent variable is (1+RPKs)

	model 1a	model 1b	model 2a	model 2b	model 3a	model 3b
constant	-107.1***	-109.5***	-91.24*	-98.92**	-117.0**	-115.2**
	(15.45)	(15.80)	(51.70)	(49.36)	(52.15)	(50.44)
b/s intangible assets	0.570	1.033**	0.586	1.046**	0.552	1.033**
	(0.458)	(0.474)	(0.463)	(0.478)	(0.462)	(0.477)
load factor			-0.194	-0.129	0.200	0.131
			(0.605)	(0.574)	(0.631)	(0.617)
profitability					-0.602	-0.429
					(0.428)	(0.477)
debt ratio	-0.360**	-0.381***	-0.365***	-0.385***	-0.406***	-0.418***
	(0.142)	(0.148)	(0.141)	(0.147)	(0.156)	(0.162)
operation size	6.063	4.981	5.975	4.901	6.823*	5.503
	(3.870)	(4.036)	(3.758)	(3.901)	(3.966)	(4.130)
institutional difference	-4.046**	-4.566**	-4.015**	-4.550**	-4.179**	-4.674**
	(1.877)	(2.020)	(1.849)	(1.997)	(1.799)	(1.951)
common language	42.58***		42.62***		43.62***	
	(5.753)		(5.767)		(5.768)	
foreign ownership cap	0.357***	0.421***	0.363***	0.425***	0.353***	0.417***
	(0.119)	(0.120)	(0.121)	(0.123)	(0.120)	(0.122)
home country GDP	-3.735	-3.484	-3.572	-3.369	-4.188*	-3.757
	(2.407)	(2.428)	(2.226)	(2.250)	(2.340)	(2.325)
host country GDP	10.07***	10.70***	10.13***	10.73***	9.968***	10.61***
	(2.282)	(2.282)	(2.276)	(2.282)	(2.268)	(2.273)
Log likelihood	-447.01	-462.51	-446.97	-462.23	-445.84	-461.73
Chi-Square	76.20	45.20	76.28	45.76	78.54	46.76
Positive observations	52	52	52	52	52	52
Observations	3710	3710	3710	3710	3710	3710

7. CONCLUSION AND DISCUSSION

This paper examined the determinants of FDI in the airline industry by using the Eclectic Paradigm model. The model is a dominant approach in the international business studies to analyse FDI. Major determinants include both the firm-level ones, represented by intangible assets that constitute the foundation of the competitiveness of individual airlines and the country-level ones, represented by the institutional difference between home and host countries that may constrain airlines in transferring intangible assets across countries.

As noted, very few past studies have employed the model based upon the regression analysis to examine the airline industry. Let us start our discussion with the general observation:

Overall, the Eclectic Paradigm model is relevant to the airline industry. It highlights the importance of both firm-level resources and capabilities (Ownership advantage) and country-level factors (Location and Internalization advantages). Our results indicate that airlines are making a rational and functional decision on FDI just like firms in other industries do by calculating these different levels of factors.

They demonstrate patterns that are generally similar to firm behaviours of other industries that the Eclectic Paradigm model posits. If they are well-managed and competitive and if they believe the competitiveness arises from their resources and capabilities, they may be tempted to expand internationally by taking advantage of them. When they expand internationally, they may want to undertake FDI to control their foreign subsidiaries so that they may exploit their resources and capabilities, the firm-level ownership advantage, to establish competitiveness in foreign markets.

One may also note that the room for the government to intervene in FDI of an airline is much larger as compared with that of other industries. The level of intervention may vary from a country to another. Airlines are likely to encounter the risk and uncertainty of doing business in a foreign country that has different, and especially less transparent, institutions. Airlines' foreign subsidiaries may encounter substantial "liability of foreignness" in doing business in institutionally different countries, which is translated into a higher level of additional costs to operate in a foreign market. Furthermore, institutional constraints for airlines may be substantially higher compared with other industries as many governments have restrictive regulatory regimes. Airlines may be more incentivized to pursue FDI in a country with familiar and transparent institutions and a more liberal regulatory regime for the airline industry, while they may be less incentivized to pursue FDI in a country with unfamiliar and less transparent institutions and a more restrictive regulatory regime.

In the old days, insights from international economics made us believe that factor endowment was the single most important reason for a firm to decide on a location. We are developing insights into institutions that may play an important role for a firm to decide whether and in which country to pursue FDI.

Beyond this observation, a few discussion points may be made. As for the firm-level determinants, the empirical results indicate that airlines with a higher level of intangible assets have more incentives to invest in other airlines of a foreign country. However, a positive effect of the intangible assets on FDI decision is weakly supported because the b/s intangible assets measure for the intangible assets independent variable is statistically significant but the other two measures are not so. These results may lead to the following observations.

First, the institutional factors may affect airlines more significantly than the firm-level factors may in their FDI decision. Second, even though we observe that the airlines may most likely be not much different from other industries when it comes to the importance of the firm-level factors for the FDI decision, we also recognize that we have a limitation under both the absolutely small number of the FDI cases in the airline industry and the current level of the availability of information. The limitation may be twofold.

One is the weakness of the measures in analysing the intangible assets. As noted earlier, the most common such measure employed in the services sector is the advertising intensity ratio, as expressed by dividing advertising expenses by operating revenues. The training and education intensity ratio may be another commonly used measure. Unfortunately, only a small number of airlines are disclosing these data, and as such, we pursued a second-best option, i.e., the balance sheet intangible assets as well as load factor and profitability. The quality of data may have some impact on the level of statistical significance. Further study regarding the quality of the dataset and the examination of alternative proxy variables may be necessary.

Another is the possibility of a lesser relevance of the intangible assets of the airline industry in FDI as compared with other industries. As discussed in the literature review section, a few observations note that airlines are distinctly national, hence they are uniquely different from other regular business. They are often protected from competition by regulatory regimes, and airline brands may have significant "national connotations" for home-country customers, as noted in the literature review section (Havel and Sanchez, 2011; Wassenbergh, 2004). Accordingly, resources and capabilities that contribute to firm-level competitive advantage in other industries may be of limited use for airlines.

However, we note that this possibility has been addressed by introducing the institutional difference. As discussed in the literature review section, protective regulatory barriers and local customer bias have been identified as institutional differences that may constrain a foreign firm when entering a host country market. One important possibility specific to the airline industry may be that the institutional difference for the airline industry arising from regulatory barriers and local customer bias may play much strongly as compared to that for other industries. Here, further study may be necessary for examining how we construct the institutional difference.

As for the country-level determinants, our analysis joins a growing number of IB studies that underscore the significance of institution for FDI. The empirical results support, even if not unambiguously, that airlines have fewer incentives for making FDI in other airlines of institutionally different countries. Institutionally different countries may be either those that have legal, regulatory and other formal rules that are relatively different from those of one's own country or those that have different social, cultural and other informal rules that are relatively different from those of one's own country. Furthermore, considerable variation exists among countries in the absolute level of the government restriction on foreign ownership of the airline. It may become a major factor that discourages airlines to pursue FDI in such a country.

The level of statistical significance of our study prompts us to explore possible issue areas that may require further studies. On the one hand, we realize that the airline industry has a few unique characteristics that might moderate the impact of institutional difference upon an FDI strategy for the airline industry. For example, the industry is characterized by large network effects that may compel airlines to internationalize irrespective of institutional difference. It may also be characterized by the international regulatory regime that may harmonize operation across countries.

On the other hand, we also realize that the airline industry has characteristics unique to consumer-oriented services industries that might increase the impact of institutional difference upon an FDI strategy. Service industries are distinctly different from manufacturing industries in which the former usually require production and consumption to take place simultaneously while the latter allow their separation. The result is a higher level of exposure of services firms to host country contexts in which the co-creation process between producers and consumers takes place. This process is usually associated with a higher level of pressure to localize operation, including the localization of services and relationship marketing (Grönroos, 1982; Khojastehpour and Johns, 2015)

We thus need to examine these seemingly competing forces, which may be uniquely associated with the airline industry, and their impact on an FDI strategy. When doing so, we may also need to take into account the fact that most airline FDI cases involve equity partners, many of which are local firms of host countries. They may reflect the fact that many countries restrict foreign ownership by laws. However, the international business studies also indicate the important role of local equity partners when the institutional difference between home and host countries is wide. These local partners may provide knowledge and expertise to help cope with "liability of foreignness" in entering a foreign market.

We realize that our study leads to a wide-open room for further studies. We nonetheless believe that our study provides initial evidences to indicate the relevance and the importance of the theoretical framework drawn from the international business studies to an FDI strategy of the airline industry. We also believe that it highlights the areas requiring more thorough theoretical investigation and empirical testing, including the identification of additional variables, and the accumulation of appropriate data.

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CONFERENCE REPORT

THE 21ST AIR TRANSPORT RESEARCH SOCIETY CONFERENCE

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The Air Transport Research Society (ATRS) was launched as a special interest group of the World Conference on Transport Research Society (WCTR) during the 7th Triennial WCTR Conference at Sydney in 1995. Headquartered at the Robert H. Smith School of Business at the University of Maryland, ATRS is a platform for exchanging research ideas and results and facilitating multi-national and/ or multi- disciplinary research collaborations. Professor Tae Oum is the ATRS Founder and Chair and Professor Martin Dresner is the President and CEO. ATRS has its networking committee consisting of representatives around the group including researchers, economists, consultants and professionals. Since 2001, ATRS has been producing on a yearly basis a Global Airport Benchmarking Report. The report provides over 30 performance metrics for measuring and assessing effects of the operating environment and service quality of the airport, and airport management strategies such as business diversification, outsourcing, etc. Initiated at the University of British Columbia, the annual Global Airport Performance Benchmarking project is currently hosted at the David B. O'Maley College of Business at Embry Riddle Aeronautical University in Daytona Beach, Florida. A task force, led by Professor Chunyan Yu, and consisting of 16 leading researchers from Asia Pacific, Europe and North America guides the development of the annual report released every summer. More than 200 airports and 20 airport groups are covered and benchmarked among peer airports worldwide and within the three regions currently including North America, Europe, and Asia Pacific & Oceania. With the objective of providing the most comprehensive and unbiased comparison of airports performance regarding productivity and efficiency, financial performance, unit cost competitiveness, and airport charges, the report currently consists of three parts. The first part provides a summary of the research methodology and main findings. The second part, which is the main body of the report, provides comparative assessments of airport performance and characteristics such as traffic volume, number of employees, terminal-airside capacity, and airport charges. The last part of the report presents a short profile of each airport, its new development and recent awards.

The 21st Air Transport Research Society (ATRS) World Conference was held in Antwerp, Belgium, on 5-8 July 2017. The conference was organized and hosted by the University of Antwerp on its beautiful campus. With the participation of 335 delegates from 40 countries worldwide including the top academia, industrial practitioners and experts, the conference started with 3 plenary and panel sessions. The ATRS president, Professor Martin Dresner, opened the conference along with Professor Eddy Van de Voorde and Professor Herman Van Goethem, University of Antwerp. Professor Ken Button, Professor of Public Policy at George Mason University, made the academic keynote speech. Mr. Brian Pearce, Chief Economist and Director at the International Air Transport Association, and Mr. Henrik Hololei, Director General for Mobility and Transport at the European Commission, gave the industry keynote speeches. Industry and academic experts discussed the prospects of the air transport industry in the changing world. The key factors in affecting airports productivity and how these factors can be captured in the benchmarking analyses were discussed in the airport panel session. The airline panel session focused on the important research issues for the airline industry and how to enhance aviation research and industry collaboration for undertaking projects in these areas. The 21st Air Transport Research Society Conference had 49 paper sessions with 220 presentations on a wide array of topics related to aviation. The topics covered were very broad, and grouped into the following 21 categories:

1. Air Transport Policy & Regulation
2. Air Transport Demand
3. Air Traffic Control
4. Airline/Airport Economics
5. Airline Planning and Operations under Uncertainty
6. Airline/Airport Strategy, Management and Operations
7. Airline Network Development
8. Airport and Airline Performance
9. Aviation, Tourism & Economic Development
10. Aviation Safety & Security
11. Aviation Finance
12. Aviation/Airport Case Studies
13. Environmental Issues in Air Transport
14. Human Resources Management in Air Transport
15. Intermodal and Air Travel Alternatives
16. Low-cost Carriers
17. Marketing in Air Transport
18. Market Outlook and Future Development of Air Transport
19. Mergers & Alliances in Air Transport
20. Operations Research in Air Transport
21. Revenue Management & Pricing

The four-day conference provided a great venue for participants to share, exchange and discuss views about not only the most updated research topics and methodologies applied to the aviation field, but also the most relevant, timely management strategies, practices and tactics in dealing with the challenges facing the industry, today and tomorrow. On the day before the start of plenary and paper sessions, the conference successfully hosted a workshop for PhD student and Junior Faculty. The conference also provided two technical tours for delegates to visit Brussels Airport and Antwerp Airport, and one post-conference tour to visit DiamondLand in the Jewish Quarter. All these tours are interesting, and further enriching the experience of every participant from the conference. In addition to having a productive, successful conference, every delegate participating in the ATRS 2017 conference enjoyed the networking opportunity, and had a delightful time visiting the beautiful city of Antwerp, thanks to the hard work and great hospitality of the local organizers from the University of Antwerp and its Center for Maritime & Air Transport Management.