Journal of Air Transport Studies

Volume 7-No2
Summer 2016

Hellenic Aviation Society

The *Journal of Air Transport Studies* (JATS – ISSN: 1791-6771) is a peer reviewed journal aiming at publishing high quality research related to air transport. JATS is interested in publishing papers primarily focusing on economics, geography, policymaking, management, marketing, operations, technology, logistics/supply chain management and modelling.

The Journal is published electronically twice a year, i.e. in January and July by the Hellenic Aviation Society (www.aviationsociety.gr). The Winter issue usually contains papers (subject to changes) originally presented at the Air Transport Research Society (www.atrsworld.org) Conference of the previous year(s) whereas the Summer issue may be occasionally dedicated to a special theme. The Journal is accessible online free-of-charge.

Journal of Air Transport Studies (JATS)

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Volume 7, Number 2, Summer 2016, ISSN: 1791-6771.

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- Fragoudaki, A., Keramianakis, M. and Jancovich, S. (2005) The Greek PSO Experience. *4th International Forum on Air Transport in Remoter Regions*. Stockholm, May 24-26.
- Forsyth P. (2002a), 'Privatization and Regulation of Australian and New Zealand Airports', *Journal of Air Transport Management*, 8, 19-28.
- Papatheodorou, A. (2008) The Impact of Civil Aviation Regimes on Leisure Market. In Graham, A., Papatheodorou, A. and Forsyth, P. (ed) *Aviation and Tourism: Implications for Leisure Travel*, Aldershot: Ashgate, 49-57.
- 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).

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.

Industry Perspectives should be up to 1,000 words and 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.

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This paper evaluates the air travel tax in Europe and focuses on the tax levied in Germany. The current status quo and disputes of the air travel tax in Germany and in Europe are explored and recent decisions by the European Union Grand Court and the European Commission with regards to the tax are given. The paper contributes to the existing literature by analysing the role the tax has on possible distortion of competition in Europe and argues that airlines with a point-to-point business model are placed at a competitive disadvantage with respect to their hub-and-spoke counterparts, when the tax is reasoned to encourage environmentally-balanced behaviour in air travel.

Flight safety has been an important topic for both academia and the industry. Aviation experts and authorities, as well as commercial airline administrators, constantly seek to improve flight safety. Researchers, on the other hand, have tried to model avionic fatalities and suggest improvements or upgrades in flight systems to reduce risk. One approach has been to use data from past accidents and incidents to capture and model the relationship between the different factors involved in each event. However, some important factors are not included in the databases maintained by entities such as the National Transportation Safety Board. This study divides the factors involved into dependent variables (DVs) and independent variables (IVs). IVs include flight factors—for instance, weather and pilot-related data. DVs report the magnitude of the incident/accident, such as the number of casualties. This research will improve existing databases—first, by adding variables, and second, by using multivariate statistical analysis to assess the effect each group of IVs has on correlations between flight factors and accident/incident-magnitude factors. Findings demonstrate that pilot-related factors exert the most influence on the correlation between the two categories. Our findings on the significance of factors or groups of factors will assist researchers, policy makers, flight managers, and flight-crew schedulers in their efforts to increase flight safety.

The city of Barretos in Brazil has the largest cancer treatment centre in Latin America, the Barretos Hospital of Cancer (HCB). The hospital provides medical care to about 4,000 daily. These patients come from about 1,600 cities, approximately 30% of the cities in Brazil. In terms of demand and initial structural conditions, Barretos is qualified to receive commercial flights, however, there are no regular flights to the city. Theoretical propositions are made on corporate social responsibility disregard nontechnical variables related to air transport operations, including the value of human life. The results of the present case study on the city of Barretos, with reference to the HCB, show the existence of initial favourable airport conditions for the implementation of a commercial airline in the city, such as runway extension, for example. Additionally, there are initiatives in the mobilization of public opinion, such as the Flight Against Cancer campaign, which can guide the adoption of nontechnical variables toward establishing a commercial airline in the city based on the value of human life and the reduction of human suffering. Managerial implications are presented, such as the redefinition of the metrics used in corporate social responsibility, the availability of public and private grants sharing agendas alternating between airlines and the establishment of a regional multimodal logistics platform.

In aviation industries, service failure during the service delivery process is foreseeable and leads to passenger complaints, which therefore presents the perfect opportunity for airlines to improve their service process and quality and examine their internal organization. Concurrently, the quality of the service recovery measures reflects the ability of airlines to respond to and handle traveler complaints. By rectifying service failures, airlines can enhance traveler satisfaction toward airlines services, thereby generating loyal customers who would engage in word-of-mouth marketing. This study aims to do examine the relationship between service failure, service recovery and passenger's satisfaction with service recovery types, employee prompt handling, and service recovery efficiency. The questionnaires used in this study consisted of three sections: (1) Customers' perception of the service recovery types; this section entails using passengers' subjective perceptions to evaluate the service recovery types adopted by the airlines when handling flight delay situations. (2) Customers' perception of the airlines employee's prompt handling; the traveler's subjective perception to evaluate the airlines employees' direct responses to flight delays. (3) Customers' perception of the problem-solving efficiency; this section involves using the passengers' subjective perception to evaluate the overall flight delay recovery progress. The traveler characteristics were divided into 'passenger attributes' and 'traveling attributes' and their relationships with service recovery types, employee's prompt handling, and problem solving efficiency were examined. The research results showed that passenger attributes demonstrated no significant differences with the three dimensions (i.e., service recovery types, employee's prompt handling, and problem solving efficiency). However, concerning traveling attributes, 'purpose of travel' and 'flight delay experience' demonstrated significant differences with the three dimensions.

Obesity affects over 25% of Americans; however, prescribed FAA standard passenger weights for US airlines are based on data compiled 15 years ago. Since increased passenger weight degrades aircraft performance and may lead to a loss of control, the hypothesis herein is that passenger weight under-estimation for states with high obesity rates could potentially lead to a runway overrun or the inability to out climb rising terrain. In terms of the employed methodology, current person weights for the ten most obese states were determined using nationwide data adjusted for state ethnicity. Performance degradation for regional aircraft was assessed by accelerate-stop distance for a rejected take-off and climb gradient. Statistical analyses employed Poisson distributions. The results reveal that obesity rates across all ten states increased ($p<0.001$) between 2000, the year for which data were captured for standard passenger weights, and 2013. Moreover a 5.4 kilogram gain over the standard weight in current usage was evident. Modelling transport-category aircraft performance demonstrated that under-estimating passenger weights could degrade climb performance potentially leading to a collision with rising terrain and/or a runway excursion in the event of a rejected take-off. In conclusion, caution should be exercised in using standard passenger weights for states prone to obesity.

EDITORIAL

This issue of the *Journal of Air Transport Studies* includes five papers.

The first paper by **Doron Levy** and **Yvonne Ziegler** examines air travel tax issues in Europe and evaluates the German air travel tax regime vis-à-vis the European Union competition laws. Statistical evaluations of the levied tax in Germany are undertaken and different scenarios in which the German tax system may distort competition under the EU competition laws are discussed.

In the second paper, **Mohammad Kashef** studies databases about aviation accidents and incidents aiming to improve them. He adds variables and divides the factors involved into dependent variables (DVs), such as the number of casualties, and independent variables (IVs), such as weather and pilot-related data. The author uses multivariate statistical analysis to assess the effect each group of IVs has on correlations between flight factors and accident/incident-magnitude factors.

Mauro Caetano and **Cláudio Jorge Pinto Alves** used the city of Barretos, Brazil as a case study in the third paper to present managerial implications, such as the redefinition of the metrics used in corporate social responsibility, the availability of public and private grants sharing agendas alternating between airlines and the establishment of a regional multimodal logistics platform. The authors choose Barretos as it has the largest cancer treatment centre in Latin America, the Barretos Hospital of Cancer (HCB) but still there are no regular flights to the city.

The fourth paper by **Chi-Ruey Jeng** examines the relationship between service failure, service recovery and passenger satisfaction with service recovery types, employee prompt handling, and service recovery efficiency. The survey results show that passenger attributes demonstrate no significant differences with the three examined dimensions, i.e. service recovery types, employee's prompt handling, and problem solving efficiency.

The final paper by **Douglas D. Boyd** studies whether passenger obesity affects aircraft performance leading potentially to a runway overrun and/or the inability to out climb rising terrain. The author uses the ten most obese states in the USA as a case study and two transport-category aircraft, one of medium-cabin (50 seats) and the other of large-cabin capacity (86 seats). Modelling transport-category aircraft performance demonstrates that under-estimating passenger weights can degrade climb performance potentially leading to a collision with rising terrain and/or a runway excursion in the event of a rejected take-off.

We wish to take this opportunity to thank our authors for their thought-provoking contributions and our referees for their support in publishing the present issue of the Journal. The open-access character of the Journal, aiming at the widest possible exposure of its content to the academic and business audience, is facilitated by our continuing partnership with the University of the Aegean, Greece as well as Air Transport News. Enjoy reading!

Professor Dr Andreas Papatheodorou, Editor-in-Chief
Dr Marina Efthymiou, Assistant Editor

EUROPEAN AIR TRAVEL TAX

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ABSTRACT

This paper evaluates the air travel tax in Europe and focuses on the tax levied in Germany. The current status quo and disputes of the air travel tax in Germany and in Europe are explored and recent decisions by the European Union Grand Court and the European Commission with regards to the tax are given. The paper contributes to the existing literature by analyzing the role the tax has on possible distortion of competition in Europe and argues that airlines with a point-to-point business model are placed at a competitive disadvantage with respect to their hub-and-spoke counterparts, when the tax is reasoned to encourage environmentally-balanced behavior in air travel.

Keywords: aviation, tax, distortion, competition, Europe, Germany

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1. INTRODUCTION

Taxation on air travel has been a major issue of dispute in several European countries for the past decades. The German air travel tax, aimed at generating additional revenue to the state's treasury, is intended by the German legislators to encourage a more environmentally-balanced air travel behavior and considered by its opponents to negatively affect the development of a competitive aviation industry in the country (Bundesverfassungsgericht.de 2015 a).

The objective of this paper is to evaluate the German air travel tax with regards to the European Union competition laws. The research questions are: (i) what constitutes the German air travel tax; (ii) how is the situation in other European countries; (iii) how do different lobbying organizations support or fight against the tax: (iv) and does the German air travel tax distort competition in Europe.

The research design of the paper is set by reviewing the existing literature and analyzing the air travel tax in Germany and in the European Union with respect to the competition laws. The paper begins by presenting studies of various scholars and distinguishing the air travel tax from other taxes and charges in the aviation industry. Current information on the levied air travel tax in Europe is given and recent decisions and rulings on air travel tax of the European Commission and the General Court of the European Union are explored. The paper continues by explaining the evaluation of the German air travel tax and presents main arguments in favor and against its application. Statistical evaluations of the levied tax in Germany are analyzed and observations are drawn. The paper ends by discussing the scenarios in which the German tax may distort competition under the competition laws of the European Union.

2. LITERATURE REVIEW

2.1 Aviation charges vs. aviation taxes

Various scholars in recent decades have been studying the differences between charges and taxes on air travel, which constitute the final price of flight tickets. Abeyratne (1993) considers taxes as general burdens imposed on the population or on various industries of a state, which benefit the government's own treasury with no straight-forward reallocation of levied revenue in return. Charges, on the contrary, are specific levied fees, which benefit particular public properties or entities and are, therefore, seen as justified. According to Abeyratne, taxation on air travel, which aims to support the development of the tourism industry, or taxation on tourism, which aims to support the aviation industry would be 'self-defeating' measures due to the strong correlations of both industries (Abeyratne 1993).

Odoni (1985) relates to aviation charges as a general label of 'user charges', which include various fees collected by aeronautical facilities (e.g. airports and air navigation service providers), and which are imposed on the users of air travel in order to recover the costs of facilitating air travel activities (Odoni 1985). These levied fees are segregated between aeronautical and non-aeronautical charges. Aeronautical charges relate to fees levied in direct relation with the facilitating of air travel activity, such as landing, security and ground handling fees. Non-aeronautical charges, on the contrary, are fees collected in an ancillary form of charges generated by commercial activities of facilities and amenities at airports (Odoni 2007). The aeronautical charges constitute the aeronautical revenues of the airport levying the charges, whereas the non-aeronautical charges represent the concession revenues benefiting the concerned airports (with relatively more airports), both private owned and state owned. Their share of concession revenues has increased over recent years (Zhang and Zhang 2003).

Pelger et al. (2003) segregate between airport aeronautical charges and government aeronautical charges. This segregation is highlighted due to the fact that airport aeronautical charges contain charges solely, whereas the government aeronautical charges contain both charges as well as taxes. Aeronautical taxes relate to cases, in which the government levies a specific Air Travel Tax (ATT) for each departing passenger (Pelger et al. 2003).

Graham (2013) follows Pelger et al. and distinguishes the taxes levied by governments from other aeronautical charges. Graham indicates the difficulty passengers often face with the term 'airport taxes and charges' shown on flight tickets. The scholar claims that it is difficult to distinguish between levied taxes benefiting the government from airport charges, which constitute revenue for the airport operator (Graham 2013).

2.2 The characteristics of the air travel tax

Smith (2010) claims that the aviation industry is considered an easy target for taxation. Politicians are little motivated to fight against such taxes, due to the fact that passengers are unaware of the real amount of taxes they pay when flying. In addition, passengers lack lobbying groups, which are able to advocate their interests against the payment of the ATT (Smith 2010). ATT is stated by Keen and Strand (2007) as an indirect tax on aviation and defined as 'a charge that is levied on passengers as a fixed amount per trip, at a common rate for all trips within some wide class' (Keen/Strand 2007 p6). Imposing ATT is explained by governments' motivation to address the environmental polluting damage caused by air transport and to raise revenue for non-transport initiatives. The scholars address the implications of ATT on competition distortion and suggest that ATT should be designed in accordance to other means of transportation and compared with the extent other transportation modes are subsidized (Keen/Strand 2007).

Adam and Chote (2008) relate to the situation in the United Kingdom (UK), where ATT was first introduced 1994 by the British government under the form of Air Passenger Duty (APD). APD was proposed as a tool for generating revenue for the state at a time of difficult financial situation on the British island. The initial APD rate has been increased throughout the years and has never been withdrawn. Efforts to correlate and consider APD as environmental tax were at the focus of lobbying groups. Policy makers in the British parliament had justified the rate increase of APD due to environmental concerns (Adam and Chote 2008). Truby (2010) suggested reforming the APD to meet such concerns. Under such reform, APD should be imposed per departing aircraft and not per departing passenger, as per-plane-tax holds incentives for airlines to operate flights with high load of passengers or cargo. It is also suggested that generated revenue of the APD would be used in order to provide tax credits for airlines to renew their polluting older fleet of airplanes (Truby 2010).

2.3 The impacts of the air travel tax

Gordijn and Kolkman (2011) studied the implications and effects of the Dutch ATT on the Dutch economy. Their findings first and foremost warn that quantifying, relating and attributing any change in passenger demand from a given airport due to ATT is complicated and should be analyzed with other factors and variables affecting airports-choice by passengers. The two scholars suggest that the Dutch ATT is responsible for a diversion of approximately one million Dutch passengers, who chose tax-free neighboring airports in Germany[2] and Belgium for their departure. They also claim that ATT does not change the demand for outbound tourism, but rather divert air travel movement accordingly (Gordijn/Kolkman 2011).

The main focus of scholars with regards to ATT was centered to address its impacts on the economy and in particular on tourism and air travel demand. Seetaram et al. (2013) studied the impacts of the APD on the outbound tourism demand from the UK. Using a demand-model specially adjusted according to data of the British market, the scholars found that APD has a marginal effect on outbound tourism demand. It seems that passengers might change their travel destination or be more aware of other costs related to their trip, but would not cancel the trip completely because of the imposed APD. However, it was found that APD does have a negative effect on choosing air travel when alternative modes of surface transportation are available (Seetaram et al. 2013).

[2] Gordijn and Kolkman (2011) had published their study before ATT was introduced in Germany.

Forsyth et al. (2014) explored the effect of the Australian ATT on inbound and outbound tourism on the Australian continent. The Australian ATT, called Passenger Movement Charge (PMC), is relevant only for airplanes departing from Australia to an international destination outside of the continent and does not apply to domestic routes. PMC has generally been manifested in order to benefit the state treasury and support local tourism. Their study concludes that both inbound and outbound tourism industries have been negatively affected by the PMC to such an extent that the proposed increase of domestic tourism cannot substitute the overall losses the tourism industry incurs (Forsyth et al. 2014).

3. AIR TRAVEL TAX IN EUROPE

3.1 The air travel tax policy in the European Union

3.1.1 Current air travel tax in Europe

ATT has been imposed throughout Europe since its introduction in 1994 by the British government, with countries in Europe levying the tax gradually. ATT is currently levied in five Member States (MS) of the European Union (EU) according to different distance bands[3] as depicted in figure 1 (Langner 2015).

Figure 1: Current levied air travel tax in Europe in EUR for economy class passengers – own illustration based on Anon (2014); Gov.uk (2015); Langner (2015): Bmf.gv.at(2015); and Developpement-durable.gouv.fr (2015)

Current levied air travel tax in the Europe in EUR			
Great Britain	Up to 3,200km: Economy 18€ Premium 36€	More than 3,200km: Economy 103€ Premium 206€	
Germany	Up to 2,500km : 7. 5€	between 2,501km and 6,000km : 23.43€	More than 6,001km: 42.18€
Austria	Short haul: 7€	Medium haul: 15€	Long haul: 35€
Italy	Any airport other than Rome: 6.5€	From Rome: 7.5€	Transit and Transfer pasengers departing from Rome: 1€ extra
France	Destination in in EU: 4.31€	All other destinations: 7.75€	

The ATT levied in the UK is subjected to the passenger's relevant seating class. ATT for premium classes are twice more expensive than economy class. In addition, the ATT in France

[3] Bands relate to the shortest-distance band A to the longest-distance band C, where applicable.

and in Italy shows several differences compared to the ATT levied from the other three MS. In Italy, ATT is a fixed tax of 6.50 EUR for flights departing from any Italian airport other than for airports in Rome, where a higher tax of 7.50 is imposed. Transit passengers departing from Rome are required to pay an extra 1 EUR as well. In France, the tax is levied not according to flight-distance, but rather according to two groups of destinations. The first group, or Band A, relates to domestic destinations in France, destinations in other EU MS as well as for destinations grouped under the Economic Area Agreement of the EU. Band B in France relates to all other destinations. Moreover, the French authorities levy 1.29 EUR ATT per tons of air cargo freight (Anon 2014; Langner 2015).

3.1.2 Tax policy in the European Union

MS in the EU are free to decide upon their tax systems according to each individual State's priorities and national needs. Any intervention by the EU ought to consider principles of subsidiarity and proportionality and may only take place when efforts to find a solution by the MS fail (Ec.europa.eu 2015 a). The EU is active in ensuring free and fair taxation of cross-border activities in Europe. The European Commission (EC) encourages MS to respect fundamentals non-discrimination tax regime and to acknowledge the importance of free competition and free-movement in the internal European market (Anon 2015).

3.1.3 Air travel tax on domestic and intra-EU flights

The policy of the EU towards domestic and intra-EU flights can be comprehended by decisions and rulings of the EC and the General Court of the EU on the Irish ATT, as summarized in table 1 (European Commission 2011). The EC had raised its concerns on the ATT imposed by the Irish Government in March 2009 in a discriminatory manner favoring airlines, which operate short-haul domestic flights of up to 300km from Dublin airport, and discriminate airlines operating cross-border intra-EU flights with a flight-distance of more than 300km. ATT on flights greater than 300km from Dublin was set at the rate of ten EUR per ticket, whereas the levied ATT for shorter flights was eight EUR less. The EC complained that such tax distorts competition and constitutes a barrier to the freedom of providing air services across borders. The EC had sent the Irish authorities a formal letter of notice on this matter, which has led Ireland to change its policy and to levy a fixed ATT rate regardless of the destination as of March 2011[4] (European Commission 2015). Following, the EC has claimed that the discriminatory Irish ATT constituted state aid incompatible with the internal market (General Court of the European Union 2015). Article 107(1) of the Treaty of the Functioning of the European Union (TFEU) provides the following definition for illegal State Aid:

[4] The Irish ATT was completely withdrawn by the Irish authorities in April 2014.

‘Aid granted by a member state or through state resources in any form whatsoever which distorts or threatens to distort competition by favoring certain undertakings or the production of certain goods shall, in so far as it affects trade between member states, be incompatible with the internal market’ (OPOCE 2008).

Table 1: Summary of the dispute regarding different ATT rates in Ireland based on European Commission (2011); European Commission (2015)

Matter of Complaint	Position of Member State	EC Decision	Ruling of the EU Grand Court
Different ATT rates in Ireland constitute illegal State Aid, which selectively favor specific air carriers and is, therefore, incompatible with the internal market: D>300km = 10 € D<300km = 2 € D= Distance from Dublin airport	Lower rate for short haul flights is proportional to the ticket price. No distortion of competition – the tax is imposed on consumers and not on the airline operators. The tax is imposed equally on all airlines.	Different ATT rates between domestic routes and long-haul routes contradict common rules for the operation of air services in the Community. Hence, the different rates constitute state aid and are incompatible with the internal market.	
		Beneficiaries of the lower ATT are requested to recover the rate difference by paying back 8€ for each passenger retroactively.	The automatic setting of the recovery rate on 8€ per passenger is problematic. The airlines might recover back a higher amount than the real ATT originally charged.

State aid does not only cover direct payments to undertakings by a member states, but it also refers to any advantages given to the undertakings of the aid. In addition, the aid must be attributed to the state resources of the granting member state. Funds originating from the European Union itself do not fall under the definition of state aid (Schmauch 2012).

The EC had ordered Aer Lingus and Ryanair to retroactively recover the difference of the levied eight Euros on each passenger the airlines had flown between the given periods of the discriminatory ATT. A recent ruling of the General Court of the EU goes out against this EC decision, stating that the EC cannot automatically consider the advantage given to the airlines to amount in all cases to eight EUR per passenger, and new negotiations are now being held to solve the case (General Court of the European Union 2015).

3.1.4 Non-application of the air travel tax to transfer and transit passengers

The non-application of the ATT to transfer and transit passengers has also been investigated by the EC in two different cases regarding Ireland and the Netherlands[5]. In both cases, the EC concluded that exempting transfer and transit passengers from paying ATT does not constitute state aid. Table 2 summarizes the Irish dispute by indicating the different considerations of the EC and the General Court of the EU in this matter (European Commission 2011).

Table 2: Summary of the dispute over the exemption of ATT to transfer and transit passengers in Ireland based on General Court of the European Union (2015); Gilmore (2011); Cyndecka (2014); European Commission (2011); and Nicolaides (2014)

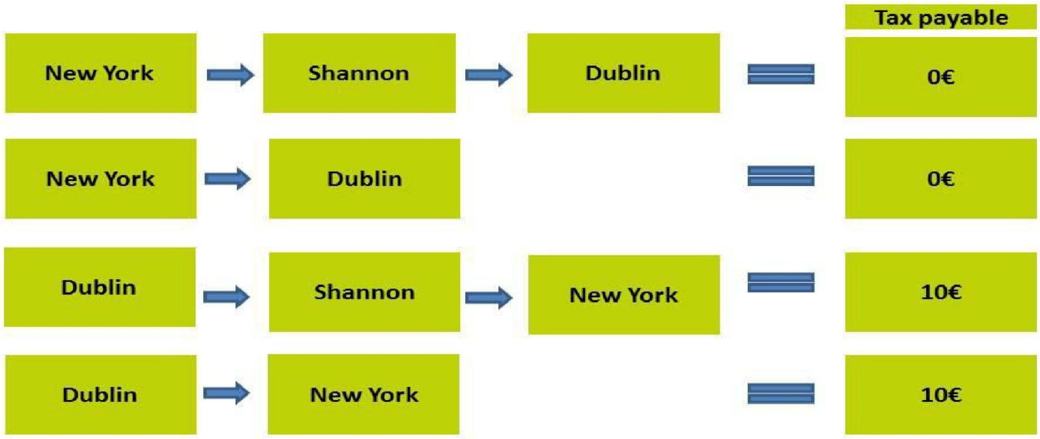
Matter of Complaint	Position of Member State	EC Decision	Ruling of the EU Grand Court
Non-application of the ATT to transit and transfer passengers	The non-application of the ATT is not selective - it does not differentiate between airlines at stake.	The exemption is not selective and is justified.	The exemption is inconsistent – the Irish ATT applies to any departure from an airport in Ireland regardless of the leg number. ATT should be levied as well in the opposite direction of inbound transfer and transit flights to Dublin via other airports in Ireland.
	Neutrality - avoiding the risk of double tax-	The exemption meets reasons of tax neutrality – avoidance of dou-	The Irish ATT cannot be compared with the nature of the British APD, which specifically considers the application of the tax to the first flight in

[5] The ATT in the Netherlands was introduced in July 2008 and withdrawn completely twelve months later.

	ation if route involves a departure from a state, which levies ATT as well	ble taxation	the entire journey only.
	Similar procedure is executed by other countries levying ATT such as the case with the British APD		

The Irish dispute regarding the above exemption has been investigated by the EC after LCC Ryanair complained against the non-application of ATT to passengers transferring via Ireland, claiming that the exemption constitutes unlawful state aid to traditional airlines. The EC had issued a preliminary investigation procedure set to investigate Ryanair's claims. The investigation had lasted more than two years with a final EC decision ruling favoring the Irish authorities. The EC explained its decision by the fact that (i) Ireland is allowed to decide exclusively on its taxation system and (ii) the non-application of ATT to transit and transfer passenger is not selective, falls between the logic of tax neutrality and therefore does not constitute state aid according to the meaning of TFEU. This ruling is consistent with the similar Dutch dispute. The EC has accepted the reasons given by the Irish authorities, claiming for neutrality from the passengers' point of view, who should be punished for paying the tax twice in cases, which passengers begin their journey from a MS imposing ATT as well. The Irish authorities had also provided the EC with the following example, illustrated in figure 2, concerning the application of the ATT to transfer and transit passengers, which was supported by the EC (Gilmore 2011). This example shows that the Irish authorities consider the application of the ATT to the entire journey of a passenger rather than considering it to individual legs of journey. Therefore, a direct flight segment between Dublin to New York has the same legal and factual situation compared to a flight from Dublin to New York with a stopover at Shannon. Hence, in both cases, ATT is levied the same and only once (Gilmore 2011; Cyndecka 2014).

Figure 2: Taxing transit and transfer passengers in Ireland based on Gilmore (2011)



Nevertheless, the above ruling of the EC was partially annulled by the General Court of the European Union in November 2014, which criticized the long time it took the commission to reach a decision and disrespected the procedure carried by the EC. In addition, the court revoked the claim for neutrality and avoidance of double taxation. The court rejected the EC's claim for tax neutrality for exempting transfer and transit passengers, who might be taxed twice if their airport of departure is located in a MS, which levies ATT as well. The court noted that ATT can be applied on either the first or the second leg of a journey. The court referred to the examples provided by the Irish authorities and noted, under paragraph 88 of the ruling, that the EC had failed to explain why passengers travelling in the opposite direction from New York to Dublin via Shannon are exempted from paying ATT upon their departure from Shannon airport, which is located in Ireland and falls with the logic and legal situation of the objective of the Irish ATT. The General Court of the EU has forced the commission to reopen its investigation in this matter (General Court of the European Union 2015).

3.1.5 Air travel tax and other forms of transportation

Other modes of transportation such as maritime, rail and road transportation are free from taxes similar to ATT. Efforts have been made to address whether this fact places air travel at a competitive disadvantage and whether other modes of transportation receive illegal State Aid. The EC policy towards this matter has been addresses by claiming that other modes of transportation cannot be compared with aviation, due to the fact that these modes are neither legally nor factually comparable to the situation of air travel operators (European Commission 2011).

3.2 The German air travel tax

3.2.1 The evolution of the German air travel tax

The ATT in Germany was first introduced on January 1st, 2011 as part of the yearly German Federal budget. The German government's aim of levying an ATT in its territory is to collect additional revenue to its treasury. In addition, the German legislatures opted to use the tax as an incentive effect in order to encourage a more environmentally-balanced behavior in air travel (Bundesverfassungsgericht.de 2015 a).

The German ATT is levied on all German and foreign air carriers operating in the country determined per capita and according to bands of flight distance in km from the main German airport in Frankfurt as follows:

- Band A: Distance from Frankfurt is less than 2,500km
- Band B: Distance from Frankfurt is more than 2,501km but less than 6,000km
- Band C: Distance from Frankfurt is more than 6,001km (Gesetze-im-internet.de 2015).

The German ATT rates for each Band was reduced in 2012 by 6.3% from the original setting to the actual levied rates as described in table 3 (Destatis 2015a):

Table 3: The development of the German air travel tax rates according to flight-distance based on Gesetze-im-internet.de (2015)

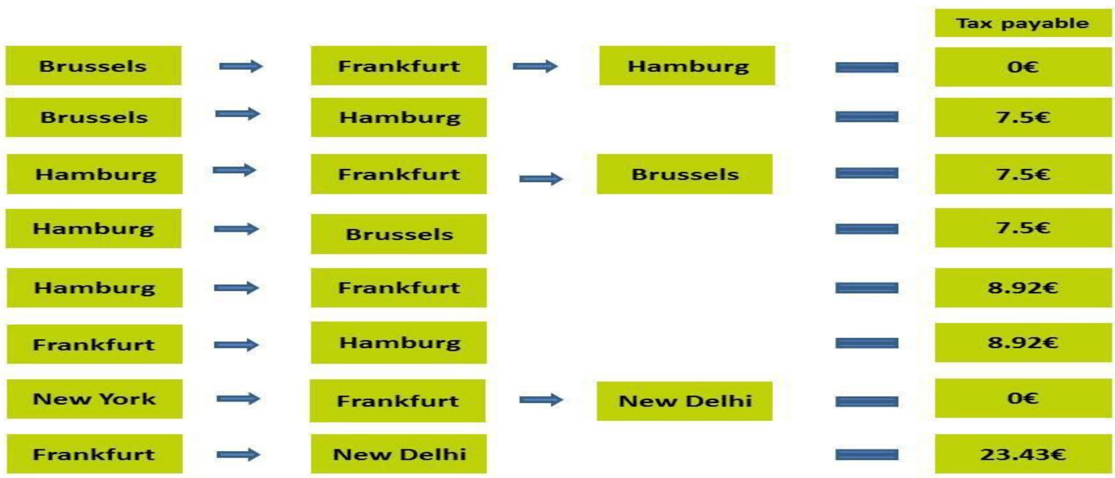
D= distance from Frankfurt airport	**Initial period 01.01.2011-31.12.2011**	**Current period 01.01.2012-present**	**Difference**
Band A D<2,500km	8€	7.5€	0.5€
Band B 2,501km<D<6,000km	25€	23.43€	1.57€
Band C D>6,001km	45€	42.18€	2.82€

The German ATT is applicable to the first segment of a journey. In case of multiple segments of a stopover flight, the tax is levied only if the flight commences from a German airport and in all cases the tax is levied on the first flight segment only (OECD 2014 p81). Further exemptions of the German ATT are listed as follows:

1. Children under two years of age, who do not occupy a seat on board the airplane.
2. Departures of passengers in airplanes or helicopters if the flights are carried for military, medical or state-sovereign circumstances.
3. Renewed departure of passengers, who are forced to return to their domestic original place of departure due to an aborted or interrupted flight.
4. Passengers departing to the remote islands in the northern Germany.
5. All-cargo flights.
6. Departures of aircrew (Gesetze-im-internet.de 2015).

The non-application of the tax to transfer and transit passengers is supported by the German authorities due to two important aims. First, the German government wishes to avoid the double-taxation of passengers under this category. Second, this special exemption is intended to make sure international German airports remain important hubs for international transfer and transit flights (Bundesverfassungsgericht.de 2015 b). In addition, passengers on domestic flights in Germany are double taxed with regards to ATT[6]. They are levied on each departure of their journey and the value added tax is added to that amount as well as depicted in figure 3 (Steppler 2011).

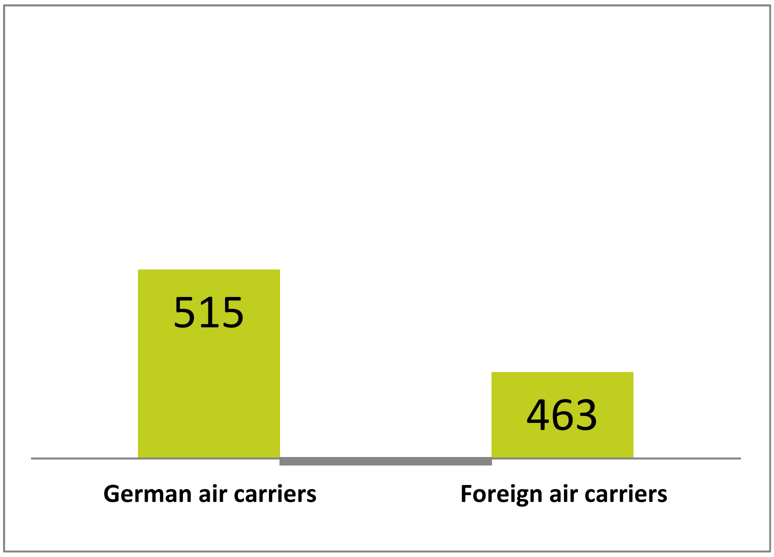
Figure 3: Taxation of direct, transfer and domestic flights to and from Germany – own illustration



[6] On domestic flights in Germany a value added tax of 1.42€ (19% of the total amount) is added on each band.

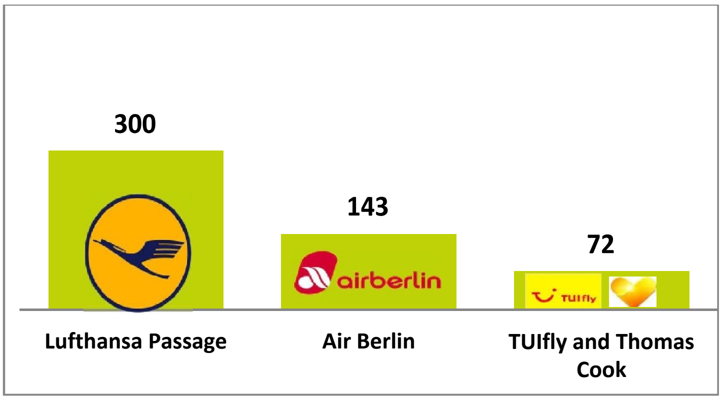
During the past three years, the German ATT has generated revenue of approximately 3.834 billion EUR to the German treasury (Destatis.de 2015 b). The vast majority of the revenue is generated by the four German air carriers: Lufthansa Passage[7], Air Berlin, TUIfly and Thomas Cook. In year 2013, for example, the contribution revenue of the German carriers was higher than the contribution of all other foreign air carriers by 52 million EUR and covered 515 million EUR out of the total sum of 978 million EUR as depicted in figure 4 (destatista 2015 a):

Figure 4: The levied amount of the German air travel tax in 2013 in million EUR - own illustration based on destatista (2015 a).



The 515 million EUR levied from the German carriers was split differently among the four carriers as illustrated in figure 5 (destatista 2015 a; Deutsche Lufthansa AG 2014; and Ir.airberlin.com 2015).

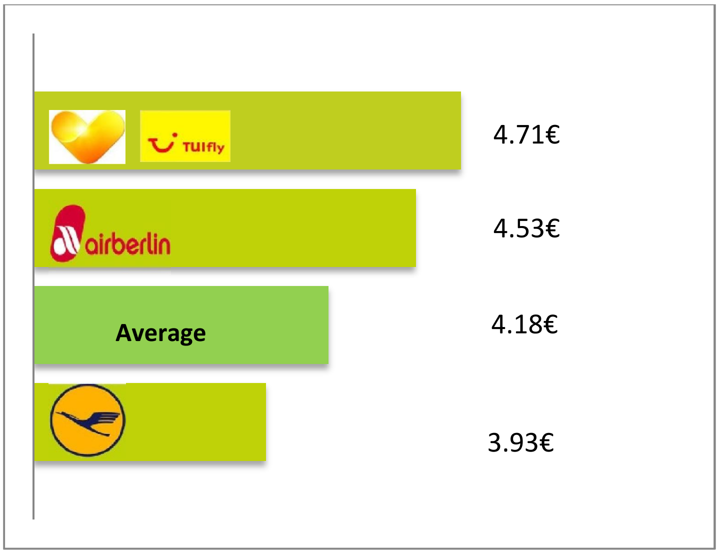
Figure 5: The segregation of levied ATT among the German air carriers in 2013 in million EUR - own illustration based on destatista (2015 a); Deutsche Lufthansa AG (2014); and Ir.airberlin.com (2015)



[7] Lufthansa Passage includes Germanwings. The Group's subsidiaries are excluded.

In-depth observation of the above levied amount reveals a disproportion of payment by each individual carrier in respect to its number of passenger. Dividing the EUR amount each carrier had to pay for the ATT in 2013 by the number of passengers flown by each airline respectively, it is shown that the least affected airline was Lufthansa Passage, which on average had to pay 3.93 EUR tax for each ticket it had sold that year. In contrast, TUIfly and Thomas Cook had paid a higher amount of 4.71 EUR in respect to their passenger volume as shown in figure 6 (destatista 2015 a; Deutsche Lufthansa AG 2014; and Ir.airberlin.com 2015):

Figure 6: Average air travel tax paid by individual German air carriers per passenger in 2013 in EUR - own illustration based on destatista (2015a); Ir.airberlin.com (2015); and Deutsche Lufthansa AG (2014)



Airline	All German Carriers	TUIFLY and Thomas Cook	Air Berlin	Lufthansa
PAX in 2013	123,076,867	15,280.000	31,535,867	76,261,000
Total paid ATT	515,000,000€	72,000,000€	143,000.000€	300,000,000€
Average per passenger	4.18 €	4.71 €	4.53 €	3.93 €

3.2.2 Lobbying in favor of the air travel tax

Supporters of the German ATT consist of governmental, semi-governmental and non-governmental organizations. The main arguments in favor of the tax relate to the direct and indirect effects aviation has on the environment. The leading lobbying associations, which support the ATT, are the German environmental organizations 'Bund', 'Brot für die Welt', 'Robin Wood' and 'Greenpeace'. These associations are supported by the German organization for ecologic transportation called 'VCD' and 'FÖS', the forum for green budget in Germany. The supporters mainly claim that there are no indications for any significant influence on the German aviation caused by the imposed ATT in Germany. The aim of these lobby association is not to withdraw the tax at all, but to develop it towards financing of environmental initiatives. The lobbyists strongly defend the tax by indicating that the passengers in air travel grew in the years 2011-2012 by 1.1% while the German Gross Domestic Product increased only by 0.7% (Thießen/Haucke 2013).

3.2.3 Lobbying against the air travel tax

Opponents of the German ATT consist of lobbying associations from the aviation industry as well as from other industries, which are directly and indirectly dependent on air travel transportation such the tourism and exhibition industries. The main lobby associations, which are actively working on withdrawing the tax, are the 'Bundesverband der Deutschen Luftverkehrswirtschaft (BDL)' - the German aviation association and the 'Flughafenverband' (ADV) – the German airports association. Both BDL and ADV represent key players of the German aviation industry and have been lobbying against the tax since it has been proposed (Bdl.aero 2015).

The non-application of the tax to transit and transfer passengers is attributed to strong lobbying activities by Fraport AG and Lufthansa German airlines, which managed to shape the conditions of the proposed tax in order fit the new ATT to their business model, which is dependent on transfer passenger volume (airliners.de 2015; Flottau 2010). Lobbying against the tax is also backed by foreign entities, which have raised their concern of potential damage to their inbound tourism from Germany, claiming that German tourists usually spend more during their visits, thus catalyzing indirect and inductive economic effects on the visited region, and imposing tax on flights from Germany would directly negatively impact the number of Germans flying long distances, who may choose different and closer destinations for their holidays (Anon 2010).

The main arguments plead against the tax focus on arguing that taxation on aviation in Germany would shift passenger volume away from the country. The lobby associations support their claims by studies conducted by independent and objective institutions, which show that the aviation industry in Germany has not developed and increased accordingly with the general growth of the German economy, unlike the situation in other MS. The lobby associations attribute this negative increase to the ATT, which diverts passenger volume outside of Germany. In addition, the associations claim that the tax, though imposed on all airlines operating routes from Germany, harms the German airlines specifically due to the high passenger volume of these airlines compared to the volume of their foreign counterparts. The aviation lobby associations also emphasize a direct impact of the ATT in the loss of passenger volume at close-border German airports to neighboring airports from France and the Netherlands (Anon 2013). The associations indicate the problematic effects on regional airports and LCC. The concern amongst the lobby groups is that LCCs may choose to base airplanes and conduct flights outside of Germany (Anon 2012).

4. DISCUSSION

4.1 The European competition laws

The distortion of competition can occur either by actions of private undertakings or by actions and principles of MS. According to article 81 section 1(d) of the EC Treaty, it is prohibited and incompatible with the common market to have any kinds of agreements between undertakings or associations of undertakings which may affect trade between MS of the EU. The treaty highlights the prohibition of applying dissimilar conditions to equivalent transactions with other trading parties, which might place them at a competitive disadvantage (Ec.europa.eu 2015 b).

Distortion of competition by a MS can be claimed in case of prohibited state aid. According to the TFEU, undertakings, which are affected by measures of a MS, may place an official complaint in front of the EC and claim for illegal aid, which has placed them at a competitive disadvantage in respect to their competitors. The EC initiates an investigation on such claims and the MS must supply the Commission all necessary information and explanation for its actions (Ec.europa.eu 2015 c). MS, which are accused of providing illegal state aid, often try to prove that their actions were not selective to benefit specific undertakings, such as companies or industries.

4.2 The German air travel tax and distortion of competition in Europe

The ATT offers an interesting paradoxon of conflicted authority and interests in the EU. On the one hand, each MS is allowed to decide upon its own tax regime with no veto power given to the EC. On the other hand, a discriminating taxation regime is against competition law in the EU, which is heavily regulated by the EC. The Commission is authorized to execute operative measures against MS if aid is proven to selectively favor specific undertakings and if it is incompatible with the internal market.

In order to claim that the German ATT distorts competition in Europe, it has to be proven that the actions and the principles of the ATT by the German government favor particular undertakings and constitute illegal state aid. These allegations must consider both reasons for imposing the tax in the first place: (i) generate additional revenue to the German Treasury; and (ii) encourage more environmentally-balanced air travel behavior. This paper identifies the following three principles in the German ATT which may be proven to constitute illegal State Aid:

1. Non-application of the ATT to flights to the northern islands of Germany: possible favoring specific airlines which mainly operate to and from these regions.
2. Different ATT rates based on distance: possible favoring specific airlines, which mainly operate short-haul routes.
3. Non-application of the ATT to transit and transfer passengers: possible favoring specific airlines with mainly hub-to-spoke business model.

With regards to the first principle, it is found that exempting flights to and from the remote islands cannot be claimed to distort competition in Europe. The German government had asked the EC to approve this non-application of the tax and to declare this exemption as an approved state aid. The Commission had approved this exemption and endorsed its decision by emphasizing the importance, of which passengers who reside in these remote islands will be able to travel to the economic and administrative centers on the mainland, thus supporting the accessibility and the development of these remote regions (Anon 2011).

The second principle of imposing different distance-based ATT rates may resemble the Irish case explained in subchapter 3.1.3, in which Ryanair accused the Irish authorities of favoring its competitors on short-haul routes from Dublin. The commission concluded this case by declaring the lower short-haul tax rates as illegal state aid, which had placed Ryanair at a competitive disadvantage. However, this scenario does not seem to be applicable with regards to the German ATT. The distance under dispute in Ireland was set to maximum 300km from Dublin airport, which had not included any cross-border flights. The lowest rate of the German ATT relates to a distance of up to 2,500km from Frankfurt airport, which includes cross-border flights within the EU, and therefore does not favor specific airlines.

In addition, the different rate system based on distance length seems to fairly communicate the reasoning of the tax in encouraging a more environmentally-balanced behavior in air travel. However, levying ATT based on environmental grounds conflicts with the already imposed EU Emission Trade Scheme charges, which are specifically designed to target the environmental effects of air travel. Consequently, airlines are placed at a situation of double-taxation on environmental reason, in which the German air carriers will be affected more heavily due to their large share of the German air travel market. Nevertheless, this fact cannot be claimed to place the German airlines at a competitive disadvantage, due to the fact that all other foreign airlines operating flights from a German airport pay the tax according to flight-distance as well, even though their share of the German market is relatively smaller.

This paper argues that the non-application of the German ATT to transfer and transit passengers differentiates between airlines with different business models of point-to-point versus hub-to-spoke. This argument is supported by paragraphs 54-56 of the General Court decision in the matter of the Irish ATT in February 2015. According to the Court's decision, the German authorities consider the application of the tax only from the origin to the destination, regardless of stop-overs in between. This argument is supported by figure 6 in chapter 3.2.3. According to the analysis, airlines such as Thomas Cook and TUIfly, which operate mostly on a point-to-point basis, have paid more ATT per average passenger (4.71 EUR) than Lufthansa Passage (3.93 EUR) and Air Berlin (4.53 EUR) did.

However due to the German government's intention to use the German ATT as a revenue-generating tool, it is not sufficient to determine that the German ATT distorts competition, or in other words places pure point-to-point airlines at competitive disadvantages with respect to traditional carriers with hub-to-spoke business models. Though supporters of point-to-point airlines may claim that they pay more tax per passenger volume, this occurs because the majority of their passengers originate from Germany. Claiming that traditional airlines like Lufthansa Passage enjoy more favorable conditions does not hold. Every airline operating to and from Germany on a point-to-point basis is subjected to the same rules, including Lufthansa Passage and all foreign carriers. Furthermore, under the current circumstances, and due to the lack of official guidelines by the EC, it is plausible that the effects arising from the German ATT for hub-to-spoke and point-to-point airlines are not the same.

Notwithstanding, this paper argues that distortion of competition does occur when the German ATT is reasoned by the authorities to encourage a more environmentally-based air travel behavior. If the government's intention is to reason the tax based on environmental grounds, any exemption would be immediately discriminatory. It is argued that under environmental reasoning it would be difficult for the German authorities to prove that the exemption is not selective because first, it contradicts the objective of the reference of the tax to levy passengers departing from German airports and second, hub-and-spoke flights are less environmental friendly than point-to-point flights. Therefore, point-to-point air carriers are placed at a competitive disadvantage with respect to their hub-and-spoke counterparts.

5. CONCLUSION

The objective of this paper was to evaluate the German ATT with regards to the EU competition laws. The methodology used was to review the existing literature, evaluate recent ATT disputes in the EU, present actual investigations by the EC, study relevant rulings by the General Court of the EU and analyze statistical data recordings of the ATT in Germany.

It was found that airlines pursuing a point-to-point business model pay more ATT on average per flying passenger than airlines with a hub-and-spoke business model. In addition, the components and principles of the German ATT were compared with the EU competition laws, the rulings of the General Court of the EU and various decisions by the EC. It was argued that the German ATT is a burden to the airlines. However, as long as it is reasoned by the authorities as a revenue-generating tool, it is difficult to claim that the tax is imposed selectively, placing particular airlines at a competitive disadvantage. However the introduction of the ATT was also justified by the authorities to encourage a more environmentally-based behavior in air travel. Under this reasoning, the non-application of the tax to transfer and transit passengers conflicts with the official intention to promote a more environmentally-based behavior and thus places airlines of a point-to-point business model at a competitive disadvantage.

Future research should focus on comparing the components and legal conditions of the EU Emission Trade Scheme with the German ATT and offer new guidelines for the EC in order to regulate MS' taxation on aviation.

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AN ASSESSMENT OF FLIGHT VARIABLES AFFECTING CIVIL AVIATION ACCIDENTS AND INCIDENTS

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ABSTRACT

Flight safety has been an important topic for both academia and the industry. Aviation experts and authorities, as well as commercial airline administrators, constantly seek to improve flight safety. Researchers, on the other hand, have tried to model avionic fatalities and suggest improvements or upgrades in flight systems to reduce risk. One approach has been to use data from past accidents and incidents to capture and model the relationship between the different factors involved in each event. However, some important factors are not included in the databases maintained by entities such as the National Transportation Safety Board. This study divides the factors involved into dependent variables (DVs) and independent variables (IVs). IVs include flight factors—for instance, weather and pilot-related data. DVs report the magnitude of the incident/accident, such as the number of casualties. This research will improve existing databases—first, by adding variables, and second, by using multivariate statistical analysis to assess the effect each group of IVs has on correlations between flight factors and accident/incident-magnitude factors. Findings demonstrate that pilot-related factors exert the most influence on the correlation between the two categories. Our findings on the significance of factors or groups of factors will assist researchers, policy makers, flight managers, and flight-crew schedulers in their efforts to increase flight safety.

Keywords: flight accident/incident, causal analysis, multivariate analysis

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1. INTRODUCTION

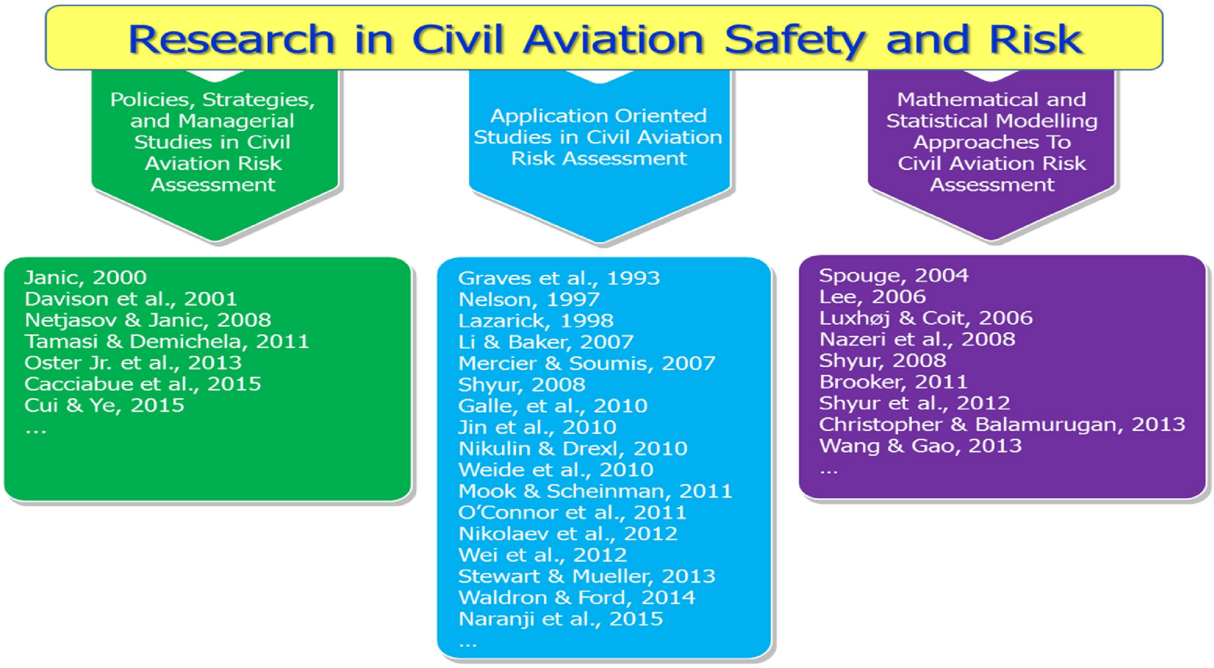
Air transportation is one of the fastest growing transportation modes, with an expected growth rate of 5% to 6% over the next two decades (Netjasov & Janic, 2008). The combination of the complexity of air-transportation systems and their respective interconnectivity with other systems, such as air traffic control and navigation, makes their management highly challenging. Air-transport management, which aims to improve flight safety and reduce the associated costs, covers a broad range of disciplines, from risk management to methods for flight-crew scheduling.

Despite major technological developments in the field, fatal accidents—often with high numbers of casualties—occur with alarming frequency. Recent crashes, and in particular Malaysian Airlines 370 (which disappeared on March 8, 2014, with 239 people on board), Air Asia 8501 (which crashed into the Java Sea during bad weather, killing all 155 passengers), and Germanwings 9525 (which was deliberately crashed by the co-pilot, killing all 150 people on board), have highlighted the critical importance of flight safety.

Aviation events are classified as either 'incidents' or 'accidents' (Nazeri, Barbara, Jong, Donohue, & Sherry, 2008). In an aircraft incident, there are no fatalities, human injuries, and/or substantial aircraft damage; nevertheless, flight safety is compromised. An accident is one in which fatality, human injury, and/or substantial aircraft damage occurs.

Because of its severe consequences, aviation safety has become an important research topic in the past decade (Orasanu, et al., 2001; Lee, 2006; Li & Baker, 2007; O'Connor, Buttrey, O'Dea, & Kennedy, 2011; Cui & Ye, 2015), and it has been reviewed and studied from a number of angles. Assessing and quantifying risk and safety in civil aviation has been the focus of many studies, and possible approaches for improving the safety of general aviation have been put forth (Janic, 2000; Li & Baker, 2007). In general, these researches can be divided into three main groups, as shown in Figure 1. Some researchers have studied aviation safety from a high-level managerial and administrative perspective (Cacciabue, Cassani, Licata, Oddone, & Ottomaniello, 2015; Oster Jr., Strong, & Zorn, 2013; Tamasi & Demichela, 2011; Davison, Ciavarelli, Cohen, Fischer, & Slovic, 2001; Netjasov & Janic, 2008). For instance, Netjasov & Janic (2008) describe four risk categories: (1) risk to an individual, (2) statistical risk that an accident will occur, (3) predicted risk, and (4) perceived risk. They also review different modelling methods of civil aviation risk and safety and divide these into four groups: (1) causal, (2) collision risk, (3) human-factor error, and (4) third-party risk.

Figure 1 - Summary of Research on Civil Aviation Safety



The second group of research includes the application of risk assessment methods in certain technical fields. Researchers in this group have investigated specific technical domains of aviation risks, such as airport properties; airplane systems control; aviation security screening; human factors, including pilot and air traffic controller; environmental impacts; and others. Airport-runway properties and their effects on aviation safety have been studied by researchers such as Waldron and Ford (2014), who investigated the airport runway's role in potential collisions and analysed how potential hazardous interactions can vary among airports. In a related vein, Galle et al. (2010) have examined runway incursions as a precursor to aviation accidents.

Another topic in this group is passenger security screening and how it affects aviation safety risks. Nikolaev, Lee, and Jacobson (2012) have studied the problem of multistage, sequential passenger screening with respect to passengers' risk levels. Mook and Scheinman (2011) have investigated risk-based screening systems to increase flight safety, while Stewart and Mueller (2013) introduced a method for risk-reduction estimation in commercial passenger airliners to prevent the aircraft from being hijacked.

Human error as a determining factor in aviation fatalities has also been studied in the second group. Nelson (1997) states that more than 50% of accidents and incidents in commercial aviation are caused by human error, and proposes a structured method to identify and correct potential human errors in aviation operations. Shyur (2008) has developed an analytical method to quantify aviation risks caused by human error, while Naranji, Mazzuchi, and Sarkani (2015) use augmented cognition and automated systems to reduce pilot error. Jin, Sun, and Kong (2010) examine the relationship between team situation awareness (SA) and information sharing, and propose a method to reduce human error. The authors also compare pilot SA and air traffic controller (ATC) requirements. Wei et al. (2012) have studied the main factors that influence human error in the cockpit, and developed a dynamic model for their prediction and evaluation. Human factors have also been studied from another perspective, which is flight-crew scheduling and the airline dispatcher's role in flight management. For instance, Graves et al. (1993) developed a new crew-scheduling system to reduce costs. The main concerns in such studies have been reducing costs, minimising flight delays, and optimising flight routing (Graves, McBride, Gershkoff, Anderson, & Mahidhara, 1993; Mercier & Soumis, 2007; Weide, Ryan, & Ehrgott, 2010; Nikulin & Drexl, 2010).

The third category includes studies that use mathematical and statistical models of civil aviation risks. Since this category is the most relevant to our research, we will discuss these in greater detail. Researchers have used a variety of mathematical tools to extract meaningful patterns from aviation safety databases. Some of the newer techniques, such as fuzzy logic, were applied by Lee (2006) to develop a quantitative model to assess aviation safety risk factors. The factors included in the model are evaluated based on their detectability, probability, criticality, etc. Other researchers have tried to capture patterns in the occurrence of accidents using more rigorous methods. Wang and Gao (2013) analysed the relationship between flight delays and aviation safety risk, and propose an approach based on Bayesian networks to model safety risk assessment. Another Bayesian-based model for avionic risk assessment was developed by Brooker (2011).

Causal methods can also be included in the third group; they are used to better determine how factors that affect the level of risk can be employed to evaluate overall risk (Netjasov & Janic, 2008). After each accident or incident, a causal report is prepared by related agencies in which they identify causal factors (Luxhøj & Coit, 2006). Janic (2000) classifies causal factors based on whether they are known or unknown and avoidable or unavoidable, and further differentiates causal factors based on accident type—i.e., whether they can be attributed to human error, mechanical failure, hazardous weather, sabotage, or military operations.

Spouge (2004) further discusses the benefits of causal analysis, and argues that safety managers and policy makers must understand the causes of accidents and evaluate the benefits of different intervention policies before selecting measures for risk reduction. Shyur, Keng, and Huang (2012) have developed an analytical model to analyse potential aviation events using both accident and performance measures; they employ an extended hazard-regression method to incorporate multiple safety performance indicators to assess the probability of aviation events. Their model may not be suitable for estimating absolute event probability, but it is valuable for understanding the structure of air events.

Common to these studies is the considerable emphasis placed on the use of different approaches to study flight accidents and incidents. These, in turn, funnel into data and prediction modelling. Underpinning these models are the data incorporated from aviation safety databases maintained by the Federal Aviation Administration (FAA), the National Transportation Safety Board (NTSB), and others, that have been used to model novel approaches to assess risk, capture patterns, and construct prediction models. Modelling the factors involved in aviation accidents/incidents has been at the core of these researches, which have focused on managing flight risk and increasing flight safety. The sheer range and diversity of these factors, however, significantly increases the difficulty of determining how each factor contributes to an event. Christopher and Balamurugan (2013) use data-mining approaches to predict aircraft accidents; they draw on the NTSB's aviation accident database, which does not include data on factors related to the pilot or weather. Because these variables offer vital insight into the causes of fatal aircraft accidents and improve data analysis, we have incorporated these factors in our database and will discuss them in detail in the following sections.

Nazeri et al. (2008) used a method called 'contrast-set mining of accidents and incidents' to interpret the relationship between those two and propose a model for accident-risk assessment. They found it difficult to identify a pattern in accidents, however, given the rarity of their occurrence—an observation well documented by Janic (2000), who highlights the difficulty in accurately locating, explaining, and managing overall aviation safety due to the scarcity of events. In turn, the former research favors incidents as the predominant tool in predicting the probability of an accident.

Though holistic in addressing all readily quantifiable data from either the FAA or NTSB databases, other factors that may have a significant impact on the analysis of risk are not included in these databases. Such factors are available, however, in NTSB Probable Cause Reports (PCRs). Capturing these factors entails close review of individual PCRs and translating relevant data points. Analyses that incorporate these factors would add robustness to already rigorous prior research and allow the consideration of additional factors. Nazeri et al. (2008) alludes to several such factors and notes, for example, the importance of an event's severity, phase of flight, and type of aircraft that, though unavailable in public databases, would significantly enhance the value of the information gained from the analysis.

Measuring how each factor affects an event—either individually or in combination—would offer researchers and decision-makers a deeper understanding of aviation events and, potentially, improve protocols and policies. It is worth mentioning that mathematical explanations of factual observations in aviation safety are also of great value. For instance, although the role of the pilot in flight safety seems obvious from an empirical point of view, one can only study the effect of pilot contributions in combination with other factors by using quantitative indices.

Differentiating and accentuating factors that have greater impact on events would save time, money, and human resources—and, ultimately, increase flight safety and efficiency. Therefore, investigating the relations between these factors—and specifically as dependent and independent variables using multivariate correlation analysis—is the main focus of this paper.

This study aims to examine how correlations between flight variables and incident/accident variables are affected by different factors. This emphasis on correlative analysis is intended to incorporate the aforementioned factors and demonstrate the approach's ability to yield highly specific results. Unlike researchers who have addressed the problem qualitatively, such as Nazeri et al. (2008), our goal is to first enlarge the aviation safety database by adding factors and values and then approach the problem quantitatively. This will not only yield qualitative results, but will also enable us to apply our findings to more advanced mathematical modelling that could be used by a variety of aviation personnel, such as flight dispatchers and crew schedulers, to optimise flight risk. For example, a flight dispatcher using the model could assess the risks imposed by weather on a specific flight against the risks imposed by pilots (i.e., the combined risks of the pilot and co-pilot) and plan the flight accordingly. The crew scheduler, in turn, could use the pilot variables to minimise risk by selecting the optimal combination of pilot and co-pilot.

The paper is organised as follows: Section 2 discusses how the current study's data were obtained, and how the raw public database was improved to allow for subsequent analysis. The section concludes by introducing dependent variables (DVs) and independent variables (IVs). Section 3 introduces the multivariate statistical analysis used, and Section 4 presents the results of our analytical method and discusses the significance of our findings. In Section 5 we present our conclusions and discuss avenues for future research.

2. DATA

To obtain meaningful results, we first required a comprehensive and reliable database. The second requirement was to define reasonable factors, including dependent and independent variables, and the third requirement was a statistical tool capable of measuring correlations between the variables. Careful selection of variables was crucial for our analysis. Criteria for data selection and methods for data pre-processing, variable selection, and grouping are described below. After building the database, a multivariate statistical method will be introduced and applied to reveal correlations among variables and identify the most influential.

Data Selection

The raw database for this research was obtained from the NTSB's database, which contains accident reports from 1962 to the present. Generally, a preliminary report is available online shortly after an accident occurs. As the NTSB investigation progresses, more data are added; upon completion of the investigation, the preliminary report is replaced by a final description of the accident and its probable cause (NTSB, 2014).

For a database to be downloaded, one must specify certain information and submit a relevant query. Preparing a database for retrieval often requires the provision of time intervals, locations, and the type of aircraft involved. The raw database used in this research was chosen from 10 different queries on the main NTSB repository; only accidents with published PCRs were considered. Table 1 shows the details of the query selected for the study, based on the data's relevance, functionality, and feasibility; data from other queries were either too cumbersome or too insignificant. The query selected includes 508 events, which comprise a sizable statistical population for data preparation.

Table 1. Selected Query Details

Query time interval	01/01/2003 to 12/31/2013
Location	USA
Aircraft category	Airplane

Operation type	Part 121: Air Carrier
Investigation type	Accident/Incident
Report Status	Probable Cause

In addition to the information provided in a downloadable spreadsheet, the PCR for each event (accident or incident) is available as a PDF and is more detailed than the information in the raw database.

The raw database was obtained and all corresponding PCRs downloaded. The database consisted of rows and columns in which rows correspond to events and columns to variables/factors. The database and PCR reports formed the basis for the process of data preparation and database enhancement.

Data Preparation

As mentioned above, the raw database retrieved from the NTSB lacked information pertinent to our study aims. We incorporated additional information as follows:
a) Grouping: Though public, the NTSB database is essentially intended for internal use; therefore, significant effort is required to prepare the database to perform statistical analysis. The first step was to group relevant factors into specific categories and reorder the variables' columns. For the purposes of this study, independent variables involving accidents/incidents were categorised according to type. Pilot information was not included in the original database, but because values were retrieved from PCRs in the next step and added to the database, a category was created for pilot information. Independent variables were divided into five categories:

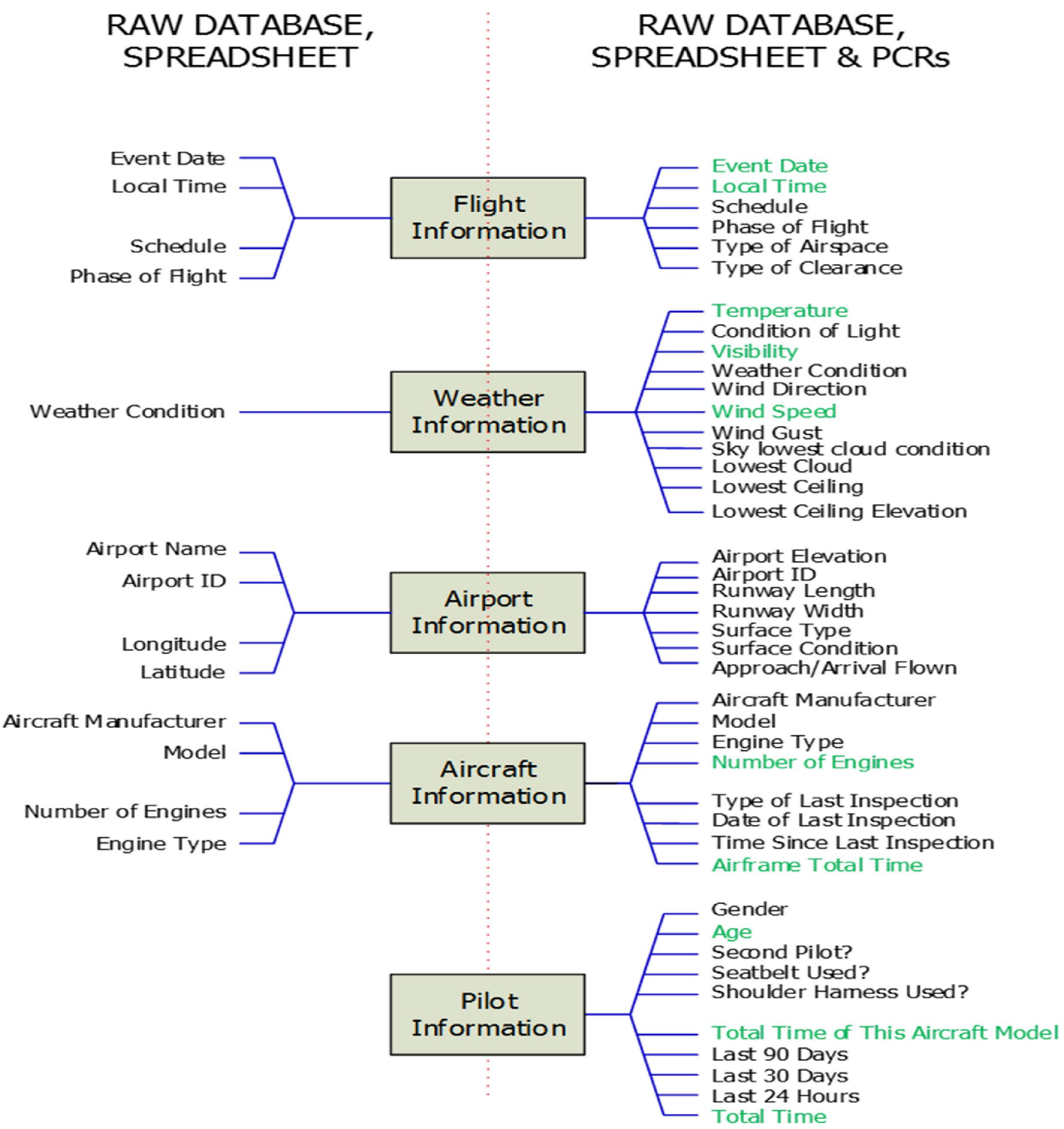
- Flight information
- Weather information
- Airport information
- Aircraft information
- Pilot information

We selected three dependent variables, which concern the magnitude of the event:

- Event type (accident or incident)
- Severity of injuries/number of fatalities
- Level of damage to aircraft

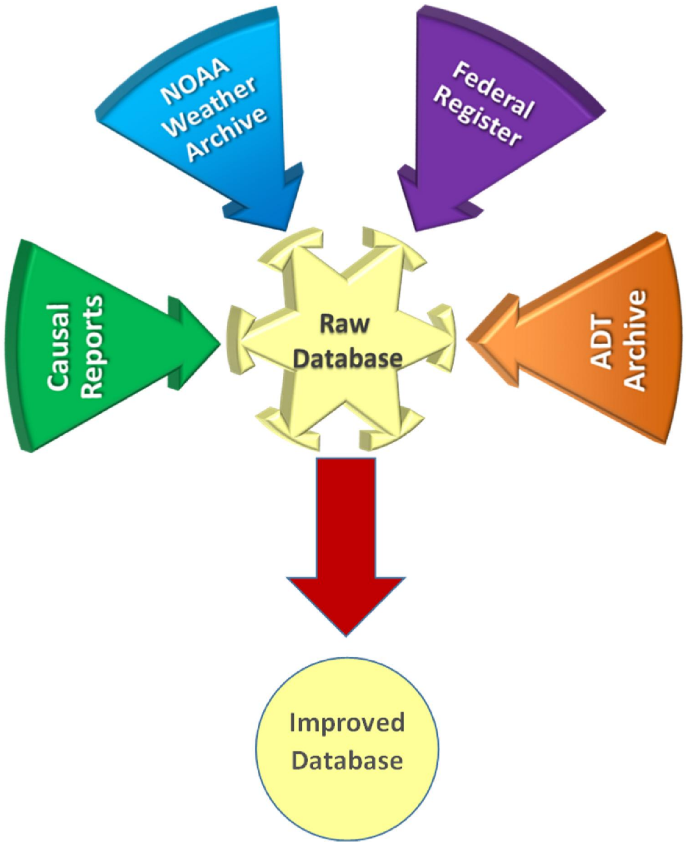
b) New Variables: The study includes several critical variables, such as pilot information, that are not provided in the raw NTSB database but are present, either explicitly or implicitly, in the detailed Probable Cause Reports (PCRs). These variables were selected based on advice from experts in the FAA and National Oceanic and Atmospheric Administration (NOAA). Once the variables had been chosen, individual PCRs were carefully examined to incorporate the new data into a more comprehensive database. Figure 2 shows the details of factors from the raw database and others that were collected from narrative PCRs. Data shown in green are those used in the final analysis, which will be discussed shortly.

Figure 2. Database Improvement using PCRs



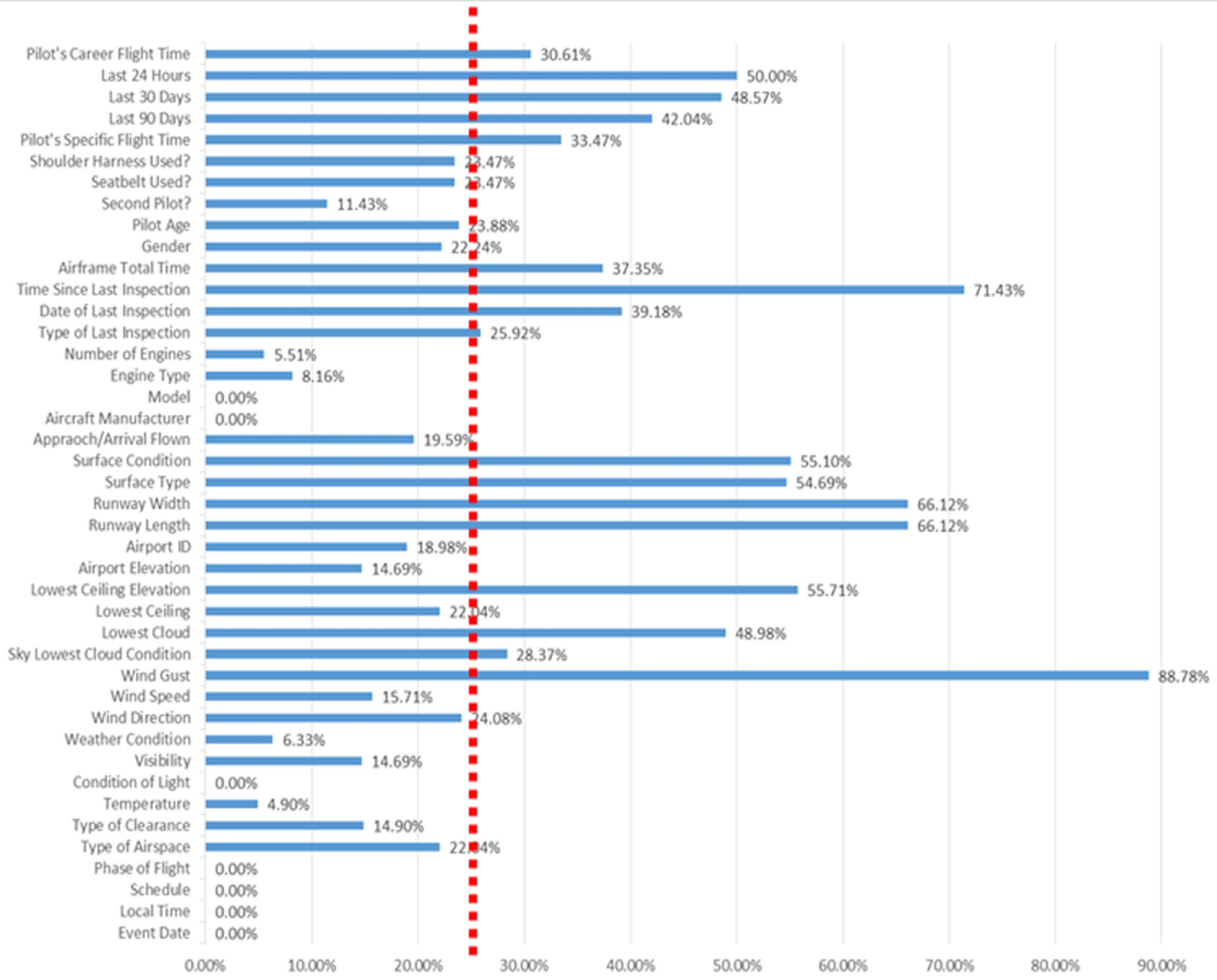
c) Data from Additional Sources: Grouping and including new variables expanded the database. In some instances, however, data for new variables—such as temperature, wind speed, visibility, airspace type, and airport elevation—were missing from either the raw databases or the PCRs. To acquire this information, we consulted sources other than the NTSB, such as the NOAA database for weather information, the average daily temperature (ADT) database of the University of Dayton, and the Federal Register for airport information. These external sources filled critical gaps in the raw database. Database improvement efforts are depicted in Figure 3. In some cases, the flight phase was not explicitly stated in the report, but was implicit in the narrative. In such cases, we based our judgment of the flight phase on the PCR's narrative.

Figure 3. Database Improvement Using Additional Sources



d) Database Cleaning: Given the sheer number of events under consideration and the range of variables, it was not possible to construct an exhaustive database. To ensure that the data collected would be relevant, we removed factors that were irrelevant or insufficiently significant (column cleaning). Likewise, events that were insufficiently significant or missing too many variables were removed (row cleaning). These steps were performed only after filling in as many gaps in the database as possible. The minimum acceptance threshold for variables was 25%—i.e., variables that were missing values for more than 25% of events were excluded. Percentages of missing values for each variable are shown in Figure 4; the red line represents the 25% threshold. Some variables were removed because they were almost uniformly constant—for example, the 'Shoulder harness used?' variable was either 'yes' or left blank in the PCR. There were also instances in which it was not possible to quantify value—for example, Airport ID and Type of Airspace are not quantifiable. To reveal their effects in the data analysis, however, they were included in the clustering phase, which will be discussed later.

Figure 4. Percentage of Missing Values for Independent Variables



In addition to the above, the date of the event (in the form of MM/DD) and the local time of occurrence (in the form of HH:MM) were normalised using the following formulas:

Date = (MM*30+DD)/365

Time = (HH+ (MM/60))/24

When it was necessary to convert qualitative data into quantitative data, we made logical assumptions. For example, wind speeds that were reported as 'calm' were assigned a numerical value of 0.5 mph. The database was now ready to perform statistical analyses, and independent and dependent variables had been finalised. Table 2 shows the resulting IVs and DVs, with information about type, range, and possible values for each variable.

Table 2. IVs and DVs for Statistical Analysis

	Independent Variables	Type and Possible Values	Unit
1	Event date	Normalised number between 0 an	N/A
2	Event time	Normalised number between 0 an	N/A
3	Phase of Fight	Standing, Taxi, Take Off, Climb, Descent, Approach, Landing	N/A
4	Temperature	Continuous values	Centigrade
5	Visibility	Continuous values	Statute Miles
6	Wind Speed	Continuous values	MPH
7	Number of Engines	Discrete values	N/A
8	Airframe Total	Continuous values	Hour
9	Age of pilot-in-command	Discrete values	Year
10	Pilot's Career Flight Time	Continuous values	Hour
11	Pilot's Specific Flight Tim accident/incident model)	Continuous values	Hour

	Dependent Variables (	Type and Possible Values	Unit
1	Event Type	Binary: Accident (2) or Incident (1)	N/A
2	Injury Severity	Discrete values: Number of fatalities	N/A
3	Level of aircraft damage	None (0) , Minor (1), Substanti Destroyed (3)	N/A

3. MULTIVARIABLE STATISTICAL ANALYSIS

To evaluate the effect of different IVs on the correlation between two sets of variables, a multivariate statistical analysis tool was necessary. In multivariate statistics, multivariate regression analysis is employed to investigate the relationship between a single DV and multiple IVs (Hair et al. 2010). In cases in which both dependent and independent variables are multivariate, the canonical correlation analysis (CCA) can be used to model the linear relationship between multiple DVs and multiple IVs (Borga 2001, Hardoon et al. 2004).

CCA and its Application

Prior research has demonstrated the uses and value of the CCA method to predict multiple DVs from multiple IVs (Bonner & Liu 2005, Singh et al. 2013, Singh et al. 2012). The aim with CCA is to identify and quantify the interrelations between a p-dimensional variable *X* and a q-dimensional variable *Y* (Dehon et al. 2000). The analysis looks for linear combinations of the original variables**,** $\mathbf{a^TX}$ and $\mathbf{b^TY}$, that have maximal correlation.

In mathematical terms, the CCA selects vectors $\alpha \in \mathrm{R}^{\mathrm{p}}$ and $\beta \in \mathrm{R}^{\mathrm{q}}$ such that:

$$(\alpha, \beta) = \mathrm{argmax}_{\mathrm{a,b}}\, |\mathrm{Corr}(\mathrm{a}^{\mathrm{T}}\mathrm{X}, \mathrm{b}^{\mathrm{T}}\mathrm{Y})|$$

The selected univariate variables, $U = X.\alpha$ and $V = Y.\beta$, are referred to as *canonical variates*. The number of pairs of *canonical variates* is equal to the minimum of *p* and *q.* Each pair of canonical variates interprets the relationship in a given way. The CCA method captures the highest correlation between linear combinations of IVs and linear combinations of DVs. The most significant pairs are those with the highest correlations (Nourzad & Pradhan, 2015). The single variables that represent *X*-values and *Y*-values, respectively, are created using the formulas below:

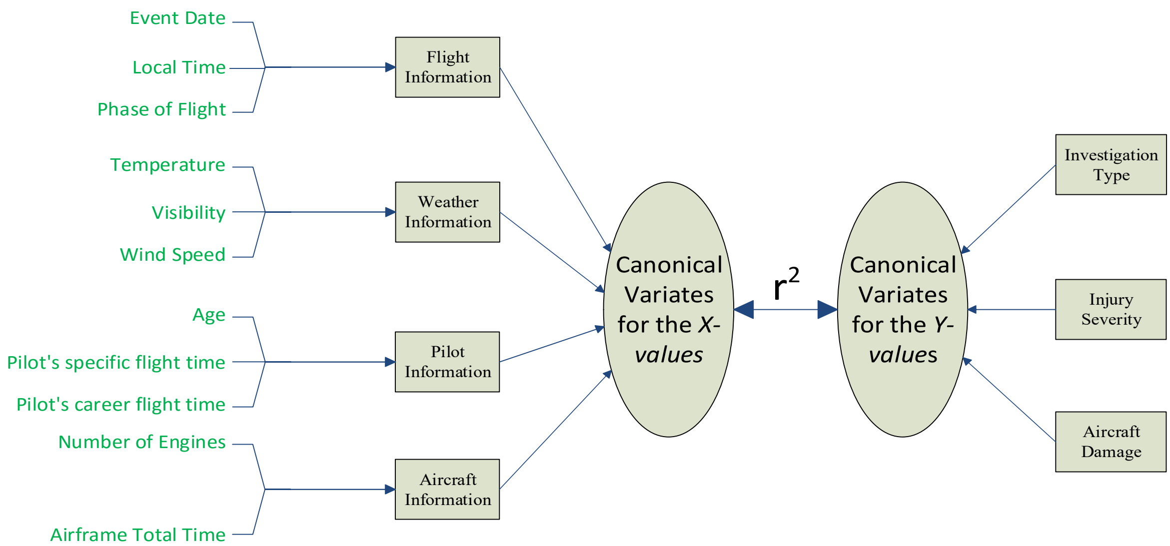
$$U = a_1.X_1 + a_2.X_2 + \cdots + a_p.X_p$$

$$V = b_1.Y_1 + b_2.Y_2 + \cdots + b_p.Y_p$$

We developed an approach to measure the correlation between DVs and IVs for flight accidents/incidents using the CCA method. MATLAB statistical toolbox functions (*canoncorr*) were used to run CCA. The first canonical correlation resulting from the MATLAB function is *the maximum correlation coefficient* between *U and V* for all *U* and *V* (Nourzad & Pradhan, 2015). The model's effectiveness depends on the goodness of fit of the captured linear relationships. The highest r-squared value (a measure of goodness of fit) corresponds to the most effective model for capturing relationships between *X*-values and *Y*-values. The main aim was to determine whether two sets of variables are related and, if so, how different variables affect the r-squared values.

As stated in the previous section, we selected *p=11* IVs and *q=3* DVs (accident-magnitude attributes) and used them to create canonical variates. The pairs with the highest r-squared values have the strongest correlations. Figure 5 depicts our model, in which the r-squared value will be measured and monitored depending on the change in the number of variables employed.

Figure 5 - Research Model



After database pre-processing, the first CCA run did not yield promising results. When all IVs were included, the r-squared value was 0.36, which signifies a weak correlation. We then performed clustering, which is a common approach in data analysis, to determine whether better results could be achieved without losing the selected IVs. Clustering is different from factors analysis; Cluster analysis tries to group cases/events that are more similar to each other than to other types of cases whereas factors analysis attempts to group features. Figure 6 is a generic illustration of how clustering can obtain stronger results from multivariate analysis.

To select the best variable to cluster, four variables capable of being clustered were chosen: Phase of Flight, Weather Condition, Flight Schedule, and Type of Clearance. Data clustering was then performed on each variable, and the resulting r-squared values compared. As shown in Figure 7, clustering based on Phase of Flight yielded the highest r-squared values.

Figure 6 - Data Clustering

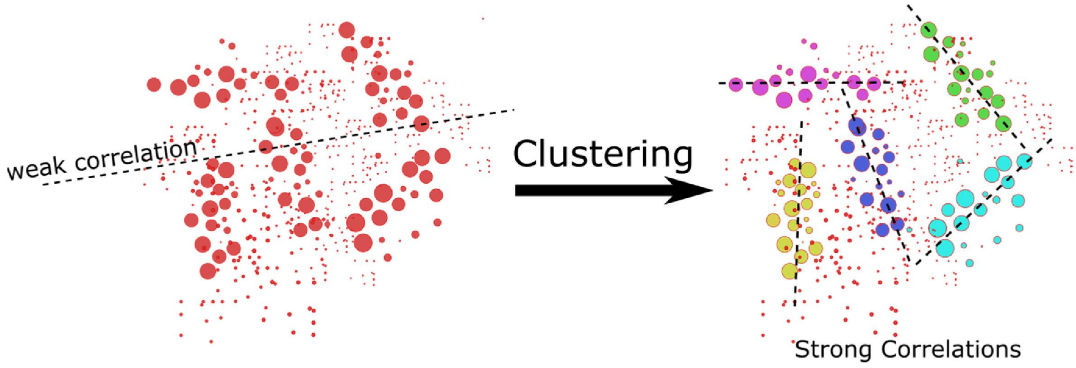
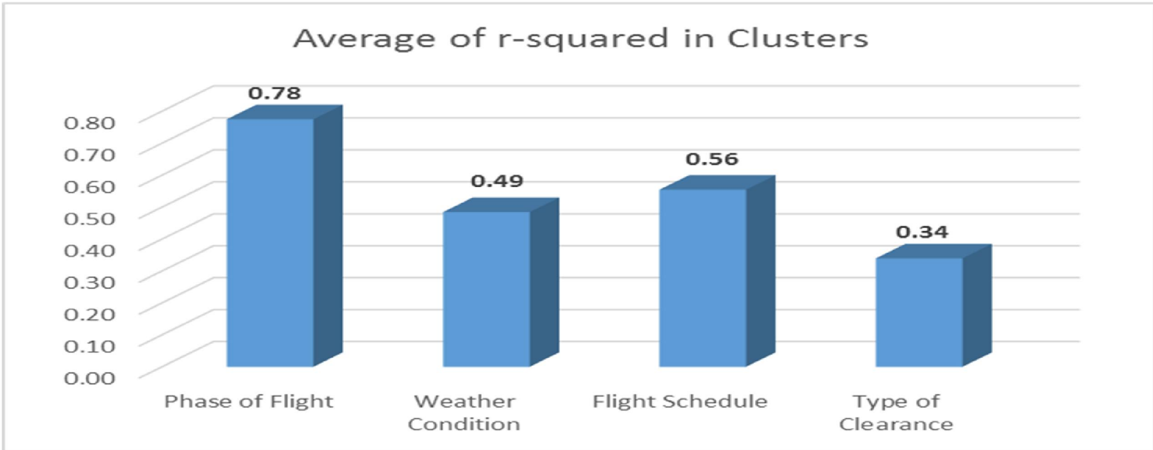


Figure 7 - Clustering Alternatives

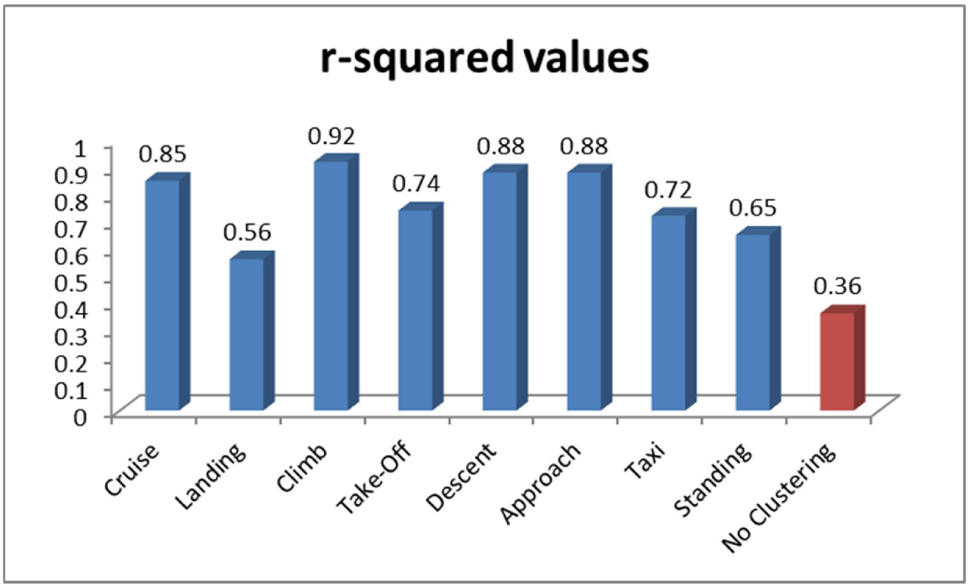


As explained in Section 1, Nazeri et al. (2008) recommended that future studies include the flight phase in which the accident/incident occurred. Together with results using other variables (Figure 7), this led us to select Phase of Flight as the variable for clustering. Eight flight phases were used as clusters for the database. To assess the effect of different variables on the correlation between canonical variates, CCA was performed multiple times on each cluster. Method details and results of the analysis are presented and discussed in the next section.

4. RESULTS AND DISCUSSION

As mentioned earlier, the first CCA run on the entire database did not yield fruitful results, since the r-squared value showed a weak correlation. Following clustering, the correlations were strengthened significantly. Clustering was based on Phase of Flight IV, which lent further relevance to nonnumerical values. The r-squared values for all eight phases, with and without clustering, are shown in Figure 8.

Figure 8 - Significance of Clustering



To investigate the effect of different variables on the r-squared values for each cluster, the CCA statistical test was run six times with different variables. The first run included all IVs. Successive runs were performed by excluding one group of IVs at a time while recording the resulting changes. Consider, for example, the Cruise cluster, which includes all events that occurred during that phase. The first run obtained 0.85 for the highest r-squared value between canonical variates. The second run included all IVs except Weather Information. The resulting r-squared value was 0.84, showing a minimal decrease in correlation. The third run was performed including all IVs except Pilot Information. The resulting r-squared value was 0.56, showing a significant drop in correlation (34%). This supports the claim that the effect of pilot-associated information is much more significant than weather information in the investigation of correlations between different factors of flight events. Remaining runs were performed in the same manner as the Cruise phase for the other seven Phases of Flight. Detailed results are shown in Table 3.

Table 3 - r-squared Values for Different Run of CCA

		Cruise	Landing	Climb	Take-Of	Descent	Approach	Taxi	Standing	All 8
1	All factors	0.85	0.56	0.92	0.74	0.88	0.88	0.72	0.65	0.36
2	Without Flight Info	0.82	0.52	0.89	0.68	0.84	0.78	0.60	0.56	0.35

3	Without Weather Info	0.84	0.47	0.81	0.67	0.86	0.83	0.65	0.52	0.33
4	Without pilot info	0.56	0.47	0.91	0.60	0.81	0.69	0.47	0.62	0.26
5	Without Aircraft Info	0.83	0.56	0.88	0.74	0.83	0.80	0.70	0.63	0.32

To gain a better understanding of the effect of different variables on goodness of fit, it is necessary to calculate the level of drop in r-squared values when each group is excluded from the analysis. Drops are calculated as percentages and shown in Table 4 and Figure 9. As shown in Table 3, in five out of eight flight phases, pilot-associated data played the most significant role in the correlation between DVs and IVs for accidents/incidents. This phenomenon was observed by removing pilot-associated variables and monitoring the changes in other variables. The highest drops are seen in the Taxi, Cruise, Approach, and Take-off phases.

Table 4 - Drop in r-squared Values in %

	Cruise	**Landing**	**Climb**	**Take-O**	**Descent**	**Approach**	**Taxi**	**Standing**	**All 8**
Drop in r^2 for Flight Info	4%	7%	3%	8%	5%	11%	17%	14%	3%
Drop in r^2 for Weather Info	1%	16%	12%	9%	2%	6%	10%	20%	8%

Drop in r^2 for Pilot Info	34%	16%	1%	19%	8%	22%	35%	5%	28%
Drop in r^2 for Aircraft Info	2%	0%	4%	0%	6%	9%	3%	3%	11%

Our findings further demonstrate that even without clustering, pilot information has the greatest effect of the IVs in all but two flight phases, Standing and Climb. The lower level of correlation in the Standing phase can be attributed to the pilot's low level of involvement; it is reasonable that other factors, such as weather information or airport-related factors, would be more influential, and this is corroborated by the results shown in Figure 9. In the case of the Climb phase, the discrepancy in correlation may be attributed to the low number of events recorded during this phase. The overall process of preparing the database, performing multivariate statistical tests, and obtaining results is illustrated in Figure 10.

Figure 9 - Drop in r-squared Values for Different Flight Phases

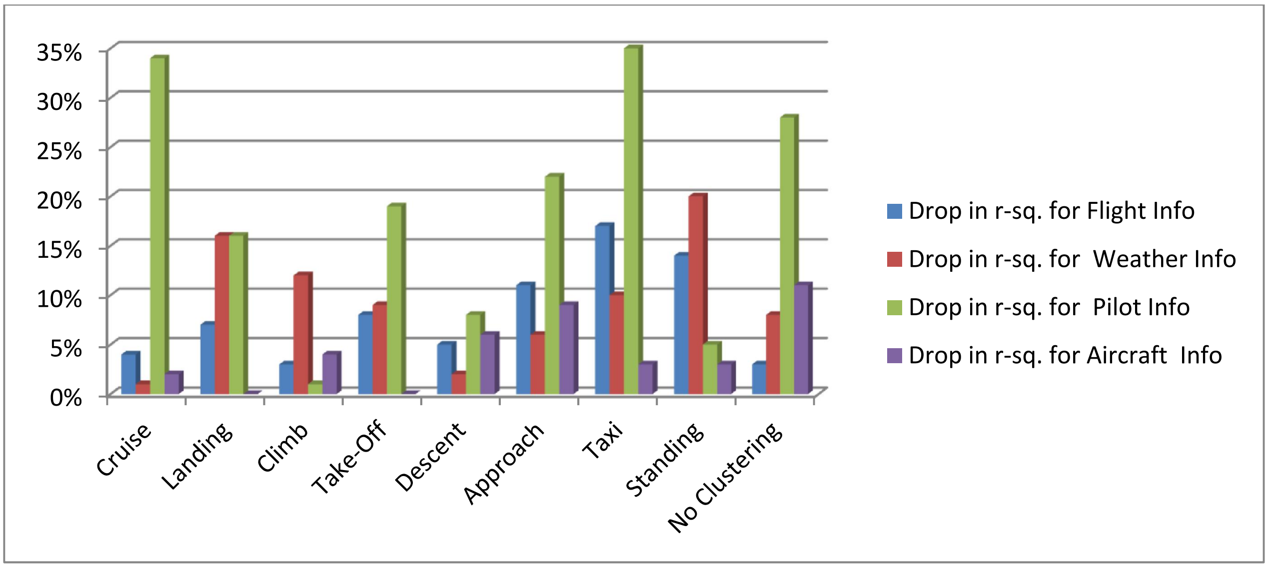
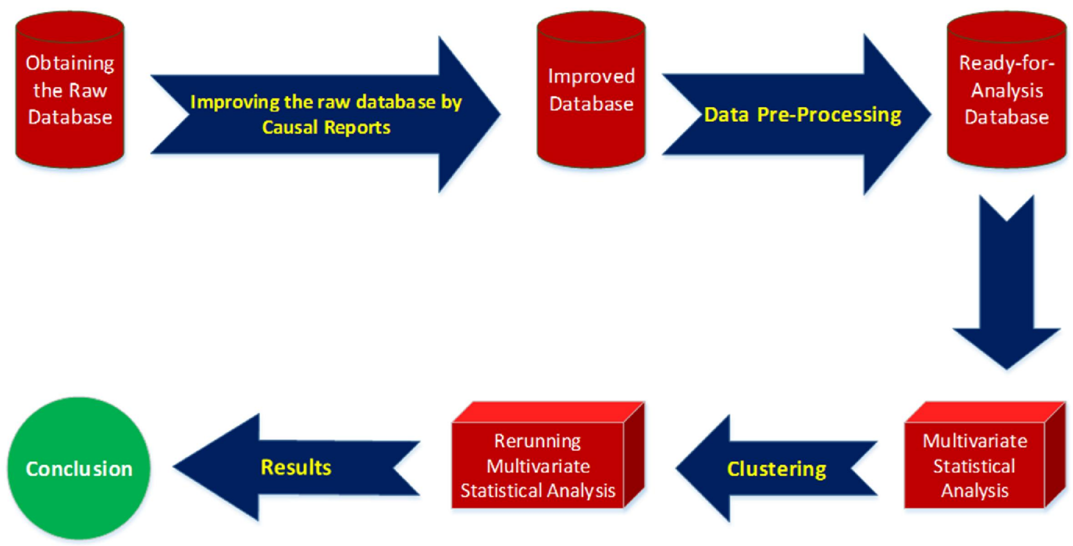


Figure 10 - An Overview of Research Methodology



5. CONCLUSIONS AND FUTURE STUDIES

In this paper, CCA was used to analyse an enhanced aviation safety database to identify the effects of different variables on correlations between flight factors and event factors. The study's focal point was to identify and assess relevant factors in aviation events. Prior research with a similar aim has lacked a comprehensive database that incorporates not only raw information from the NTSB, but, as with this study, additional data from sources that are not immediately quantifiable (e.g., the NTSB's PCRs). Database enhancement was performed by studying all associated PCRs and retrieving new variables. The enhancement process included grouping, introducing new variables, obtaining data from additional sources, and database cleaning. Having said that, this research was limited to events happened in USA and mentioned in the NTSB main database. The next step was to determine whether the enhanced database would be suitable for CCA, with the goal of discovering the most influential factor among the IVs considered. Initial results were not promising, so a clustering method was proposed. Clustering based on Phase of Flight was selected after comparing clustering options. CCA was run six times in each cluster with different variables, based on the research model, to investigate the variables' effects on r-squared values between DVs and IVs.

Our findings statistically support the empirical observation that pilot-associated data, including age, career flight time, and experience with the aircraft model involved in the event, are the most effective factors in demonstrating a correlation between dependent and independent variables of aviation events. The second, third, and fourth most significant factors were variables associated with weather, flight time, and aircraft, respectively.

This research provides a framework for further inquiry and the construction of a predictive model using the more comprehensive database we have made available. Such a predictive model could be used by different stakeholders, such as risk managers, airline planners, crew schedulers, and dispatchers, to minimise flight risk and improve flight safety. These findings could be used to improve flight-crew scheduling and dispatching practices; consideration of these factors when selecting pilots and co-pilots could also reduce flight risk. Prior entering raw data in regular flight scheduling process, the above mentioned predictive model can be used to assess the combination of those factors and the level of risk they impose. This model can potentially tell schedulers that in specific weather conditions, *how* assigning low experience pilot will increase the risk of flight. This model can also be used to reduce the risks based on the known variables prior to flight. "Flight variable assessment" based on this model can be added into existing flight scheduling processes to measure the level of risks imposed by flight variable combination. For example, a pilot with more experience and higher variable values could be paired with a low-hours co-pilot with less experience to optimise flight risk and, possibly, lower cost. Likewise, if weather factors based on our findings were included in the crew- scheduling process, better results might be obtained. By evaluating the risks prior to flight, the dispatcher or flight-crew scheduler could modify and reroute the flight, if necessary, based on weather conditions and pilot variables.

CCA was applied in this research so it imposes its limitations and assumptions. Linear relationship assumed for all variables in each set and also between sets. Applying none-linear methods can improve results and contribute to findings of our study. Widening the events selection criteria and including other countries aviation events, can potentially improve the results. Our method is also adaptable for a wide range of research topics. Other analytic methods, such as neural network analysis or fuzzy logic, could be used to determine whether similar results can be obtained.

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ESTABLISHING A COMMERCIAL AIR ROUTE BASED ON MORE THAN JUST TECHNICAL VARIABLES: THE CASE OF BARRETOS CITY, BRAZIL

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ABSTRACT

The city of Barretos in Brazil has the largest cancer treatment center in Latin America, the Barretos Hospital of Cancer (HCB). The hospital provides medical care to about 4,000 daily. These patients come from about 1,600 cities, approximately 30% of the cities in Brazil. In terms of demand and initial structural conditions, Barretos is qualified to receive commercial flights, however, there are no regular flights to the city. Theoretical propositions are made on corporate social responsibility disregard nontechnical variables related to air transport operations, including the value of human life. The results of the present case study on the city of Barretos, with reference to the HCB, show the existence of initial favorable airport conditions for the implementation of a commercial airline in the city, such as runway extension, for example. Additionally, there are initiatives in the mobilization of public opinion, such as the Flight Against Cancer campaign, which can guide the adoption of nontechnical variables toward establishing a commercial airline in the city based on the value of human life and the reduction of human suffering. Managerial implications are presented, such as the redefinition of the metrics used in corporate social responsibility, the availability of public and private grants sharing agendas alternating between airlines and the establishment of a regional multimodal logistics platform.

Keywords: Airline Route; Health Care; Human Value.

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1. INTRODUCTION

The establishment of commercial air transport routes requires the consideration of different conditions, including business strategies and airport conditions, demand, such as the available markets, and government conditions and regulations. Although there is a hierarchy among these conditions, the demand set by market conditions is believed to be one of the most relevant in designing a commercial airline route.

The analysis of market demands considers different financial variables adopted by airlines, which can be identified in the literature on corporate social responsibility (CSR). These variables include, on the shareholder side, the return on equity and net profit growth; on the customer side, the average price, on-time performance, accident rate, and flight frequency; on the employee side, the growth of employee revenues; on the government side, the tax performance; and, finally, on the general public side, the environmental protection investment, donations, and sponsorships (Wang et al., 2015). However, some variables, such as the value of human life and the reduction of human suffering, are neglected in theories. These should rather be considered as determining factors in the deployment of commercial airline routes.

The present study seeks to identify and show the possible application of new variables in the implementation of commercial air transport routes, based on a case study on a possible target of a regional route, the city of Barretos in São Paulo state, Brazil.

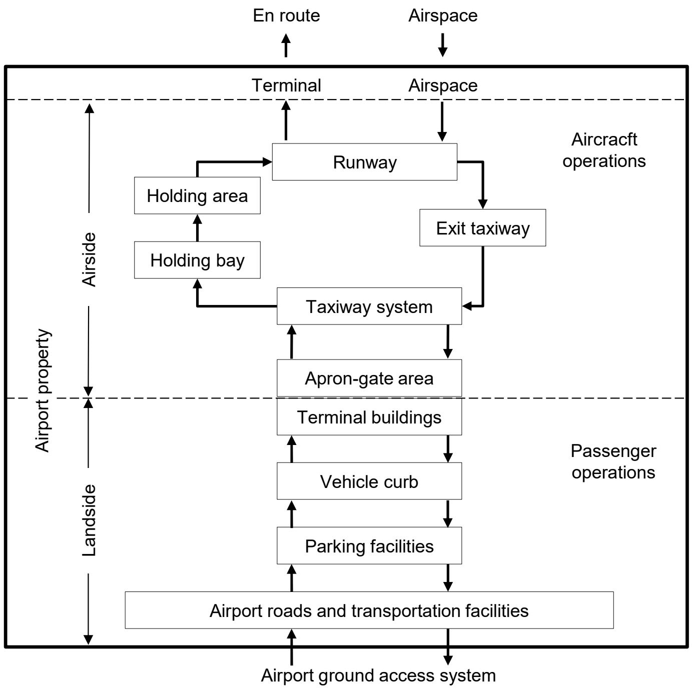
2. ESTABLISHING A COMMERCIAL AIR TRANSPORT ROUTE

The establishment of a commercial air transport route considers different factors related to market demands, the provision of air transport products and services, airport structural conditions and approval from aviation control authorities, among others.

The market demands can be targeted based on variables related to the needs of consumers regarding the origin and destination of people or cargo, the prices charged by the airlines (Nicolau, 2011), the quality of services provided by companies (Wu and Cheng, 2013), the restrictions on access to other modal, time constraints or air transport priorities in relation to other kinds of transport and in addition to other variables, as identified in Valdes (2014). Note that most of these variables are objective and can be measured. Managers make choices of an air transport route as a rational process grounded in data, such as the financial costs or travel time for the passenger. However, subjective or emotional variables are often disregarded by companies and government agencies.

Besides the market demands, variables related to product offerings and air transport services are considered. These include the feasibility of providing a particular service according to an analysis of the costs per flight based on the aircraft size, cost per seat, schedule delay due to airport congestion (Silva et al., 2014), fleet assignment problem (FAP), resulting from the aircraft type and capacity, operational costs and potential revenues, as proposed by Sherali et al. (2006), landing and takeoff costs, maintenance and administrative costs, and airport facilities (see Figure 1).

Figure 1 - The Components of an Airport



Source: Young and Wells (2011).

As shown in Figure 1, the air transport services supply considers airport technical decisions on aircraft operations, including the airside (runway and apron), air traffic control systems, terminal buildings, and safety conditions for equipment and passenger operations personnel, as well as landside questions like government policies, airport slot allocation regulations (Knieps, 2014), equipment and infrastructure approvals and certifications, and compliance with the rules and guidelines set by relevant agencies, such as the National Agency for Civil Aviation (ANAC in Brazil), the International Air Transport Association (IATA), and the International Civil Aviation Organization (ICAO), among others.

Figure 2 presents an overview of the main factors that affect the establishment of a commercial air route and thus are considered in such operation.

Figure 2 - Main Factors in an Air Transport Route Operation

The factors presented in Figure 2 have a common feature. They can be measured to guide the decision-making of public and private stakeholders in establishing a commercial air route. However, there are factors that are neglected both in the literature and in practice. Although these are not easy to measure, they can make a significant difference in customers' lives.

3. THE CASE OF BARRETOS, BRAZIL

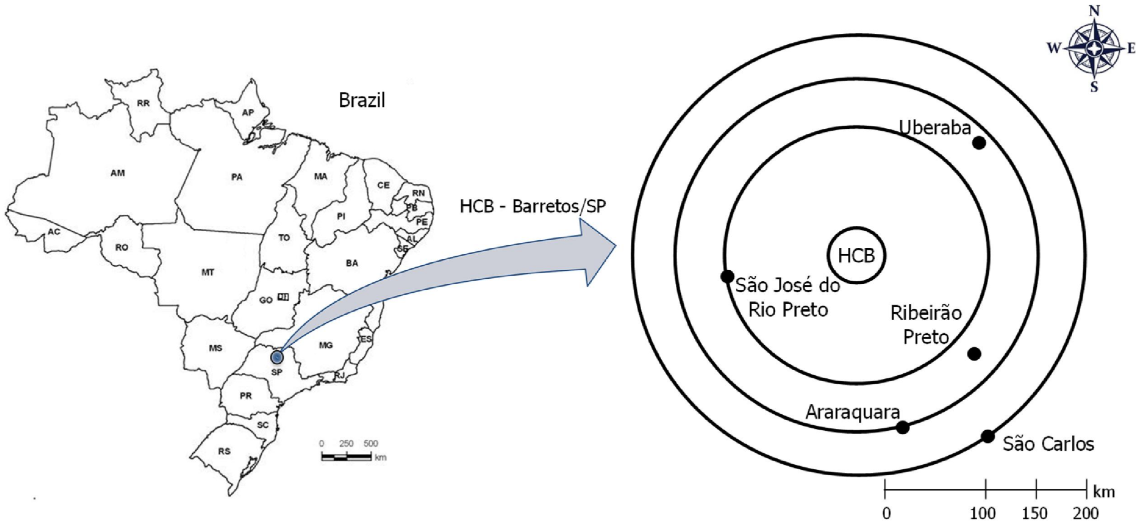
The city of Barretos is located in the state of São Paulo (SP), Brazil, about 420 km from the state capital, São Paulo. It has 119,000 inhabitants (IBGE, 2016) and is home to the Barretos Hospital of Cancer (HCB), the largest reference center for cancer treatment in Brazil and the largest cancer hospital in Latin America. The history of the HCB originated with the institution of Pio XII Foundation in 1967. Today, it has 260 doctors and about 3,500 employees. Besides having the infrastructure and highly qualified professionals in cancer treatment, the hospital differs from other institutions in that it adopts a humane treatment approach, considering much more than just technical criteria in treating patients and caring for the people involved (Prata, 2012).

About 4,000 daily attendance are performed at the hospital, seeing patients 1,585 municipalities from Brazil (HCB, 2015). The country has 5,570 municipalities (IBGE, 2016), and about 30% of these have had citizens attend the HCB for treatment. All treatments are carried through the Unified Health System (SUS) of the Federal Government, as well as the fundamental and significant collaboration of different individuals and corporations that often support the hospital by providing different types of resources.

This national relevance of the HCB in cancer treatment raises the issue of its difficult access by patients coming from different cities, given that the hospital is about 100 km from the nearest regional airport, which is located in São José do Rio Preto/SP (SBSR/SJP), with about

691,000 passengers annually in 2015 and operated by the airlines LATAM, Passaredo, Pantanal and Azul (DAESP, 2016). Four other cities, Ribeirão Preto/SP (SBRP/RAO), located 130 km distance and 1,1 million passengers in 2015, Uberaba/MG (SBUR/UBA), 140 km and 137,700 passengers in 2015 (Infraero, 2016), Araraquara/SP (SBAQ/AQA), 150 km and 6,500 passengers in 2015, and São Carlos/SP (SDSC/QSC), 200 km and 1,100 passengers in 2015, which are located up to 200 km away from Barretos, also have regional airports which can assist these patients. However, there is a tight supply or even a lack of regular commercial flights to these airports, making it difficult to access the hospital by air transport. Figure 3 shows an approximate representation of the distances of these airports relative to the HCB in Barretos/SP, Brazil.

Figure 3 -Distances between the HCB and nearby Cities with Regional Airports



Even when a patient or a professional uses one of the mentioned airports, as shown in Figure 3, road transport is still necessary to reach the HCB. If one of the airports serving the state capital of São Paulo (SBSP/CGH - Congonhas, SBGR/GRU – Guarulhos, or SBKP/VCP - Viracopos/Campinas) is used, it would still take at least four hours of land travel to get to the HCB. For a patient in treatment, who goes through weekly sessions of chemotherapy over several months, this travel time and the exposure to risks caused by land modal can not only worsen the prognosis but can also spell the difference between life and death. Moreover, if the mentioned travel time and conditions apply to the transport of organs, carrying out transplants in the hospital can become impractical.

Regarding the air transport service and supply conditions, the Chafei Amsei State Airport (SBBT/BAT) in Barretos, managed by the Airway Department of São Paulo (DAESP), is located 8 km away from the HCB or a few minutes by land transport between the airport and the hospital. Certain factors are believed to have restricted the use of both airports solely to business purposes and at specific times of the year, such as during the international rodeo circuit of Barretos. These factors include the availability of operations and services, the strategies of airlines and the feasibility of implementing commercial flights.

Regarding the availability of a runway, which is just one of the main elements of airport conditions, the airport of Barretos has a sufficient runway length to receive aircrafts of the major companies operating in the country (85%), such as the Airbus A320 and A319 - which represents 37% of the commercial aircraft fleet in the country, the Boeing 737-800 and 737-700 - 33% of the fleet, and the Embraer EMB-195 and EMB-190 - 15% of the fleet (ANAC, 2015). Using the ANAC information, the runway extensions of the main airports in the region and the state were specified, as shown in Table 1.

Table 1 - Runway Extensions of Nearby Airports

City/State	Runway extension (meters)
Barretos/SP	1,800
Main airports at the region	
Araraquara/SP	1,800
Ribeirão Preto/SP	2,100
São Carlos/SP	1,630
São José do Rio Preto/SP	1,700
Uberaba/MG	1,800
Main airports at the São Paulo state	
São Paulo (Guarulhos)/SP	3,700
São Paulo (Congonhas)/SP	1,940
Campinas (Viracopos)/SP	3,240

The area extending from 60-750 meters (200-2.500 feet) after the end of runway threshold, identified as the runway protection zone (RPZ), was also measured but is not shown in Table 1 (Young and Well, 2011). Note that the runway at Barretos airport has the second largest extension in the region (elevation 579 meters), only less than Ribeirao Preto. It is also bigger than the runway at Congonhas airport, the second busiest airport in the country, which accounted for over 8% of total landings and about 80.000 flights in 2014 (ANAC, 2015). Thus, it can be said that Barretos airport satisfies one of the main conditions for airport operations.

Regarding airport regulations, government authorities have shown their political will in response to the economic conditions of the region and the demands presented by the HCB. To strengthen the hospital demand, an advertising campaign with the theme 'Flight Against Cancer' was launched (HCB, 2015), which seeks to increase the awareness of both public authorities and airline managers regarding the need to establish a regular commercial air route to the city of Barretos. However, although one airline has actively participated in the campaign, and even carried out an inaugural flight to the city, such flights are still not commercially available.

Air transportation is significantly relevant in obtaining access to the city of Barretos not only because of the medical conditions of patients undergoing cancer treatment at the HCB, but also in view of the psychological conditions of these patients and their families, for whom death and human suffering are constant companions. Previous studies have shown that among the four main factors considered in establishing a commercial air transport route, in the case of the city of Barretos, the business strategies of airlines may be the deciding factor.

4. CONCLUSION AND MANAGERIAL IMPLICATIONS

Based on the theoretical analysis, initiatives could be taken to overhaul the concept of CSR, as proposed by Porter and Kramer (2006). In the case of air transport, companies can adopt social metrics that are related not only to the number of employees, percentage of female employees, number of accidents, number of trainees (Székely and Knirsch, 2005), or the financial and environmental impacts of the organization on its stakeholders (Wang et al., 2015), but also to the services provided to customers at risk, such as the patients of the HCB and their companions. The number of seats for these customers in different sections that lead to HCB could also be increased by civil aviation authorities to promote humanization in the transport of patients.

Regarding management practices, companies can provide patients with access to mileage points donated by customers participating in frequent flyer programs or even allow patients to use mileage points that have expired or are unused by customers. Also, airlines can offer discounted prices to verified patients and their companions. These discounts could be subsidized by public programs and offered alternately on a daily or weekly basis by different companies. Further, this service could be accompanied by the provision of public transport between the airport and the HCB or of an exclusive transfer service for patients and caregivers, optimizing the transport of patients.

The Essential Air Service program of the United States (Özcan, 2014), in which small communities receive airline services subsidized by federal programs, could be analyzed to aid the formation of public policies on air transport in Brazil, such as in the case of the HCB.

Finally, the use of commercial air transport services to carry cargo to the city could be encouraged by the development of other sectors of the regional economy, such as the establishment of a multimodal logistics platform for industries of interest, thus favoring the improvement of the socioeconomic conditions of the region.

Future research could identify other structural and managerial elements, related to the Barretos airport services, to create strategies to search investment and create the necessary conditions for the realization of scheduled flights to the city.

ACKNOWLEDGMENTS

National Council for Scientific and Technological Development (CNPQ - Process: 160348/2015-3, PDJ) and The State of Goiás Research Foundation (FAPEG).

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AIRLINE SERVICE FAILURE AND RECOVERY: THE IMPACT OF RELATIONSHIP FACTORS ON CUSTOMER SATISFACTION

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ABSTRACT

In aviation industries, service failure during the service delivery process is foreseeable and leads to passenger complaints, which therefore presents the perfect opportunity for airlines to improve their service process and quality and examine their internal organization. Concurrently, the quality of the service recovery measures reflects the ability of airlines to respond to and handle traveler complaints. By rectifying service failures, airlines can enhance traveler satisfaction toward airlines services, thereby generating loyal customers who would engage in word-of-mouth marketing. This study aims to do examine the relationship between service failure, service recovery and passenger's satisfaction with service recovery types, employee prompt handling, and service recovery efficiency. The questionnaires used in this study consisted of three sections: (1) Customers' perception of the service recovery types; this section entails using passengers' subjective perceptions to evaluate the service recovery types adopted by the airlines when handling flight delay situations. (2) Customers' perception of the airlines employee's prompt handling; the traveler's subjective perception to evaluate the airlines employees' direct responses to flight delays. (3) Customers' perception of the problem-solving efficiency; this section involves using the passengers' subjective perception to evaluate the overall flight delay recovery progress. The traveler characteristics were divided into 'passenger attributes' and 'traveling attributes' and their relationships with service recovery types, employee's prompt handling, and problem solving efficiency were examined. The research results showed that passenger attributes demonstrated no significant differences with the three dimensions (i.e., service recovery types, employee's prompt handling, and problem solving efficiency). However, concerning traveling attributes, 'purpose of travel' and 'flight delay experience' demonstrated significant differences with the three dimensions.

Keywords: service failure, service recovery, satisfaction

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1. INTRODUCTION

Satisfaction of customers is the most priority for all service industries and the civil aviation industry is no exclusion. Due to the characteristics of service, such as intangibility, inseparability and variability, failures are inevitable. However, defects or dissatisfaction in any encounter during service delivery may cause customer dissatisfaction (Lapre, 2011), which leads to customers' negative behavioral responses (Zeelenberg & Pieters, 2004). Service failure and the subsequent complaints from customers are a likely occurrence over a product/service lifetime and the rapid, effective handling of these has proven to be vital in maintaining customer satisfaction and loyalty (Bamford & Xystouri, 2005). Organizations that avoid service failure fare lot better than organizations focusing on service recovery after failure (McCollough et al., 2000). Thus, when service failure happens, service providers must immediate take necessary recoveries to retain their customers.

Service failures in airline industry such as flight delays are inevitable. In airline industry, external factors beyond the immediate control frequently can cause service failure, such as flight delay or cancellation due to air traffic congestion, or a failure in another airport where the airline's aircraft are involved. In addition, many airports around the world face serious delay problems as a result of imbalanced demand of flights and available capacity after air transport liberalization. Boshoff (1997) surveyed 540 travellers, presenting them with a constantly negative service situation (a missed flight connection caused by flight delay) and looked for the most successful recovery strategies. They were: a fast response by the highest possible person in terms of seniority; a fast response accompanied by full refund plus some amount of compensation; a large amount of compensation provided by a high-ranking manager.

Bamford & Xystouri (2005) also mention that, the importance of service recovery reinforces the need for organizations to find approaches that are effective in both identifying service failure and in developing strategies to recover successfully. Service recovery should be the cornerstone of a customer satisfaction strategy. According to Weber and Sparks (2004), ineffective service recovery may lead to a negative word-of-mouth. Xu & Li (2016) suggest that service providers' ability to understand their customers' views of service failure can be the antecedent for developing an appropriate recovery processes and providing more robust service operations. Therefore, this study aims to do examine the relationship between service failure, service recovery and passenger's satisfaction with service recovery types, employee prompt handling, and service recovery efficiency.

2. LITERATURE REVIEW

In general, to increase customer satisfaction, companies in the service industry can adopt two major strategies: active or passive strategies. Active strategies are focused on minimizing the gaps of inconsistencies before the events occur (Churchill & Suprenant, 1982; Oliver, 1980; Oliver & DeSarbo, 1988). Passive strategies are concentrated on providing timely service recovery when service failures occur. Fisk et al. (1993) argue that due to the unique nature of services (specifically, coproduction and the inseparability of production and consumption) it is impossible to ensure 100% error-free service. According to Bitner et al. (1990) asserted that service failure occurs when the service providers are unable to meet the customers' service demands or when the core services provided failed to satisfy the customers' minimum expectation.

This corporate service behavior (from first to last service encounter) is considered by the customers to be unsatisfactory. Therefore, service failure can occur any time during the customer-service provider interaction. And the types of service failure were proposed by Bitner et al. (1990), who investigated service failure from the service encounter perspective and summarized three major failure types based on 700 case projects regarding airlines, hotels, and restaurant industries: (a) customer dissatisfaction resulting from service delivery system failure; (b) customer dissatisfaction resulting from inability to respond to customer demands; and (c) customer dissatisfaction resulting from poor employee conduct.

Airlines are susceptible to service failures due to the nature of the service process they apply in service delivery (Steyn et al., 2011). Previous research has indicated a number of causes leading to service failures in the airline industry, including flight cancellations, diversions or delays, attitudes of ground and cabin staff, strikes, reservation problems and overbooking of flights (Bamford & Xystouri, 2005). As a result, it was anticipated that most airline passengers would find manipulations regarding recovery expectations, recovery performance, and justice realistic and believable. In airline companies, service failure during the service delivery process is completely inevitable and leads to traveler complaints. Service recovery strategy is among the most efficient ways to alleviate the negative outcome caused by service failure (Craighead et al., 2004). Service recovery actions also provide an opportunity for service providers to implement recovery actions and turn angry and complaining customers into loyal customers (Lapre, 2011). Concurrently, the quality of the recovery procedures reflects the airlines' ability to respond and handle passenger complaints. By rectifying the service failures, airlines can enhance the passenger's satisfaction toward airlines services, thereby generating loyal customers who would engage in word-of-mouth marketing. The most common airlines service failure is flight delay, which leads to financial losses for both the airlines and the passengers. For most passengers, when facing a flight delay or cancellation, will have no choice but to seek redress as canceling the trip is not an option (McColloug et al., 2000). For passengers, the effects of flight delays may differ based on the cause of the delay and the purpose of travel. Nevertheless, customer rights and interests will inevitably be negatively affected.

According to Hart et al. (1990), Johnston & Hewa (1997), and Maxham III (2001), service recovery refers to the actions taken by the service providers to reduce or recover the losses suffered by the customers during the service delivery process. When service failure occurs, customers believe that companies should take actions to compensate them, regardless of effects of the recovery measures (Cheng, 2002). Related studies on air transport have shown that a satisfactory service recovery measure promotes post-recovery satisfaction of customers. Poor service recovery leads to the customers' repeated bias in their service expectations. When this occurs, basic services provided and service recovery efforts attempted by the companies would be proven ineffective (McCollough et al., 2000). Therefore, providing a satisfactory service recovery compared with poor recovery measures is the only opportunity to enhance customer satisfaction when service failure occurs. Effective service recovery has a positive impact on post-recovery word-of-mouth communication (Schoefer & Ennew, 2004).

3. STUDY METHODS

3.1. Study Framework & Hypotheses

Based on the research objectives mention above, this study examined the relationship of customer post-recovery satisfaction with traveler characteristics (passenger attributes and traveling attributes), service recovery types, prompt handling and problem solving efficiency, which comprised the study framework.

When service failure occurs, the recovery processes adopted by companies and the time/speed adopted to implement these processes have an undeniable effect on customer satisfaction. Therefore, service recovery types, prompt handling and problem solving efficiency play a critical role in company operation. Moreover, passenger attributes also have an effect on customer satisfaction. The previous literature shows that difference types of service recovery strategies to have a significant impact on customer post-recovery satisfaction (Wirtz & Mattila, 2004; Wen & Chi, 2013). Liao (2007) argues that prompt handling refers to service employees' quick response to a customer complaint. Response speed has been linked to customer satisfaction in the service recovery literature. Wirtz & Mattila (2004) also suggest that a fast recovery would be seen by consumers as a cue for a service provider being efficient and generally offering good quality service. According the above literature, the hypotheses of this research are listed as follows:

H1: Passenger attributes positive effect on post-recovery satisfaction

- H1-1: Service recovery types positive effect post-recovery satisfaction for different passenger attributes
- H1-2: Prompt handling positive effect post-recovery satisfaction for different passenger attributes
- H1-3: Problem solving efficiency positive effect post-recovery satisfaction for different passenger attributes

H2: Traveling attributes positive effect on post-recovery satisfaction

- H2-1: Service recovery types positive effect post-recovery satisfaction for different traveling attributes
- H2-2: Prompt handling positive effect post-recovery satisfaction for different traveling attributes
- H2-3: Problem solving efficiency positive effect post-recovery satisfaction for different traveling attributes

3.2. Questionnaire Design & Data Collection

In this study, questionnaires were implemented for conducting the investigation. The questionnaires consisted of open-ended questions to obtain the responses of the respondents when encountering flight delays. The questionnaire was divided into five parts, which were used for obtaining the respondents' demographic information, travelling conditions, and their satisfaction with the service recovery measures, employee responses, and recovery efficiency.

The questionnaire was designed with a 7-point Likert scale for measurement, and the scores were judged based on the passengers' subjective perception. The degree of importance was identified as '*extremely unimportant*, unimportant, slightly unimportant, neutral, slightly important, important, and *extremely important'*, which were allocated a score of 1, 2, 3, 4, 5, 6, and 7, respectively. A higher score indicated greater importance.

The study respondents were customers who had travelled on international flights. The questionnaires were disseminated to respondents found in the Arrival and Departure Hall at the Kaohsiung International Airport. They respondents were asked to complete the questionnaires on site. A total of 450 questionnaires were disseminated and returned, yielding a questionnaire return rate of 100%. After removing 84 incomplete questionnaires, 366 valid questionnaires were obtained, yielding a response rate of 81.3%.

3.3. Data Analysis Methods

This study employed the SPSS statistics software to analyze the valid questionnaires for testing the study hypotheses. The statistical methods included the following:

(1) Reliability analysis: used to measure the reliability of the data and items such as recovery measures, employee responses, and service recovery efficiency. Cronbach's α was used as the discriminant value.

(2) Descriptive analysis: frequency distribution, percentage, standard deviation, and ranking were used to describe the data distribution of the variables traveler characteristics, recovery measures, employee responses, and service recovery efficiency.

(3) *T* test: used to determine whether customer satisfaction with the service recovery measures, employee responses, and service recovery efficiency differs significantly between customers of different sexes and for passengers who have and have not had flight delay experiences.

(4) Single-factor ANOVA: adopted to determine whether customer satisfaction with the service recovery measures, employee responses, and service recovery efficiency differs significantly for customers of different ages, education levels, occupations, monthly incomes, numbers of flights taken, and travel purposes.

4. STUDY RESULTS

4.1. Reliability Analysis

The reliability of this research shows as Table 1, the Cronbach's α values are 0.903, 0.937, and 0.871 for the 'Service recovery types', 'Prompt handling', and 'Problem solving efficiency', respectively. The Cronbach's α value for the overall item in the questionnaire was 0.957, indicating overall content consistency and high reliability.

Table 1 - Reliability Analysis

	questions	Cronbach's α values
Service recovery types	8	0.903
Prompt handling	6	0.937
Problem solving efficiency	4	0.871
Total	18	0.957

4.2. Descriptive Analysis

This descriptive analysis including seven variables shows as Table 2, which were sex, age, occupation, education level, monthly income, purpose of travel, and have or have not had a delayed flight experience. Concerning service recovery for flight delays, three dimensions that consisted of service recovery types (8 questions), prompt handling (6 questions), and problem solving efficiency (4 questions) were used. Next, the means and standard deviations from the descriptive analysis were used to examine customer satisfaction.

The questionnaire analysis showed that female respondents (56.6%) are more than male respondents. The traveler groups that accounted for the highest proportions of the other variables are listed as follows: (a) age: 21 to 30 (41.5%); (b) education level: university degree (51.7%); (c) occupation: service industry (29.6%); (d) monthly income: NT$20,000 to NT$40,000 (44.8%); (e) purpose of travel: tourism (73%); (f) airline chosen: China Airlines (44.8%); (g) flight delay experience: yes (54.9%).

Table 2 - Descriptive Analysis

Variables	Counts	%
Sex		
Male	159	43.4%
Female	207	56.6%
Age		
Below 20	23	6.3%
20 to 30	152	41.5%
31 to 40	124	33.9%
41 to 50	50	13.7%
51 to 60	15	4.1%
61or above	2	0.5%
Education level		
Junior high school or below	2	0.5%
High school/vocational school	59	16.1%
Vocational college	64	17.5%
University	189	51.7%
Graduate school or above	52	14.2%
Occupation		
Civil servants	14	3.8%
Businessmen	34	9.3%
Military and police officers	4	1.1%
Teachers	18	4.9%
Freelancers	48	13.1%
Service industry workers	108	29.6%
Housekeepers	19	5.2%
Students	62	16.9%
Other	59	16.1%
Monthly Income		
NT$20,000 or below	78	21.3%
NT$20,000 to NT$40,000	164	44.8%
NT$40,000 to NT$60,000	79	21.6%
NT$60,000 to NT$80,000	21	5.7%
NT$80,000 to NT$100,000	12	3.3%
NT$100,000 or above	12	3.3%
Purpose of travel		
Business trip	48	13.0%
Tourism	267	73.0%
Visiting relatives	34	9.3%
Study	4	1.1%
Other	13	3.6%
Flight delay experience		
Yes	201	54.9%
No	165	45.1%

1. Importance of Service recovery types

   Regarding service recovery types, the analysis results showed that the item 'airlines' assistance to arrange a new flight or other means of transport' scored the highest degree of importance (5.965), which was followed by 'airlines offering monetary compensation or refund' (5.902). The item 'airlines apologizing in person' demonstrated the least degree of importance (5.514).

2. Importance of Prompt handling

   Concerning prompt handling, the analysis results showed that the item 'employees taking the initiative to explain the recovery progress' scored the highest degree of importance (6.137), which was followed by 'employees demonstrating an sincere attitude' (6.096). The item 'ability to pacify traveler's discontent' demonstrated the least degree of importance (5.910).

3. Importance of Problem solving efficiency

   Regarding the problem-solving efficiency, the item 'the service recovery time was longer than what I expected' scored the highest degree of importance (5.661), which was followed by 'airlines' recovery result compensated for the time I had lost' (5.765). The item 'airlines' recovery result was able to meet my demand' demonstrated the least degree of importance (5.910).

4.3. The Effects of Traveler Characteristics on Recovery Measures, Employee Responses, and Service Recovery Efficiency

This section examines the differences in the customers' satisfaction with the various service recovery types, prompt handling and problem solving efficiency based on different sex, age, education level, occupation, monthly income, purpose of travel, and flight delay experience.

The results show that customer satisfaction presented no significant differences between those of different personal attributes, e.g. sexes, ages, education levels, occupations, and monthly incomes. However, significant differences were observed for purposes of travel and flight delay experience.

Table 3 - ANOVA on the Effects of Personal Attributes on Service Recovery Measures

Variables	Service recovery types (mean)	Prompt handling (mean)	Problem solving efficiency (mean)
Sex			
Male	5.7602	5.9937	5.7846

Female	5.8050	6.0411	5.8350
T value	0.403	0.576	0.062
Significance level	0.526	0.448	0.804
Age			
Below 20	5.7717	6.1232	5.8804
20 to 30	5.7738	6.0044	5.7748
31 to 40	5.8317	6.0175	5.8387
41 to 50	5.6950	5.9267	5.7050
51 to 60	5.7833	6.2778	6.1333
61or above	6.2500	6.6667	6.6250
F value	0.243	0.500	0.701
Significance level	0.943	0.776	0.623
Education level			
Junior high school or below	6.2500	6.5833	6.5000
High school/vocational school	5.7987	5.9294	5.7331
Vocational college	5.7539	6.1380	5.9063
University	5.7493	6.0000	5.7886
Graduate school or above	5.9231	6.0321	5.8510
F value	0.470	0.514	0.470
Significance level	0.758	0.726	0.758
Occupation			
Civil servants	5.7054	6.0357	5.8036
Businessmen	5.5662	5.9216	5.8235
Military and police officers	5.9688	6.5833	6.0625
Teachers	5.5208	5.6111	5.5417
Freelancers	5.7526	5.9792	5.6406
Service industry workers	5.9352	6.1497	5.9190
Housekeepers	6.0658	6.2281	5.9868
Students	5.8367	6.1210	5.8074
Other	5.6081	5.7853	5.7712
F value	1.245	1.395	0.555
Significance level	0.272	0.197	0.815
Monthly Income			
NT$20,000 or below	5.8029	6.0897	5.8141
NT$20,000 to NT$40,000	5.8438	6.0549	5.8313
NT$40,000 to NT$60,000	5.7642	6.0190	5.8196
NT$60,000 to NT$80,000	5.5536	5.6429	5.6310
NT$80,000 to NT$100,000	5.7604	6.0000	5.8958
NT$100,000 or	5.4479	5.7917	5.7500

above			
F value	0.676	0.826	0.160
Significance level	0.642	0.532	0.977

**$p \leq .05$

Table 4 - ANOVA on the Effects of Traveling attributes on Service Recovery Measures

Variables	Service recovery types (mean)	Prompt handling (mean)	Problem solving efficiency (mean)
Purpose of travel			
Business trip	5.4714	5.4714	5.4714
Tourism	5.9471	5.9471	5.9471
Visiting relatives	5.2132	5.2132	5.2132
Study	5.9375	5.9375	5.9375
Other	5.0769	5.0769	5.0769
F value	8.692	3.964	2.685
Significance level	0.000**	0.004**	0.031**
Flight delay experience			
Yes	5.6831	5.9050	5.8053
No	5.9045	6.1596	5.8273
T value	12.512	23.185	7.609
Significance level	0.000**	0.000**	0.006**

**$p \leq .05$

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

By using empirical analyses, this study investigated the relationship of customer post-recovery satisfaction with traveler characteristics (passenger attributes and traveling attributes), service recovery types, prompt handling and problem solving efficiency. The test results of study hypotheses are organized and shown in Table 5 as below.

This study divided traveler characteristics into 'passenger attributes' and 'traveling attributes' and examined whether customer satisfaction with service recovery differed significantly for customers of varying passenger attributes and travelling attributes. Flight delays were used as the service failure setting and the relationship between customer post-recovery satisfaction and the three dimensions (i.e., service recovery types, prompt handling and problem solving efficiency) were investigated.

The analysis showed that the statistical values of the items for service recovery types were similar, indicating that all the passengers considered recovery types crucial. Of all the recovery types, the item 'airlines' assistance to arrange a new flight or other means of transport' achieved the highest score whereas the item 'airline apologizing in person' achieved the lowest score. When flight delays occur, the ability of airlines to promptly arrange a new flight or other means of transportation for passengers to reach their destinations is highly essential. Apologies in person without concrete, tangible recovery measures result in commotion and agitation among customers because they have no knowledge regarding the subsequent progresses.

Table 5 - Study hypotheses and test results

Study hypotheses	Results
H1-1: Service recovery types positive effect post-recovery satisfaction for different passenger attributes	False
H1-2: Prompt handling positive effect post-recovery satisfaction for different passenger attributes	False
H1-3: Problem solving efficiency positive effect post-recovery satisfaction for different passenger attributes	False
H2-1: Service recovery types positive effect post-recovery satisfaction for different traveling attributes	True
H2-2: Prompt handling positive effect post-recovery satisfaction for different traveling attributes	True
H2-3: Problem solving efficiency positive effect post-recovery satisfaction for different traveling attributes	True

In addition, the results showed that the statistical values of items for employee prompt handling were similar, indicating that all the passengers considered employees' prompt handling is very important. Of the entire employee prompt handling, the item 'employees taking the initiative to explain the recovery progresses achieved the highest score whereas the item 'ability to pacify traveler's discontent' achieved the lowest score. When flight delays occur, what passengers are concerned with are the cause of the delay and the airlines' plans, such as 'the scheduled departure time of the next flight', and 'whether other means of transport or meals are provided'. If the airlines only focus on pacifying the passengers' discontent without revealing any recovery progress and if the employees fail to honestly describe the recovery situation and satisfy customer needs, they will lower customer satisfaction. Therefore, airlines must train and educate employees concerning their direct responses.

Concerning the items for s problem solving efficiency, the results showed that the item 'ability to promptly answer my questions' achieved the highest score whereas the item 'the service recovery time was longer than what I expected' achieved the lowest score.

This finding indicated that regardless of industry, all customers demand high service recovery efficiency. Therefore, when flight delays occur, employees must answer the passengers' questions quickly and inform them of the recovery progress to minimize customer discontent. Superior service recovery efficiency will improve post-recovery satisfaction and project a positive image of the airlines, thereby increasing traveler repurchase intentions.

5.2 Study Limitations & Recommendations

There are some limitations in this study. First, the sample of the study is limited to airline passengers at Kaohsiung international airport in Taiwan so the results might not be generalized. Replicating similar studies at other airports even other service industry would help to increase the generalizability of the findings.

The second limitation is the sampling type and size. Since service failure is not a common occurrence for every passenger, it is hard to recognize a sufficient number of airline service failures for taking a random sample of the population. Consequently, a convenience sampling method was used for this study and therefore the results might not be generalized.

The punctuality of flight operations is essential to both airlines and passengers. When facing a flight delay or cancellation, most passengers will have no choice but to cancel or change their itinerary. When service failure occurs, airlines must emphasize the relevant recovery measures and incorporate the recommendations made by passengers as a part of the recovery measures, thereby enabling the customers to feel respected and improving their satisfaction with airlines. The frontline employee skills training and development of a customer-oriented employee attitude are also crucial. If frontline employees are able to take the initiative and explain the cause of service failure, offer timely customer care, and provide customers with a clear understanding of the recovery progress, they will eliminate potential customer anxiety and anger caused by confusion. In addition, high service recovery efficiency can reduce the time required to recover a service failure (e.g., flight delay).

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PASSENGER OBESITY AND REGIONAL AIRCRAFT PERFORMANCE FOR THE MOST CORPULENT STATES IN THE USA

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ABSTRACT

Obesity affects over 25% of Americans; however, prescribed FAA standard passenger weights for US airlines are based on data compiled 15 years ago. Since increased passenger weight degrades aircraft performance and may lead to a loss of control, the hypothesis herein is that passenger weight under-estimation for states with high obesity rates could potentially lead to a runway overrun or the inability to out climb rising terrain. In terms of the employed methodology, current person weights for the ten most obese states were determined using nationwide data adjusted for state ethnicity. Performance degradation for regional aircraft was assessed by accelerate-stop distance for a rejected take-off and climb gradient. Statistical analyses employed Poisson distributions. The results reveal that obesity rates across all ten states increased ($p<0.001$) between 2000, the year for which data were captured for standard passenger weights, and 2013. Moreover a 5.4 kilogram gain over the standard weight in current usage was evident. Modelling transport-category aircraft performance demonstrated that under-estimating passenger weights could degrade climb performance potentially leading to a collision with rising terrain and/or a runway excursion in the event of a rejected take-off. In conclusion, caution should be exercised in using standard passenger weights for states prone to obesity.

Keywords: aircraft performance, passenger weight, aircraft weight, transport-category aircraft, obesity, aircraft accident.

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1. INTRODUCTION

Obesity (defined as a body mass index of 30 or greater kg/m^2) (Kelley et al., 2016) is at epidemic proportions affecting more than a quarter of the United States population (Center for Disease Control (CDC), 2015a). Medically, obesity is a major cause of hypertension, diabetes mellitus, heart disease, cerebrovascular disease and osteoarthritis (Malnick and Knobler, 2006).

From an aviation perspective, passenger obesity or, as a corollary, an individual's weight is germane to safe aircraft operations. Aircraft performance in terms of runway length required for take-off and the subsequent climb gradient is a function of aircraft load inclusive of passenger weight (Federal Aviation Administration, 2015b). Increased aircraft weight requires a longer runway for take-off (or stop distance in the event of a rejected take-off) and results in a shallower climb gradient (Federal Aviation Administration, 2008a). Indeed, for transport-category aircraft certification, minimum performance requirements are specified per the Code of Federal Regulations Subparts 25 and 29. Specifically, in the event of engine failure for an aircraft with two power plants, a minimum climb gradient (Federal Aviation Administration, 2008a; Federal Aviation Administration, 2015b), allowing for a mere 35 foot vertical obstacle clearance, is mandatory. This climb gradient is of particular importance at airports with surrounding rising terrain and under conditions (high ambient temperature, high field elevation) that degrade aircraft performance. Also, in the event of a rejected take-off, sufficient distance is required to allow the aircraft to come to a full stop without incurring a runway overrun. Certainly, rejected take-offs are not infrequent; a query of the Aviation Safety Reporting system database (National Aeronautics and Space Administration (NASA), 2015) returned a total of 261 such events by air carrier-operated aircraft for the period between 2001 and 2015. A rejected take-off from a runway whose departure end is immediately followed by descending terrain or water carries an increased potential for loss of life in the event of a runway excursion. Indeed one study reported 400 fatalities associated with 57 rejected take-offs for western-built jet transports through 2003 (Federal Aviation Administration, 2015b). Another concern is that an aircraft operating outside of its weight and balance envelope may experience an in-flight loss of control. In fact, the cause of two fatal aviation accidents (a McDonnell Douglas DC-8 and a Beech 1900 aircraft operating as Arrow Air 1285 and Air Midwest 5481 respectively) was ascribed, at least in part, to an under-estimation of passenger weight and, for the latter, an out-of-centre-of-gravity aircraft. As a consequence of the Air Midwest 5481 accident, the Federal Aviation Administration (FAA) revised upwards the average adult passenger weights (hereafter referred to as standard passenger weights) used by air carriers (per Advisory Circular (AC) 120-27E) to determine aircraft weight and centre of gravity. These revised weights were based on measurements compiled by the National Health and Nutrition Examination Survey (NHANES) for the years 1999-2000 then the most current data at the time that AC 120-27E was implemented.

However, despite the passage of fifteen years, the standard passenger weight (78.9 kg. (174 lbs.) body mass) exclusive of the 16 lbs. (7.3 kg.) carry-on luggage) specified by AC 120-27E for the summer months (an additional 5 lbs. (2.3 kg.) for clothing is added for winter months) is still in current usage. It should be noted that the 86.2 kg. (78.9 + 7.3 kg. carry-on luggage), represents a mean value for male (90.7 kg.) and female (81.2 kg.) passengers. If however, the US population has continued to increase in body mass since 1999-2000, airlines may be under-estimating passenger and hence aircraft weights. Indeed, there is some evidence consistent with this notion. For example, in one report (Krueger et al., 2014) covering a study period extending a decade beyond capture of the NHANES data used to establish standard passenger weights, a trend for an increase in body mass for US-born whites was evident; Hispanics showed the steepest linear increase (Krueger et al., 2014).

In view of these findings the hypothesis herein is that for states carrying the highest obesity rates passenger loads, based on standard passenger weights, under-estimate aircraft weight and thus degrades aircraft performance. To test this hypothesis, the effect of under-estimating passenger load for the ten states with the highest obesity rates on performance of two transport-category aircraft in usage by US regional carriers (which transported 157 million passengers in 2013 an 89% increase over 2000 (Regional Airline Association, 2015)) was determined. Specifically, could usage of standard passenger weights for these states potentially lead to a (i) runway overrun in the event of a rejected take-off and/or (ii) climb gradient insufficient to clear surrounding rising terrain?

2. METHODS

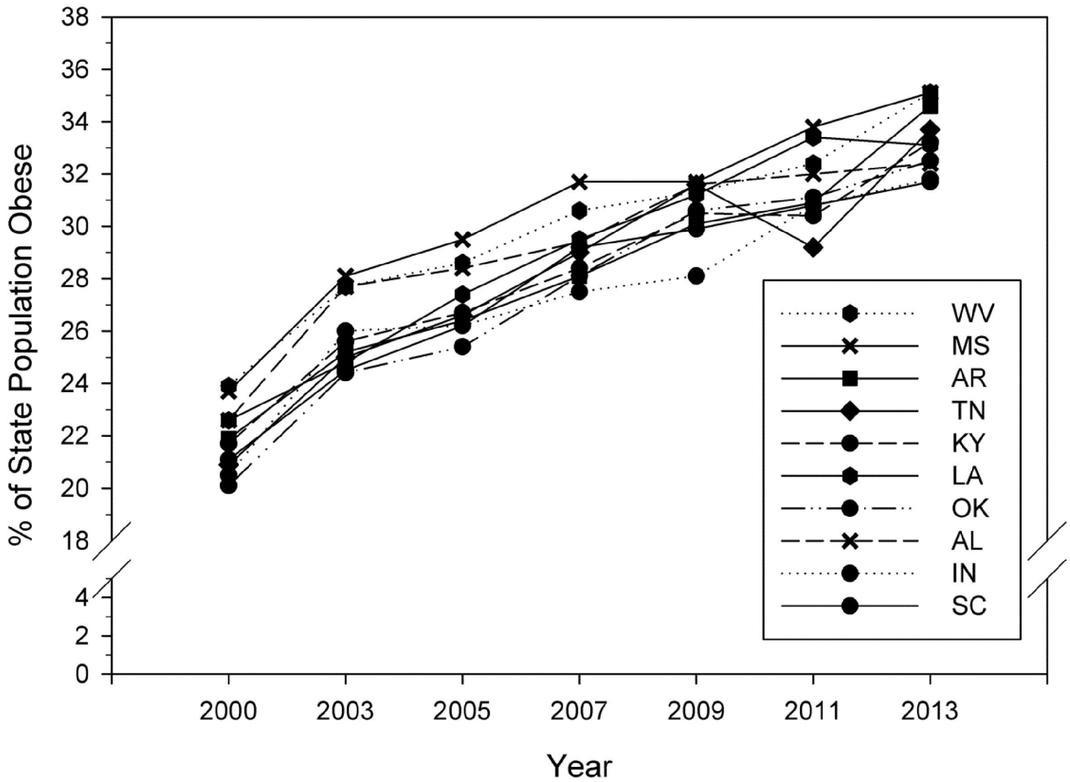
2.1 Procedure

State obesity data were from the State of Obesity Project (Levi et al., 2015) and the Behavioural Risk Factor Surveillance System (BRFSS) (Center for Disease Control (CDC), 2013). Obesity is defined as a body mass index (BMI) of 30 kg/m^2 or greater (Kelley et al., 2016). BRFSS data were downloaded, opened with SPSS (v22) software and exported to Excel.

State-specific average passenger weights were calculated using two independent sources: (a) the NHANES (actual measurements) and (b) BRFSS data (self-reported). Regarding the NHANES, which represents measurements of the non-institutionalized US population, data for the most recent period available (2011-2012) were obtained from the Centers for Disease Control (Center for Disease Control (CDC), 2015b). Records with null weights and for persons of less than 18 or over 65 years of age were deleted for this study. These nationwide weights were cross-referenced with race to determine a US-wide, ethnic group-specific average weight for individuals in this age range. A state-specific average passenger weight was calculated as follows. First, the ethnic composition of the ten most obese states was obtained from the United States Census Bureau (United States Census Bureau, 2015). Then the aforementioned US-wide, ethnic group-specific average weights were adjusted by mathematical weighting based on the racial group composition for each state.

Figure 1 – Increasing Obesity Rates Post-Establishment of Standard Passenger Weights

For the indicated state, the percentage of the surveyed population that was obese (>30 kg/m2) is shown.



For BRFSS-derived person weights, data for the most recent year available (2013) were downloaded from the CDC website (Center for Disease Control (CDC), 2013), opened with SPSS software and exported to Excel. The data were then filtered for the ten most obese states (Levi et al., 2015). Records null for weights or corresponding to individuals younger than 18 or older than 65 years of age were deleted. Performance data for two transport-category aircraft, one of medium cabin (50) and the other of large-cabin capacity (86 seats) were used in the study. The performance charts for the Embraer 175 (86 seat maximum capacity) was downloaded from the company website (Embraer, 2013) and exported to a bitmap image file format. The latter was imported into vector-based graphics software (CorelDraw v X7) allowing for the construction of vertical and horizontal intercept lines to determine the effect of excess weight on runway distance required in the event of a rejected take-off at decision speed (V1). Using a similar strategy, climb gradients in the event of a powerplant failure (at or after V1) were determined for the two engine aircraft of 50 passenger capacity aircraft whose manufacturer kindly provided performance charts but under condition of anonymity.

2.2 Statistics

To determine if obesity rates averaged across the ten most obese states for a particular period differed from the earliest year (2000), a generalized linear model with Poisson distribution was employed adjusting for differences in population sample size for each time period. Statistical analyses were performed using SPSS (v22) software.

3. THEORETICAL CONTRIBUTION

3.1 Increase in Obesity Rates for the Upper Ten Obese States.

Standard passenger weights (per AC 120-27E) prescribed by the FAA are based on nation-wide measurements (NHANES) made in 1999-2000. However since this survey represented averages for the entire nation, it is possible that such data under-estimated weights for states with high obesity rates. Moreover, if obesity rates continued to climb after 1999-2000 this might cause further divergence of passenger weights for the most obese states from the values specified in AC 120-27E.

Towards addressing these concerns, obesity rates were first determined for the top ten obese states (WV, MS, AR, TN, KY, LA, OK, AL, IN, SC) (Levi et al., 2015) for the period following the 1999-2000 NHANES survey (Figure 1). For the individual states, comparing data for the 2013 and 2000 surveys, Oklahoma and Tennessee showed the greatest increase in obesity rates (62 and 61% respectively) for their populations. Alabama showed the most modest gain in obesity rate increasing from 22.6% to 32.4% for 2000 and 2013 respectively.

Obesity rates were then averaged across all ten states for each time-period. The sample size for the combined ten states was 32,626, 69,059 and 72,878 for the years 2000, 2010 and 2013 respectively. For the most recent year (2013) for which data were available, a Poisson distribution showed a highly significant ($p<0.001$) increase in obesity rate relative to 2000 one of the two consecutive years for which data were captured for establishing standard passenger weights per AC 120-27E. Since a modified survey methodology was implemented in 2011 (Center for Disease Control (CDC), 2013), obesity rates for 2000 and

2010 were also compared. Again, the averaged obesity rate across the ten states was significantly higher for 2010 ($p<0.001$). These data would suggest that obesity rates for these ten states have continued to climb in the 13 years since establishment of standard passenger weights.

3.2 Person Weight Determinations for the Upper Ten Obese States.

While the aforementioned state-specific obesity data are calculated from corresponding weight (and height) data one caveat of using the latter is that they are self-reported rather than measured (Center for Disease Control (CDC), 2013). It is well recognized that individuals often under-estimate their weights likely, in part, due to the perception of social desirability (Shiely et al., 2010). Moreover, such under-estimations have increased over time (Shiely et al., 2010). At the same time, while the NHANES data represent actual weight measurements, they lack state identifiers. Considering these limitations, dual approaches were employed. First, the most current NHANES data (2011-2012) were used to derive average weights per capita for each of the ten most obese states based on their racial composition. As mentioned above different ethnic groups have shown disparate temporal gains in obesity (Flegal et al., 2012; Krueger et al., 2014). Second, state-specific self-reported weights were employed using BRFSS data.

Table 1 – Average Passenger Weights for the Ten Most Obese States Adjusted for Ethnic Group Composition

Nationwide (NHANES) weight data for 2011-2012 were cross-referenced with race to determine a US-wide, ethnic group-specific (sample sizes were 1,467, 973 and 1,229 for whites, Hispanics and blacks respectively) average weight for individuals aged 18-65 years. State-specific, average passenger weights were derived by adjusting, by mathematical weighting, the aforementioned US-wide, ethnic group values for the state's racial group composition.

		WV	MS	AR	TN	KY	LA	OK	AL	IN	SC	Average passenger weight (kg.) for the ten most obese states
State Ethnic Group Composition (%)	white	93	48	75	76	86	60	68	66	81	64	
	Hispanic	2	3	6	5	3	5	10	4	6	5	
	Black	4	37	15	17	8	32	8	27	10	28	
	Other	1	12	4	2	3	3	14	3	3	3	
	Average Pax Weight (kg.) Adjusted for State Ethnic Group Composition	**83.9**	**85.5**	**84.2**	**84.3**	**84.0**	**85.0**	**83.6**	**84.8**	**83.9**	**84.8**	**84.4**

For the most current NHANES data, the average nationwide weights for the predominant ethnic groups (ages 18-65 years) were determined to be 83.9, 88.3 and 78.5 kg. for whites, blacks and Hispanics respectively. Ethnic group composition for each state was then used to generate an average person weight for each of the ten states with the highest obesity rates (Table 1). Using this approach, the populations of Oklahoma and Mississippi were determined as having the lowest and highest average weights (83.6 and 85.5 kg. respectively). The mean value across these ten states was computed as 84.4 kg. per capita a 5.5 kg. gain over standard passenger weights (78.9 kg. inclusive of 2.3 kg. for summer clothing but exclusive of the 7.3 kg. assigned to carry-on baggage per AC 120-27E). Interestingly, the aforementioned average passenger weight (84.4 kg.) was close to the 83.9 kg. calculated using the most current BRFSS self-reported data for individuals (n=47,042) 18-65 years of age across the ten most obese states.

3.3 Degraded Aircraft Performance with Increased Passenger Weight

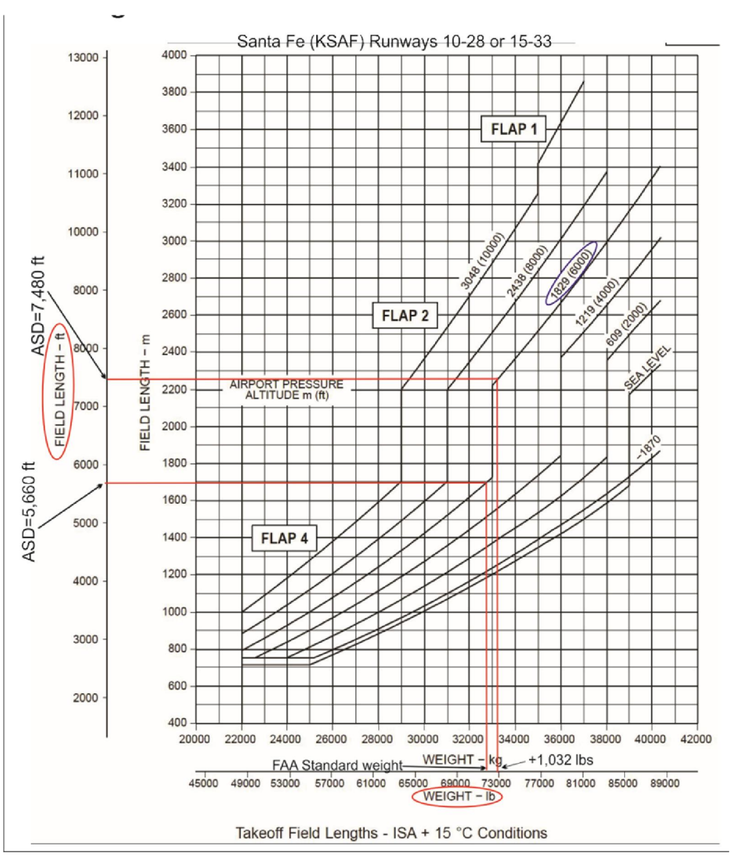
Since aircraft performance diminishes as a function of increased weight (Federal Aviation Administration, 2008b), the adverse impact of under-estimating passenger load on two parameters for a flight carrying passengers fitting the average weight profiles for the top ten obese states was modelled. The studies described below were performed using two separate transport-category aircraft with a 50 and 86 passenger capacity both in usage by regional airlines (Regional Airline Association, 2015). Two high elevation airports (Santa Fe Municipal (KSAF) and Denver International (KDEN)) both served by regional air carriers were selected for this model.

The first question posed was whether under-estimating passenger weights could potentially lead to a runway over-run in the event of a rejected take-off. Pilots and their despatchers are required to determine that the runway assigned for take-off is of sufficient length to allow a full stop in the event of a rejected take-off at decision speed (V1). This calculation is of importance when the departure end lacks an engineered material arresting system and is followed by water or descending terrain.

In this scenario, the performance of an Embraer 175, with a maximum seating capacity of 86, departing from Santa Fe Municipal airport (1,829 metres field elevation) under conditions (15°C higher than standard temperature) that degrade performance was modelled. Runways 15-33 and 10-28 are approximately 1,920 metres in length (Federal Aviation Administration, 2015a) and a 21 metre drop in terrain lies beyond the departure end of runway 10 as determined from Google Earth imagery. Using standard passenger weights and for an aircraft at full occupancy and at a take-off weight of 32,568 kilogrammes, the accelerate-stop distance (ASD) was computed at 1,725 metres (Figure 2), well within the 1,920 metres length of either of these runways in the event of a rejected take-off at V1. However, adjusting for the additional 468 kilogrammes (86 passengers X 5.44 kilogram each) would now require approximately 2,280 metres and consequently a runway excursion for either of these two airstrips. For a departure from runway 10, the aircraft would continue its roll down a 21-metre embankment. It should be noted that these take-off weights are below the maximum take-off weight (40, 370 kilogram) specified (Embraer, 2013) for this aircraft.

Figure 2 – Increased Accelerate-Stop Distance for a Transport-Category Aircraft Based on Passenger Weight Under-Estimation

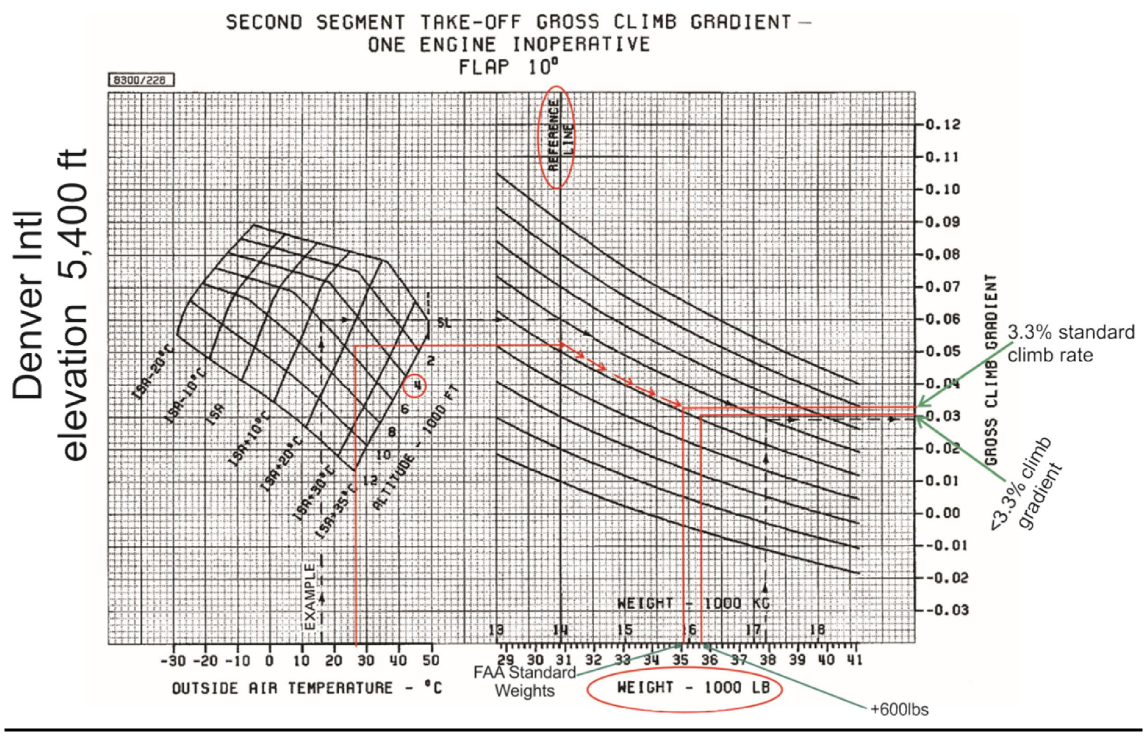
The performance of an Embraer 175 (86 seat capacity) aircraft departing from Santa Fe airport (field elevation 1,920 m) was determined using the corresponding performance chart (red lines). The conditions were 15ºC over standard temperature using standard weights or with an additional 468 kg. (5.44 kg. X 86 passengers). For the purpose of this calculation, field elevation was approximated to 1,829 m. A rejected take-off at decision speed (V1) was assumed. The accelerate-stop (ASD) distances under these conditions are shown on the y axis.



The second question asked was whether the 5.44 kilogrammes excess weight per passenger could diminish climb performance such that the flight path on departure intersects with rising terrain in the event of an engine failure for an aircraft with two power plants. A scenario involving a charted departure procedure (Denver Eight (Federal Aviation Administration, 2015c)) from Denver International airport (elevation 1,646 metres) at a temperature of 28ºC and requiring a standard (Federal Aviation Administration, 2014) climb gradient (61 metres per nautical mile equivalent to 3.3%) was created. For the 50 passenger seat capacity aircraft at full occupancy and at a take-off weight of 15,921 kilogrammes (inclusive of standard passenger weights), the 3.3% climb gradient was met (Figure 3). However, addition of 272 kilograms (50 passengers X 5.44 kilogram each) yielded a gross climb gradient less than the required 3.3% potentially leading to a collision with surrounding rising terrain. Again, the aircraft weight inclusive of the increased passenger load was within the maximum take-off weight limit (19,461 kilogram) specified for this aircraft.

Figure 3 – Diminished Climb Performance for a Transport-Category Aircraft Based on Passenger Weight Under-Estimation

The climb performance for a medium-cabin size, two-engine, transport-category aircraft (50 seat capacity) departing from Denver International airport (field elevation 1,646 m) via the charted (Denver Eight) procedure (which requires a standard (3.3%) climb gradient) was determined using the indicated performance chart (red lines). Conditions were an ambient temperature of 28ºC, a powerplant failing at or after V1 and with either standard passenger weights or with an additional 272 kg. (50 passengers X 5.44 kg. each). The corresponding gross climb gradients are shown on the right hand y axis.



4. SUMMARY AND CONCLUSIONS

The study herein indicates that use of standard passenger weights may lead to under-estimates for aircraft operating out of states with the highest obesity rates. In turn, and of relevance to airline operations at high altitude airports, such an underestimation could potentially lead to a runway overrun or, in the event of engine failure, the inability to clear rising terrain or obstacles.

Standard passenger weights, in current usage, are based on nation-wide measurements made in 1999-2000. However, these nation-wide data do not take state-specific differences into account. The present study indicates that the standard passenger weight of 78.9 kg. (excluding 7.3 kg. for carry-on luggage) under-estimates by 5.4 kg. the average passenger weight for the ten most obese states. For the most obese state (Mississippi) this under-estimation rises to 6.4 kg. per capita.

The conclusions herein are based on conservative estimates in two respects. First, obese state-specific passenger weights employed in this study from the NHANES data were generated using nation-wide average weights for the major ethnic groups adjusted for the state's racial group composition. The fact that the NHANES data were almost identical (84.4 vs. 83.9 kg.) to the self-reported BRFSS weights and that self-reported data almost invariably represent under-estimations (Shiely et al., 2010) argue in favour of this point. Second, the current study assumed "book value" aircraft performance, computed by the manufacturer for a new aircraft. Time in service however results in aircraft performance degradation (increased drag due to e.g. ill-fitting seals, slats, flaps, bird strikes) (Airbus, 2002) which in turn would create longer accelerate-stop distances and a more shallow climb gradient.

Although airlines have curtailment programs which are more restrictive than the loading envelope generated by the aircraft manufacturer, it is unlikely that such a program compensates for the aforementioned weight under-estimations. Curtailment programs are not designed regarding passenger over-loading. Typically, such programs are utilized to consider in-flight movement of passenger/crew or service carts, fuel transfer/usage or for cargo or seating variation (AC 120-27E Section 3).

The author is aware of several limitations of this study. First, the passenger manifest might also include individuals from states for which obesity rates are lower. In such cases, the degraded aircraft performance calculated herein would be offset by the lighter passenger load. Second, the flight models herein assume that passengers are comprised entirely of persons aged 18-65 years of age. The lower age limit is probably not unreasonable for operations during periods when schools are in session. Conversely, the upper limit of 65 years of age may be conservative due to increasing longevity of the US population (National Institute on Aging, 2011). However, re-analysis of NHANES data increasing the upper age to 70 years revealed no change in the derived state weights. Third, there is the assumption that passengers across all socio-economic levels have an equal opportunity to fly. This may not be the case despite the 45% decline in air fares prices (in real-terms) since airline de-regulation (Smith and Cox, 2008). Accordingly, if there is skewing of the average passenger weight data towards lower social-economic groups and such individuals have a lower financial access to this transportation mode the adverse impact on aircraft performance calculated herein would be over-estimated.

Nevertheless, it is well recognized that aviation accidents are often due to an adverse conjunction of multiple active (e.g. high altitude airport, high ambient temperature, an aircraft at full occupancy) and latent (e.g. passenger load deviating from standard passenger weights) causal factors (Reason, 1990), each one necessary but singly insufficient to yield a mishap. While for most flights one, or more of these conditions, would not be met, a convergence of these factors, (considering the high volume of regional airline operations -4.38 million for 2013 (Regional Airline Association, 2015)), could create a trajectory of opportunity ultimately culminating in an accident (Reason, 1990).

Taken together the data suggest that caution should be exercised in using standard passenger weights based on nationwide measurements for states prone to obesity. Strategies to address this issue include operators utilizing an on-board weight and balance system or implementing a region-specific survey of passenger weights per AC 120-27E. Moreover with a trend for increasing obesity across many developed countries (Ono et al., 2015), the findings herein likely impact operations for carriers outside the confines of the United States.

ACKNOWLEDGEMENTS

The author expresses his gratitude to Dr. Alan Stolzer (Embry Riddle Aeronautical University) and Sally Sims, Airline-Transport-Category-certified general aviation pilot for their invaluable inputs.

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