



# The 3rd International Aviation Management Conference 2016

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PROCEEDINGS OF THE THIRD INTERNATIONAL AVIATION MANAGEMENT  
CONFERENCE, IAMC – 2016, DUBAI, UAE, 23 – 24 NOVEMBER 2016



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AVIATION MANAGEMENT CONFERENCE**

**IAMC – 2016, DUBAI, UAE, 23 – 24 NOVEMBER 2016**

**Editor**

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## Message from the Conference Chairman

We are very pleased to host the third International Aviation Management Conference (IAMC) at Emirates Aviation University (EAU) in Dubai, United Arab Emirates, from the 23<sup>rd</sup> to the 24<sup>th</sup> of November 2016 under the theme of ***Lessons Learned, Current Challenges and the Road Ahead***. The IAMC has now become a recurring conference following the success of the first two events, which were held in 2012 and 2014, as well the positive feedback received from keynote speakers, sponsors, authors, and other participants.

The goal of the conference is to bring together aviation management researchers, professionals, professors, and students to share their ideas and knowledge of case studies and best practices. The theme of this year's conference is addressed with a four-dimensional approach: (1) commercial and operational practices; (2) technological impacts; (3) environmental issues; and (4) regulatory considerations.

The invitation for papers has attracted authors from a number of countries around the world. The Technical Committee carried out a blind review and accepted eighteen papers for oral presentation. We apologise to those who have missed the deadlines, and anticipate that more authors, from both the academia and the industry, will be encouraged to prepare their work for publication in the next IAMC. The steady growth in the various sectors of aviation necessitates the need for more research on the key issues that impact this industry.

I take this opportunity to thank the keynote speakers for their vigorous and expert participation, and the authors of the research papers for their valuable presentations. My appreciation goes to the distinguished sponsors and strategic partners who supported this event as well as the members of the Technical Committee who devoted their time and expertise to ensure compliance with the highest quality standards.

A special note of appreciation to His Highness Sheikh Ahmed bin Saeed Al-Maktoum, Chairman and Chief Executive Emirates Airline & Group and Chancellor of Emirates Aviation University. We remain indebted to his leadership and continuous support.

On behalf of the IAMC – 2016 conference committees, it is my privilege and pleasure to welcome you to Dubai. I hope that you find this an excellent opportunity to share knowledge and meet colleagues from around the world. To the readers of these proceedings, I wish that you find them insightful.

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## **Keynote Speakers**

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**Gary Chapman, President – Emirates Group Services and DNATA**

*Lessons Learned, Current Challenges, and the Road Ahead from DNATA Perspective*

**Laila Bin Hareb, Asst. Director General, Strategy and International Affairs – UAE  
General Civil Aviation Authority**

*Lessons Learned, Current Challenges, and the Road Ahead from GCAA Perspective*

**Michael Herrero, Area Manager - IATA**

*Lessons Learned, Current Challenges, and the Road Ahead from IATA Perspective*

*Delegates' Papers*

# Developing a Mathematical Model for Scheduling of Turnaround Operations (Low Cost Airline as a Case Study)

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**Abstract:** On-time departure performance is important for airlines that seek the highest satisfaction of their passengers. The main component of achieving on-time departure is being able to complete the turnaround operations of an aircraft within the scheduled time. To address this problem, the present paper examined planning and scheduling of turnaround operations in the low cost airline industry. A mathematical model, named ‘TurnOper\_LP’ was developed for a low-cost Turkish airline to identify the critical path of turnaround operations and the optimal turnaround time. The results of the model in terms of optimised turnaround times are then analysed and an example of schedule of turnaround operations is presented.

**Key Words:** turnaround operations, low cost airlines, mathematical modelling, flight types.

## 1. Introduction

From the airline business point of view, turnaround operations are one of the most important processes in the Airline Industry. Therefore, many airline companies especially Low Cost Airlines (LCAs) have been working on improving the efficiency of the turnaround process with an objective to reduce turnaround time. This can be considered as one of the serious challenges that decision makers face in planning and scheduling turnaround operations with the view to achieving minimum cost and most efficient performance. Hence, a proper planning and scheduling of turnaround operations for LCA companies is very important since every second on the ground make these companies loose potential profit. In this sense, most LCA companies have problems in completing turnaround operations on time which leads to delays. For this reason, such companies strive to optimally schedule their turnaround operations by using most up-to-date data collected from their hub airports.

Scheduling of turnaround operations have been investigated by a number of researchers including, but not limited to, Wu and Caves (2004) who develop a stochastic mathematical model for optimising aircraft turnaround time at an airport. Sanz de Vicente (2010) analyses different scenarios in ground handling operations of low-cost and conventional carrier according to their parking positions (apron or terminal). Kunze, Oreschko and Fricke (2012) model the randomness of turnaround operations for each fight considering the operational and strategic information. Mao, Roos and Salden (2009) introduce a stochastic programming model to schedule aircraft ground operations within high uncertainty environment. Han, Chung and Liang (2006) propose a fuzzy critical path method for planning of the airport cargo-ground operations. Vidosavljević and Tošić (2010) present an aircraft turnaround model using Petri Nets (PN). The model includes all turnaround operations such as air-bridge positioning/removal, passengers’ disembarking/boarding, potable water loading, catering, lavatory services, baggage loading/unloading and fuelling. Gomez and Scholz’s (2009) suggest a direct cost method for improving turnaround operations for a low cost airline.

However, previous research focuses on achieving optimal schedules of turnaround operations for different types of flights. These types include arrivals from a domestic destination to the hub airport turning around to a departure to another domestic destination, arrival from a

domestic airport turning to a departure to an international destination, arrival from an international origin airport and departure to a domestic airport, and finally arrival from an international airport departing to another international destination. The main advantage of considering the above different types of arrival-departure turnaround pairs in the proposed optimisation model ‘TurnOper\_LP’ of turnaround operations is that it includes turnaround operations/ times that are different from one flight type to another and hence, a realistic schedule of turnaround operations taking into consideration the different flight types is produced. Ultimately, the main aim of this study is to generate an optimised schedules profile of turnaround operations of different flight types for a low-cost airline while achieving the minimum completion time.

## 2. Methodology

### 2.1 Data Collection

In the data collection phase, the non-participant observation technique is selected. According to the non-participant observation type of data collection, the observer does not intervene with the participants. The data is mainly collected by observing the system from a distance while taking notes. Observations are performed over a 3-day site visit to the hub airport of the low-cost company. At the airport, the sequence of the operations, number of resources used and the starting and finishing time of each operation involved in the turnaround process are observed and recorded on a specific research instrument paper that was prepared prior to the observation process.

Since there is more than one flight type; domestic-domestic, domestic-international, international-domestic, and international-international, the data are collected by dividing the flight types into 4 different clusters/groups and hence, cluster sampling is decided to be used as a data collection technique. Cluster sampling is a type of sampling method which divides the population into different group of samples (Saunders et al. 2009).

### 2.2 Process Mapping

The most used list of turnaround operations is in (Sanchez, 2009). However, in order to model the turnaround operations of low-cost airlines and to identify constraints, a process-mapping technique is used. For each turnaround operation inputs, outputs, constraints and resources are identified. The parent process-map diagram of the turnaround operations is shown in Figure 1.

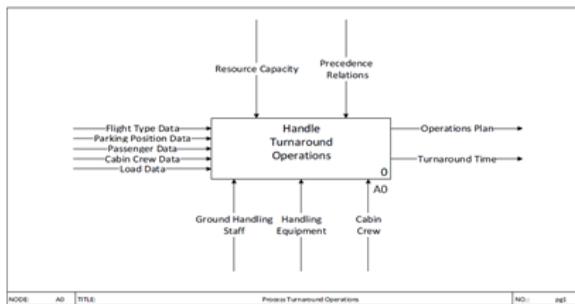


Figure 1: Process Map Level 1 (Parent Diagram)

The process map presented in Figure 1 is called ‘Parent Box’ and has an ID as 0 with a sub-diagram ID node number/ index equal to A0. In this diagram, the inputs to the handling activity of the turnaround are flight type data, parking position information, passenger data, cabin crew data and load data which contains the information about the amount of fuel, clean water and baggage is needed for or expected at that flight type. The outputs of this process are schedule(s) of turnaround operations and the optimal turnaround time. There are some constraints that would control/ restrict the turnaround activity including precedence relationship of operations and resource capacities. Resources which are used during this process, are ground handling/ turnaround operations staff, handling equipment and cabin crew.

The turnaround operations module presented in Figure 1 is then decomposed into a child diagram that involves a number of detailed turnaround operations. A detailed process map of DomInt and IntDom flight types is presented in Figure 2.

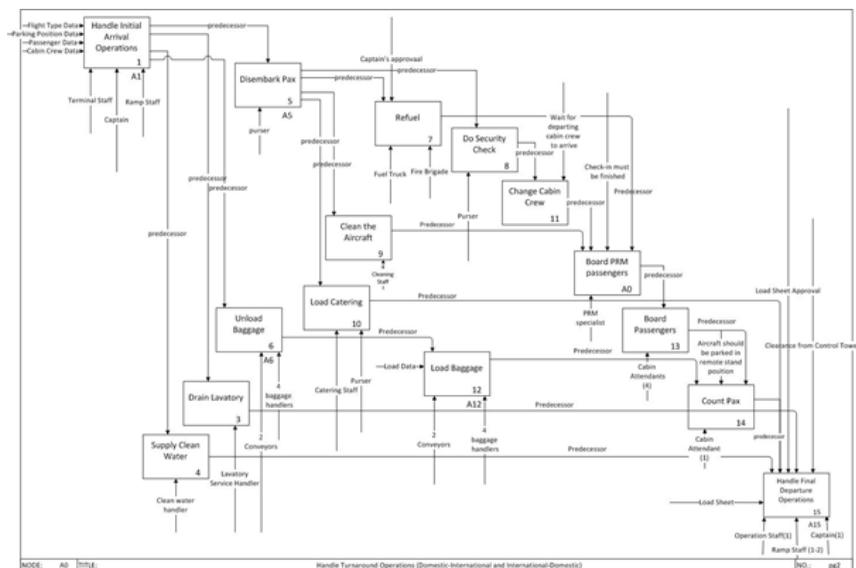


Figure 2: Turnaround Processes of DomInt and IntDom flight types (Child Diagram)

In Figure 2, the process map begins with the initial arrival operations with inputs of flight type data, parking position, passenger and cabin crew information. Terminal staff, captain and ramp staff are involved as resources in this process. After disembarking of all passengers; baggage unloading and lavatory and potable water services operations begin.

The process of passengers disembarking is a predecessor of many other processes such as refuelling, security checks, aircraft cleaning and catering. In order to start the refuelling process another constraint has to be satisfied, the captain's approval on the amount of fuel to be lifted. Catering loading is handled by catering staff often with participation by the flight pursuer. Another output of passenger disembarking is considered as a constraint that would restrict security checks where the cabin crew checks inside the aircraft in case someone left their staff. The output of aircraft cleaning is a predecessor to boarding of PRM passengers. Waiting for

the departing crew to arrive is another constraint that would restrict the “change cabin crew” process. The output of this process is a constraint to the passengers boarding process because passengers cannot be boarded unless the new crew are on-board the aircraft. The baggage unloading process is the constraint for baggage loading process. After boarding PRM passengers by a PRM specialist, passenger boarding starts. Passenger boarding process is handled by cabin attendants as well. The output of this process is constraint of counting the passengers. Another constraint of this process is baggage loading and aircraft should be parked in remote stand position. As a final step, the final departure operation is handled by operation staff, ramp staff and captain. Input of this process is the load sheet approval. The constraints of this process are predecessors from the drain lavatory, supply clean water, load catering operations beside other constraints including load sheet approval and clearance from the control tower.

## 2.3 Development of the Mathematical Model

The first step of developing a mathematical optimisation model involves setting a number of assumptions. The next sub-sections will reflect the step-by-step stages of the model development starting from the modelling assumptions.

### 2.3.1 Modelling Assumptions

Managing turnaround operations is a complex process with many variables. For this reason, a number of assumptions are set in order to make the problem solvable in a polynomial time.

These assumptions are:

- The following operations are considered necessary in every flight:
  - Cabin Crew change
  - Fuelling
  - Lavatory Service
  - Water Service
  - Boarding and disembarking PRM passengers
- All equipment and other vehicles are ready in the parking area before aircraft arrives
- There is no restriction on the number of resources required for each operation.

### 2.3.2 Model Indices & Decision Variables

- Model Indices

Here,  $j$  and  $k$  are the turnaround operations and they belong to a set where  $j$  or  $k$  starts from 1 to total number of operations in the system.

The parameters used in this model are:

- $p_j$  which, is the processing time of job  $j$
- $M = \sum_{j=1}^n p_j$  is the upper bound on the total duration of operations

- Decision Variables

The decision variables used in the developed mathematical model are:

$C_{max}$  = Completion time of the last job,

$S_j$  = Start time of job j,

$$y_{jk} = \begin{cases} 1, & \text{if job } j \text{ is processed before job } k \\ 0, & \text{otherwise} \end{cases}$$

### 2.3.3 Development of the Linear Programming Model

The developed mathematical model ‘TurnOper\_LP’ based on the aforementioned assumptions is as below:

$$\text{Minimize } C_{max} \quad (1)$$

subject to

$$S_k \geq S_j + p_j \quad \forall_{j \rightarrow k} \in A \quad (2)$$

$$C_{max} \geq S_j + p_j \quad \forall_j \in J \quad (3)$$

$$S_k \geq S_j + p_j - M(1 - y_{jk}) \quad \forall_{j,k} \in B \mid j \neq k \quad (4)$$

$$S_j \geq S_k + p_k - M y_{jk} \quad \forall_{j,k} \in B \mid j \neq k \quad (5)$$

$$S_j, C_{max} \geq 0, \quad y_{jk} \in \{0,1\} \quad \forall_{j,k} \in J \quad (6)$$

The objective function (1) will find the minimum completion time of the final job taking into account the following constraints:

Constraint (2) ensures that the turnaround operations must be scheduled taking into account the precedence relationships of these operations. For example, refuelling needs to be finished before the passenger boarding can start. This constraint does not allow the model to schedule these two operations in parallel. It forces to assign the boarding to start after the finish time of the refuelling.

Constraint (3) makes sure that the completion time of any operation is the sum of start time and processing time of that operation. For example, if the start time of operation j=1 is at time 0, and if the processing time of that operation is 5 minutes, then the completion time of the operation will be at time 5.

Constraint (4) and (5) are the disjunctive constraints which do not allow these operations to be handled simultaneously (either j will precede k or k will precede j). An example to these two operations can be given as; loading the PRM passengers while the aircraft is on the remote parking stand cannot be handled at the same time while loading the Catering from the front door. Both uses the same door (space) hence with this constraint, it is not allowed for both operations to be handled simultaneously. The final constraint (6) ensures that Non-negativity is achieved and  $y_{jk}$  is binary.

After running this model, the start time of each operation will be generated and all the turnaround operations will be scheduled taking into consideration constraints (2-6). Hence the critical path can be identified after the start time of the operation is provided by the model, so that turnaround operations that will increase/ decrease the turnaround time will be identified if the time of these operations is increased/ decreased (such as passenger boarding).

### **3. Case Study and Model Implementation**

One of the Turkish low-cost airline companies is considered as a case study. This company is the most rapidly growing airline in Europe started its flight schedule in (2005). Flight network of the company has reached to 76 locations since then 31 domestic flights and 45 international in almost 30 countries. The company's hub airport is located in the first biggest city in Turkey. There are two airports in the city and the hub airport of the company is located in the smaller one, which has 3,500,000 passenger capacity per year and 8,760 aircraft per year. The hub airport of the low cost carrier has only 1 runway and the carrier uses 70% capacity of the airport.

In this case study, 5 same aircraft types are observed for 4 different inbound-outbound flight combination scenarios (DomDom, DomInt, IntDom, IntInt). In total, 20 observations are recorded. A number of on-site visits are performed in addition to other historical data collection including turnaround operations logic, their sequence and number of resources used in each process.

In addition, 4 different types of boarding and disembarking styles/ options in the turnaround process being investigated are considered including:

- Disembarking and boarding passengers via pax stairs.
- Disembarking and boarding passengers via airbridge.
- Disembarking passengers from airbridge and boarding from pax stairs.
- Disembarking passengers from pax stairs and boarding them via airbridge.

In order to run the developed model 'TurnOper\_LP', data on the processing times of each operation are collected (operation times of each flight type and boarding and disembarking style are confidential and unauthorised to be published in this paper). After the data have been collected, durations of each operation are gathered and an average duration for each operation is calculated. Four different sets of inputs each representing a different flight type can then be individually fed into the developed model (referred as "coefficients" such as the processing time (p) of every operation (j)) to generate the required flight type schedule. 16 different schedules for 4 different flight types along with 4 different disembarking and boarding styles are generated.

The third style of boarding and disembarking of passengers for the DomInt flight type is presented in this work and will be discussed in the next sections. The developed mathematical optimisation model is translated to CPLEX software format.

#### **3.1 Result Analysis and Discussion**

The third style of disembarking and boarding passengers is considered before running the developed model in section 2.3. Results reveal that the total turnaround time is equal to 3180 seconds (53 minutes). A schedule for DomInt flight type is presented in Figure 3.

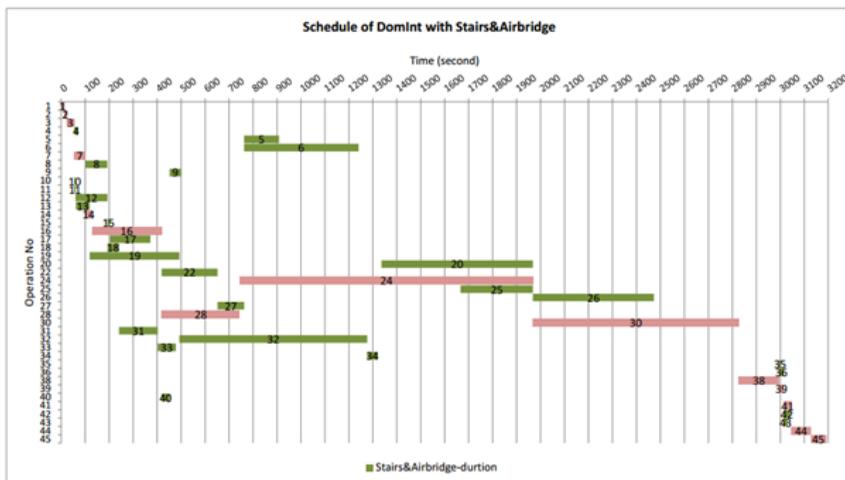


Figure 3: Schedule of Domestic to International Turnaround Operations using Pax Stairs Deboarding and Airbridge during boarding of Pax

Critical operations are identified and highlighted in red in the Gantt chart provided in Figure 3. Table 1 shows common turnaround operations in the critical path are the first and last operations, i.e. placing/ removing front and rear aircraft wheel blocks.

Table 1 shows the critical turnaround operations for DomInt flight type along with the third style of boarding and disembarking passengers.

| Operation No | Name of the Operation  |
|--------------|--|
| 1            | Place front chocks   |
| 2            | Stop engines   |
| 3            | Place rear chocks  |
| 7            | Position pax stairs (forward)                                |
| 14           | Open front pax doors and ask purser if there are any PRM pax |
| 16           | Disembark pax from the forward door                          |
| 28           | Disembark wheelchair pax via truck                           |
| 24           | Cleaning   |
| 30           | Pax boarding   |
| 38           | Hand in the load sheet and get Captain's approval            |
| 39           | Close pax doors  |
| 41           | Remove airbridge   |
| 44           | Push-back connection   |
| 45           | Remove rear chocks   |

Table 1: Critical operations for DomInt with Pax Stair & Airbridge

Table 1 shows the most critical turnaround operations involved in the DomInt flight type. Some benefits of focusing on these critical operations are identified. For example, in Table 1, it is evident that, the passenger boarding (operation no 30) is in a critical path during the turnaround process and hence applying efficiency interventions on the passenger boarding style could assist in improving the overall turnaround time.

As an overall comparison, the turnaround time and schedule of the third disembarking /boarding style for DomInt flight type was presented. Schedules were generated by applying 4

disembarking and boarding styles along with 4 flight types and then compared with regards to total turnaround times. It was concluded that, using passenger stairs for disembarking and airbridge for boarding results in minimum turnaround time for each flight type. For DomDom flight type, the minimum turnaround time is equal to 40 minutes, for both DomInt and IntDom 53minutes and 41 minutes for IntInt flight type.

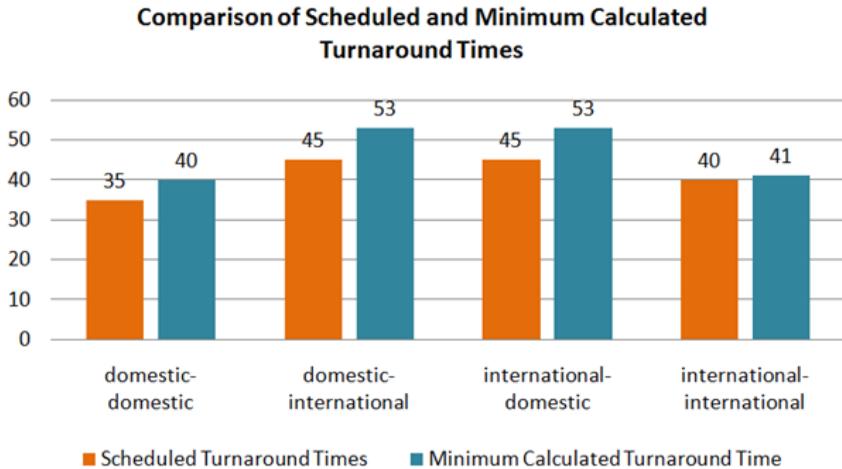


Figure 4: The planned and optimised turnaround times

Figure 4 shows that the planned/ scheduled turnaround times generated by the company are lower than the optimised turnaround times generated by applying the ‘TurnOper\_LP’ model. In fact, based on these results, the optimised turnaround times should be 5,8,8, and 1 minutes less respectively than the planned/ scheduled turnaround operations for each flight type. This is possible when passenger stairs are used for disembarking and airbridge used for boarding and which is why the company being investigated are experiences delays, as it used to adopt overlay optimistic turnaround times. However, by adopting the optimised turnaround times and schedule provided by the ‘TurnOper\_Lp’ mathematical optimisation model, the company is expected to achieve a higher on-time departure performance and almost no delays occurring from the turnaround time point of view.

The optimised turnaround times based on different styles of disembarking and boarding passengers for different flight types are calculated and presented in Figure 5.

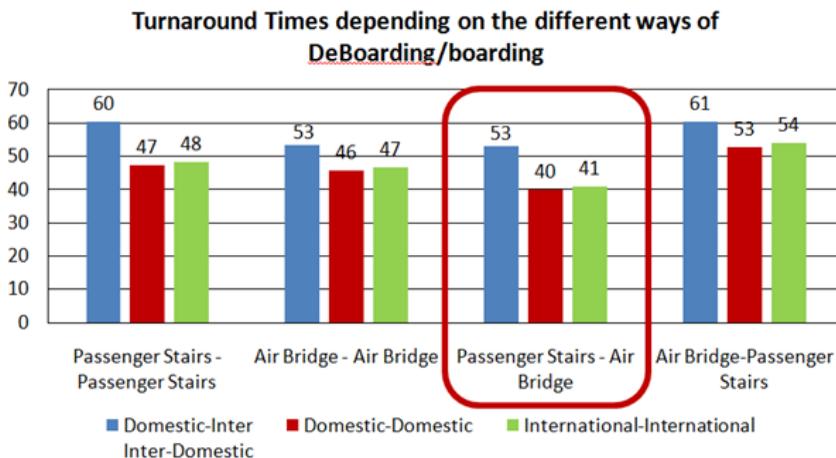


Figure 5: The optimised turnaround times based on different deboarding and boarding passenger

Figure 5 shows that for each flight type, minimum ground handling operation time have been achieved by using passenger stairs for disembarking and airbridge for boarding, which always gives the minimum time for each flight type. The second best scenario is to use airbridge for both disembarking and boarding of passengers for every flight type.

## 4. Conclusions & Recommendation

### 4.1 Conclusion

This research has successfully addressed the problem of scheduling turnaround operations taking into consideration different inbound-outbound flight combination scenarios, and successfully provided the optimal schedule with minimum turnaround time for each flight type. The developed integer programming model; ‘TurnOper\_LP’ has assisted in solving this problem. This was possible by introducing a number of constraints that ensured the precedence relationships of turnaround operations while the scheduling process takes place. From the model outputs, it was evident that, using passenger stairs for disembarking and airbridge for boarding scenario resulted in minimum turnaround time for each flight type. In addition, the minimum turnaround time was achieved for the DomDom flight type compared with other types of flights.

### 4.2 Recommendation

As multi-skilled resource allocation in the context of turnaround operations scheduling for different inbound-outbound flight combination scenarios has not yet received enough consideration, and hence, it is recommended that more mathematical optimisation models in this area of research is required to generate more realistic scheduling plans of turnaround operations under different resources allocation scenarios. In addition, Constrained Programming (CP) can be used to solve the complexity inherited in modelling such combinatorial scheduling problems.

## **5. Acknowledgements**

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# Investigating Passenger Satisfaction and Its Effect on Brand Persona from an Airline Prospective: The Case of British Airways

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**Abstract:** The aviation industry has been in turmoil for the last 10 years, effected, mainly by the high prices of fuel, and the high competitions in the global market these days. Consumer brands' preferences play a major factor in the profit and success of any industry, including the aviation industry, and in particular the airline industry. Hence, British Airways is not immune from this shock. The paper provides an in-depth understanding of the passenger satisfaction and brand persona. Quantitative methodology approach has been adopted to gain an insight to the issue. The data has been collected from 100 random employees and passengers of BA, but this paper focuses on passenger. The findings have shown that British Airways has been quiet successful in implementing passenger service practices and has gained a significant brand persona in the market which is benefiting the airline.

**Key Words:** brand persona, strategies, passengers' satisfaction, British Airways, customer.

## 1. Introduction

The airline industry strives continuously to survive the competitive market (Qasim, 2015). It has to manage the fluctuating demands (Ito, and Lee, 2005), cutting costs as well as strict quality checks so that the customers remain satisfied based on the superior customer service it receives. However, it is noted by (Sengupta et al., 2015) that the airline industry faces extreme low levels of customer satisfaction. It is said based on the customer satisfaction index that the airline industry ranks lowest out of 47 industries (Baker, 2013), despite shifting their focus towards customer oriented services. Thus, the importance of identifying perceptions and expectations of passengers regarding the customer service increases many folds. Hussain et al. (2015) also pointed out the need of assessing kinds of services that customers consider most important. In case of airline industry, the customer services remain complex mix of the physical as well as intangible needs. Experiences and performances of the airline is also the key to attract customers and make them loyal.

Importance of brand personality in terms of the customer services is important to assess as it links the brand with its credibility as said by (Nysveen et al., 2013). When the brand personality is strong, then staff is also able to create positive experiences for the customers. One such example is of Southwest Airlines that has a specialised team dedicated to identify the mistakes made by the airline. Customers are then apologised in case of unexpected service and are compensated accordingly. Hunter and Lambert (2016) pointed out that it is willing assumption and honesty of the airline that enables it to maintain loyalty and trust of the customers. Thus, it is critical that the service leaders of the airline industry are able to handle the customer service effectively and deal with the consumers positively so that they become customers for life.

### 1.1 Background of the Company

British Airways is the standard main British airline in the UK (Hanlon, 2007). Also, it is the biggest airline in the United Kingdom based on the size of fleet (Balmer and Greyser, 2003). The airline was established in the year 1974 subsequent to the merger of British European Airways (BEA) and British Overseas Airways Corporation (BOAC) and since its inception, the airline has gone through many changes such as privatisation and downsizing (Balmer and Greyser, 2003). The airline has struggled to enhance its positive brand image by bringing many

changes to its vision and image, including the famous event when the ex-British Prime minister, Mrs Thatcher covered the tail's image of one of the aeroplane models with her Union Jack handkerchief. The airline was considered as indifferent and incompetent by the consumers in its early years. However, it earned its place as the respected, competitive and profitable airline due to changes in branding as well as customer services. British Airways presented itself as the "world's favourite airline". It also changed the look of its planes from contemporary original folk art to radical new idea of representing diversity.

## **1.2 Aim & Objectives**

This paper aims to investigate and discuss in-depth the relation of customer services with brand persona for British Airways. In order to stimulate the interaction and attachment of consumers, organisations are investing heavily on branding (Nysveen, Pedersen and Skard, 2013). In the airline industry, such investment is highly important and aims to reduce dis-attachment of customer towards the high-level services intangibility offered. Hence, the airline services have to manage the brand-related activities carefully. Considering the above, the study explores the concept of brand personality and its dimensions in terms of its effects on the customer's services quality and value. The objectives of this study are, as follows:

- To explore and critically analyse the existing literature on brand persona.
- To identify and understand the constructs of customer services and brand personality for British Airways.
- To determine the impacts of brand personality of British Airways on customer services.
- To develop a framework of customer services which recommend ways of which British Airways can improve its brand personality to target customers and provide them with high quality services.

## **1.3 Justification**

Brand personality is one of the most commonly discussed topic on consumer behaviour by scholars and marketing practitioners (Azoulay and Kapferer, 2003). Previously, it has been considered from the point of differentiating the brands from competitors. However, recently the concept of brand personality emerges as the connection of brands with the emotions and feelings of the consumers (Caprara et al., 2001). Brand personality is augmented as the personal concept of the consumer towards the brand. Nevertheless, recently, and despite the fact that brand personality has attracted considerable amount of academic attention due to its importance for the brand and consumer behaviour, relationship of customer services is still unexplored (Kim et al., 2001).

The topic on customer services and brand persona of British Airways helps the readers to understand, the congruence between brand personality and the services provided by the brand, i.e. to find out if any. If there is congruity, then it can be established through this study that, there is an emotional brand attachment (Thomson, MacInnis and Park, 2005). Thus, the study provides a valuable insight that, the positive brand preference and attitude is influenced by the brand personality and the services offered by the brand indicate the personality dimensions are strongly linked (Aaker, 1997). Nevertheless, it is important to notice that it might not be the case. The study discusses how the consistent brand personality serves as the basis for long-term relationship between the airline and customers (passengers). Customers are highly attached to those brands which match their own values and personalities (Supphellen and Grønhaug, 2003). Hence, the brand personality is an important criterion that affects the

business and thus it is important to understand the brand personality to find out, how consumer services are influenced by it?

## **2. Literature Review**

### **2.1 Brand**

Brands have been experienced by people many times in a daily basis. They exist in the stores which customers visit, and in customers' homes, in short, brands are all over the place in the society. Although, brands are the constituent of our routine life, the question is still unanswered, what exactly the brand is? So to elaborate on what a brand really is, this can be very complex. Although, Shepherd (2005) elaborates, a brand is defined as a sign, term, name, design or symbol or a mixture of these, planned to recognise the services or products of a merchant or a group of merchants and to distinguish them from those of their rivals. Brands can also be defined as the tactics that management employs whenever they desire to form recognition for the sake of their business (Keller, Aperia and Georgson, 2008). They argued that, this elaboration usually does not take into consideration the philosophy of customers and their understandings of a brand. Brands provide businesses with the possibility of being noticeable and distinguish themselves from rivals (Davies and Chun, 2003). For example, brands correspond to a service or a product which is trustworthy and of best quality to customers (Blythe, 2008).

### **2.2 Brand Personality**

Today, there are various things which could be recognised as brands. Not merely, organisations or companies, even customers could be observed as brands, like politicians, but also the ordinary persons themselves like a brand (Kefallonitis, 2015). Brand is basically become, as an element of the human activity to observe objects as encompassing human aspects for the purpose of understanding and communicating around the world. The perspective of a specific brand could be impacted both straightforwardly and indirectly. The one who provides straight traits of personality regarding a brand are the customers that are associated with the brand, for instance, consumers and could be employees, who altogether construct a consumer image (Aaker, 1996). In other words, it is a manner to distinguish a business from its rivals. Businesses can carry on improving services or products and additionally they can employ personality of brand to construct an image for the aspects of the non-service or non-product based characteristics, specifically the tangible element (Azoulay et al., 2003). Though, customers do not have choices for products or services that appeal to their personality straight forwardly. As a replacement, the customers may choose an image they will desire to have and they get it by purchasing a product or service suitable to this unique image they contain themselves with. Because of this reason, brand personality has an attractive characteristic for customers, e.g. expensive and exclusive car brands, such as Mercedes or branded motorcycles (Harley-Davidson), the latter constitutes an image of masculinity and strength (Aaker, 1997).

## **3. Methodology**

The methodology of research is the evaluation of the systematic literature which researchers will make use of during conducting a study. Appropriate use of the process evaluates the researcher to achieve the aim of the research. This research involves deductive approach (quantitative methods) and the method of descriptive analysis (Saunders et al., 2016) will be used, taking into account the original research question, "What is the relation of customer services with brand persona particularly in the case of British Airways?". The research questions guides the path towards selecting the right methodological approach in designing the

suitable theoretical framework. Building upon the concepts learned from the analysing the existing literature, and the collected the primary data, which helps in developing the theoretical framework, by exploring its advantages and disadvantages. A questionnaire was developed, where fifty employees of BA and fifty travelling passengers were participated. Some of the questions were different to address issue relevant to employees, others to passengers, in order to have a real feel for their personal experience in using the brand.

### 3.1 Research Approach and Theoretical Framework

This section presents the theoretical framework, predominantly based on the literature review. It is worth mentioning that this paper focuses on the relation between brand personality and customer service and it will cover brand values and benefited that are shown in Figure 1, due to the scope and limited length of the paper. With the personality features related to the brands, as proposed by Aaker (1997), in which the core values of a business are reflected in the business potentials along with the perspectives of their targeted customers. Brand benefits should be defined in order to construct specific characteristics. Also, the pleasure model (LeBel, 2005) emphasised on the new insight to the fields of customers' relation and services. The model is specifically important in the aviation industry, due to the different nationalities and large aviation markets. So, it is significant to consider different ethnicities that exist in the local markets prior to implementation of the pleasure model. It is worth mentioning that while carriers such as (Ryanair and Finnair) offer similar service i.e. air transportation; hence, similar service outcome is anticipated, the procedure of delivering the services to the customers is entirely dissimilar.

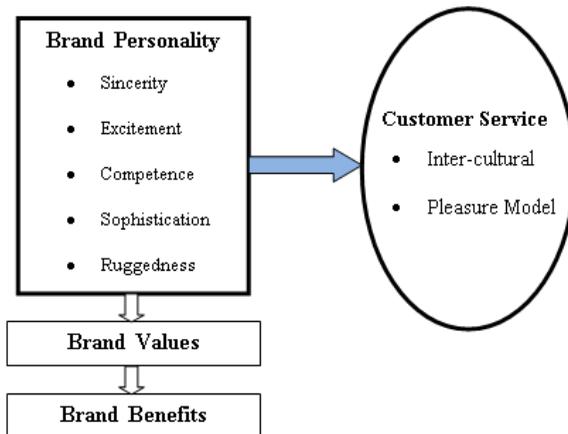


Figure 1: Theoretical Framework

### 4. Analysis of the Results & Key Findings

The Statistical Package for the Social Sciences (SPSS) was utilised to analyse the data collected from 100 participants (fifty employees and fifty passengers). The gender is distributed by 51% and 49%, male and female respectively. 100 customers were chosen in order to attain accuracy in results and address research questions effectively.

**Quest. 1: It is easy for me to contact the customer service department of the company**

On the basis of the question that has been asked in the questionnaire, most of the people did not have any issues in the services that had been provided by the customer service department of the company. Therefore, 45 % of the people were strongly agreeing with the fact that the customer service is excellent in their response. Trailing it were 37% who were also agreeing with the fact that has been asked in the question. However, 12% of the people were having no opinion of their view and 6% of them were not happy with the services that had been provided by the customer services department.

|                | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------------|-----------|---------|---------------|--------------------|
| Strongly Agree | 45        | 45.0    | 45.0          | 45.0               |
| Agree          | 37        | 37.0    | 37.0          | 82.0               |
| Valid Neutral  | 12        | 12.0    | 12.0          | 94.0               |
| Disagree       | 6         | 6.0     | 6.0           | 100.0              |
| Total          | 100       | 100.0   | 100.0         |                    |

Table 1: It is easy for me to contact the customer service department of the company

**Quest. 2: The Company has always responded positively to all of my queries**

In correspondence to the question that has been asked in the questionnaire, around 86% of the people were totally agreeing with the response that has been provided by the company on the queries that have been put up by the customers. 14% of the population had no views as their response and none of them disagreed with the question that has been asked in the question.

|                | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------------|-----------|---------|---------------|--------------------|
| Strongly Agree | 48        | 48.0    | 48.0          | 48.0               |
| Valid Agree    | 38        | 38.0    | 38.0          | 86.0               |
| Neutral        | 14        | 14.0    | 14.0          | 100.0              |
| Total          | 100       | 100.0   | 100.0         |                    |

Table 2: The Company has always responded positively to all of my queries

**Quest. 3: I always recommend this brand to my friends and family whenever they intend to travel**

Recommendation was considered as the most important aspect that had to be observed while conducting the survey. However, the results of the survey were in total favour of the airline; with around 37% of the passengers were willing to recommend the airline to others. Trailing them were 42% of the passengers who were also willing to recommend the airline to others. While 17% of the passengers questioned were having no opinions on recommendation and the rest 7% were not willing to advise the airline to others.

|                | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------------|-----------|---------|---------------|--------------------|
| Strongly Agree | 37        | 37.0    | 37.0          | 37.0               |
| Agree          | 42        | 42.0    | 42.0          | 79.0               |
| Valid Neutral  | 17        | 17.0    | 17.0          | 96.0               |
| Disagree       | 4         | 4.0     | 4.0           | 100.0              |
| Total          | 100       | 100.0   | 100.0         |                    |

Table 3: I always recommend this brand to my friends and family whenever they intend to travel

**Quest. 4: I am happy to travel with British Airways**

On the basis of the mentioned question that has been asked in the questionnaire, it has been observed that 48% of the people were strongly agreeing to the fact that has been asked in the questionnaire and were very happy to travel with British Airways. Trailing them were 29% who were also happy to travel with the airline. 20% of the total population was not holding any views and were found to be Ok with any airline they travel with. However, 3% of the people were disagreeing to travel with the airline again.

|                | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------------|-----------|---------|---------------|--------------------|
| Strongly Agree | 48        | 48.0    | 48.0          | 48.0               |
| Agree          | 29        | 29.0    | 29.0          | 77.0               |
| Valid Neutral  | 20        | 20.0    | 20.0          | 97.0               |
| Disagree       | 3         | 3.0     | 3.0           | 100.0              |
| Total          | 100       | 100.0   | 100.0         |                    |

Table 4: I am happy to travel with British airways

**Quest. 5: I think that this brand is always looking to improve its products to better satisfy the consumer needs**

As discussed in the introduction that, improvisation was highly significant in maintaining and increasing the brand persona; it was found that the British Airways has been focusing on it as well. The British Airways has been thoroughly improvising in their procedures to provide better facilities to passengers. The fact has also it has been supported by the results which have been derived from the survey. It was found that 87% of the passengers were agreeing to the fact that the British Airways have been continuously improving their procedures in flight operations and customer care. Moreover, 9% of the people were not having any views regarding the question that has been asked in the survey. However, 4% of the passengers were disagreeing with the fact that has been discussed in the questionnaire.

|                | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------------|-----------|---------|---------------|--------------------|
| Strongly Agree | 40        | 40.0    | 40.0          | 40.0               |
| Agree          | 47        | 47.0    | 47.0          | 87.0               |
| Valid Neutral  | 9         | 9.0     | 9.0           | 96.0               |
| Disagree       | 4         | 4.0     | 4.0           | 100.0              |
| Total          | 100       | 100.0   | 100.0         |                    |

Table 5: I think that this brand is always looking to improve its products to better satisfy the consumer needs

## 5. Conclusion

The paper focused on identifying the customers' satisfactions and brand personality in a European airline, which has been successfully utilised in other industries in addition to aviation. The airline industry is an integral part of the aviation industry. It is important to identifying and satisfying passengers' needs, i.e. the gap between passengers' expectations and experiences is strongly linked to brand. The dimensions identified by both Aaker (1997) and (LeBel, 2005) were adopted and applied using developed questionnaire, where fifty travelling passengers and fifty employees of BA were participated. Some of the questions were different to address issue relevant to passengers, others to employees. This is done, in order to have a real feel for their personal experience in using the brand and its effect on the brand. While, the company is striving to maintain its performance, other entrants and huge giants like Cathay Pacific and other airlines are also facing a tough competition for the British Airways. Moreover, the competition in the market has made it difficult for the existing brands to preserve their performance. But, British Airways has been very successful in standing against the norms and is continuously proving to be the first choice airline for British as well as international passengers.

Despite the fact, that the company has been very successful in maintaining the brand persona and the image. However, there could be improvements, by having the customer feedback, in order to improve quality and maintain it or even enhance brand persona. The company focuses on their employee satisfaction too (happy employees = happy passengers), i.e. within as well as outside their organisation, to better provoke a positive impression on the market. Baggage loss issue has been found to be the most important to both passengers and airlines, such issue needs to be addressed as it is crucial to any airline's image and brand. Therefore, the company enforces good practice to reduce such incidents. British Airways takes many initiatives to mark new innovations in the field and should utilise the used of latest technology to improvise their operations. As this will rely on the established revenue resources and should invest properly so that the risk of loss of customers could be minimised. This includes formulating new strategies to stand the threats for new entrants and existing airlines. Further studies can focus on investigating the relationship between brand values, brand benefit, and customer service.

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# Improving Workforce Planning of Aircraft Ground Handling Operations Using Mathematical Optimisation

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**Abstract:** Improving performance of aircraft ground-handling operations has been previously discussed. However, proper allocation of workforce to such ground handling operations still needs more investigations. In this study, a mathematical optimisation model “WFP\_GH\_ILP” is developed using integer linear programming to identify the best route taken by workers when serving different aircraft types & inbound/outbound flight combinations. The objective of the proposed model is to satisfy different ground handling operations requirements of all aircraft on the ground while minimising total working time. Results show that allocating ground handling staff optimally could reduce total working time by up to 15.77%. It is concluded that when optimal allocation of ground handling staff is implemented, a reduction in equipment operating costs, emissions from equipment, noise pollution by equipment and encountered traffic on the apron could be seen.

**Key Words:** ground handling operations, workforce planning, mathematical optimisation, different ground handling operations requirements.

## 1. Introduction

The demand on air transport has been growing since commencement of commercial flights. In fact, the demand on air transport continues to grow despite external factors affecting it such as wars and oil price fluctuations (Airbus 2015: 12). To sustain this growth; airports have been expanding, enhancing their infrastructure, improving their operational procedures, efficiency and resource utilisation. On the other hand, airlines have been ordering new aircraft, expanding their operations and developing new business models to satisfy all types of demand (CAPA 2006). In addition, technology has been developing to improve air navigation control and reduce congestion in skies (SESAR 2015).

While airlines could continue buying new aircraft and expanding their operations; airports could not continue expanding due to environmental, political, financial and other types of constraints. Instead, airports tend to focus on improving operational efficiency and resource allocation and utilisation. To achieve such, it is common for airports to outsource the provision of ground handling operations to aircraft on the ground. Some of these operations include passengers embarking/disembarking, baggage loading/unloading, aircraft cabin cleaning and others.

Ground handling providers outsourced by airports aim at performing their role efficiently. Planning and management of workforce in the context of ground handling operations is a challenging task due to a wide range of parameters including but not limited to different aircraft numbers, requirements and types along with different inbound – outbound flight combinations. Overcoming such challenge will lead to better cost management, favourable environmental impact and other benefits.

Hence, the problem of the workforce planning of ground handling operations is chosen to be presented in this work. The problem statement of such workforce planning in ground handling operations will be discussed in the following subsection.

## 1.1 Problem statement

There are many ground handling operations involved in servicing an aircraft having an interim stop between flights. The types of services provided depend on aircraft type, its origin and destination and the airline’s business model (Low cost versus full cost). A schematic diagram that describes the problem of workforce planning of ground handling operations is presented in Figure 1.

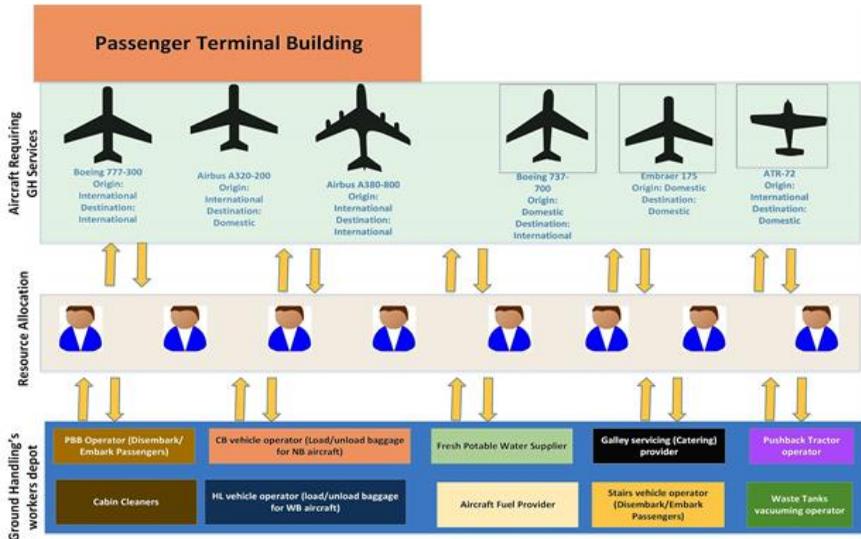


Figure 1: The Problem of workforce planning in ground handling operations

In Figure 1, the schematic layout of an airport’s apron shows for example 6 aircraft having different attributes. These attributes are: Aircraft type (e.g. Boeing 737-800, airbusA320, ATR-72), inbound outbound flight combination (e.g. from domestic origin to an international destination), and Scheduled time of departure (STD). This airport has a single ground-handling provider that employs a number of skilled workers. This means that a worker can perform the assigned task on multiple aircraft types. Those workers are assigned to aircraft by the ramp supervisor who receives staff allocation plans from roster planners (Dowling et al. 1997). For each aircraft, all ground handling operations must be completed by its scheduled time of departure. The ground handling operations (number and service times) required by each aircraft vary as they depend on the aforementioned aircraft attributes.

Roster planners faces the challenge of assigning GH staff to aircraft in the best sequence. Assigning workers in random sequence could result in having low system’s efficiency and low worker’s utilisation rates. In addition, it does not guarantee that all aircraft will be ready to depart on their scheduled time of departure. The rational of having a proper workforce planning/ resource allocation plan is obvious to ground handling companies. It saves them time, cost and ensures adherence to service level agreements. On the other hand, the avoidance of flight delays is crucial to airlines. In fact, it has been found that Low cost carriers operating short-haul point to point flights could increase aircraft utilisation by 8% if ground handling/turnaround time is reduced by only 10 minutes (Mirza 2008).

Although some airlines and ground handling providers started utilising computer software to improve the allocation of their staff (Felici and Gentile 2004), there remain recorded flight delays caused by delays in the provision of ground handling operations and over/under staffing issues. Moreover, purchasing custom made scheduling systems software imposes huge costs on GH companies (Herbes 2005).

## **1.2 Aim of Research**

This research aims at optimising the allocation plan of skilled staff to ground handling operations of various aircraft types and different flight scenarios. The optimal allocation is achieved by developing a mathematical optimisation model that can be used to find the best sequence of service visits that staff members should follow to fully satisfy the required operations by aircraft on the ground. The main objective of this research is to minimise workers' total travel time between aircraft and subsequently minimise the total working time.

## **1.3 Previous Related Work**

This research intends to find best solutions in assigning ground-handling workers to aircraft demanding ground handling operations. Workers leave the central station (referred to in the text as “Depot”) to serve multiple aircraft per visit/ trip. The visit ends when workers go back to the depot. This can be described as having a number of nodes with specific demands to be fulfilled within a certain time. Yan-Du et al. (2014) develop a mathematical model using mixed integer programming to model the assignment of towing tractors to several aircraft on ground. In their model, each aircraft (node) requires towing only. However, the duration taken to tow an aircraft is different based on the nature of the towing job. The model considers a heterogeneous fleet of towing vehicles that can originate and terminate from multiple depots. This means that processing times vary based on the type of towing vehicle providing the service. The model is then solved using column generation heuristics. Results indicate routes that should be taken by towing vehicles to minimise total variable cost associated with operating towing vehicles.

Similar to this work but considering a set of operations rather than a single one, Padron et al. (2015) develop a mathematical model to model the assignment of various ground handling vehicles to multiple nodes (aircraft). The model considers a fixed set of operations to be performed on all aircraft. In addition, it assumes a homogenous fleet of vehicles. This means that the processing time of a single job is considered to be the same for all aircraft on the ground. The model is solved using insertion heuristics and hybrid of constraint programming, large neighbourhood search and variable neighbourhood search. Like the towing assignment problem mentioned above, the results of this model produces a set of routes that should be followed by ground handling vehicles to either minimise waiting time at an aircraft or to minimise total completion time of turnaround operations. Chu and Zhu (2007) consider workforce requirements rather than the equipment ones. The researchers develop a goal programming model to model the assignment of the workforce based on generated demand in an operational day in Hong Kong International Airport. In addition, rather than considering specific demand by each aircraft (node), the study models given data to generate a cumulative demand pattern generated by all aircraft on the ground. The generated demand is for a single type of operation. The operation is transporting bags from the aircraft to one of two available locations. In addition, it is assumed that the workforce have homogenous skill levels. Results provide a plan of workforce scheduling based on demand in such a way that aircraft delays would be minimised.

However, this research is different from that of Yan-Du et al. (2014) when it comes to the number of operations required by each aircraft. To clarify, the current research considers multiple operations required by multiple aircraft rather than a single operation. In addition, it considers different numbers and types of operations required by each aircraft based on aircraft's type and flight sector. This means that each aircraft will require a different set of ground handling operations based on its origin, destination and size. This adds a new dimension of complexity to the simulated environment when comparing it with a single set of operations considered by Padron et al. (2015). Moreover, this research considers the assignment of the workforce to various aircraft rather than considering the vehicles' assignment problem. The assignment of workers to multiple aircraft is different from vehicles as some turnaround operations should be performed by more than one worker sharing a single vehicle (e.g. aircraft cleaning). The difference here from Chu and Zhu's (2007) work is that specific demands by aircraft will be satisfied for rather than a cumulative demand. In addition, this research presents a new modelling constraint that links the finishing time of all ground handling operations on a certain aircraft to its scheduled time of departure. This constraint is further detailed in section 3.3.6. The gap in knowledge has been identified based on the critical review above, see Figure 2.



Figure 2: The Gap in Knowledge

Figure 2 shows that the current research introduces a new approach in allocating ground handling resources. This approach would bridge the gap in knowledge that has been identified in each of the researches presented above.

## 2. Research Tools & Techniques

In order to understand the process at which ground handling operations take place on an aircraft, relationship diagrams are developed. In addition, one of the mathematical programming techniques is used to develop an Integer linear programming model, which is used to translate the problem scenario presented in sub-section 1.1 into a mathematical format. A more detailed description of the tools and techniques used in modelling then solving the current problem is discussed in the following subsections.

## 2.1 Relationship Diagrams

Relationship Diagrams show the sequence in which turn-around operations are performed. Different aircraft types require different ground handling operations. Therefore, it is essential to have these diagrams in order to develop a model that respects the required type of operations and their order of execution. An example of a relationship diagram of turn-around operations for a Boeing 737-700 is presented in Figure 3.

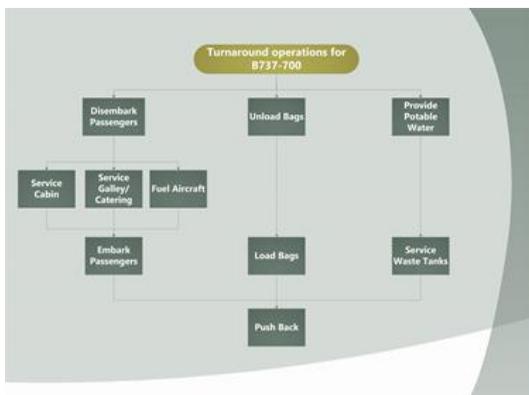


Figure 3: Relationship Diagram of ground-handling operations for a Boeing 737-700

## 2.2 Mathematical Programming – Linear Programming Technique

Integer linear programming is used to simulate the problem in hand. To clarify this and in order to find the best task allocation scheme (sequence) of ground handling workers; the problem is treated as a vehicle routing problem with time windows (VRPTW). Integer linear programming has been proven as an excellent tool to use when simulating VRPTW as it accurately represents incurred cost, time or distance (Chang and Chen 2007). The basic VRPTW is adopted and tailored to solve the problem of assigning workers to multiple aircraft on ground in the best sequence. A single trip with multiple visits, identifying the number of workers needed and considering multiple vehicles in a single problem are some of the tailor made changes.

### 2.2.1 Modelling Assumptions

The mathematical model is developed based on the following assumptions:

- Workers depart and return to single depot
- The visiting nodes differ from one aircraft to another
- Flights serving domestic origins and destinations require less turn-around operations. Requirements scale up as flights travel longer routes (e.g. requirements for flights of international origin and destination are more than those of domestic origin and an international destination)
- Workers are considered multi-skilled and can perform their assigned task on multiple aircraft types
- A single worker is utilised unless the task requires more than a single worker or a single worker is not sufficient to meet the demand

- Service durations are derived from aircraft handling manuals
- Delays due to ad-hoc causes are not considered
- 6 aircraft are considered for the quiet airport scenario
- 14 aircraft are considered for the busy airport scenario
- The ground handling operations that are included in the model are:
  - Embark/disembark passengers by stairs or air-bridge,
  - Unload/load baggage by conveyor belt vehicles or high loaders,
  - Fuel aircraft,
  - Provide potable water,
  - Vacuum waste tanks,
  - Service aircraft cabin,
  - Galley servicing (Catering),
  - Push back aircraft

### 2.2.2 Indices & Parameters

The **indices** used to model the problem in hand are:

1. Aircraft Identifier index:  $i \in \{0 \text{ (starting depot)}, 1, 2, 3, \dots, I\}$
2. Task identifier Index:  $j \in \{1, 2, 3 \dots J\}$
3. Worker identifier Index:  $w \in \{1, 2, 3 \dots W\}$
4. Precedence Identifier Index:  $k \in \{1, 2, 3 \dots K\}$
5. Critical tasks Index:  $c \in \{1, 2, 3 \dots C\}$

The **parameters** below are used in the developed model:

Performing a turn-around operation on aircraft requires some time. The duration taken depends on the nature of operation that is being performed. This is represented in the model as:

$$SD_{j,i} \quad \text{Service duration of activity (j) on aircraft (i)}$$

When on ground, aircraft are parked on different stands. The ground-handling worker should move between stands at a certain speed limit and in some cases with the permission of an apron controller. The time spent in traveling between aircraft depends on the apron's layout. For the purpose of this work, we assume a random duration between 4 to 6 minutes. The travel time is expressed in the model as shown here.

$$TT_{w,i,i+1} \quad \text{Travel time between starting depot to aircraft, between aircraft and from aircraft to end depot}$$

To ensure aircraft are served before their scheduled time of departure (STD), a parameter representing the scheduled time of departure for each aircraft is included and is shown below.

$$STD_i \quad \text{Scheduled time of departure of flight (i)}$$

The following parameter is used to model the starting time of an operation. This is important to allow the formation of precedence constraints. These constraints ensure that precedence constraints are satisfied.

$ST_{j,k,i}$  Starting time of activity (j) with priority (k) on aircraft (i)

### 2.2.3 The Developed Integer Linear Programming Model “WFP\_GH\_ILP”

The developed model consists of a number of constraints that are controlled by an objective function. The details of such constraints are provided below.

#### Objective Function

The objective of the developed model is to minimise total working time which consists of total services durations plus total travelling time between aircraft. Since service durations are fixed, the objective function minimises workers’ total travel time. Therefore, the objective function  $Z$  can be written as:

$$Z = \min \sum_{i=0}^I \sum_{w=1}^W TT_{w,i,i+1} \cdot X_{w,i,i+1}$$

#### Decision Variables

Transportation between aircraft (i.e. route taken by worker) is the decisive variable that when changed would produce different completion times. To model transportation between aircraft, the decision variables below are defined:

- 1) **R(i):** This decision variable maps the route taken by workers when travelling between aircraft.
- 2) The second decision variable is of a binary nature. It determines whether a worker moves from a node to another or not. This is represented in the model as:

$$X_{w,i,i+1} = 1 \text{ if worker travels between two nodes, } 0 \text{ otherwise}$$

#### Constraints

To create a mathematical model that mimics reality, the model should take into consideration actual constraints. Below is an explanation of real life limitations incurred while performing turn-around operations and their relative representations in the developed model:

##### Constraint No 1

A turnaround operation (e.g. cleaning aircraft galley) should be performed only once. This limitation is represented in the model by ensuring that workers keep on moving between aircraft until they are back to the depot

*Each Activity (j) should be performed only once on aircraft (i) by worker (w)*

$$\sum_{i=1}^{I-1} X_{w,i,i+1} = \sum_{i=1}^I X_{w,i+1,i+2} \quad \dots (1)$$

##### Constraint No 2

In a real environment, a worker cannot perform more than one ground handling operations at a time. In other words, workers cannot serve more than a single aircraft at a given time.

Worker ( $w$ ) cannot serve aircraft ( $i + 1$ ) until serving aircraft ( $i$ ) is done

$$\sum_{j=1}^J [ST_{j,k,i} + SD_{j,i} + TT_{w,i,i+1}] \cdot [X_{w,i,i+1}] \leq ST_{j,k,i+1} \quad \dots (2)$$

### Constraint No 3

Turn-around operations have two factors that control the sequence at which they are executed. These two factors are *safety considerations* and *space availability* (Gok 2014). Therefore, there is a need to include a constraint that controls the sequence at which turn-around operations are performed in:

*Activity ( $j + 1$ ) with priority ( $k + 1$ ) on aircraft ( $i$ ) cannot be performed until activity ( $j$ ) with priority ( $k$ ) on aircraft ( $i$ ) is finished*

$$\sum_{i=1}^I [ST_{j,k,i} + SD_{j,i}] \cdot X_{w,i,i+1} \leq ST_{j+1,k+1,i} \quad \dots (3)$$

### Constraint No 4

An aircraft cannot depart until its required ground-handling operations are completed. Flights are tied to strict schedules. It is expected that flights respect their schedules with no delay. Therefore, all required ground-handling operations must be performed and completed before its scheduled time of departure.

*All activities for aircraft ( $i$ ) should be completed before scheduled time of departure  $STD(i)$*

$$\sum_{i=1}^I [ST_{j=1,k=1,i} + \sum_{c=1}^C SD_{j,i}] \leq STD_i \quad \text{where } c \in J \quad \dots (4)$$

### Constraint No 5

In reality, workers start their journey from a central depot where all ground handling equipment are parked. In addition, workers return to the same depot when they complete their job to have some rest before they start another journey.

*Workers ( $w$ ) have to start from the depot*

$$\sum_{w=1}^W X_{w,0,i+1} = 1 \quad \dots (5)$$

### Constraint No 6

To ensure that the model calculates minimum time taken to serve aircraft rather than overall minimum time (i.e. zero) a non-negativity constraints was added

*Non – negativity Constraints*

$$X_{w,i,i+1} > 0 \quad \dots (6)$$

## 3. Hypothetical Numerical Test

The developed mathematical model “WFP\_GH\_ILP” is verified by testing its behaviour under two airport environments. In each environment, two scenarios are tested. The environment-scenario combinations are:

- 1) Static airport environment: All aircraft are on the ground at the same time (i.e. time =0). No additional aircraft arrive. The scenarios considered are:
  - a. Quiet airport

b. Busy Airport

- 2) Dynamic Airport Environment: Aircraft arrive, others are serviced on the ground and others depart. The scenarios considered in this environment are the same ones considered in the static airport environment.

The model’s inputs are populated into an Excel spreadsheet to enable solving it using an evolutionary algorithm provided by Excel Add-Ins Solver. One of the results obtained from solving the model is presented in Figure 4.

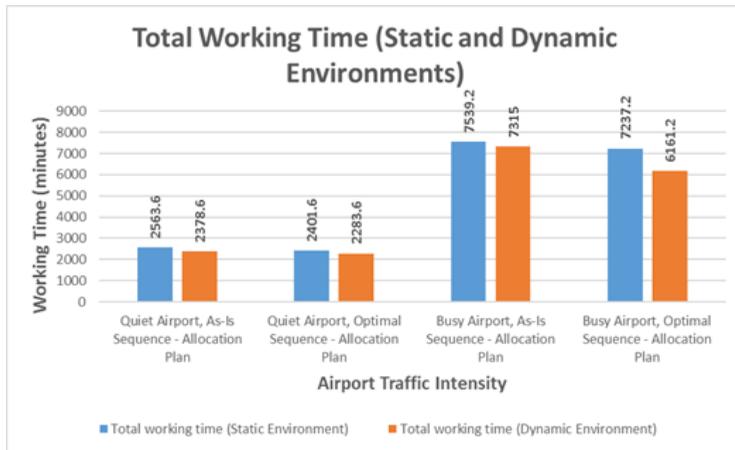


Figure 4: Total Working Time (Static and Dynamic Environments)

Figure 4 shows that in general, applying an “Optimal” sequence – allocation plan when allocating Ground handling staff to aircraft on the ground leads to a reduction in the total working time (Workers’ total travel time + total service time). The reduction in the quiet airport scenario can be seen at its highest in a static airport environment with a total reduction of 6.32%. On the other hand, the reduction in the total working time in the busy airport scenario is highest under the dynamic environment with a total reduction of 15.77%.

#### 4. Conclusion and Recommendation

##### Conclusion

It can be concluded that implementing an “Optimal” sequence -allocation plan in allocating ground-handling staff to aircraft on the ground could significantly reduce total working time. When implementing the developed mathematical model, it could benefit ground handling providers by reducing equipment operating variable costs, staffing costs, emissions from equipment, noise pollution by equipment and encountered traffic on the apron.

The research has successfully addressed the problem of assigning workers to aircraft to provide multiple and different turnaround operations to aircraft on the ground. The developed mathematical model considered the variability of required operations in terms of operation details and the required level of workers for a small number of aircraft on ground based on their type and origin and destination. The model is implemented in two airport environments testing two hypothetical scenarios in each environment.

## **Recommendation**

Based on this research, more real life environments including different scenarios should be tested, by considering a holistic optimisation model that considers all turnaround operations that take place in the airside and expanding the scope of the developed mathematical model “WFP\_GH\_ILP” to include more real life parameters and variables.

## **5. Acknowledgements**

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# **Investigating Effects of Perceived Service Quality on Overall Service Quality and Customer Satisfaction: Case of Saudi Airlines**

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**Abstract:** An increase in information readiness and intense competition between service organisations leads to more challenges in the business environment. On top of these service characteristics and need for human touch are additional challenges for airline companies to not only be successful but also to survive. Thus knowing what airline customers think about an airline and gauging their satisfaction levels are of utmost importance. This study aims to diagnose the perceived service quality and satisfaction levels customers of a national airline company in Saudi Arabia. To do so, the present study adopts Ekiz et al.'s (2009) AIRQUAL scale. A 44-items scale based on seven distinct dimensions, namely; airline tangibles, terminal tangibles, personnel, empathy, image, perceived service quality, and customer satisfaction, is used to achieve the aim of the study. Results of extensive data analysis support significant relationships with the study dimensions. Most notably, 'Airline Tangibles' found to be the most influential factor creating a pool of satisfied airline customers. The results and implications are discussed in the text.

**Key Words:** perceptions, overall service quality, customer satisfaction, Saudi Airlines.

## **1. Introduction and Background**

In an era of intense competition, all service organisations attempt to not survive but also be successful. This is vital in service organisations in general but especially the airline industry (Nadiri et al., 2008; Alotaibi, 2015). One sure way of doing this is to provide a high level of overall service quality which promotes customer satisfaction, stimulates intention to return, and encourages recommendations. Customer satisfaction increases profitability, market share, and return on investment (Bailey, 1996; Chris, 1995; Sultan and Simpson, 2000). Thus, managers in the aviation industry must find ways to make their services stand out from others (Hussain, Al-Nasser and Hussain 2015; Al-Refaie, Fouad and Eteawi, 2013). To do so, they must understand their customers' needs before setting out to meet and preferably exceed them. If service quality and customer satisfaction are to be improved, they must be reliably assessed and measured. Several researchers have sought to define and measure the concept of service quality (Cronin and Taylor 1992; Parasuraman et al., 1988; 1991).

A synthesis of the related literature reveals that the SERVQUAL model (Parasuraman et al., 1988) became one of the most influential models that dominated service quality literature for more than three decades (Ceylan and Ozcelik, 2016). According to Parasuraman and his colleagues, service quality is based on five dimensions of service (Parasuraman et al., 1988; 1991): tangibles-the physical surroundings represented by objects (for example, interior design) and subjects (for example, the appearance of employees); reliability-the service provider's ability to provide accurate and dependable services; responsiveness-a firm's willingness to assist its customers by providing fast and efficient service performances; assurance-diverse features that provide confidence to customers (such as the firm's specific service knowledge polite and trustworthy behaviour from employees); and empathy-the service firm's readiness to provide each customer with personal service. The authors called on other researchers for replicating SERVQUAL in different industries and settings. Since then, hundreds of replication studies have been conducted (to name few: Angur, et al., 1999; Asubonteng, McCleary and Swan, 1996) with varying degrees of success. Also, SERVQUAL is adapted to be a base for several other scales, for instance, AIRQUAL (Ekiz et al. 2009), E-

S-QUAL (Rafiq, Lu, and Fulford, 2012), HiEduQual (Annamdevula and Bellamkonda, 2016), RENTQUAL (Ekiz et al., 2009), etc.

According to Churchill and Surprenant (1982) satisfaction is determined by overall quality perception which in turn is affected by several factors. In the case of the present study these factors are; airline tangibles (ATANG), terminal tangibles (TTANG), personnel (PER), empathy (EMP), and image (IMG). There is overwhelming support in the literature to back these relationships. For instance, Parasuraman et al. (1988; 1991) stressed the importance of tangible factors in creating a strong quality perception which leads to customer satisfaction. Westbrook and Oliver (1991) investigate the interrelationships between empathy, perceived quality and satisfaction and concluded that empathy displayed by the employees create satisfaction. Bowen (2001) conducted a research to looking into the antecedents of customer satisfaction. She found a substantial relationship between positive employee/personal perception and quality perceptions and customer satisfaction. Finally, Anderson and Sullivan (1990) stressed the importance of image on quality perception that leads to pre-decided satisfaction (where the customers make up their minds to be happy with the product/service even before they purchase it).

This study is necessary, useful, and relevant because: a) it focuses on perceived service quality about national airlines of Saudi Arabia which have received little attention in the past except for Alotaibi (2015); and b) the majority of tourists coming to Saudi Arabia use air transportation, predominantly Saudi Airlines. Thus, knowing how Saudi Airlines services are perceived and whether their customers are satisfied is of utmost importance. Moreover, measuring airline service quality is a vital strategic issue for increasing the market competitiveness in the Middle East and in the international tourism market.

### **1.1 Tested Hypotheses and Model**

Considering the above-mentioned literature review support as well as Ekiz et al.'s (2009) and Nadiri et al.'s (2008) research models, the following hypotheses were developed to test the relationships between perceived quality factors/dimensions and overall quality perception and customer satisfaction for Saudi Airlines.

H1: A high level of perceived personnel related quality will have a significant positive effect on overall service quality.

H2: A high level of perceived airline tangibles related quality will have a significant positive effect on overall service quality.

H3: A high level of perceived empathy related quality will have a significant positive effect on overall service quality.

H4: A high level of perceived terminal tangibles related quality will have a significant positive effect on overall service quality.

H5: A high level of perceived image related quality will have a significant positive effect on overall service quality.

H6: A high level of overall service quality will have a significant positive effect on customer satisfaction.

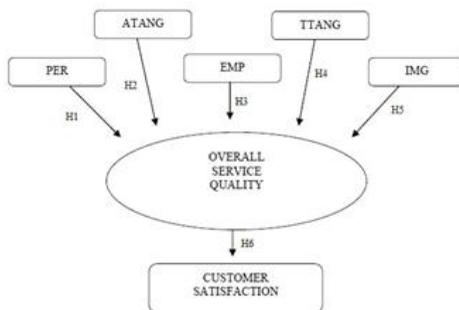


Figure 1: Tested Hypotheses and Model

## 2. Methodology

### 2.1 Research Approach in Brief

The sample of the study consists of customers using the national airline of Saudi Arabia between February and May 2016 with non-probability convenient sampling technique. 800 questionnaires were distributed to airline passengers both in Arabic and English language, after using back-translation method for translation. Of these, 740 questionnaires were returned. In all, 712 questionnaires were found to be useful, which represents 89% response rate. The adopted survey instrument was first developed by Ekiz et al. (2006; 2009), then tested and confirmed by Nadiri et al. (2008). There were 42 items measuring perceived service quality of airline services. Following is the breakdown of the instrument: 6-items for airline tangibles (ATANG), 12-items for terminal tangibles (TTANG), 8-items for personnel (PER), 7-items for empathy (EMP), and 3-items for image (IMG), 3-items each for overall service quality (OSQ) and customer satisfaction (CSAT). A five-point Likert scale (Likert, 1934) was used for data collection with '1' being 'strongly disagree' and '5' being 'strongly agree'. SPSS 20.0 and Lisrel 8.70 for windows were used for the analyses. Descriptive analysis such as means, standard deviation and frequencies are calculated. Reliability issues are tested. Exploratory and Confirmatory Factor Analyses were conducted and Path Analysis was used to test the hypotheses of the study.

## 3. Findings

### 3.1 Demographic Breakdown of the Sample

Descriptive analyses results show that the overwhelming majority of the respondents (596 respondents, 87.3%) were male. More than sixty-four percent of the respondents were between the ages of 18 and 37 (457 respondents, 64.2%). More than half of the respondents had higher education, either undergraduate or graduate level (371 respondents, 52.1%). Additionally, more than seventy-two percent of the respondents reported an income range between 10.000 and 20.000 SAR (516 respondents, 72.5%). The majority of the respondents (495 respondents, 69.5%) reported fulfilling their religious responsibilities and performing Umrah as their motivation to visit Saudi Arabia.

### 3.2 Psychometric Properties of the Instrument

In assessing the psychometric properties of the instrument, issues of reliability, dimensionality, convergent and discriminant validity were considered. In order to provide support for the issue

of convergent validity, corrected item-total correlations were computed. The inter-item correlations being equal to or exceeding 0.32 provide support for the convergent validity of the scale. Overall, the results of this assessment support the issue of convergent validity of the scale.

After employing corrected item-total correlations, reliability coefficients were computed for each study variable and at the aggregate level. Alpha coefficient was found to be 0.89 at the aggregate level and all reliability coefficients were deemed acceptable. Specifically, reliability coefficients ranged from 0.70 to 0.91 for study variables. Overall, these findings show that each coefficient exceeds the cut-off value of 0.70 and all t-values were significant ( $>2.00$ ) as recommended by Nunnally (1978), as were the cases with those of Ekiz et al. (2006; 2009) and Nadiri et al. (2008).

A rigorous test was undertaken for the issues of convergent and discriminant validity, and dimensionality. Specifically, composite scores for each study variable were calculated by averaging scores across items representing that dimension. Results indicate that all correlations among the study variables are significant at the 0.01 level. The correlations among the study variables range from 0.34 (image and terminal tangibles) to 0.54 (perceived service quality and customer satisfaction). Moreover, the confirmatory factor analysis demonstrated a reasonable fit of the data to the seven-factor measurement model on several criteria ( $\chi^2 = 821.33$ ,  $df = 210$ ,  $GFI = 0.94$ ,  $AGFI = 0.95$ ,  $NFI = 0.92$ ,  $NNFI = 0.94$ ,  $CFI = 0.91$ ,  $RMR = 0.027$ ) as recommended by Nunnally (1978). Overall, these results were consistent with those of Ekiz et al. (2009) and Nadiri et al. (2008) which provide additional support for the reliability and validity of the scale.

### **3.3 Tests of Research Hypotheses**

The six hypothesised relationships were tested using LISREL 8.54 through path analysis (Jöreskog and Sörbom, 1996). To be more specific, the first group hypotheses refer to the effects of service quality dimensions on overall quality perceptions. Specifically, the first group hypotheses refer to the effects of airline tangibles, terminal tangibles, personnel, empathy, and image on overall service quality level. The second group hypothesis relates to the effect of overall quality perceptions on customer satisfaction.

Table 1 shows that all of the hypothesised relationships were supported. A careful examination reveals that airline tangibles have the most significant positive effect on overall service quality ( $\beta = 0.43$ ,  $T = 7.28$ ). Thus, hypothesis 2 is accepted. Table 1 also shows that personnel exerts a significant positive effect on perceived service quality ( $\beta = 0.31$ ,  $T = 5.63$ ). Thus, hypothesis 1 is accepted. As for the rest of hypotheses 3, 4 and 5 they were all statistically significant and had the following values respectively: H3 ( $\beta = 0.24$ ,  $T = 3.54$ ), H4 ( $\beta = 0.36$ ,  $T = 6.21$ ), and H5 ( $\beta = 0.19$ ,  $T = 3.17$ ). These findings suggest that terminal tangibles, empathy and image have a significant positive impact on overall service quality. The first five dimensions jointly explain 89% of the variance in overall service quality. Finally, overall service quality has a very strong positive impact on customer satisfaction ( $\beta = 0.47$ ,  $T = 8.93$ ). Thus, hypothesis 6 is accepted. Overall service quality explained 61% of the variance in customer satisfaction.

|  | Standard Parameter | T-values | Significance |
|--|--------------------|----------|--------------|
|  | Estimates (ML)     |          |              |
| <b>Impact on Overall Service Quality</b>       |                    |          |              |
| H <sub>1</sub> : Personnel (PER)               | 0.36               | 6.21     | 0.0001       |
| H <sub>2</sub> : Airline Tangibles (ATANG)     | 0.43               | 7.28     | 0.0001       |
| H <sub>3</sub> : Empathy (EMP)                 | 0.24               | 3.54     | 0.0001       |
| H <sub>4</sub> : Terminal Tangibles (TTANG)    | 0.31               | 5.86     | 0.0001       |
| H <sub>5</sub> : Image (IMG)                   | 0.19               | 3.17     | 0.0001       |
| <i>Explained Variance R<sup>2</sup>=0.89</i>   |                    |          |              |
| <b>Impact on Customer Satisfaction</b>         |                    |          |              |
| H <sub>6</sub> : Overall Service Quality (OSQ) | 0.47               | 8.93     | 0.0001       |
| <i>Explained Variance R<sup>2</sup>=0.61</i>   |                    |          |              |

Table 1: Path Analysis Results

#### 4. Discussions and Implications

The airline industry is one of the most important parts of every tourist destination, regardless of the type of tourism. As more and more customers seek better, if not the best, quality for the money they pay, airlines should provide the best possible service to satisfy their customers. To be successful, the key factor is to create and maintain service quality. But to do so, they need to know what customers think, how they perceive airline's service quality, are they satisfied with it? The present study aimed to shed light on these questions in the case of Saudia, the national airline of Saudi Arabia.

The presented results of 712 respondents reflect a positive picture of Saudi Airlines. More precisely, mean scores show all the perceived quality dimensions - airline tangibles, terminal tangibles, personnel, empathy, image - are positive and lean towards 'satisfied and/or delighted'. This means customers who used Saudi Airlines were happy with above mentioned factors. Moreover, all the hypothetical relationships were statistically significant and had the theorised effects on overall service quality dimension with varying strength. For instance, consistent with Ekiz et al. (2006; 2009) and Nadiri et al. (2008) airline tangibles had the most significant relationship with overall service quality. This means airlines should pay extra attention to keep their aircraft updated and well-looked after. Given the most of the service - transportation from one point to the other - takes place inside the aircraft, this result is expected. Airline tangibles dimension is followed by personal dimension. This is a unique finding, since terminal tangibles dimension is usually the next significant one (see Ekiz et al., 2006; 2009). The importance given to personnel can be linked to Saudi Arabia's culture which is characterised by being friendly and hospitable. Given this cultural context, one may expect the same level of satisfactory personal service, friendliness and positive attitude towards guests. Thus, airline managers should focus on selecting the right crew with interpersonal skills and continuously monitor and train their interactions with customers. Terminal tangibles and empathy dimensions also had statistically significant relationships with overall quality perception. As such, airlines should invest not only in the betterment of their aircrafts, but also facilities at the terminal. Passengers spend a considerable amount of time while waiting to board their planes, which is part of the overall travel experience. For this reason, airline companies should consider providing clean, well air-conditioned and comfortable terminal facilities. Although, the measured impact of image was the lowest among the other dimensions, it was still positive. This might be due to the fact that low airline ticket prices are not so

important to many Saudis. Earnings from a strong oil-based economy is shared among the citizens, thus many Saudis have an income well above the world average. Finally, overall service quality perception has a strong and positive impact on customer satisfaction. This is consistent with the previous research findings (Ceylan and Ozcelik, 2016; Parasuraman et al., 1988; Ekiz et al., 2006). Airline companies should consider spending more resources on the overall quality of their offerings. Failure to do so may lead to a fall in their customer satisfaction levels which in turn results in financial losses. Nowadays, the line between success and failure in the airline industry is thinner than ever. Paying attention to what airline customers perceive, think and feel can be the tipping point towards success.

#### **4.1 Limitations of the Study**

It should be underscored that there are few limitations to the current study. First, this study used a non-probability sampling technique (convenience). Although it used a considerably large sample, future studies should consider using one of the probabilistic sampling techniques. Secondly, the majority of the respondents were educated young males. Reaching out to female respondents is a limitation in Saudi Arabia. Future studies may consider using a marketing research company that can provide an evenly distributed pool of respondents. Also, this study focused on only Saudia Airlines, but there are more and more carriers both public and private entering the market. Thus, future studies may consider comparing public and private airlines. Moreover, this study utilised only five independent variables, as dimensions of perceived service quality. Future studies should consider adding more dimensions to increase representation and coverage. Finally, there are only handful studies focusing on perceived service quality and customer/tourist dis/satisfaction in Saudi Arabia. Such studies, based on service industries in general and tourism and hospitality in particular, are needed to assess and improve the current situation.

#### **5. Acknowledgements**

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# **A Study on Air Transport Liberalisation based on ICAO's Extant Documents**

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**Abstract:** The need to reduce control over the rules that influence commercial activities resulted in an effort to liberalise the airline industry. Nations that embraced the idea of liberalisation and committed to this cause with long term strategies placed significant investments and regulatory improvements and became dominant players in the aviation industry. ICAO's Worldwide Air Transport Conferences developed awareness at an international level about increased concerns related to the progress of liberalisation. This paper aims to provide an in depth discussion through the analysis of ICAO's extant documents in understanding concerns raised during ATConf/5 and ATConf/6 and to support the view that Worldwide Air Transport Conferences not only contributed in understanding global air transport problems in the area of economic regulation but also fortified ICAO's role in this field.

**Key Words:** air transport liberalisation, Chicago Convention, competition, ICAO, air service agreements.

## **1. Introduction**

Controlled mainly by an international regime established in 1944, international aviation is supported by a series of treaties, a network of bilateral agreements and detailed national rules (Kassim & Sevens 2010). During the Chicago Conference, States opted for regulating the economic aspects of air transport bilaterally and that limited significantly ICAO's role in the area of economic regulation but ICAO remained the forum where member States, developing and developed alike, initiate important high level discussions for the future of this industry in terms of economic development. The Air Transport Conferences at an ICAO level emerged as a "problem addressed" mechanism during the 21st session of the ICAO assembly in 1974. The harsh economic climate distressed the air transport industry and the Council nominated four areas of discussion related to economic regulation for an upcoming high level dialogue that initiated a Special Air Transport Conference which meant to become the first of this type (ICAOa 2016). The conference was held in Montreal in April 1977 and was the stepping stone towards developing a universal approach on formulating aviation strategies at a multilateral level through collective discussion. In 1994, ICAO held the 4th Conference of this magnitude and officially named all Conferences from that time onwards as World-Wide Air Transport Conference (ATConf).

ATConf/4 was a significant step towards reflecting all facets of the current economic regime of international air transport (ICAOa 2016). This was also the time when States acknowledged that liberalisation was due to strengthen internationally, but decided that "a global multilateral agreement for the exchange of traffic rights" was not the preferred approach and remained faithful to the key principles of the Chicago Convention. States chose to design their own path to liberalisation and to commit in this effort at their own pace (Hooper, 2014:18). This decision acted as a catalyst for economic liberalisation. Nations that embraced the idea and committed to this cause with national strategies placed significant investments and regulatory improvements and became dominant players in the years to come. In 2003, ATConf/5 convened in Montreal with a core objective, namely, to design a framework for economic liberalisation where "international air transport may develop and flourish in a stable, efficient and economical manner without compromising safety and security and while respecting social

and labour standards” (ICAOa 2016). After ten years of continuous progress, the key theme of ATConf 6 was the “Sustainability of Air Transport” focused on the impact of excessive liberalisation, the imbalances and asymmetries caused by the fact that regions adopted a different pace, which is a direct consequence of the customised as opposed to a multilateral approach chosen by the States.

ICAO’s Worldwide Air Transport Conference working papers (WPs) became a powerful tool for States and industry stakeholders in their effort to outline recent developments, trends and discussion areas that needed to be addressed at an international level. A clear outcome of ATConf 6 was the mere fact that ICAO has been mandated by the 38th session of the Assembly to develop international agreements on the liberalisation of market access, air cargo and air carrier ownership and control which is telling as to the evolving role of ICAO in the area of economic regulation. This paper aims to evaluate the impact of ATConf/5 and ATConf/6 WPs in understanding concerns related to the liberalised environment and support the standpoint that after the proceedings of ATConf/6, ICAO has entered a new era where a more active role is developed in the area of economic regulation and this role is significant for the future of international civil aviation.

## **2. Background to the Liberalisation Process**

One would expect that a global industry, such as aviation, is regulated by global rules, especially as far as its economic aspects are concerned. Naturally, one would ascribe the role of the global regulator to the International Civil Aviation Organisation (ICAO) (Abeyratne, R., 2009, 2013). However, the reality is somewhat different. Civil aviation is a relatively new industry. The first effort to regulate it dates back to 1919, when the Paris Convention was signed in the aftermath of World War I. <sup>1</sup> The principle of national sovereignty, enshrined in Article 1 of the Paris Convention, coloured the regulation of the industry for the years to come. The same principle set the tone during the Chicago Conference, held towards the end of World War II. <sup>2</sup> At that time, technological progress had rendered clear the role civil aviation would play in the years to come in the transportation of people, cargo and mail. At the same time, the destruction caused by military aviation resulted in States insisting on their exclusive and complete sovereignty over the airspace above their territory (Dempsey, P., 2008).

National security and defence was not the only reason behind the attachment of States to their national sovereignty during the Chicago Conference. Economic protectionism was yet another reason. Europe was destructed after the War, in stark contrast with the United States, which was going through a period of growth. This asymmetry resulted in a policy disagreement over the regulation of the industry. The UK, whose aviation industry was destructed, yet which was still a colonial power controlling strategic points around the globe, advocated a system whereby the economic aspects of air transport would be regulated bilaterally, on the basis of government-to-government negotiations. The United States, which had 20,000 aircraft to deploy to different destinations after the War, advocated free market access agreed upon at international level on the basis of a multilateral agreement (Dempsey, P., 2008).

The UK view prevailed during the Conference, resulting in the genesis of the so-called “nationality clauses” in air services agreements, namely provisions which entitle a signatory State to refuse the designation of an airline which is not substantially owned and majority controlled by the other contracting State and/or its nationals. These clauses, included for the first time in two ancillary multilateral agreements that came out of the Chicago Conference

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<sup>1</sup> Convention Relating to the Regulation of Aerial Navigation, *opened for signature* Oct. 13, 1919, 11 L.N.T.S. 173.

<sup>2</sup> See Article 1 of Convention on International Civil Aviation, *opened for signature* Dec. 7, 1944, 61 Stat. 1180, 15 U.N.T.S. 295 (entered into force Apr. 7, 1947).

(next to the Chicago Convention), namely the International Air Services Transit Agreement (IASTA) and the International Air Transport Agreement (IATA),<sup>3</sup> were replicated in bilateral air services agreements concluded after the War (Havel, B. & Sanchez, G., 2014). The most prominent of these agreements, on which subsequent bilaterals were modelled, was the so-called Bermuda I agreement between the UK and the US (1946).<sup>4</sup> What is peculiar is that whilst the nationality clauses in IASTA and IATA, included as they were in multilateral agreements, entitled the signatory States to designate any airline having the nationality of one of the signatories - something which in the context of Bermuda I was translated into the UK designating either UK or US airlines and vice versa – the nationality clauses in subsequent bilaterals entitled States to designate only their own airlines. This regression from multilateralism (IASTA and IATA) to bilateralism (Bermuda I) to unilateralism (subsequent bilateralism) is telling as to the readiness of States to liberalise the industry (Haanappel, P., 2001).

Nationality clauses stand in the way of cross-border investment in the industry by means of mergers and acquisitions. This is due to the risk that traffic rights will be lost should an airline's ownership and control regime change (Mendez de Leon, P., 2009). In order to achieve the efficiencies brought about by mergers, airlines have settled with the second best option, namely alliances. That said, domestic consolidation poses no risks to airlines' traffic rights. The United States pioneered domestic deregulation in the late 70s, by means of the 1977 Cargo Deregulation Act and the 1978 Airline Deregulation Act. The challenges the Civil Aeronautics Board was faced with in terms of deciding on all aspects of an airline's operations, such as routes, frequencies, capacity and pricing, combined with the overcapacity that existed in the market at that time, prompted the US to deregulate the industry. US deregulation resulted in consolidation and the emergence of the so-called big six airlines, but also in inflated prices and predation, a problem that was addressed years later (Slater, R., 2003).

Europe initiated a process of gradual air liberalisation a decade later with the adoption of a first package of measures in the year 1987, followed by a second package in 1990 and a third package in 1992. The creation of a single air transport market coincided with the creation of a single market, although the freedom to provide cabotage was only granted in 1997. Liberalisation in Europe was necessitated not so much due to the complexity and overcapacity experienced in the United States, but due to the unprofitability of national flag carriers that were artificially maintained on the market by means of operating State aid. This type of aid distorts competition and the recipe to phase it out was to liberalise the market. A period of grace was given to national governments to restructure their flag carriers with a view to eventually privatising them (even if privatisation runs counter to the principle of neutrality regarding the system of property ownership, enshrined in Article 345 TFEU) (Lykotrafiti, A., 2011).

The creation of a single air transport market in Europe in the year 1992 coincided with the launch of the US open skies policy, founded on free market access, unrestricted capacity and frequency and free pricing. The effort of the United States to spread liberalisation at international level by means of liberal air services agreements, irrespective of its motives, enticed a number of EU countries to enter into this type of agreements with the United States (Mendez de Leon, P., 2002). However, open skies agreements do not go as far as liberalising ownership and control. This resulted in EU Member States violating the EU freedom of

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<sup>3</sup> See International Air Services Transit Agreement (IASTA), *opened for signature* Dec. 7, 1944, 59 Stat. 1693, 84 U.N.T.S. 389 (the so-called Two Freedoms agreement) and International Air Transport Agreement, *opened for signature* Dec. 7, 1944, 59 Stat. 1701, 171 U.N.T.S. 387 (the so-called Five Freedoms agreement).

<sup>4</sup> See Agreement between the Government of the United States of America and the Government of the United Kingdom Relating to Air Services Between Their Respective Territories, Feb. 11, 1946, US-UK; 60 Stat. 1499.

establishment by assuming the obligation to designate only airlines owned and controlled by them and/or their nationals to fly to the United States. However, the creation of a single air transport market marked a transition from the concept of a national airline to the concept of an EU airline. The seminal open skies judgments of the European Court of Justice paved the way for the first inter-regional air transport agreement between the EU and the US, signed in 2007 (White, B., 2002; Heffernan, L. & McAuliffe, C. 2003; Toe Laer, R., 2006). The EU-US Air Transport Agreement aimed at liberalising the transatlantic market by entitling EU airlines to fly from any point in Europe to any point in the United States and US airlines to fly from any point in the United States to any point in Europe. The Parties adopted a staged approach, whereby liberalisation would be implemented progressively by means of three agreements, culminating in unlimited investment opportunities in each other's airlines. The second stage agreement was reached in 2010, but fell short of liberalising ownership and control to any meaningful degree (Linzell, S. 2010). Since then, no progress has been achieved, the negotiations appearing to have stalled (Lykotrafiti, A., 2011).

Liberalising ownership and control presupposes, on the one hand, amending national laws which restrict foreign investment in national airlines, and, on the other hand, amending the nationality clauses in bilateral (or multilateral) air services agreements (Havel, B. and Sanchez, G., 2010-2011). This has proven to be difficult even in countries which have advocated liberalisation, most notably the United States. Amending the national law which caps foreign inward investment in US airlines has been met with opposition by Congress (Sanchez, G., 2012). In other countries, most notably in the Philippines, allowing majority foreign ownership and effective control of national airlines requires amending the country's Constitution (Tan, A., 2009). The reluctance of States to amend their national laws unilaterally has resulted in open skies agreements having achieved very little in the area of cross-border investment. As pointed out, national laws restricting foreign investment in national airlines in combination with nationality clauses in air service agreements have locked States into a prisoner's dilemma (Havel, B., 2009). Unilateral action is meaningless, something which suggests that liberalisation of ownership and control in particular can only be achieved multilaterally by means of an international agreement agreed upon within ICAO (Lykotrafiti, A. 2015).

The side effect of the regulation of international civil aviation by means of bilateral agreements is the creation of national airlines. Although it could be claimed that national airlines promote connectivity, civil aviation is a global industry, something which may suggest that consumer welfare would be better served by means of global, namely multi/transnational airlines (Abeyratne, R., 2005/2006). To reap the efficiencies generated by mergers, airlines have forged international alliances (Toe Laer, R., 2007). Ironically, strategic airline alliances have received antitrust immunity from competition authorities, which enables them to engage in practices which are per se illegal under competition law, such as price-fixing, revenue-sharing, profit-sharing, cost-sharing, sharing of sensitive information, etc. (Bilotkach, V. & Hüscherlath, K., 2011). Traditionally, antitrust immunity is granted only if there is an open skies agreement in place. This is because open skies promotes new entry, which, in turn, disciplines incumbents, addressing the elimination of competition that is caused due to the cooperation agreement (Gillespie, W. & Richard, O., 2011). It has been argued that the policy of open skies and antitrust immunity pioneered by the United States has promoted liberalisation (Dean, W., Shane, J. 2010; Misfud, P. 2011:117-130).

Irrespective of whether one shares this view or not, the need for liberalisation is ever-present. The hybridisation of the industry experienced today, taking the form of business models such as the long-haul low-cost carrier, may suggest that the current regulatory framework throttles

innovation, leaving the industry with no alternative but to reinvent itself. The mandate granted to ICAO by the 38<sup>th</sup> session of the Assembly to “to develop and adopt a long-term vision for international air transport liberalisation, including examination of an international agreement by which States could liberalise market access...”, “to develop a specific international agreement to facilitate further liberalisation of air cargo services,” and “to initiate work on the development of an international agreement to liberalise air carrier ownership and control” is a clear sign that liberalisation is needed and that ICAO can play a significant role in this cause (Resolution A38-14 2013).

### 3. Methods Used

In addition, to the literature presented, this study is reviewing an independent source of data in the form of extant documents. Extant documents are created for a specific purpose and provide important insights on particular views and discourses. In a qualitative study the focus is shifted towards “what the documents do” rather than “what they cover” (Charmaz 2014:46). The sample for this study includes Working Papers (WPs) from ATConf /5 (47) and ATConf/6 (109). In principle, ICAO WPs are “brief, action-oriented and concise” documents submitted by States or organisations that follow a specific template quite strict in terms of their length and context (ICAO 2016). In this form of research, working papers are treated as material that provides diverse information in terms of their purpose, their identity and the meanings that are embedded in them. The textual analysis conducted focuses on how these documents foster ICAO’s role in the area of economic regulation. Interpretive coding techniques, following mainly grounded theory principles, involving a rigorous process of data coding and analysis, are followed, as presented in Figure 1.

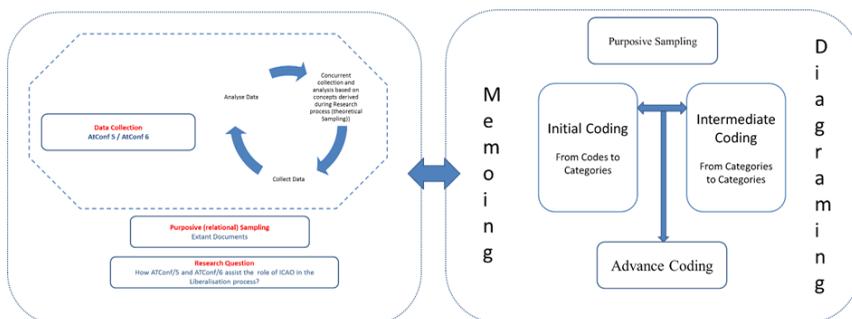


Figure 1: Hybrid Grounded Theory Framework for Extant Documents (Charmaz, 2014; Birks and Mills 2015; Boyatzis 1998; Corbin and Strauss 2015)

### 4. Results and Analysis

Before proceeding with the analysis of the extant documents, it is important to acknowledge the major steps that have been taken by the aviation community in the liberalisation process, namely the 1978 Deregulation Act, the birth of a Single Aviation Market in Europe and the launch of the US open skies policy. These are action-based initiatives that changed the Chicago path towards a more liberal approach regarding key areas of the economic regulatory content namely market access, capacity control, air carrier tariffs, airline ownership and control, commercial and competition practices, air passenger related matters, and airport related matters (ICAO 9626 chapter 4). Is there a linkage between the development of liberalisation and the launch of ICAO’s Worldwide Air Transport Conferences (ATConf)? A historical review

reveals that the nature of all six conferences was concerned with air transport problems mainly in the area of economic regulation. In 1994, two years after the third liberalisation package in Europe and the signing of the first Open Skies agreement between the US and the Netherlands, ICAO linked conference proceedings to a specific theme, while participation of member States, key organisations and industry experts increased significantly (ICAOa 2016). The analysis of the results presented is made of two stages. The first stage is the outcome of text queries on WPs of ATConf/5 and ATconf/6 based on thematic analysis. The second stage is based on data coding and analysis in the context of Grounded theory presented mainly by Corbin and Strauss (2015) and Charmaz (2014).

#### 4.1 First Stage “Text Query”

In analysing ATConf/5 and ATConf/6 WPs, on a query run for the most frequent 300 words used in each conference (Figure 2 and Figure 3), the outcome revealed basically how many times specific concepts were discussed. The findings provide useful insights into the focus of each conference.



Figure 2: ATConf/5 300 Word Query



Figure 3: ATConf/6 300 Word Query

For ATConf/5, it is apparent that the key theme is “Liberalisation”. Liberalisation was addressed as a necessity and the only path that could deliver growth and prosperity in the air transport field. States is the second most popular word in the query and this could also be explained as in the Chicago regime States act as catalysts for introducing and employing strategies that foster or limit liberalisation. Airlines were also at the forefront of this query due to the fact that business stability and performance is highly associated to the impact of liberalisation on business practices. The word “Agreements” was also frequently used as States and other Parties were looking for best paradigms in this area. Competition emerged as a great concern quite naturally as it is directly influenced by the way liberalisation is implemented. Ten years later, the Sixth Air Transport Conference (ATConf6) convened with sustainability as a key theme. The effects of extensive liberalisation in key markets such as Europe, North America, Middle East and Asia Pacific indicated that the international air transport community needed to adopt a path that would allow key stakeholders to maintain existence in the market place. In 2013, North America and the European markets showed signs of maturity, while Asia Pacific and Middle East of increased growth. Progress in Latin America and Africa was also discussed with Africa experiencing the least growth especially due to lack in adopting liberalisation policies more effectively.

A similar query run for this conference uncovered a more complex query in terms of the most frequent words used. Sustainability is not a key word despite the fact that it is the theme of the conference. However, the words that emerged are vital to the sustainability discussion. The search informed that the word “States” is still powerful and dominates the presented material.

ICAO's role in supporting initiatives was also considered principle. In fact, States agreed to a more active role for ICAO in the area of developing international agreements on liberalisation of market access, air cargo and air carrier ownership and control. Transport is mentioned frequently to highlight the main function of this industry but what is fascinating is that the word "airports" emerged in this conference as a key concern to sustainability and to liberalisation and mentioned equally to the word "airlines" in numerous WPs. In addition, words like "passengers / consumers", "competition", "liberalisation", "markets", "navigation", "protection" are discussed in the context of developing a long-term strategy for the future. What has become evident from this query is that liberalisation has been embraced as the preferred approach by key regions since 2003 but the beneficial effects did not come without a price. Further development in liberalisation raises the issue of sustainability and the need to embrace a global understanding in designing a long term strategy.

## **4.2 Second Stage "Data Coding and Analysis"**

A more rigorous analysis of the WPs is meant to provide a useful insight into the future path of liberalisation and ICAO's involvement and requires a coding technique. Initial coding process based on line-by-line coding of the relevant WPs revealed a plethora of codes. However, when codes were tested against their properties to identify if they are describing similar phenomena through constant comparison, code numbers decreased to 18. In addition, constant comparison allowed codes to be grouped into categories. In this way, phenomena are described more effectively. The analysis of the existing working papers revealed that the aviation industry encountered many opportunities and challenges from the implementation of the liberalisation process at a worldwide level while the pace of liberalisation varied significantly by geography. Following coding, four key areas were identified as emerging categories, named by the researchers as "liberalisation effects", "economic development in aviation", "competition challenges", and "sustainability areas". Despite the fact that WPs from ATConf5 and ATConf/6 were written ten years apart they are addressing common areas when discussing liberalisation. Axial Coding process discovered links between categories and at this stage analysis is meant to provide higher level of codes (Charmaz 2014; Huddleston, J., Harris, D. 2007). In this study, categories were decomposed and reassembled to form a more meaningful set of codes. Memoing played a significant role especially in the area of identifying repeatable concepts.

Two categories basically occurred from the process. The first was named: "Path to Smarter Liberalisation", looking into codes that have properties and dimensions that mould the liberalisation path, and the second: "Sustainable Progress in Aviation", which includes codes with properties that map key concerns to sustainability. Both categories were compared against two variables, namely "pace" and "geographic region". From the list described by Corbin and Strauss on theoretical sensitivity (2008:69) three techniques were used in an effort to enhance the coding process: "making comparisons" between codes and industry data related to the impact of liberalisation; "thinking about various meanings of the words", especially how different aviation stakeholders understand their meaning; and "drawing upon personal experience" as researchers of the current study have expertise in the area of liberalisation and also one member of the team participated in ATConf/6 as an observer.

Constant comparison between the two categories progressed even further in an effort to create a larger category that in Grounded theory could result in forming a theory of action (Charmaz 2014:148).

For the purpose of this research and due to the fact that the analysis is based on extant documents, the selective category will not be able to form a theory but it will provide concepts that could be tested against phenomena that contribute to understanding how ATConf/5 and ATConf/6 upgraded ICAO’s role in the area of economic regulation. The selective category is presented in Figure 4 and took the name “Sustainability Dynamics” due to the fact that sustainability is becoming a challenging concept in liberalised markets and any failure to address issues related to sustainability could question the existence of liberalisation. In brief, the emerging selective category incorporates properties of previous codes in five main concepts.

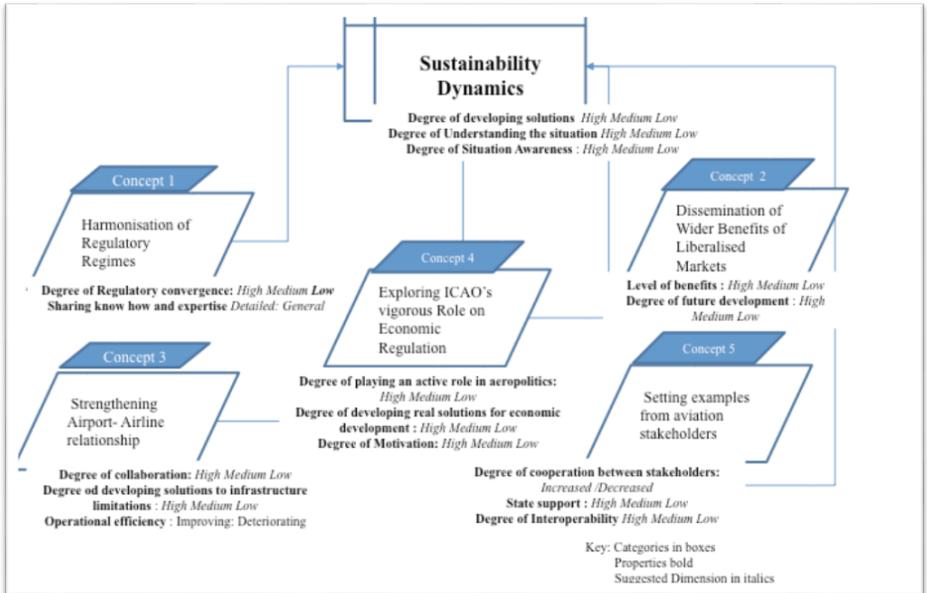


Figure 4: Diagramming the Selective Category

Diagramming as Charmaz suggests (2014:218) is used to provide the relative power, scope and direction of the emerged concepts. All five concepts leave room for interpretation but also need to be tested against specific properties and dimensions (as per Figure 4) to reveal various actions and interactions in between. The selective category that emerged from the coding process validates ICAO’s active role and the need to monitor developments in accordance with the mandate and guidance given by Assembly resolution A38-14. Furthermore all five concepts can be used as the foundation in the development of a core category that investigates links between sustainability and liberalisation in aviation. From the analysis it is evident that further research is needed to provide valid conclusions as to how the air transport industry can build a sustainable path when stakeholders operate in a liberalised environment. Currently there is asymmetry in the way that liberalisation has been implemented in different regions and this course is causing concerns to the international community. In today’s environment where aviation experiences constant growth and increased competition additional research on “Sustainability Dynamics” could improve situation awareness for aviation decision makers and even contribute to policy changes.

## **5. Conclusion**

International aviation is a dynamic, complex and highly regulated sector (Doganis 2010) and ICAO's role in this framework is tectonic. Working papers (WPs) presented during ICAO's Worldwide Air Transport Conferences 5/6 (ATConf) provide an excellent insight in understanding global concerns in the area of economic regulation in liberalised market places. The study can safely conclude that extant documents revealed a more active role for ICAO in economic regulation which emerged as a consequence of the excessive liberalisation which is directly linked to wider benefits occurred for States, consumers and industry stakeholders from liberalising key world markets. ICAO's new role is confirmed not only by Resolution A38-14 adopted during the 38th Session of the ICAO Assembly, but also from a series of working papers ready to be presented in the 39th Session of the ICAO Assembly. These papers not only embrace a more vigorous role for ICAO in economic regulation but also present the progress achieved since 2013 in the areas of developing international agreements on liberalisation of market access, air cargo and air carrier ownership and control; addressing economic aspects of airports and air navigation services; and the implementation of ATConf/6 recommendations and decisions with a view to enhancing economic sustainability. Decisions made in the 39th Session of the ICAO Assembly will become evidences as to whether the selective category, "Sustainability Dynamics", with the emerged concepts could evolve into a core category that supports a solid framework to aviation sustainability and the basis for discussion for developing the theme of ATConf 7. Further research on validating dimensions of the selective category could result in improving sustainable development for key stakeholders which is important in order to limit protectionist trends, strengthen global connectivity, improve performance and maximise benefits for passengers.

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# **Global Airline Cooperation: Equity Stakes, Strategic Partnerships and Alliance Membership**

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**Abstract:** This paper looks at three core global cooperation strategies for major airlines; equity stakes, strategic partnerships and alliance membership. Data from a five stage Delphi study are utilised as part of a wider industry level analysis of the global airline industry and its likely future trajectory. This wider study assessed key current and likely future industry trends across major geographical regions of the world, and via core global considerations shaping the industry. A key theme to emanate from this study's data was global cooperation, which then resulted in three sub-themes; equity stakes, strategic partnerships and alliance membership. Data, discussion and analysis for each is presented, concluding that each is likely to persist well into the foreseeable future, as part of flexible strategies and practices for individual airlines wanting to extend their global reach.

**Key Words:** Delphi study, airline cooperation, equity stakes, strategic partnerships, global alliances.

## **1. Introduction**

As major airlines around the world continue to seek ways to work with each other, the perennial airline industry question remains as relevant as ever; to what extent should airlines strategically cooperate with each other? The natural follow-on question then becomes; how should airlines pursue such cooperation? These questions have gained added traction of late with the three major Gulf carriers, Emirates Airline, Etihad Airways and Qatar Airways each demonstrating the pros and cons, and strengths and weaknesses, of the main strategic cooperation approaches available globally; namely equity stakes, strategic partnerships and global alliance membership. Although important, code-sharing does not feature strongly in this paper's analysis as it rarely achieves the strategic and network depth and scope of the three main options above.

Geographical location (home base/citizenship), and international relations (notably bilateralism versus multilateralism), evidently play pivotal roles in determining which cooperation strategies are viable and pursued; yet with the exception of two seminal works in the 1990s (Nayar, 1995; Richards, 1999), and an inconclusive attempt in the early 1980s (Jönsson, 1981), limited scholarly worked as explicitly linked these important areas to the airline industry. Few global industries are so extensively impacted by international relations, and likewise by geography, as is the airline industry. These factors have led many to describe the industry as being caught in a globalisation paradox; that is, it enables and promotes global interconnectedness, yet itself is trapped within national borders (Macara, 2009). This study sought to clarify this apparent paradox.

## **2. Methodology**

### **2.1 Industry Insights using Delphi**

This study was predicated on an industry level analysis that aimed to gain key industry insights into the global airline industry's likely future trajectory, and was based on a mixed-method Delphi study that unfolded across five stages of data collection from late 2013 through 2014. The Delphi method is a forecasting tool that seeks the views of experts and has been widely applied to the airline industry (Linz, 2012; Mason & Alamdari, 2007). Historically, Delphi sought to discover consensus agreement (often set at 75%); in more recent times its focus has

shifted toward gaining key insights from a diverse plethora of opinions (Bolger & Wright, 2011).

A focus group, standalone survey or in-depth interviews could each have generated valuable data; however, the Delphi method is well tailored to scholarly problems such as in this study, where reliable data is either challenging to find, or simply non-existent. Furthermore, Delphi iterations allow data to emerge that might otherwise remain hidden (Rowe & Wright, 1999). A key shortcoming of Delphi is that it weights all opinions as equal (Vasigh, Fleming & Tacker, 2013); although as discussed below in section 2.2, this was mitigated in this study by defining expert midway through the data collection process through use of two self-rated metrics.

The first stage of data collection was a brainstorming Workshop (n=5)<sup>5</sup>, followed by a Pilot Survey (n=12), and then a Main Survey 1 (n=122)<sup>6</sup>, a Main Survey 2 (n=34); and finally, semi-structured In-Depth Interviews were conducted (n=13). A literature analysis, together with the emerging data, shaped the study's structure and focus, resulting in 18 core questions on the Main Survey 1, and 27 forecasts on the Main Survey 2. These were grouped by geographical region (North Atlantic – mostly the US and EU; Asia, and emerging markets), and by global considerations (e.g. environmental concerns, infrastructure constraints, etc.), and into global cooperation strategies, centred on the big three alliances, substantial equity stakes and bilateral partnerships.

## **2.2 Conceptual Frameworks Employed**

To help structure this research study, two conceptual frameworks were employed as scaffolds to guide the research; Porter's five forces of competition model, and the Political, Economic, Social, Technological and Environmental (PESTE) framework (Shaw, 2007). Porter's framework looks at industry structure by considering the rivalry amongst competitors, the threat of new entrants, the threat of substitute products or services, the bargaining power of suppliers, and the bargaining power of buyers (Heracleous, Wirtz, & Pangarkar, 2009).

Porter's framework helps to highlight where airlines are competitively vulnerable, while also identifying key opportunities. The five forces framework for industry level analysis essentially helps to determine the profit realities and potential of an industry (Porter, 2008). Meanwhile, PESTE is widely regarded in the aviation literature, with some referring to it as "the most notable" such strategic framework (Itani, O'Connell, & Mason, 2014). PESTE covers core external considerations, many of which individual airlines have limited direct control over. A number of authors contend that employing both the Porter and PESTE frameworks helps to gain more comprehensive insights into the complex and dynamic global airline industry (Heracleous et al., 2009).

The airline industry's unique characteristics make using standalone strategic models and frameworks challenging, with important forces and factors like international relations, specifically bilateralism and multilateralism, along with geographical location (predicated on home base requirements and airline nationality), playing vital roles as well. International relations and geographical location occupied prime positions within this study.

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<sup>5</sup> n = number of participants

<sup>6</sup> 71 out of 122 were experts (all 34 subsequent Main Survey 2 participants and 13 interviewees were experts)

### **2.3 Defining Expert**

At the completion of the Main Survey 1, a cut-off point for expert was established, with only those defined as expert and willing to continue then invited to participate in the Main Survey 2 and In-Depth interviews to follow. Expert was defined using a combination of two background questions covering self-rated level of industry knowledge (minimum of 'good' level), and years of industry knowledge (minimum of '6 to 10 years'). In addition, each survey contained a question covering willingness to participate in the next stage. Research has found that experts tend to have more stable opinions across stages (or rounds) compared to non-experts (Hussler, Muller, & Rondé, 2011); although some argue that "people do not change their opinions as much as they should" (Bolger & Wright, 2011, p. 1500).

In this study experts were clearly more confident in their industry knowledge, and more willing to participate in multiple stages, compared to their non-expert counterparts. What remains vital is that a wide array of views are canvassed, and that Delphi experts are given the opportunity to anonymously "discuss and refract ideas" in order to arrive at solid and effective conclusions (Lentz, 2009, p. 54). This study's five stages of data collection provided ample opportunities for participants' views to be captured, and to then extract the most salient insights from a clearly defined expertise pool thereafter.

### **2.4 Sampling Strategy and Sample**

Purposeful (or purposive) and snow ball sampling were used in this study, whereby potential participants were contacted in the former approach, and encouraged to share the online surveys in the latter, to reach as wide a cohort of respondents as possible (Mason & Alamdari, 2007). Participants were initially found in a wide range of locations, including an air transport research conference, professional emailing lists, university staff contacts, university alumni, professional associations and groups, and via direct contact (e.g. journalists and journal article authors). This then resulted in the number of participants for each stage (as above), broadly reflecting the attrition and retention experiences and outcomes from other similarly structured and focused air transport Delphi research (Linz, 2012; Mason & Alamdari, 2007).

### **2.5 Data Analysis**

Data from this study were manually thematically analysed to establish key themes and sub-themes, while survey responses were also statistically assessed, mostly utilising chi-square tests and t-tests to a 95 percent confidence level. For example, binary groups were generated containing either those who selected a particular geographical region of best industry knowledge, or those that did not select that specific region (grouped into 'other'). The regions generated were: US and Canada, Europe, Asia, Oceania and Emerging Markets.

The survey responses for these dichotomous groups (and others) were then subjected to chi-square tests and t-tests to discover if they had statistically significant differences. In this context, non-parametric statistical analysis centred on chi-square tests, and was conducted on multiple-choice responses from the Main Survey 1 (a mix of single and multiple response format). Meanwhile, parametric t-tests were performed on the Main Survey 2 forecasts which were based on five-point Likert-type items (all 27 forecasts were single response format).

### 3. Key Findings

#### 3.1 Equity Stakes

A key theme to emerge during this study’s Workshop, and then raised and covered during all subsequent stages, was airline global cooperation. A sub-theme to evolve out of this overarching theme was airline equity investments. Not since the trials and ultimate demise of Swissair in the late 1990s and early 2000s have airline equity stakes been so centre stage (Hermann & Rammal, 2010). Swissair took code-sharing and alliance formation to a deeper level by making a series of substantial equity investments in its airline partners. Most of these partners were second tier European carriers burdened by significant debt, and in late 2001 their economic woes helped to bring about the demise of Swissair (Chang & Williams, 2002). Workshop Participant 2 argued that Swissair was “horrendously unsuccessful [at] buying an alliance”; while Interviewee 13 contended that buying and trying “to turnaround fading airlines – I don’t think that’s a successful strategy; certainly didn’t work out that way for Swissair”.

Nevertheless, most experts in this study held a favourable view of airline equity stakes overall. Forecast 15 proposed: Buying substantial equity stakes (10% or higher) in other airlines is becoming a more effective way for individual airlines to build strong and lasting partnerships than simply code-sharing, global alliance membership or strategic agreements. Sixty-seven percent of experts agreed with this forecast.

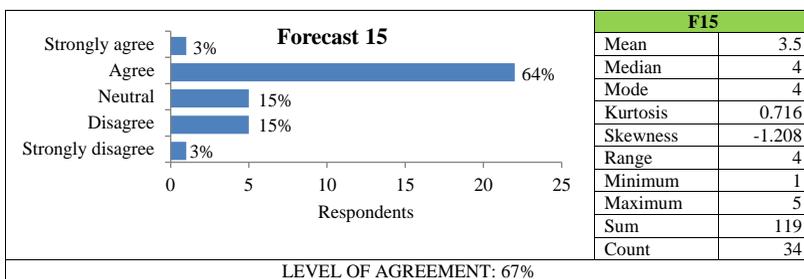


Figure 1: Main Survey 2: F15 – Substantial airline equity stakes

Consensus agreement was not too far off here. Those with best industry knowledge in Oceania returned a significant t-test result for Forecast 15 (T-value was 2.003. P-value was 0.027). Experts with Oceania as a best region of industry knowledge were in consensus agreement for Forecast 15 at 81 percent (although only one expert strongly), while the group ‘other’ were in lower agreement than the overall Main Survey 2 cohort at 56 percent. It is reasonable to assume that such Oceania knowledge experts were to a measurable extent influenced by events surrounding Virgin Australia and its widely publicised, and mostly positively promoted, equity stake holders; the most prominent of which is arguably Etihad Airways (Kingsley-Jones, 2013).

This result reflects a range of other findings in this study that revealed where an expert’s regional knowledge was highest tended to influence how they viewed issues and considerations elsewhere across the global industry. What this result also demonstrates is that there is wider support amongst aviation experts for airline equity stakes than some researchers have acknowledged. For instance, nearly a decade ago Iatrou and Oretti (2007) observed: “It seems that airlines have come to realise that they can work together without having to buy one another’s stakes” (p. 79). Even so, parallels with the past such as Swissair are rarely linear or complete. History holds lessons, but equally true is that contemporary considerations and

context rarely, if ever, precisely mirror those of the past. According to most experts in this study, the future of equity investments is fairly bright, echoing some in the literature who are likewise upbeat about their future prospects (Meager, 2015).

### 3.2 Strategic Partnerships

Another sub-theme to emerge across all stages of this study in relation to global cooperation was that of strategic airline partnerships. In late 2012 Emirates Airline and Qantas Airways announced they would form a strategic bilateral alliance. This partnership turned out to be the first move toward considerably different partnership models for the three major Gulf carriers. One year later Qatar joined oneworld, and the following year Etihad announced its Etihad Airways Partners alliance. To further complicate matters, Qatar invested in BA and Iberia’s parent company IAG (Kingsley-Jones, 2013; Fan & Lingblad, 2016). All three major Gulf carriers partner and code-share with a wide range of other airlines, including rival global alliance members.

In order to better understand this situation, Forecast 16 asked experts to respond to the claim that: Strategic partnering outside global alliance structures will become a significant feature of the airline industry over the next 10 years or so.

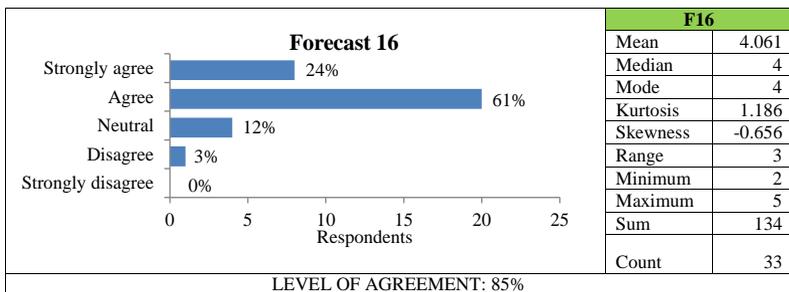


Figure 2: Main Survey 2: F16 – Strategic partnering outside alliance structures

This forecast achieved a resounding consensus agreement of 85 percent. Only four forecasts out of 27 in total on the Main Survey 2 achieved above 80 percent consensus; with the highest being 88 percent (covering the bilateral system’s longevity). It is true that this topic area of strategic partnerships enjoyed a particularly high profile at the time the Main Survey 2 was conducted in mid-2014, as the Emirates/Qantas strategic partnership was in its early stages (Fan & Lingblad, 2016).

The impact of such bilateral alliances was covered on the Main Survey 1, multiple choice question 14 (MCQ 14; single response); it asked: Are bilateral alliances, including agreements between competing alliance members, weakening the major global alliances?

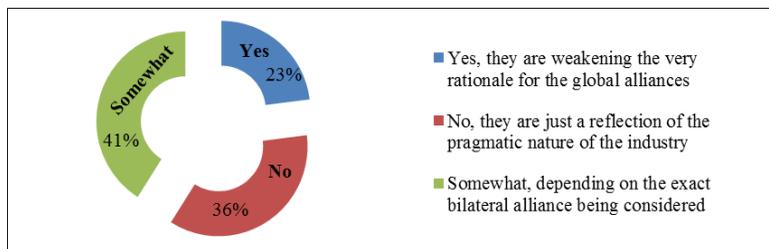


Figure 3: Main Survey 1: MCQ 14 – Are bilateral alliances weakening the global alliances?

This question sought to establish into which category experts were placed; yes, no or somewhat. Interestingly, and to some extent unexpectedly, the lowest expert cohort here was yes at 23 percent. That left a combined total of 77 percent for both somewhat (41%) and no (36%); each representing a fairly pragmatic option in its own right. As elsewhere throughout the study's findings, expert pragmatism was once again on display as a majority of experts were evidently not too concerned that such bilateral alliances are having any significant material impact on the big three global alliances. Furthermore, any potential impacts were seen as dependent on context.

Non-experts were even less concerned than experts about the potential negative impacts of bilateral alliances; 92 percent chose either somewhat (38%) or no (54%). A chi-square test utilising the two groups expert and non-expert returned a significant result for MCQ 14 (chi-square statistic was 6.199. The P-value was 0.045). No other key expert grouping returned a significant result here. The fact that experts were more likely to select yes (23%) for this question in comparison to non-experts (8%) suggests that bilateral alliances may not be entirely benign in their likely impacts on the big three global alliances heading forward, especially when the somewhat category is considered here as well.

### 3.3 Global Alliance Membership

A third sub-theme to develop out of this study's overall global cooperation key theme was the future prospects for the big three global alliances; Star Alliance, SkyTeam and oneworld. On the Main Survey 2, Forecast 17 attempted to establish which of these global alliances is viewed as being in a stronger strategic position vis-à-vis each other. Forecast 17 asked: How would you characterise the likely future strategic position of each of the three big global alliances in 10 years or so from now? Five response options were given for each alliance: (1) Likely disbanded; (2) Weaker; (3) Unchanged; (4) Moderately stronger; and (5) Much stronger.

The results for Forecast 17 show that Star Alliance was clearly viewed as being in the strongest strategic position of the three, with 62 percent of experts choosing Moderately stronger, and a further 26 percent opting for Unchanged. This meant that 88 percent of experts thought that Star Alliance is not likely to strategically weaken in the foreseeable future. In contrast, experts were least confident of SkyTeam's strategic future, although only marginally so compared to oneworld. At first glance, oneworld does seem to have trumped SkyTeam on this forecast; however, closer inspection reveals that they are fairly evenly matched. SkyTeam's ratings of Unchanged (35%), Moderately stronger (29%) and Much stronger (6%); totalling 70 percent, are not much different to oneworld's respective scores (18%, 50% & 3%) and total of 71 percent.

Only one expert across all three alliances in Forecast 17 selected Likely disbanded (for SkyTeam); this represented about one percent of the forecast selections (i.e. out of the 102 selections made in total). Global alliance disbandment is not a serious issue according to the experts surveyed in this study. Even so, just over a quarter of experts did think that a Weaker strategic position was likely for both SkyTeam (26%; and when disbanded is added: 30%) and oneworld (29%); Star Alliance received 12 percent for Weaker. It is fair to conclude from these results that experts, on the whole, were not particularly concerned about the strategic future of the big three global alliances. Most experts think that the big three global airline alliances will endure.

The results for Forecast 17 likely closely link to the fact that the main rationale for global alliances is mostly viewed as the ability to extend an airline’s global geographic reach (Iatrou & Oretti, 2007); not simply due to regulatory restrictions on mergers as many have claimed (Macara, 2009). MCQ 13, on the Main Survey 1, asked survey participants (multiple response format): How would you best describe the main rationale for the global airline alliances?

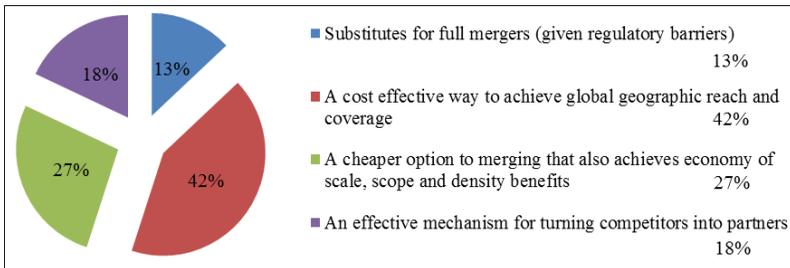


Figure 4: Main Survey 1: MCQ 13 – The main rationale for the global alliances

When results are tallied according to experts, and not total selections as above, 66 percent of experts chose “a cost effective way to achieve global geographic reach and coverage”; a proposition raised by some in the alliance literature (Gudmundsson & Lechner, 2006). Meanwhile, 21 percent of experts opted for the “substitutes for full mergers” option. However, 87 percent of total selections made were not concerned with full mergers (as per above data in Figure 3.4), while 79 percent of experts avoided the “substitutes for full mergers” option (admittedly the question was not directly about mergers). Other research has found that airlines adopt the view that expanding “the geographic scope of their networks so as to achieve global scale” primarily motivates them to form and/or join alliances (Iatrou & Oretti, 2007, p. 195).

The results here align well with some experts in this field who maintain that “the alliances to mergers logic is by no means a natural process” (Gudmundsson & Lechner, 2012, p. 181). Thus, the findings of this study strongly suggest that airlines mostly look to global alliance membership to provide global geographic reach, and not as a poor substitute to merging, or to collude and achieve some measure of protection from competitors.

### 3.4 Geographical Knowledge Diversity and Pragmatism

Two key overarching findings emanated from this study. One was that experts significantly differ in their opinions about the global airline industry and its future prospects based on their geographical region/s of best industry knowledge. Where an expert rated their geographical

knowledge highest tended to influence how they conceptualised industry events and trends in that region and elsewhere.

This study also found that pragmatism, founded on the perceived need to carefully consider the situational context, almost always outweighed ideological positions and preferences, and contentious positions. Evidence of this pragmatic tendency was shown with regard to airline cooperation options when Workshop Participant 2 postulated that “if you’re smart you just go for the best fit”. Likewise, Interviewee 5 stressed several times across multiple industry issues and questions, including global cooperation options, that there are “no right or wrong answers”.

#### **4. Study Limitations and Further Research**

There is an evident gap in the air transport academic literature covering both geographical location and international relations, and how each shapes and influences global airline industry development, and in large measure assists in determining what regions and carriers will play more prominent roles in the industry’s future. This gap also presented limitations for this study. Expert knowledge across a wide spectrum of emerging air markets and regions was limited to non-existent. Given that geographical region/s of best industry knowledge generated a plethora of statistically significant results in this study, a lack of expertise in emerging markets without doubt limited a fuller understanding of how, why and where the industry is headed in future.

Future research is needed in emerging air markets to discover salient industry insights and encourage capacity building and expertise development; chief amongst these are Africa and Latin America, along with Russia, Central Asia and South Asia. The growing possibility of Iran investing heavily in its airline sector in the near future, together with Indonesia, Vietnam and others experiencing considerable future air market expansion, adds to this contention. Likewise, becoming fixated on developments in China runs the risk of failing to more fully appreciate the growing airline networks in consequence of China’s growth in Africa, Latin America and elsewhere. Clearly, the global airline industry has enormous latent potential for future growth and development.

#### **5. Conclusion**

Global airline cooperation is likely to continue to include substantial equity stakes, strategic partnerships and global alliance membership well into the foreseeable future. Geographical location predicated on home base and airline citizenship, together with international relations founded on bilateralism versus multilateralism, ensure that most major carriers around the world will continue to choose from each of these cooperation strategies in flexible and pragmatic ways aimed at achieving the best strategic fit to extend global reach. A majority of expert participants in this study held a positive view of substantial equity stakes (67%), a very positive view of strategic partnerships (85%), and were of the view that Star Alliance (88%), oneworld (71%) and SkyTeam (70%) would remain unchanged or strategically stronger into the future.

Experts did achieve statistically significant differences on regional industry knowledge grounds, demonstrating in the process that higher profile regional examples of cooperation strategies do influence how experts view overall future prospects. These results also infer that historical lessons from former airlines like Swissair are not equally applicable across time. However, regional differences (including in expert opinions) also suggest that no cooperation strategy is without risk, nor destined for either assured success or doomed by the past to failure.

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# **Assessment of Transport Policy and Regulation for the Ground Access at Airport**

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**Abstract:** Considering a worldwide tendency, air transports growing rate saturates the airport capacity, resulting mounting congestion and delay to access airport landside area and terminals. Given the complexity of airport operation, the best use of existing capacity is the key driver of efficiency and productivity. This paper deals with the evaluation framework for the ground access at airports, by using a set of mode choice indicators providing key messages towards airport's ground access performance. The application present results for a sample of 12 European airports, illustrating recommendations to define policy and improve service for the air transport access chain.

**Key Words:** air transport chain, airport access, aviation business, public transport access airport.

## **1. Introduction**

### **1.1 Subject and Objectives**

In the early days of the civil aviation, the ground access to air transport system presented no substantial issue to travellers and authorities. Most of the airport was located on the end or the periphery of the city it served and no activity caused by aviation disturbs the city normal life, (Ashford and Wright; 1991). From that time the picture has totally changed and the access to airports constitute one of the key success factors to stimulate air transport demand, directly, linked to reliable and resilience of air transport system, (Janic; 2007, Diana; 2013). Because of the rapid urbanisation, the high growth of car ownership and the increase of generalised cost for air travellers, the airport ground access system may deliver to air travellers huge delay and high cost.

In addition, the modern airport business development concept focused on increase of non-aeronautical revenues from activities into but also out of the terminal, therefore, the commercialisation of the airport land-side area and the airport access system play an essential role in airport business development. Furthermore, access to airport territory considers a top item in the discussions agenda within the aeronautical and non-aeronautical society, as well as, the stakeholders and decision makers involved on aviation business development, (Danwen et al.; 2016).

In the modern society connectivity related to economic competitiveness, regional development and social cohesion.

Transport industry spend considerable amounts of resources and capitals to improve accessibility and meet the needs of different market segments. Considering a worldwide tendency, air transports are growing at a rate that saturates the airports capacity, resulting in mounting congestion and delay on air and on ground. Planners and managers argue that airport ground access performance impacts upon the whole air transport chain, therefore, the concept of integration between the air and ground transport services is very crucial towards assessment of the air transport attractiveness and sustainability, (Junic, 2007).

Airport connection and distribution systems are highly complex, especially, for airports accommodate over 5 million passengers, usually, serving a large catchment area in terms of space and/or population density. Typically, the ground access networks are characterised as ‘many to many’, where passengers and cargo from many different points go to many district destinations into airport territory and the opposite. However, into the scale of strategic planning the ground access system could be simplified as ‘many to one’, where passengers have to deal with the transport option transmit them to airport terminal. The airport layout, the terminals location and the nature of ground flows into airport territory increase the complexity to manage and control traffic, while the mitigation measures and the adaptation policies towards aviation industry sustainability oversize the complication in planning and traffic control in terms of transport system flexibility and availability, (Neufville and Odoni; 2003).

The key objective of this paper deals with the analysis framework to review policies and regulations for ground access to airport. Based on transportation planning principles and transport system operational characteristics for the different transport options offered to/from airports, a set of key indicators are introduced to assess policies and measures towards effectiveness of the offered transport services to meet the aviation industry, authorities and regional governmental bodies targets. The goal of these series of high level indicators is to provide key messages to planners, decision makers and stakeholders on airports ground access performance and efficiency, as well as, to provide key messages towards the applied transport policy one hand; and the effectiveness to meet the regional targets on the other.

## **1.2 Access System Key Definitions**

Getting to the airport can be a challenge. Travellers going to airport may feel that this part of the trip is the most annoying and stressful part of the whole journey, especially, at peak hours where congestion and delays take place. Sometimes, the airport traffic patterns is totally different with the traffic patterns of the access system connecting airport to city, making travellers and visitors to be confusing about the journey time, cost and the most suitable transport option, (Diana; 2013). In addition, for the airport employee society, the daily trip to/from airport can be expensive in terms of time or money. All above together, is making access to airport a very important factor of the airport attractiveness and getting to airport conventionally and reliably may constitute an essential conflict issue between airport operators and regional authorities, (Neufville and Odoni; 2003).

Satisfactory design of the access system entails integrated care for the travellers’ needs from the origin point to the final destination, including terminal processing. However, the differentiations in traffic patterns in airside and landsite area of the airport, the urban mobility characteristics of the city that the airport is serving and the variety of alternative transport options could be offered its making the access to the airport not just a planning problem but also a decision optimisation problem, subject to many and different solutions depending on time, passenger needs and level of service. The capacity restrictions and the variables stimulating demand for transport to/from airport is depicted to the following figure.

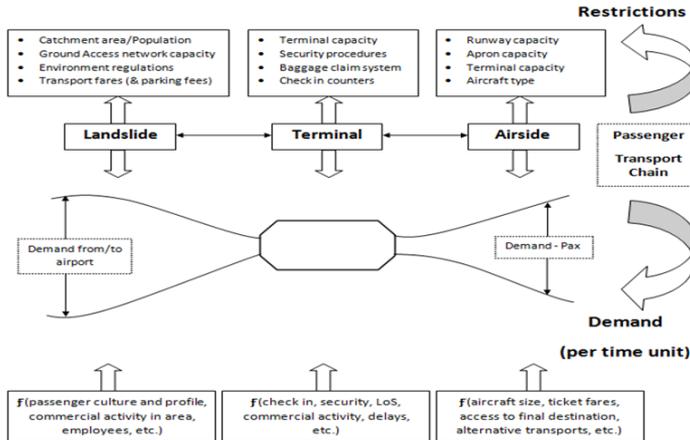


Figure 1: Overview of the passenger transport chain characteristics at airports, (Dimitriou; 2013)

It's noteworthy that the expectations for the airport ground access system are, significant, different between the group of stakeholders that involved in the decision process for airport access effectiveness. Airport operator focuses on revenues generated in landside area, therefore, car-parking demand and commercial areas accessibility are the key drivers in their strategy. Airlines and travel agents focus on low fares and integrated services that meet the passenger expectations, promoting quick and safe access from the point of origin to final destination. Aviation authorities focus on aviation business sustainable development, promoting safety, security and technology innovation to mitigate emissions and efficient use of existing capacity and resources allocation. Regional authorities and governmental bodies focus on continuing growth of connectivity and its effects in regional economic development. Those different priorities and motivations may lead to dysfunctional decisions and inefficient policies on airport ground access system impact essential the air transport business.

However, while it's not provided a special regulation on optimum transport mode choice, it's widely mentioned that successful surface access policy at airport is promoting the use of Public Transports (PT). Janic (2007) highlights that the main objective for airport operators should be to increase the market share for PT to about 50% and encourage authorities to invest on PT reliability of operation to meet this target. A such high target may support decision towards modernisation of PT system to meet the expectation of users and mitigate disturbance on environment impact in local and global scale.

## 2. Methodology

### 2.1 Methodology Approach and Assessment Criteria

Individually, a primary concern for passenger is getting to the airport on time. This means that passengers tend to be most concerned about the reliability of their travel time to the airport rather than other parameters affected mode choice such as information or the trip comforts. To deal with unreliable access, passenger routinely allow substantial extra time for their trip to airport, (Hongwei and Yahua; 2016).

Collectively, passengers also want access system that can distribute them to their destination speed widely over the urban area. The filling of a quick access for a given region could achieved only if the users can recognise that the selected transport option move faster than alternative transport options. Higher access speed levels demonstrate a buffer to ensure that the trip time to/from airport is the appropriate for the user abilities and needs.

Fare can be a significant consideration. May it's the second concern for passengers, compared to reliability and accessibility. Business travellers may be prepared to pay reasonable amounts to get them comfortable to airport, while economy travellers may not. In other words, whereas some passengers are willing to pay for premium service to access airport, many passengers and the most of employees cannot accept this kind of service. Ground access fares till passengers and employees upon the use of mass transit systems such as the PT services. In the most of the cases PT are cheaper than other private vehicles and it provides average cost per trip much lower for groups.

The benefits for the use of PT are essential in terms of environment protection. The new technology in rail and bus vehicles provide low emission and low energy consumption operation. Also, the PT network could offer services to many destinations into the city, very often, much faster than the private car of the taxi especially during the peak hours. Reliability and fare policy for PT is the key driver to achieve high market shares offering cost effective transportation options to majority of the air transport travellers.

Taking all above into consideration, the assessment of the airport ground access system should review the different transport services outputs. However, the analysis of transport outputs related to modelling and simulation of a variety of situations, such us all the destinations into airport catchment area, the time windows and the physical and socioeconomic conditions (weather, level of security, passenger profile, behavioural issues etc.). A such detailed analysis needs too much time and resources, while the results may not support the really needs of the stakeholders for decisions on policy actions and measures towards access system effectiveness to meet aviation industry and regional economy goals.

Purposefully considering the airport ground access system as System of System (SoS) within the regional transport system domain, then the access system at airport could be reviewed as an independent control part of the transportation system, (Crossley and DeLaurentis; 2015). In this content, the assessment exercise deals with the review of the key decision parameters which are: (a) to compare the most suitable transport options serving the most attractive destinations or landmarks; and (b) to compare this performance between airports. This functionality is quite flexible with behaviour types ranging from simple reactive (take action based on fixed rules) that airport access system is represented. The provision of comparisons between airports provides essential benefits to decision-making entities to be transformed to learning/adaptive type (take action after updating internal logic scheme via learning by best practices reviewing).

Employing airport ground access as a SoS problem, the analyses include a series of indicators to compare alternative access transport services in both directions: a) the most efficient PT service vs premium services; and b) range results for a group of airport in the same market. The selected sample of airports include a group of 12 European airports served capital cities. Therefore, the analysis results based on calculation of a high level of indicators providing key messages for the access system from/to the airport terminal to/from the city centre, which it's

the most powerful landmark for residents and visitors, as well as, it, usually, achieves the highest share in origin-destination matrix from/to airport.

The criteria adopted for this analysis is grouping in two main categories: transportation characteristics and fare policy. Each category includes 2 criteria as follows:

- Transport characteristics
  - Travel time
  - Access speed
- Fare policy
  - Using parking services
  - Using taxi services

## 2.2 Modelling Framework and Assumptions

The key assumption is to define the time frame for each transportation process for all alternatives transport services to/from the city centre for the sample of airports is selected. The distinguished time window for PT and car transport options are presented in the following figure, providing key definitions for the travel time calculations.

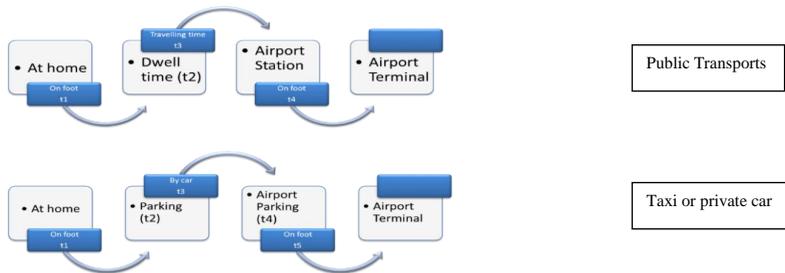


Figure 2: Transport chain for Public Transports and car services to access airport, (author, 2016)

The adopted criteria adopted in this analysis include the development of key performance indicators for the operation and the fare policy formulas between alternative transport options. The formulas of each evaluation criterions is given below:

$$T_p = \frac{\text{minimum time (minutes) of public transport}}{\text{peak hour travel time (minutes) by car}} \quad (1)$$

$$V_p = \frac{\text{commercial speed of public transport}}{\text{average speed for car}} \quad (2)$$

$$F_p = \frac{\text{One single ticket of the fastest mean of public transport}}{\text{Cost of gas+fares+average cost of parking for 1–5 days}} \quad (3)$$

$$F_t = \frac{\text{One single ticket of the fastest mean of public transport}}{\text{Fares of taxi}} \quad (4)$$

The key hypothesis in calculations for the above indicators adopted in this analysis could be summarised as follows:

- Only direct routes at rush hour (peak hour) are taken into account. This time period has been chosen because it represents the worst travel conditions for the pair of origin-destination (city centre and airport);
- Distance is measured in kilometres (km) and fares in euros (€). The calculations take into account the European central bank exchange rates for countries out of Eurozone, e.g. UK and Norway;
- The calculations take into account only the best route in terms of travel time (minutes); and in cases for more than options with the same travel time, then the direct route - without vehicle change - is taken;
- Transport fares are calculated for 1 adult (single ticket) with no discounts. Other ticket fares, such those for a large time (e.g. one day/week/month ticket) or specific group of users, are not taken into account;
- Dwell time is calculated only for PT. It is defined that the time a passenger reach the station/stop, the mean of transport has just left and the time the passenger spend waiting the next operation consist the dwell time. Dwell time for cars (e.g. time waiting in traffic signals, cross sections etc.) is not considered;
- Walking time to/from the PT station from/to airport terminals ( $t_4=0$ ) is not calculated, because usually the PT station located into, under or close to terminal and this path is part of the terminal process;
- For car and taxi the  $t_1=0$  and  $t_2=0$ . It is defined that the car parking lot and the taxi pick up point ate the point of origin for these type of transport service;
- Fuel's price is taken 1.45 euros per litre, which it's the average price in Europe. Car's fuel consumption received 0.07 litres per kilometre (7litres/100km) that represent a normal consumption for medium class cars, travelling in urban environment; and the length of each private car and taxi vehicle is taken 5 meters; and
- The number of wagons per train is taken 6 and the capacity per wagon is taken 150 passengers.

### **3. Key Findings**

#### **3.1 Research Results**

The research sample include 12 European airports, serving capital cities. The analysis is providing essential results easy to compare with other regions in Asia, USA and Middle East.

Based on above presented formulas and collecting information from statistical data, rout planners and reports presented on official airport operator websites or regional authorities, the results are given in the following table.

| Airport / Country            | T <sub>p</sub> | Y <sub>p</sub> | F <sub>p</sub> | F <sub>t</sub> |
|------------------------------|----------------|----------------|----------------|----------------|
| Eleftherios Vezinelos/Athens | 1.62           | 0.60           | 0.27           | 0.26           |
| Heathrow/United Kingdom      | 0.33           | 3.02           | 0.70           | 0.75           |
| Zurich/Switzerland           | 1.81           | 0.55           | 0.12           | 0.11           |
| Oslo/Norway                  | 0.58           | 1.71           | 0.61           | 0.26           |
| Schiphol/Netherlands         | 0.72           | 1.39           | 0.10           | 0.07           |
| Charles de Gaulle/France     | 1.00           | 1.00           | 0.32           | 0.19           |
| Brussels/Belgium             | 1.00           | 0.56           | 0.09           | 0.06           |
| Vienna/Austria               | 1.47           | 0.68           | 0.24           | 0.22           |
| Lisbon/Portugal              | 1.23           | 0.81           | 0.07           | 0.09           |
| Madrid/Spain                 | 0.82           | 1.21           | 0.25           | 0.20           |
| Luxemburg/Luxemburg          | 0.54           | 1.85           | 0.07           | 0.06           |
| Rome/Italy                   | 0.72           | 1.38           | 0.56           | 0.56           |
| <b>AVERAGE</b>               | <b>0.88</b>    | <b>1.39</b>    | <b>0.28</b>    | <b>0.23</b>    |

Table 1: Results for the operational and fare indicators of airport ground access, (source: airport operator official websites and author analysis)

Analysing the research results, the efficiency range for each category of criterion have to be defined. In the following table depicted the efficiency range for the indicators used to compare efficiency in operation and fares between PT and Premium Services (PC).

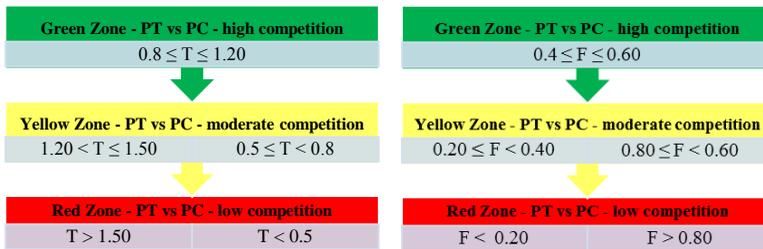


Figure 3: Efficiency levels for the used indicators to assess ground access at airport, (author analysis, 2016)

### 3.2 Highlights on Results

#### Travel time - T<sub>p</sub>

T<sub>p</sub> expresses the relationship between the time required using the fastest mean of PT and the time required by PC to go to the airport. If T<sub>p</sub> is equal to 1 means the PT and PC offer the same travel time to users, in other words, the operation between PT and PC is totally competitive. If T<sub>p</sub> is less than 1.20 and greater than 1.00 or between 1.00 and 0.8, it means that for the passenger point of view the travel time is about the same, in other words, none of transport option can influence passenger's decision because of travel time. About the yellow zone, there are two possible options, the first one is  $1.20 < T_p < 1.50$  where PC represent a better option and the second one is  $0.5 < T_p < 0.8$  where PT are faster than car. The yellow zone represents better efficiency in terms of travel time, but the time saving is not too substantial to influence passenger decision. In the red zone, T<sub>p</sub> can be greater than 1.50 or less than 0.5, the travel time advantages of transport choice are wide and there is no competition between the transport modes for this criterion. It could be concluded that, if someone wants to travel fast from the centre of the city to the airport, the best choice is travelling by car in cities like Athens and

Zurich. On the other hand, the passenger could be unconcerned travelling by PT or PC in terms of travel time ( $T_p=1.00$ ) in Paris and Brussels. For Heathrow the fastest option is PT (Heathrow Express) providing much lower travel time compared to others.

#### Access speed - $V_p$

$V_p$  expresses the speed between the fastest mean of PT and PC and basically reflect to the impression of the passenger whether he is selecting the optimum transport option. There are also three different zones as in  $T_p$ , represented the high, moderated and low competitive operational environment, according to the values depicted in figure 3. Therefore, in Heathrow/UK (3.02), Madrid/Spain (1.21) and Charles de Gaulle/France (1.00) the access speed by PT represents high values and may influence users. On the other hand, Athens/Greece and Zurich/Switzerland the access speed provide essential benefits to car users.

#### Fare to use parking - $F_p$

$F_p$  expresses the ratio of cost effectiveness of the PT vs PC in the case that the passenger goes to the airport by their own car taking into consideration the average airport parking fee for one up to five days. There are also three different zones as in operational performance indicators, representing the high, moderated and low competitive fare policy, given in figure 3. In green zone there is strong competition between PT and PC, as Rome/Italy represents. In yellow zone, access by PC or access by PT is not essential accountable the fare pricing to decision, like it happens in Oslo/Norway and Heathrow/UK. In the red zone, there are significant advantages for PT or PC, depending on value area, such as in Luxemburg where the PC fare is totally inconvenient compared to PT.

#### Fare to use taxi - $F_t$

$F_t$  expresses the cost between a taxi and the PT in order to examine which of them is more affordable to travel with. Green, yellow and red zone are the same with  $F_p$ . So, as  $F_t$  is moderate (yellow zone), taxi is more than 3 times expensive than the fastest mean of public transport, while in the red zone is more than 5 it means that even a group of 5 passengers is cheaper to use PT, such as happens in Luxemburg, Zurich and Lisbon.

## **4. Discussions**

Conventional wisdom for the stakeholders is to establish an airport access strategy and reviewing applied policies and actions efficiency to meet the goals. While the need is well understanding, there are many difficulties to define a strategy deals with the:

- Large number and different expectations of the stakeholders
- No definition on optimum performance of the access system
- Differentiation in infrastructure capex and transport mode opex between transport options
- Limitation for an integrated monitoring system between different transport authorities
- Determination of safety and quality measures

Taking all this into consideration and according to multi-agent decision making theory, a five step approach to define ground access strategy at airport is depicted in the following figure.

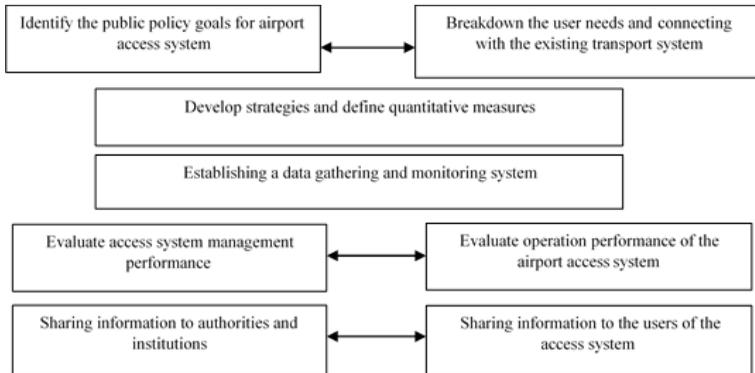


Figure 4: Five steps approach to define an airport ground access strategy, (author)

## 5. Conclusion

In the modern society connectivity is the basis for economic competitiveness, regional development and social cohesion. Considering a worldwide tendency, air transports is continuing grow and especially for the airports serving large cities and capitals meet their level of capacity, resulting mounting congestion and delay in both, the airside and landside of the airport territory. Given the complexity of airport operation and management, the best use of existing capacity is the key driver of efficiency and productivity not just for airports but also for aviation industry.

The paper deals with the analysis framework to assess policies and regulations for ground access to airport. Based on a system of system approach the key assessment criteria are defined and the modelling outlook is presented. The application includes a sample of 12 European airports providing essential results to decision makers, planners and managers towards airport's accessibility, as well as, illustrate recommendations to improve accessibility and quality of service to access air transports. The analysis framework and the results can support decisions even for investments even for policies in ground access system measuring the benefits to air transports and national economies.

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# **Code Share Rights under the UAE-German Bilateral Air Service Agreement**

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**Abstract:** The codeshare services of a UAE carrier and a German carrier gave cause for a law suit regarding the interpretation of the bilateral air service agreement between the Federal Republic of Germany and the United Arab Emirates. This happened after a unilateral change of the approval practice for the air services by the German government. Finally, the dispute was resolved by a court's ruling confirming the previous practice. This dispute may have influence on the future development of an EU-UAE air service agreement.

**Key Words:** code sharing, air service agreement, route schedule.

## **1. Introduction**

There is an ongoing dispute between European and American carriers on one side and the so called Gulf carriers on the other side. The Gulf carriers are accused to receive state aids and have, therefore, a better starting position which results in unfair competition between these airlines.

Nevertheless, not all European and American airlines complain about the competition. There is some substantial cooperation between some of the carriers. Especially Etihad Airways (hereinafter Etihad) with its equity alliance Etihad Airways Partner as well as Qatar Airways, investing in the International Airlines Group., have established such cooperation.

One of these cooperation is between Etihad, the national carrier of the United Arab Emirates, and Air Berlin, the second biggest airline of Germany. In January 2012, Etihad has entered into a strategic partnership with Air Berlin. Within an increase of capital Etihad has acquired 29.21 % of the shares of Air Berlin and made some other significant investments in Air Berlin. To deepen the relationship both airlines undertook a coordination of their flight plans, recognition of frequent traveller programmes and other forms of strategic cooperation in IT systems, maintenance and procurement. The core element was to conduct code share flights – with all benefits resulting from a bigger marketed network. This applies particularly to the joint services between Abu Dhabi and Berlin, and from there to outgoing connections, as well as and to services from Abu Dhabi to a point to Germany and from there in flight to other points within or beyond Germany (5th freedom).

In the general dispute about traffic rights, for the so-called Gulf Carriers arose a very concrete and unique lawsuit about the permission of conducting the above mentioned code share flights between the governments and airlines involved.

## **2. Motivation and Methodology**

We have chosen this topic, as we submitted a legal expertise on this matter. For the future and apart from this particular case, this issue shows some general rules of interpretation of bilateral air service agreements as well as the general development of the aviation policy between the European Union and the Gulf countries. The EU Commission claimed competence for negotiations of new air service agreements between the EU and with ASEAN countries, Turkey, Thailand, Malaysia and Singapore as well as the Gulf Cooperation Council countries. The mandate was given to the EU Commission only on 8 June 2016.

### 3. Analysis

#### 3.1 Legal Framework Conditions

The bilateral air service agreement (hereinafter the agreement) establishes - where relevant - among others, the following:

- According to Article 2 of the agreement the routes over which the designated airlines of the Contracting Parties will be authorised to operate international scheduled air services are to be specified in a route schedule to be agreed upon by the civil aviation authorities and confirmed later on through an exchange of notes (para. 2). Transport services between points in the territory of the other Contracting Party (so-called cabotage) are expressly excluded (para. 3).
- According to Article 2 paragraph 1 of the agreement the Parties mutually grant each other the right to land in its territory at the points named on the routes specified in a route schedule under paragraph 2 to take on or discharge passengers, mail and cargo on a commercial basis in combination or separately" (Letter c).
- According to Article 3 paragraph 1 the operation of the international air services on the routes specified in accordance Article 2 para. 2 may be started at any time, provided that the Contracting Party granting these rights has authorised the designated airline or airlines to initiate the air service" (Letter b). Article 3 para. 2 provides that the Contracting Party, "granting these rights shall give without delay the said authorisation to operate the international air service".
- The bilateral air service agreement contains in article 8 the usual "fair and equal opportunity" clause, which refers in its various aspects exclusively on the "under Article 2, paragraph 2 fixed lines".

Based on Article 2 para. 2 of the agreement the Parties agreed on 14 and 15 June 2000 on a route schedule. In the "Agreed Minutes and Revised Route Schedule" the German side granted - in addition to the two points already existing since 1986 - one more point in Germany (which by letter of the German Federal Department of Transport was expanded to a fourth point) and on three points limited to codeshare services.

The "Agreed Minutes and Revised Route Schedule" read literally as follows:

#### *"Route Schedule*

*After lengthy discussions between both delegations and based on the request from the United Arab Emirates side to liberalise the Route Schedule completely, the German side which was only able to agree, for the time being, to grant 1 additional point to the 2 existing ones and 3 additional points limited to code-share services only in the Federal Republic of Germany. As no further development could be reached during negotiations, both sides agreed on a gradual increase over and above the number of points in the Route Schedule agreed in 1986. The newly agreed Route Schedule is attached as Annex 3."*

Annex 3 deals with the routes granted to the air carriers of the UAE as follows:

"(II) Routes to be operated by airlines designated by United Arab Emirates

| 1   | 2                              | 3   | 4                    |
|---|--------------------------------|---|----------------------|
| <i>Points of Origin</i>                   | <i>Intermediate Points</i>     | <i>Points in the Territory of the Federal Republic of Germany</i>   | <i>Points beyond</i> |
| <i>Points in the United Arab Emirates</i> | <i>via intermediate points</i> | <i>Three points in the Federal Republic of Germany with additional three points limited to code-sharing services only</i> | <i>countries</i>     |

[...]

*(IV) The designated airlines of the Contracting Parties are entitled to operate any number of frequencies with any type of aircraft on the above routes with full unrestricted traffic rights via intermediate points and similarly points beyond."*

### 3.2 The Dispute

Since 2012 the German Federal Aviation Authority (Luftfahrt-Bundesamt, LBA) approved all applied code share services for six scheduling periods without any reservation.

All of a sudden, a unilateral turning away from this traditional line was initiated by the LBA in 2014. The LBA pointed out that from the perspective of the German Ministry of Transport (BMVI) some codeshare services had been approved in the past, which had not been covered by the bilateral air service agreement. These include the Air Berlin operated flights from the UAE to Germany (e.g. Abu Dhabi-Berlin), as well as connecting flights between the German gateway cities (e.g. Berlin-Dusseldorf or Berlin-Stuttgart or Munich-Hamburg) as well as the fifth freedom flights from the code share cities (e.g. Berlin-Copenhagen). The LBA announced not to approve these services in the future.

Virtually overnight, the German side considered the three additionally granted codeshare points (Berlin, Stuttgart and Nuremberg) is to be intended solely to enable feeder services to four undisputed main points in Germany, which can be served directly from UAE carriers (Munich, Frankfurt, Dusseldorf and Hamburg). This would firstly mean that no code-share services are possible except on the main points between the UAE and Germany, and, secondly between the main points and the three codeshare points, and thirdly between the main points and points beyond in third countries.

In contrast, the UAE side holds the view - in accordance with the traditional approval practice - that in addition to the four points which can be served directly by UAE carriers, also direct flights to the three code-share points are covered by the agreed route schedule – even though only by means of code-sharing. In addition, codeshare feeder services are allowed to this main points within Germany and to and from all points in Germany to points in third countries. Both positions assume the common view that the UAE air carriers may operate to the four main points mentioned above in Germany directly (and with own aircraft). However, they differ according to the operation of codeshare services.

### **3.3 Interpretation of the Bilateral Air Service Agreement**

Consequently, it is to be examined which of these two interpretations is the right one. This is determined by the accepted methods of interpretation of legal treaties as emerged in jurisprudence and as laid down in the Vienna Convention on the Law of Treaties (VCLT).

The interpretation of international treaties rests primarily with their parties. It is an objective approach that uses the treaty text as a basis for the interpretation. This approach is shared by the codification of methods of interpretation in article 31 VCLT. The Federal Republic of Germany is party to the VCLT, however, the United Arab Emirates is not. Although the VCLT is not directly applicable in relation between the two parties it has only codified much of customary international law which is applicable anyway.

Under Article 31 paragraph 1 VCLT, a contract has to be interpreted in good faith in accordance with the ordinary meaning and in the context and in the light of its object and purpose. Consequently, a contract has to be interpreted firstly according to its text. The wording defines and limits the scope of a legal norm and no interpretation of a provision must go beyond the text.

At issue was the position of the word “only” in the Agreed Minutes and Revised Route Schedule “...and 3 additional points limited to code-share services only in the Federal Republic of Germany”.

From this the conclusion is to be deduced that the start and end points of these codeshare connections can exclusively be located in Germany – or that the traditionally approved codeshare services between the UAE and Germany (concretely between Abu Dhabi and Berlin) and to points in third countries are not covered by the bilateral air service agreement.

The German side tried to introduce this by the argument that the word “only”, which is placed between two parts of text, refers to the latter part of the text reference, so that it would mean “only in the Federal Republic of Germany”. This approach must be objected. In English the word “only” is placed subsequent to the referenced word. This means that it is not “...only in the Federal Republic of Germany” but shall be read “... 3 additional points limited to code-share services only”.

This traditional common understanding between the Parties is also evidenced by the fact that it is precisely this assignment made by the “Agreed Minutes and Revised Route Schedule” in Annex 3, where the last reference to the Federal Republic of Germany is missing. The German position would have been reasonable if instead “in” the word “within” had been chosen.

Hence, there can be no limitation also regarding the use of 5th freedom code share services. The points in other countries referred to in column four relate to all points mentioned in column 3, that means the main points in Germany as well as the points limited to code share services. This opinion is also supported by point IV of Annex 3, providing for the designated airlines of the Contracting Parties to be entitled to operate any number of frequencies with any type of aircraft on the above routes with full and unrestricted traffic rights via intermediate points and similarly points beyond.

Beside this, there are other legal norms providing help for the interpretation of the route schedule. The structure of a route schedule and relevant explanatory material is specified in the “Manual on the Regulation of International Air Transport” (ICAO Doc. 9626). This is the

internationally agreed document published by the ICAO providing the harmonised standard for the negotiation and conclusion of bilateral air service agreements.

The route schedule in the UAE-German agreement looks the same as the pattern in the ICAO Manual (Table 4.1-1. Routes for State A (tabular format)). In the explanation to the pattern all columns traffic is made between the columns on all possible routes.

Finally, the historic occasion and purpose of the agreement as well as the standard practice can contribute to the interpretation of agreements. In the 1990s, the bilateral air service agreement was supplemented by the code share clause to form the basis for a cooperation between Emirates Airlines and the Deutsche BA. The German airline should provide code share services from the three German code share cities to the destinations where Emirates Airlines operated direct services to and from the United Arab Emirates. These kinds of code share services were still allowed under the new interpretation of the BMVI. However, all other services between one main point and another main point as well as solely between two code share cities should not be approved under the new interpretation.

This historical origin and practice is not in line with the bilateral air service agreement. There is no justification for services operating just within column 3. All flights departing from a city mentioned in column 3 have to end in one of the other columns. A wrong interpretation should not have any implication on an entitlement from customary law.

Therefore, for the application of Etihad only the flights between the seven German points have to be evaluated as critical, as they are not covered by the route schedule.

### **3.4 The Courts' Legal Opinion**

The first instance court denied the applied code share services adopting the new interpretation of the BMVI justifying its decision also with the historical origin and practice of code share services.

This decision was not upheld by the second instance court. The ruling allowed almost all code share services excepting only those within Germany, irrespective which type of cities (main points or code share cities) should be connected. The main reason was in the correct interpretation of the code share agreement in the bilateral air service agreement: As the court stated, the classification of the extra points in column 3 of the matrix of the "Route Schedule" under the main points ("additional") and the subsequent column 4 ("points beyond") is crucial to the interpretation. Air traffic should be possible to the designated carriers between all columns but not within the columns.

The court of appeal also stated, that the argument of lack of reciprocity based on the actual traffic development and the number of passengers carried by the mutually designated airlines is not reasonable to make a unilateral attempt to change this situation. If the competitive development is unsatisfactory from the BMVI's point of view, the bilateral air service agreement provides for a consultation mechanism (Art. 14 para. 1 and Art. 8 para. 5) between the aviation authorities of the Parties. Actually, equal rights are granted to both Parties. Thus, the German side has also the same landing and take-off rights in the UAE as UAE carriers have in Germany. This is based on the principle of reciprocity. This principle does not include economic equality in the perception of the granted traffic rights.

As a result, even if administrative proceedings are not legitimate to change the implementation of a bilateral air service agreement, the court's ruling allows that - if an ingrained practice does not correspond with the perception of one party to an agreement - a change can be introduced by an administrative procedure.

#### **4. Conclusion**

The very concrete outcome of this lawsuit is, that almost all code share services except those within Germany – irrespective which type of cities (main points or code share cities) should be connected – were approved by the second instance court's ruling.

Furthermore, it is important to have the simple fact confirmed by the court that a bilateral agreement cannot be changed by a unilateral decision. The only way to settle a dispute on a bilateral agreement the means prescribed by an air service agreement as a bilateral legal instrument. The better formulations of bilateral are negotiated, less struggle with its interpretation is to be expected.

Finally it must be stated: Even if this dispute was settled by a court's ruling, the general problem of the access of the UAE carriers – and Gulf carriers in general – to the European market is not resolved, yet. The perspective for the negotiations of an EU-UAE bilateral air service agreement is very gloomy.

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# **Serving Transfer Passengers: An Evolving Business for European Low-Cost Carriers**

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**Abstract:** We analyse the departure of European low-cost carriers (LCCs) from the traditional point-to-point model and investigate how European LCCs target new passenger segments by offering connections. We describe different strategies to combine single flights into marketable connections and provide empirical data on the utilisation of these strategies. This leads to new insights about how the airline industry has changed.

**Key Words:** business strategy, low-cost airlines, self-connecting, code-sharing, hubbing.

## **1. Introduction**

In the European air transport market, many airlines still considered to be low-cost carriers (LCCs) have turned away from the archetypical LCC business model when adopting features traditionally associated with full service network carriers (FSNCs). This change of business strategies is referred to as ‘hybridisation’ (Klophaus et al. 2012, Fageda et al. 2015) or ‘business model convergence’ (Daft/Albers 2015). The observable trend towards a hybrid business model might be the result of lower growth rates as the European market for low-cost air travel appears to mature, as well as the consequence of developing low-cost subsidiaries within the large European airline groups. Nowadays, carriers that are labelled ‘LCC’ use primary airports, provide ‘frills’ like seat reservation and free drinks, sell tickets via global distribution systems, or arrange for frequent flyer programmes. The confinement to point-to-point services has been considered to be a core characteristic of the LCC business model (Doganis 2010). This paper concentrates on the partial replacement of the point-to-point paradigm by LCCs offering different variants of connecting services, such as the support of passenger self-connecting, the provision of offline connections by code-sharing with other airlines, and online connections within the airline, which might be the first step towards creating a hub-and-spoke network.

Recent papers on LCCs analyse several developments which are either part of the hybridisation process or closely linked to it. Budd et al. (2014) discuss entry and exit within the European low-cost market, showing that only few LCCs have been successful. Therefore, deviating from the pure LCC model might be one strategy to avoid pure price competition within the low-cost segment. The prospects of European based long-haul low-cost services are still considered to be rather doubtful. De Poret et al. (2015) show that even with the most efficient aircraft, fluctuations in passenger demand and fuel prices severely affect the potential economic success of this business model. Several papers analyse different aspects of an ‘airline-within-the-airline’ strategy, i.e. the coexistence of traditional FSNCs and LCCs within one airline group (Gillen/Gados (2008), Lin (2012), Pearson/Merkert (2014), Homsombat et al. (2015)). Our paper is organised around different strategies to combine single flights to marketable connections. These strategies are supported passenger self-connecting, code-sharing and hubbing. Hubbing, i.e. the provision of online connections, implies a range of managerial issues like through fares and complex network operations not included in the archetypical LCC business model. We also consider code-sharing marketing agreements, i.e. the provision of offline connections, requiring schedule coordination and proration between airlines. A rather ‘soft’ approach is to facilitate self-connecting by passengers. This allows LCCs in principle to continue with pricing and schedule planning for stand-alone routes. The paper discusses each of these approaches to allow for connecting traffic. The empirical part assesses relative

frequencies of self-connecting, code-sharing and hubbing among European LCCs. By analysing data from the OAG airline schedules database, we determine how often and to what degree each strategy is applied and, hence, the multiple use of these approaches to connecting traffic.

Switching from isolated point-to-point services to route networks with offline and/or online connections adds complexity and increases unit costs. On the other hand, there is revenue potential in connecting flights. These opposing effects need be evaluated by the management of LCCs. One key result of our paper is the classification of European LCCs into two categories with regard to connection-building. Independent LCCs like Ryanair or Easyjet that only offer short-haul services stick to the point-to-point paradigm whereas LCCs that are affiliated with one of the large European airline groups (e.g. Vueling or Transavia) as well as LCCs with own long-haul services (e.g. Norwegian or Eurowings) offer connections be it in the form of code-sharing or hubbing. Further, establishing connections coincides with other deviations from the ‘pure’ LCC business model, especially the inclusion of primary airports into the route network.

## 2. Carriers Included in the Analysis

This paper assesses the relative occurrence of different types of connection-building among European LCCs. This first requires a selection of carriers to be included in the analysis. There are several compilations of European LCCs significantly varying in the total number of airlines included. In its annual ranking of the largest 100 LCCs worldwide by passenger numbers, Airline Business (2016) includes 28 LCCs based in Europe (excluding Russia and Turkey). From this comprehensive list we drop small carriers and leisure carriers to arrive at a set of ‘relevant’ LCCs. This includes Ryanair, Easyjet, Norwegian, and Wizz Air as the leading independent LCCs in Europe and the FSNC low-cost subsidiaries Vueling, Eurowings, and Transavia. Table 1 provides basic information on these LCCs (Germanwings is included in Eurowings, Transavia combines Transavia Airlines and Transavia France).

| LCC       | IATA code | PAX* (m) | Fleet* size | SLF* (%) | FSNC subsidiary | Long-haul |
|-----------|-----------|----------|-------------|----------|-----------------|-----------|
| Ryanair   | FR        | 106.4    | 352         | 92.9     | --              | --        |
| Easyjet   | U2        | 68.6     | 249         | 92.6     | --              | --        |
| Norwegian | D8/DY     | 25.8     | 106         | 86.2     | --              | ✓         |
| Vueling   | VY        | 24.8     | 102         | 81.3     | ✓               | --        |
| Wizz Air  | W6        | 20.0     | 67          | 88.2     | --              | --        |
| Eurowings | EW/4U     | 17.0     | 87          | n/a      | ✓               | ✓         |
| Transavia | HV/TO     | 10.8     | 62          | n/a      | ✓               | --        |

Table 1: Profiles of LCCs in the survey (\*Source: Airline Business 2016)

## 3. Supported Passenger Self-Connecting

In principle, it is always possible for passengers to ‘self-connect’ two or even more LCC flights by simply buying separate tickets. However, self-connecting has several major shortcomings such as the risk of missed connections due to delayed or cancelled flights. The passenger also has to collect and re-check his luggage and may have to go through security and immigration twice at the transfer airport. In order to overcome some of these shortcomings and to make self-connecting more attractive, airport operators may consider to assist self-connecting passengers. This assistance might be accompanied by an airport-airline-cooperation. In general, such an initiative is more promising if a given airport handles many flights by LCCs that do not codeshare with other airlines and also do not provide through tickets with a transfer possibility at this airport. Table 2 shows for all selected LCCs the airports with the highest number of

scheduled weekly frequencies. Notably, the list comprises hubs like Barcelona and Amsterdam. As discussed below, London Gatwick and Milan Malpensa offer programmes to support passenger self-connecting, while Barcelona and London Stansted with a similar or even higher number of weekly LCC departures do not.

| No. |                                  | No. |                                | No. |                                   |
|-----|----------------------------------|-----|--------------------------------|-----|-----------------------------------|
| 1   | Barcelona (BCN)<br>(2,010)       | 6   | Dublin (DUB)<br>(803)          | 11  | Milan Malpensa (MXP)<br>(662)     |
| 2   | London Gatwick (LGW)<br>(1,479)  | 7   | Palma de Mallorca (PMI)<br>776 | 12  | Berlin Schoenefeld (SXF)<br>(649) |
| 3   | London Stansted (STN)<br>(1,432) | 8   | Oslo Gardermoen (OSL)<br>(765) | 13  | Cologne Bonn (CGN)<br>(625)       |
| 4   | London Luton (LTN)<br>(919)      | 9   | Paris Orly (ORY)<br>(743)      | 14  | Milan Bergamo (BGY)<br>(619)      |
| 5   | Amsterdam (AMS)<br>(868)         | 10  | Rome Fiumicino (FCO)<br>(708)  | 15  | Malaga (AGP)<br>(609)             |

Table 2: Top 15 airports by flight departures (in brackets) of all LCCs in the survey for the week ending June 5, 2016 (Data source: OAG)

Table 3 shows for the selected LCCs the three respective European airports with the highest number of scheduled weekly frequencies. All LCCs have developed bases with significant destination coverage, many of them outside their home countries (see also Klein et al. 2015). These LCC bases are no traditional hubs if flights are commercially planned as stand-alone operations within a point-to-point route network. A comparison of the data shown for the LCCs in Table 3 with the ones of Lufthansa and Star Alliance in Frankfurt (FRA) and Munich (MUC) puts the LCC activities in perspective. Lufthansa (Star Alliance) has 2,961 (3,535) weekly departures in FRA and 2,204 (2,580) in MUC. Due to the high number of departures offered by Lufthansa and Star Alliance in FRA and MUC, a passenger flying to these hub airports has a wide choice of available onward flights. These connections are schedule-coordinated and typically supported by code-sharing.

|           | No. 1                            | No. 2                            | No. 3                        |
|-----------|----------------------------------|----------------------------------|------------------------------|
| Ryanair   | London Stansted (STN)<br>(1,196) | Dublin (DUB)<br>(776)            | Milan Bergamo (BGY)<br>(559) |
| Easyjet   | London Gatwick (LGW)<br>(1,248)  | Milan Malpensa (MXP)<br>(504)    | Geneva (GVA)<br>(466)        |
| Norwegian | Oslo Gardermoen (OSL)<br>(749)   | Stockholm Arlanda (ARN)<br>(343) | Copenhagen (CPH)<br>(278)    |
| Vueling   | Barcelona (BCN)<br>(1,194)       | Rome Fiumicino (FCO)<br>(268)    | Paris Orly (ORY)<br>(197)    |
| Wizz Air  | London Luton (LTN)<br>(297)      | Budapest (BUD)<br>(189)          | Bucharest (OTP)<br>(149)     |
| Eurowings | Düsseldorf (DUS)<br>(589)        | Cologne Bonn (CGN)<br>(462)      | Hamburg (HAM)<br>(378)       |
| Transavia | Amsterdam (AMS)<br>(321)         | Paris Orly (ORY)<br>(310)        | Rotterdam (RTM)<br>(117)     |

Table 3: Top 3 airports by flight departures (in brackets) and airline for the week ending June 5, 2016 (Data source: OAG)

Programmes offered at airports to support passenger self-connecting might include providing information on suitable connections and assistance during the booking process, facilitating check-in of luggage and immigration, providing assistance or compensation payments in case of missed connections, and suggesting or arranging optional activities during the stay-over, as well as other benefits for transfer passengers (e.g. free WiFi, shopping vouchers). From an

airport operator's perspective, such a programme should generate additional revenues. Therefore the airport may charge a service fee from the self-connecting passenger. The airport may also be able to negotiate commissions from airlines if flights are booked via the airport's self-connection website. Further, if such a programme leads to an increase in total traffic, additional revenue results from higher passenger fees and increasing non-aviation business. Although the cooperation with the airport requires some specific activities (e.g. operating additional check-in desks close to the baggage reclaim area) the core elements of the respective airlines' business model are not affected. Therefore, cooperating with an airport that offers self-connecting assistance is not a major deviation from the low-cost business model as it allows LCCs in principle to continue with pricing and schedule planning for stand-alone routes.

'GatwickConnects' at London's second largest airport and 'Via Milano' at Milan Malpensa airport are two established schemes for assisting self-connecting passengers. Connecting flights on Easyjet, Norwegian or several other airlines can be booked via the GatwickConnects website. The programme was introduced in 2015, requiring individual bookings via the airlines' websites which are linked to the GatwickConnects platform. Unlike GatwickConnects, using Via Milano is free of charge for the transfer passenger. If a minimum connecting time of 90 minutes is observed (100 minutes if the flights are operated at different terminals) and the passenger registers in advance with Via Milano, the airport provides luggage services as well as limited insurance against missed connections. Moreover, a fast track for security control and a shopping voucher is offered. Although Via Milano provides a platform for searching suitable connections, it is not necessary to book the flights via this website in order to benefit from the programme. Obviously, the airport operator expects the programme to increase passenger numbers and, hence, revenues from passenger fees as well as non-aeronautical revenues.

#### **4. Code-sharing**

Code-sharing agreements establish offline connections and include procedures on schedule coordination and proration between different airlines. It should be noted that multi-carrier interline tickets can be issued for connecting flights by airlines which do not share codes (i.e. advertise through tickets with each other) but still have an interline agreement. Proration refers to the division of passenger revenue between the carriers participating in the routing. When a carrier sells a ticket to a passenger for an interline itinerary, this carrier collects the entire fare. The other carrier(s) involved in transporting this passenger need to charge the ticket issuing carrier. Prorate agreements settle this billing issue, so that the non-issuing carrier receives revenue for transporting the interline passenger. Whereas code-sharing by definition requires that at least two codes exist for one flight, one airline might also sell tickets for flights operated by another airline under the operating airline's code. For example, Lufthansa flights (with LH code) are sold via the Eurowings website and vice versa. Such reciprocal distribution requires a connection of the airlines' reservation systems even without code-sharing.

Whereas several types of code-sharing can be distinguished (e.g. unilateral and reciprocal code-sharing, parallel and complementary code-sharing), in our analysis we only distinguish between the operating carrier and the marketing carrier of a codeshare flight. According to Morandi et al. (2015) 17 out of 31 European LCCs had at least one codeshare agreement in 2011. 15 times they acted as operating carrier and 10 times as marketing carrier. However, the definition of a low-cost carrier in Morandi et al. (2015) appears to be rather broad.

|                   | No. of operating flights | No. of codeshare flights as operating carrier | No. of codeshare flights as marketing carrier |
|-------------------|--------------------------|---|---|
| Ryanair           | 13,674                   | --  | --  |
| Easyjet           | 10,420                   | --  | --  |
| Norwegian (D8/DY) | 3,923                    | --  | --  |
| Vueling           | 4,067                    | 3,806   | 22  |
| Wizz Air          | 2,688                    | --  | --  |
| Eurowings (EW/4U) | 3,742                    | 1,006   | --  |
| Transavia (HV/TO) | 1,832                    | 432   | --  |
| Total             | 40,346                   | 5,244   | 22  |

Table 4: Code-sharing among European LCCs for the week ending June 5, 2016 (Data source: OAG)

Table 4 shows that in June 2016 none of the independent LCCs actually offered code-sharing. Easyjet used to have 14 codeshare flights as operating carrier with Russia's Transaero Airlines on the route between Moscow-Domodedovo and London-Gatwick. However, Transaero filed for bankruptcy on October 1, 2015, and ceased operations on October 25, 2015. Further, with the exception of Vueling none of the LCCs acts as marketing carrier, i.e. sells tickets for flights operated by other airlines. The 22 codeshare flights offered by Vueling as marketing carrier are on Iberia operated flights between Barcelona and Madrid. In contrast, all FNSC low-cost subsidiaries act as operating carriers and offer feeder flights for their respective parent companies and sometimes also for affiliated FSNCs of the parent company. This holds for Eurowings with Lufthansa and other FSNCs from Star Alliance putting codes on Eurowings operated flights, Transavia operating KLM-code-sharing flights as feeder flights for passenger transferring at Amsterdam Schiphol, and especially Vueling operating with codes from Iberia and British Airways, the FSNCs in the International Airlines Group (IAG) that includes Vueling as low-cost subsidiary. Obviously, a link between establishing code-sharing connections with other deviations from the 'pure' LCC business model exists, such as the inclusion of primary airports.

Code-sharing has become more common among European LCCs since 2011. In the first week of June 2011, Iberia put its designator code on 1,835 flights operated by Vueling, Germanwings was operating only five flights with Eurowings being the marketing carrier, Transavia was not yet involved at all in such agreements. Somewhat different is the situation for Norwegian. The carrier operated four weekly flights until 2014 with Russian Rossiya Airlines as code-sharing partner. Easyjet has claimed that code-sharing does not fit into its business model (Otley 2015) whereas Ryanair negotiates with other airlines (FSNCs as well as LCCs) about possible feeder traffic especially to long-haul services (McArdle 2015). As code-sharing pushes up operating costs and might also negatively affect a carrier's punctuality performance, this appears to be a somewhat surprising stance for an archetypical LCC like Ryanair. However, after the tie-up with Amadeus global distribution system in 2014, Ryanair already fulfils an essential prerequisite for entering into code-sharing agreements with FSNCs. It remains to be seen whether FSNCs are willing to offer commercial conditions that allow for contract flying of Ryanair on short-haul routes under FSNC code. This might also depend on the long-term success of the airline-within-airline strategy that has been implemented by each of the three largest European airline groups.

## 5. Hubbing

Hubbing is the provision of online connections by a single airline and implies a range of managerial issues like through fares and complex network operations not included in the archetypical LCC business model. One of the early European examples was Germanwings (now operating through Eurowings) with its 'Smart Connect' programme, introduced in 2007.

This programme did not include the cost-intensive through-checking of luggage. Several LCCs offer connections within their own network (see Table 5). At the end of 2015, Norwegian provided online connections at five European airports (ARN, CPH, OSL, LGW and Helsinki), Vueling via BCN and FCO. These airports are among the busiest in the route network of Norwegian and Vueling, respectively (see Table 3). Eurowings offered online connections at several German airports (Cologne, Stuttgart, Hanover and Berlin).

|           | Hubbing | FSNC subsidiary | Long-haul |
|-----------|---------|-----------------|-----------|
| Ryanair   | --      | --              | --        |
| Easyjet   | --      | --              | --        |
| Norwegian | ✓       | --              | ✓         |
| Vueling   | ✓       | ✓               | --        |
| Wizz Air  | --      | --              | --        |
| Eurowings | ✓       | ✓               | ✓         |
| Transavia | --      | ✓               | --        |

Table 5: Hubbing among European LCCs

Hubbing among European LCCs is limited to low-cost subsidiaries of FSNCs and LCCs with own long-haul services. Transavia is the exception to this rule which might be explained by the relatively small size of Transavia’s route network in comparison with Norwegian, Vueling, and Eurowings. It is striking that average load factors for Norwegian and Vueling are significantly below the load factors of Ryanair and Easyjet (see Table 1). This might at least partially be the result of a different network strategy as some short-haul services of Norwegian and Vueling are not operated as stand-alone flights but also fulfil a feeder function for FSNCs and own long-haul operations.

Oslo Gardermoen (OSL) is the most important airport within Norwegian’s route network with 749 departures in the first week of June 2016 (see Table 3). These departures included 14 long-haul services with Boeing 787-8. It is unlikely, that the 291 seats on these long-haul services were filled with local traffic alone. As shown in the previous section, there was no feeder traffic from marketing flights with other airlines. Hence, Norwegian offers connecting flights within its own network. However, this does not necessarily imply integrated hub-and-spoke operations with OSL serving as consolidation and dispersal airport. The establishment of an integrated hub-and-spoke system adds complexity and vulnerability to an airline’s operation that goes way beyond the effects of providing online connections between flights that are originally planned as stand-alone operations. It is interesting to note that Norwegian charges for connecting services. The charge for connections via airports in Scandinavia and Finland is 7 GBP (per person and per leg) and 15 GBP for connecting flights via London Gatwick. For this charge the passenger receives a reservation for the entire journey and the checked baggage is sent through to the final destination. Further, if the passenger misses the connection because of a cancelled or delayed first flight, the carrier will rebook him to the next available flight.

## 6. Conclusions

Our study demonstrates a hitherto limited deviation from the original point-to-point paradigm among the largest European LCCs. Code-sharing is confined to low-cost subsidiaries within the large European airline groups, all of them acting as operating carrier. Only Vueling also offers a few flights as marketing carrier. Hubbing, the most complex approach to combine single flights to marketable connections, is provided by Vueling and Eurowings as FSNC subsidiaries and Norwegian as an independent LCC with long-haul services. These observations indicate that there is a division among European LCCs. Large independent carriers that exclusively offer short-haul services (still) stick to the point-to-point paradigm. On

the other hand, LCCs hierarchically linked to one of the large European airline groups as well as LCCs with own long-haul services offer connections, be it in the form of code-sharing or hubbing. Even for LCCs that do not want to deal with code-sharing and hubbing, cooperating with airport operators in order to support passenger self-connecting might be a ‘soft’ approach for connection-building. Today, only two out of the 15 airports with the highest number of low-cost operations provide assisted self-connecting and only London-Gatwick has implemented a system that requires at least some cooperation of the participating airlines.

It remains an issue for further discussion whether a pure point-to-point network is crucial for LCC categorisation. Further, while there is some literature on the economic viability of long-haul low-cost operations, the ripple effect on short-haul low-cost services used for feeder traffic has not yet been analysed and, hence, could be an interesting issue for future research. In addition, FSNCs might be interested in figuring out under what commercial conditions independent LCCs would sign contract flying agreements on short-haul routes with a FSNC code. If such agreements materialise, this would be another step in the hybridisation of the European air transport market that also calls for additional research. Clearly, the future relevance of this issue will largely depend on the success of the airline-within-airline strategy currently pursued by all large European airline groups.

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# Assessing the Competitive Position of European Airlines at the Network Level

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**Abstract:** Assessing an airline's competitive position is not trivial, as airlines serve many different markets with varying degrees of competition. Hence, networks compete against each other, meaning that the "typical" competition assessment at the airport- or direct route-level may not be sufficient. Fed with origin-destination data from Sabre Market Intelligence, this paper presents a modelling approach to assess the individual competitive position (CP) of airlines in intra-European air transport at the whole network level. The results indicate that LCC like Ryanair or WIZZ Air have a quite comfortable competitive position, while Lufthansa is more exposed to competition than Air France-KLM and BA/IAG.

**Key Words:** airline, network, competition, market power, competitive position.

## 1. Introduction and Objective

Given the increased presence of low cost carriers (LCC) and the existence of competing hubs dominated by different full service network carriers (FSNC) and their alliances, one would generally expect a high level of competition intensity and hence low degrees of market power and only limited needs for market regulation in the deregulated European air transport market. Competition analyses usually contain market structure assessments e.g. at the airport or national level, or for selected direct routes, employing concentration measures like the Hirshman-Herfindahl index (HHI). Such approaches may, however, fall short when it comes to the assessment of the overall, i.e. network-wide, competitive position of a carrier (Borenstein, 1992). The reason is that airlines serve many different (direct and indirect) origin-destination (sub) markets between which competition varies. For example, the competitive position (and hence potential market power) of airline X on a direct route from A to B will not only depend on its own (direct) supply between A and B in relation to other carriers' (Y) direct flights, but also on the latter's indirect supply from A to B via one or more hubs  $H_y$ , if applicable, and vice versa.<sup>7</sup>

This paper aims at assessing the competitive position of airlines in intra-European air transport at the whole network level, which is regarded as relevant. The term "competitive position" is defined as the position an airline occupies in the whole relevant market (network), relative to its competitors (see e.g. Veldhuis, 1997, or [businessdirectory.com](http://businessdirectory.com)). The modelling approach considers a carrier's actual competitive position (measured by market share) on each single OD and the relative contribution of each OD to the airline's total output (measured by passenger volume). The model is fed with traffic flow data as provided by Sabre Market Intelligence at the OD-level as main input. Output is an indicator for the airline's competitive position (CP) which shows the extent to which it is competed by other carriers, ranging from – in theory – 0.00 (all ODs purely dominated by other airlines) to 1.00 (no competition from other airlines). As many airlines are not financially or strategically independent from each other and hence should not be regarded as competitors, the analysis is also run at the airline group level, controlling for common ownership.

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<sup>7</sup> Not considered here are other factors on the competitive position of carrier X on route A-B, such as competition from other airline' routes from nearby airports, or from other modes of transport.

This approach might provide useful, additional information e.g. for policy-makers or regulators. The application of the methodology is not limited to intra-European air transport market but could also be conducted for other regions or more specific research questions, such as mergers or the overall competitive exposition of European network airlines to Gulf or low cost carriers.

The paper is structured as follows. Section 2 looks at the relevant literature on the role, impact and measurement of competition in the airline market. In section 3, the methodology and dataset are presented. Section 4 then contains the key findings and a related discussion, followed by a summary and remarks regarding possible future research in section 5.

## **2. Background and Literature Review**

Monopolisation and resulting market power have proved to be an issue in the air transport value chain and here especially in some of the upstream markets. Examples are air traffic management (ATM), where airlines can usually not choose between more than one ATM providers (Button and McDougall, 2006); ground handling, which has – yet only partly – been opened to new competitors by EU legislation (EC, 1996; Meersman et al, 2011); and the airport landscape, where the question of monopolies and subsequent market power is a more diverse one as it depends on various factors such as overlapping catchment areas and resulting airport leakage effects, alternative hubs, or the degree of countervailing power of the airlines (see e.g. Barrett, 2000; Button, 2010; Maertens, 2012).

In many (downstream) airline markets, in contrast, deregulation steps are widely believed to have increased competition, be it in form of competing carriers serving the same or alternative routes, or indirectly via hubs (Alderighi et al, 2005; Pels, 2008). After a ten year, step-wise process, the liberalisation of the intra-EU air transport sector was completed in 1997 when EU-carriers were allowed to fly almost everywhere within the union, including cabotage, at self-determined fares (Regulations (EC) No 2407-2409/92). Other countries, such as the Balkan states, Norway and Iceland, followed suit, leading to the formation of the European Common Aviation Area (Decision of the Council and of the Representatives of the Member States of the European Union meeting within the Council 2006/682/EC), and the EU-US horizontal Open Sky agreement now even allows for almost unconstrained traffic right allocation on the transatlantic market (Decision of the Council and the Representatives of the Governments of the Member States of the European Union meeting within the Council 2007/339/EC).

This new policy regime paved the way for a more competitive air transport market which is now characterised by more routes and lower fares, mainly driven by the emergence and subsequent growth of LCC such as Ryanair, easyJet and a changing number of smaller firms (Dobruszkes, 2013). Most of the FSNC have developed differently. Some had to downsize (e.g. CSA, JAT, LOT, Olympic, SAS...) or disappeared completely (e.g. Balkan, Malev, Swiss, Sabena,...), while others intensified their hubbing activities at their main airport(s), often in close cooperation with alliance partners, and strengthened especially their supply in long haul services. In addition, some FSNC founded low-cost subsidiaries in attempts to get a foot into the low cost sector and to benefit from cheaper operating platform for intra-European operations. Examples include Lufthansa (germanwings/Eurowings), IAG (Vueling) and Air France-KLM (Transavia).

However, there are still air transport market segments that seem to be characterised by only limited degrees of competition:

- Due to slot constraints or for other reasons, some airports are dominated by one or few airlines and/or are not yet served by a noteworthy number of low cost services (e.g. Frankfurt, Heathrow). The hub carriers operating here are supposed to have a strong market position at least in the local, direct flight market where they seem to be able to charge “hub premiums” – an issue which has however been discussed controversially in the literature: While some authors found empirical evidence for hub premiums stemming (partly) from market power (e.g. Borenstein, 1992; Evans and Kessides, 1993; Lijesen et al, 2001), others shows that higher fares charged by hub carriers for flights from their hubs can be explained with e.g. higher service levels rather than market power (e.g. Dresner and Windle, 1992).
- A number of nonstop routes are exclusively served by one or two carriers, often even (alliance) partners, which may reduce competition. Examples are Frankfurt-Brussels or Frankfurt-Zurich, which have been exclusively operated by the Lufthansa Group, following Lufthansa’s acquisitions of Brussels Airlines and Swiss, respectively.
- In international air traffic, a number of direct country-pair markets are still monopolistic or duopolistic as many restrictive bilateral air service agreements only allow few carriers to operate a usually restricted number of frequencies.
- And even indirect ODs are not always competed by alternative routings. For example, the airport of Graz is dominated by feeder services to hubs of airlines of the Lufthansa Group, meaning that indirect routings from most places via e.g. Frankfurt (Lufthansa) or Vienna (Austrian) to Graz cannot really be considered to be in competition with each other.

As most (network) airlines serve not only isolated nonstop routes but many different “submarkets” with varying degrees of competition (Obermayer et al, 2013), it is not trivial to assess an airline’s “overall” competitive position. A quite simple approach would be to look at aggregated airline market shares at the regional (e.g. national) level, such as the US domestic market. Such approaches do however neglect the degrees of actual competition in the relevant origin-destination markets or at the airport levels. Borenstein (1992) argues that “measures of national concentration” are hence just “convenient reference points”. Also common are papers (e.g. Borenstein, 1992; Dresner et al, 1996; Ben Abda et al., 2012; Detzen et al, 2012) assessing the level of competition in air transport markets (mostly the US domestic market) at the direct route or airport level, employing indicators like the Hirshman-Herfindahl index (HHI). Examples for relatively recent papers in this context, but with a European focus, are Obermayer et al (2013) who estimated HHI-competition levels (based on carrier-specific frequency shares) and resulting price dispersion at the direct route level, and Gaggero and Piga (2010) who assessed route-specific competition in the UK-Ireland market to assess the impact of a potential Ryanair-Aer Lingus merger on route domination. The consideration of nonstop route level competition only was also subject of some regulatory decisions. For example, in the Lufthansa-Eurowings merger case, the Bundeskartellamt (German Federal Cartel Office) defined only the German domestic market as being relevant and not the indirect markets from German spokes via hubs to the rest of the world (Bundeskartellamt, 2001).

This paper aims at providing an approach for the assessment of the competitive position of individual airlines at the total network level, considering actual competition in terms of market shares on all direct and indirect routings. This network perspective is not new, but most of the earlier papers either tackle the role of network competition from a theoretical or conceptual perspective (e.g. Adler, 2001; Aldeighi et al, 2005) or focused at the US market. An example for the latter is Borenstein (1992) who showed that HHI-concentration at the city-pair route

level (incl. indirect routings) has decreased following the US deregulation act as airlines have switched their business models to hub&spoke network operations that tend to compete at the city-pair level. Veldhuis (1997) also looked at the network competition perspective. However, he applied a (supply-based) connectivity model to assess the relative connectivity performance of airports (incl. Amsterdam), while this paper takes a demand-perspective and bases the approach on actual passenger flows.

### 3. Methodology and Data

Airline  $i$  is assumed to have an uncontested competitive position ( $CP_i$ ) if it was free from any competition on all markets it serves, while it would be heavily contested if its market shares on all relevant ODs were small. The relevant market is defined as all OD-relations an airline actually sells tickets for, and hence not only the nonstop routes. Otherwise, large shares of the total traffic volumes of network carriers that fly passengers over their hubs would not be considered.

The overall competitive position ( $CP_i$ ) of carrier  $i$  at the network level is defined as the sum over all OD-specific market shares ( $MS_{ij}$ ) of carrier  $i$  in the origin-destination markets  $j$  multiplied by the airline-specific relevance of each OD $_j$ , which is measured by e.g. the number of passengers of airline  $i$  on OD $_j$  ( $PAX_{ij}$ ) divided by the airline's total passenger number  $PAX_i$ <sup>8</sup>:

$$CP_i = \sum_{j=1}^n (MS_{ij} * PAX_{ij} / PAX_i) \text{ where } MS_{ij} = \frac{PAX_{ij}}{PAX_j}$$

If an airline had a market share of 100% on all ODs it serves, the CP index would take the value of 1, which would mean that the carrier was free from any intra-modal competition (not counting competition from similar routes from alternative airports, though). If the carrier's market shares on most of the ODs were small, the CP index would take a low value.

Passenger numbers at the origin-destination level are provided by the Sabre Market Intelligence (Sabre-MI) database (Sabre, 2014) for each carrier and intra-European route. This database uses validated raw bookings from MIDT (market information data tapes) data from the global distribution systems as its main source of data, combined and adjusted with data from external sources and with estimations for increasingly important direct bookings and charter operations.

In a first step, the analysis is run at the individual airline level, not controlling for groups of airlines under the same ownership (which might not really compete against each other). In a second run, a modified dataset is used in which airlines have been aggregated to airline groups, where applicable (Table 1).

To scale the massive amount of data down, September 2015 is chosen as reference and not a full year. September is believed to be a good proxy for the annual average as this month is characterised both by solid business and leisure demand. Also, only intra-European traffic from, to and within the Sabre-MI regions Eastern Europe and Western Europe (including basically all of geographical Europe including Russia but excluding Turkey) is considered, as it is the aim of this paper to assess the competitive situations of airlines in the intra-European market. This will also allow for comparisons between LCC (which hardly serve any long haul routes) and the intra-European business of the FSNC.

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<sup>8</sup> Alternatively, airline- and origin-destination-specific revenue passenger kilometres (RPK) or total revenues (REV) might be used to model the airline-specific relevance of each OD.



One drawback of this approach is the analysis at individual airline level, meaning that all other carriers are treated as competitors. However, in reality, many carriers are part of the same airline group, following a series of mergers, acquisitions or as a result of the formation of subsidiaries. Hence, a second model run was done, this time for a modified dataset in which airlines were merged into airline groups (Table 1).

| <b>Airline Group</b>              | <b>Airlines</b>  |
|-----------------------------------|--|
| Aeroflot Group                    | Aeroflot, Rossiya, Orenburg Airlines, Donavia  |
| Air Berlin Group                  | airberlin, NIKI, Belair, LGW   |
| Air France-KLM (AF-KLM)           | Air France, Transavia Airlines, Transavia France, Brit Air, KLM, Regional, KLM Cityhopper                                    |
| easyJet                           | easyJet, easyJet Switzerland   |
| International Airline Group (IAG) | British Airways, Iberia, Aer Lingus, Vueling, BA Cityflyer, Open Skies   |
| Lufthansa Group                   | Lufthansa, Germanwings, SWISS, Austrian, Brussels Airlines, Lufthansa Cityline, Eurowings, Edelweiss, Air Dolomiti, Tyrolean |
| Norwegian                         | Norwegian Air Shuttle, Norwegian Air International   |
| SAS Group                         | SAS, Blue1, Wideroe  |
| Sunexpress                        | Sunexpress, Sunexpress Germany   |
| Thomas Cook                       | Condor, Thomas Cook Airlines (UK), Condor Berlin, Thomas Cook Airlines Scandinavia   |
| TUI                               | TUIFly, TUI Airlines Belgium, TUIFly Nordic, Thomson Airways, TUI Airlines Nederland, Corsair                                |

Table 1: Airline groups

At airline group level, AF-KLM is 2nd in terms of passengers and easyJet slips to third place. The CP of AF-KLM reaches 0.60, which is higher than KLM's CP of 0.40 and smaller than Air France's CP of 0.71 when calculated separately. The CPs of two of the big three FSNC groups, AF-KLM and IAG, are relatively close (0.6 versus 0.57, respectively), while Lufthansa Group only reaches a CP of 0.50, which seems to result from low individual CP's of Lufthansa's subsidiaries Austrian, SWISS and Brussels Airlines (+/- 0.45).

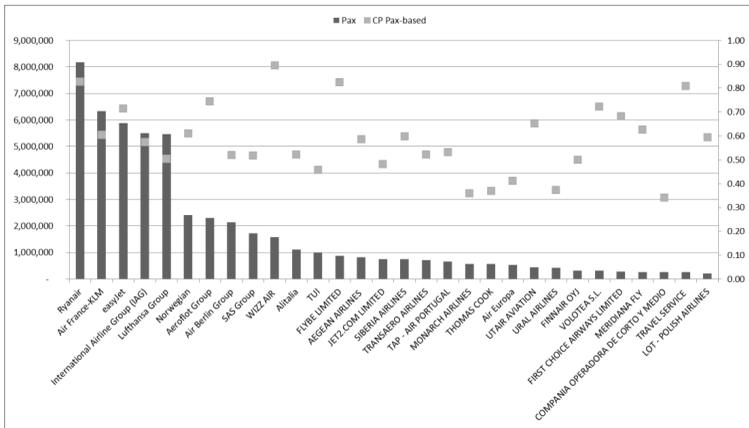


Figure 2: Competitive Position of Europe's 30 largest airlines and airline groups

## 5. Conclusion

Measuring an airline's competitive position is complex as airlines serve many different (direct and indirect) markets with varying degrees of competition. Hence, networks compete against each other, meaning that the "typical" competition assessment at the airport- or (direct) route-level may not be sufficient in all cases.

Based on traffic flow data at the OD-level, provided by Sabre Market Intelligence, this paper presents an approach to assess the competitive position (CP) of airlines at the network level, considering the actual competitive positions on each single OD in relation to competing carriers, as well as the relative importance of each OD in terms of OD passengers in relation to the airline's total passenger number. Large OD markets where an airline can operate free from competition contribute with a high value to the overall CP (which can take a maximum value of 1.00), while small OD markets where an airline has only a small market share will contribute only marginally.

Results for Europe for September 2015 indicate that low cost carriers like WIZZ Air (0.90), Ryanair or hybrid carrier FlyBE (0.83 each) score highest. This means that they only face limited competition on the ODs they serve. This does also apply to Aeroflot which serves many OD pairs for which most passengers do not chose other carriers, probably for geographical reasons. Heavily exposed to competition are leisure carriers like Monarch (0.36) which has a high degree of overlapping routes with easyJet, or Condor (0.4) and TUIFly (0.41) which compete against each other and many fellow carriers on routes to the Mediterranean.

The paper also considered the airline group level, to control for common ownership of carriers. It was found that Lufthansa Group scores lower with a CP of 0.5 than its competitors Air France-KLM and IAG, which can be explained by relatively low individual CP's of Lufthansa's subsidiaries Austrian, SWISS and Brussels Airlines.

Our approach might be useful e.g. for policymakers or regulators. For example, in cartel cases on mergers that might result in route or airport dominance, it could be worth looking at an airline's overall CP value (and at the simulated CP value for the merged firm) before e.g.

imposing route- or airport-specific limitations. Other, topical cases for the application of this approach could be questions such as on the competitive impact of low cost carriers or gulf carriers on the European network carriers. The latter tend to complain that more and more traffic rights for Gulf carriers would mean more (and unfair) competition for them, but it should be investigated if there really is that much competition at the actually relevant OD-levels, given that the focus of FSNC like Lufthansa is on the Europe-North East Asia axis while Gulf carriers are strong to South East Asia and Oceania.

There is a range of limitations to the approach. First, only the competition intensity on the same OD-pairs is considered, neglecting any competition from similar routes operated from and/or to alternative airports. Hence, the model should be enhanced to account for this, e.g. in defining multiple airport regions. In addition, the relative importance of the ODs at the carrier level could be modelled in weighting the OD-specific competitive positions  $CP_{ij}$  with revenue shares ( $REV_{ij}/REV_i$ ) rather than passenger shares, as those might better serve as proxies for the importance of each OD from the carrier's perspective. What is more, the role of alliances and joint ventures is not (yet) modelled.

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# **The Impact of the GCC/Etihad Railway on the Aviation Sector in the UAE**

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**Abstract:** The UAE, aligned within the Gulf Corporate Council (GCC) has a geographical advantage compared to most other countries in the world, with an average flying time of 8 hours to 2/3 of the world's population (Dubai Airports, 2016). The UAE encompasses various cultures and nationalities while housing some of the best airlines in the world including Emirates Airlines and Etihad Airways. With air travel congestions proliferating day by day and the GCC looking to formulate myriad ways to become a union that signals unity, similar to the European Union, they are relentlessly working to integrate both monetary usage and interlinking the transportation system. Retaining such factors in mind, the aim of this paper is to investigate the long term feasibility of a pan regional network, through rail services and the impact it can have on the aviation industry in the UAE. This paper being the first exploratory research paper delving into the topic, both qualitative and quantitative approaches has been resorted to in the form of in-depth analysis of literature review, interviews with industry experts and public surveys. The findings from the aforesaid techniques attest the argument of an adverse effect on the aviation stream with the introduction of the Etihad/GCC railway network in the UAE. While the GCC/Etihad Railway project is only due to be completed in eleven years by 2028, recommendations and implementation plans listed within this paper, play a significant contribution towards the betterment of the project.

**Key Words:** GCC, Etihad railway, transportation, aviation.

## **1. Introduction**

As it currently stands, the rail infrastructure in the Middle East is in the nascent stage and transportation in the region is conducted either through aircrafts, ships or road vehicles. Thus, studying the consequence of introducing a new form of transportation in the region is of significant importance in order to understand how it will affect other modes of transportation especially within the aviation industry. This report is important, as there is a severe dearth of studies on the rail as a form of transportation for both goods and people in the region. The rail project, officially known as the GCC Rail, will be connecting the six Gulf Cooperation Council countries: UAE, KSA, Qatar, Oman, Bahrain and Kuwait and is expected to translate into reality by 2028. Having said that, this paper is a noble attempt to explore the potential impact the upcoming GCC rail project can have on the aviation sector in the UAE. The UAE established in 1971, is a federation of seven Emirates: Abu Dhabi, which is the capital, Ajman, Dubai, Sharjah, Fujairah, Ras Al Khaimah and Umm al- Quwain respectively. With Dubai airports handling an immense amount of passenger flow, as seen in 2015, over 78 million people were recorded to have utilised Dubai airports facilities (Dubai airports, 2016). The former fact shows the inherent necessity of a rail service to help relieve the air traffic, abate carbon footprints as well as use this as an opportunity to expand current means of transport and introduce new sources of transportation such as rail.

Etihad Rail, established in 2009, is situated in Abu Dhabi, the capital of UAE and is responsible for the development and operation of the railway in the country. This project split into three phases. The first phase consists of the construction and operation of a line from Shah and Habshan to Ruwais, spanning a total length of 264km with seven locomotives in service and each train containing 110 wagons. Trial operations have been completed for Phase 1, and Etihad Rail has been granted approval to commence commercial operations, consisting of transporting 22,000 tons of granulated Sulphur, since December 2015. The second phase will be connecting the railway to Mussafah, the ports of Jebel Ali and Khalifa, and to the Saudi and Omani borders. Engineering groundwork is complete and tendering for contracts covering the

final design is in progress. The third phase will be extending the rail network from Dubai to Fujairah, Ras Al Khaimah and Sharjah (Etihad Rail, 2016). The fourth phase will see the connection of all the six GCC countries, which will happen by 2028.

The benefits that the country will obtain, after completion of all the phases, lies in terms of revolutionising the physical and economic landscape while simultaneously reducing the carbon footprint of the country. The benefits are perceivable from the following statement by the Chairman of the Board of Directors of Etihad, Mr. Nasser Al Sowaidi, “Recently the Federal Transport Authority – Land and Maritime had granted Etihad Rail approval to begin commercial operation Stage One, which has carried close to 4 million tonnes of Sulfur as of the end of December 2015 – the equivalent of more than 265,000 truck trips” (Chairman’s message 2016). Another statement made by the Chairman illustrates the concurrence of companies in the UAE who would use the rail for transportation of their goods, “To date, Etihad Rail has signed more than 50 Memorandums of Understanding with a number of customers throughout the Emirates – in industries ranging from petrochemicals and agriculture to aggregates and waste – all of whom recognise rail as the preferred mode of transport for their goods” (The Etihad Rail Story 2016).

The proposed rail network will be connecting the UAE’s centres of trade, industry, population and is expected to act as a catalyst for the region to encourage economic growth and social development. This project will inevitably redefine logistics and transport in the GCC. The potential for rail carriers to substitute for aviation has been documented in the European and several Asian settings, however, there is a need to explore how the rail network can serve as a complementary mode to abate airport congestions and provide customers with a better array of traveling options. On this note, this exploratory study will be the first of its kind to the best of the authors’ knowledge in exploring the impact that the GCC/Etihad railway platform will have on the aviation industry in the region. The findings of the study can act as a pathway for future studies in the development as well as the composition of laws and regulations binding into the Etihad and GCC railway platform.

## **1.1 Research Objectives**

1. To explore and analyse the published literature reviews on the effects the railway network from around the world has on the aviation network and its relation to the Etihad rail and GCC aviation network
2. To identify techniques and models from existing rail networks that can be implemented within the Etihad/GCC rail
3. To determine the potential effect of the rail network in the UAE for the transportation of people and goods
4. To identify the direct and indirect effect that the rail network will have on the aviation industry in the UAE

## **1.2 Motivation and Purpose**

The concept of rail as a form of transportation in the Middle East is an underdeveloped area of study and practice. The region has primarily depended on land-based transport, aircraft and sea movements for all means of transportation. Rail is a new concept that is being applied to the region, and at the moment there is a limited amount of credible literature pertaining to the GCC available that has studied the effect the rail may have. The shortage of GCC literature and

reports, therefore, acts as a primary motivator to undertake the given study. Another motivating factor for the study is based on the fact that the GCC, and the UAE in particular, are resolute on sustainable development and environmental protection. The introduction and extension of the Etihad/GCC railway network will assist in abating the soaring environmental concerns. This paper will also provide future academics the basic groundwork needed to continue studying the effects of rail in the UAE and the GCC.

## 2. Literature Review

The literature review outlined in Table 1 below outlines some of the relevant literature surfaced from various economic settings.

| Title   | Author                                       | Findings   | Methodology                                   |
|---|--|--|---|
| From Planes to Rails: Realising the potential from shifting short-haul flights to rails | Aviation Environment Federation (AFE) (2000) | <ul style="list-style-type: none"> <li>• Potential of shifting the short haul operations to rail in Europe and the environmental benefits it would bring.</li> </ul>   | Scenario approach                             |
| High speed rail operation on an existing network: An assessment model for China         | Wong, Han, Ferreira & Zhu (2002)             | <ul style="list-style-type: none"> <li>• Development of model to be able determine the extent to which HST operations on conventional rail lines are economically feasible and the results of which may be used to aid with the task of train planning and scheduling</li> </ul>               | Cost based analysis                           |
| High-Speed Rail & Air Transport Competition   | Adler, Nash, & Pels (2008)                   | <ul style="list-style-type: none"> <li>• Displays the need for analysis of different policy options in a network setting, taking into account the reactions of relevant competitors.</li> </ul>  | Cost-benefit analyses and Network based model |
| Analysing Competition between the High Speed Train and Alternative Modes                | Román, Espino & Martín (2010)                | <ul style="list-style-type: none"> <li>• High speed trains will have an impact on air travel with time &amp; scheduling</li> <li>• Time is a key component as far as competition is poised</li> </ul>  | Estimation of logit model from air and rail   |
| High speed rail and its impact on airline markets                                       | Butterworth-Hayes (2012)                     | <ul style="list-style-type: none"> <li>• Massive market share for High Speed Rail (HSR) in Europe + other markets (China) over air travel</li> <li>• Railways have severe effects on airlines market shares</li> </ul>   | Market share analysis                         |
| The Climate impact of High-speed rail and Air transportation                            | Clewlow (2012)                               | <ul style="list-style-type: none"> <li>• The environmental impact and costs associated with HSR are significantly lower than air travel</li> <li>• Substitution of air transport with rail could be performed through competition and complementarity of both modes with each other</li> </ul> | Primary research                              |
| When trains go faster than planes   | Jimenez & Betancor (2012)                    | <ul style="list-style-type: none"> <li>• HSR has reduced the amount of air transport operation by approximately seventeen percent in Spain</li> <li>• Competitive threat present that high-speed rails have to the aviation industry.</li> </ul>   | Econometric analysis                          |
| The impact of high-speed railways on routes with high air traffic density               | Clewlow, Sussman & Balakrishnan (2013)       | <ul style="list-style-type: none"> <li>• Rail travel times have a direct correlation with demand for short haul air travel.</li> <li>• The use of HSR led to a modest reduction in system wide air travel demand.</li> </ul>   | Empirical & Econometric analysis              |

|  |                               |   |  |
|--|-------------------------------|---|--|
| Eurostar to threaten budget airlines' dominance on London to Amsterdam service as it promises competitive prices | Davies (2014)                 | <ul style="list-style-type: none"> <li>• Introduction of railways reduces market share of airlines</li> </ul>   | Analysis of market shares and annual reports of airlines |
| Cross-border Barriers to the Development of HSR Projects: Analysis of the Singapore- Kuala Lumpur High           | Mori (2014)                   | <ul style="list-style-type: none"> <li>• The impact of the rail network from both Singapore and Malaysia's point of view</li> <li>• Benefits of HSR to the economy</li> </ul>   | KJ-Method CLIOS  |
| Competition and cooperation between HSR and air transportation in Europe.  | Albalate, Bel & Fageda (2014) | <ul style="list-style-type: none"> <li>• There is direct competition between high speed rails and airlines, however both modes can play a complementary role if the HSR can provide feeding services to long haul air services in hub airports</li> </ul> | Supple orientated empirical analysis                     |
| The effect of rail travel time on airline fares: first evidence from the Italian passenger market                | Capozza (2015)                | <ul style="list-style-type: none"> <li>• Rail travel times affect the pricing strategies of airlines</li> </ul>   | Empirical analysis                                       |

Table 1: Literature review

A review of prior literature documents a vacuum in studies related to the GCC setting and therefore the current paper will contribute to existing research by being the first of its kind to explore the potential impact of the proposed GCC/ Etihad rail project on the aviation sector in the UAE.

### 3. Theoretical Model

Several models can be used for the Etihad Rail to develop the rail infrastructure, however, to create an integrated system that complements different modes of transport, it is the intermodal and multimodal transport models that are suggested to be used (Figure 1). Although the two terms are used interchangeably, there are fundamental differences between the two.



Figure 1: Intermodal model (Manadaadiar , 2013)

Firstly the intermodal transport, according to Manaadiar (2013) is the movement of cargo from the origin to the destination through the use of several modes of transport. The idea behind intermodal transport is that each of the modes has a different transport provider with their independent contracts. This essentially means that there are multiple carriers during a single journey. The benefit of using this model is that terms can be negotiated separately with the different entities involved. This would, however, require more overhead costs due to the need to track multiple contracts in place with the transport providers. This would also entail the additional task of the coordination of delays by informing one company of a delay by another company.

Multimodal is based on the same concept, which is the movement of cargo from origin to destination; however, the fundamental difference lies in the fact that although there are multiple modes of transport, the same company handles them all necessitating a single contract. This can either be done by entering into contracts with a company that has all the modes of transport needed or by hiring an agent to act as the middleman and conduct the negotiations based on the requirements listed. The benefit of this model would be the reduction in overhead costs. Nevertheless, this method can be expensive compared to the intermodal method since negotiations are not conducted separately.

If Etihad Rail is looking to invest in building an infrastructure that is based on complementarity rather than competition, the company is recommended lean towards the use of intermodal transport. The rationale behind this statement relies on the fact that Etihad Rail firstly does not have a sea freight division and secondly it will be interacting with different rail companies that the country borders, hence raising the requirement for multiple contracts. The concept of complementarity in Etihad Rail comes from the construction of rail stations in the major ports of the country, which would allow faster, cheaper and more efficient movement of goods in the region. Less time and money will be wasted on changing the form of transport as rails are typically equipped to handle goods that range from time sensitive materials to large volumes of goods, hence allowing for a faster and more effective “change of hands”.

#### **4. Hypothesis Formulation**

The Etihad Rail represents a significant step in the country’s path to diversifying and developing itself and acts as a catalyst for the region. The introduction of a supplementary form of transportation in the country will inevitably have an effect on the aviation industry and other types of transportation. The question arises on the significance of this impact, as the size of the ripple effect needs to be understood. To recapitulate, Davies (2014), points towards significant impacts and factors such as airline fares, the demand for air travel and general domestic competition, which will be challenged by the railway network. In a similar vein, Jimenez & Betancor (2012) prove that there is heavy competition between rail and air as the HSR in Spain reduced air transport by 17%. Additionally Janic (2003) looks at how the environment will benefit from the introduction of the rail. Furthermore, Capozza (2015) elaborates on how airlines differ their pricing according to the scheduling and times of rail networks while Clewlow, Sussman & Balakrishnan (2013) voice similar opinions, stating that rail travel times have a direct correlation with demand for short-haul air travel and how it has brought down worldwide system demand for air travel.

Lending support to the former findings, the introduction of the Etihad/GCC rail is deemed to have an adverse effect on the aviation sector, from an economical, demographical as well an environmental point of view. The proposed Etihad/GCC railway line will connect more cities and district that have no access to airports, which in turn would create jobs and boost the overall

economy's Gross Domestic Product (GDP). From an environmental stand, the railway service will considerably cut down emissions while transporting the same or more passengers than air travel does (Janic 2003). With a model such as inter-modal or mass rapid transport system being in place, the aviation sector will have fierce competition from the rail service as they will not be able to match attributes such as pricing structure, connectivity, timings, flexibility and comfort. Based on the literature review and the arguments put forth above, the introduction of the rail network will have a significant impact on other means of transport in the UAE, particularly the aviation sector.

Thus the hypothesis stands as follows,

H1: *Ceteris Paribus*, the rail network will have a significant impact on the aviation sector.

## **5. Methodology and Data**

The exploratory nature of the study made it imperative to conduct a qualitative and quantitative research design. Interviews and surveys were carried out in order to gain a deeper understanding of customer perceptions and thereby test the hypothesis. According to Tansey (2007), interviews are considered to be the apt method for process tracing research. In this paper, open-ended questions were asked during the interviews with senior university professors with extensive industry experience. Close-ended question surveys were conducted to 500 individuals within Emirates Aviation University and the public in Dubai (Airports, Malls, Travel depots) in order to understand the "customer/passenger" view on the proposed project. To test the reliability of the questionnaire a Cronbach's alpha test was performed to judge the extent of dependability with which the instrument is successful in measuring 'what it is intended to measure or to infer'. Bland and Altman (2007) states that the Cronbach's alpha determines the internal consistency in the survey instrument. Results reveal a score of 0.67(rounded as 0.7), which further attests the reliability of the construct. Nunnally and Bernstein (1994) and Streiner and Norman (2003) recommend a reliability score of 0.7 and above while employing survey instruments. Convenience sampling, a non-probability sampling technique was adopted based on convenient accessibility and proximity of subjects to the researcher. Once interviews were conducted, the information was processed to infer the general trend in the expert's perceptions. Results obtained from surveys were tabulated and transformed into an analytical format, which helped the researcher understand the effect, reasoning and response regarding the validity of the set hypothesis.

## **6. Results and Findings**

### **6.1 Interview Analysis and Findings**

The interview analysis revealed that all three-industrial experts appeared to be sceptical towards the entirety of the project, however, this is expected as the project is early in its time frame (10 years till completion). All of them share the common outlook that the railway service would initially play a bigger competitive role on cargo than on passenger service until the entire project has been completed. They embarked on comparing the proposed rail service to existing rail services in other countries and stated the disadvantages the former had such as, relative slow speed, lack of "rail" culture in the middle east, target market and pricing uncertainties as compared to other rail networks,. Two out of the three experts concluded that the proposed rail would not be a competitor to air travel but will, however, be part of the transportation scheme and will be a benefactor in a scheme of MRTS (Mass Rapid transport system), a complimentary form of transport. The hypothetical question that was asked regarding expansion into other continents were all turned down with a conclusive answer that in order for the service to have

any source of existence, Iraq, and Syria, which are currently war-torn countries would have to be completely neutralised and stable, a scenario which neither of them saw possible in the near future. Finally, they concluded that there would be adverse competition between cargo rail and air courier services as it would be a much more economical means of transport. The industrial experts' opinions had a sense of commonality in them, stating that there is a lack of culture for this form of transportation in the GCC, negating the car users of freedom and the air travellers of "wasted" time. The industrial experts' also stressed the importance of having schemes such as the MRTS and encouraged initiatives from the government and private entities to consider investing in leisure rail services, such as the EURO STAR. While suggestions were given, there were also some concerns that were addressed such as security, pricing, time, technological preface, border control and visa constraints for expats and locals.

## **6.2 Survey Analysis and Findings**

The survey responses were as expected with a mere refraction of anomalies. The first question looks into whether adverse competition will be faced from the aviation sector with the introduction of the Etihad/GCC railway, for which 78% surveyed agreed that there would be imminent pressure and competition faced by the aviation sector due to cheaper fares and several station depots in relation to limited airport feasibility. With similar intent, question two looks into whether there will be a reduction in road traffic due to the introduction of the Etihad/GCC railway network, to which 52% of the surveyed audience merely agreed that there would be a reduction, whilst 48% of respondents believed that the traffic would only penetrate cargo/truck users which doesn't constitute much of traffic within the UAE and GCC. Question three looks into the realistic approach of whether the surveyed individuals would use the service over other existing services when travelling within the GCC, to which a profound 74% said they would use the service, citing that it would not only be a new experience but it would also be an experience that would be more flexible and economical. Furthermore, question four looks into whether individuals would use the rail system on multiple journeys a month within the GCC over air service, to which a strong 63% of those surveyed agreed they would use rail over air, stating similar reasons to the previous question, noting the economic factors and flexibility of timing and destination, whilst the 27% who disagreed went on to mention how the rail service would take almost double the time of air service. They emphasised the adage that "Time is money, and money is time" therefore enforcing time would be lost along with probable money and opportunities. Taking forward the notion that "time is money and money is time" question 5 was framed to see if the speed at which the Etihad/GCC rail is expected to run at (210 Km/h) is considered too slow, too fast, or runs at a perfect speed, for which 68% of the answers leaned towards the fact that the current projected speed is sufficient and would meet the purpose of rail transport sufficiently. Meanwhile a profound 32% concluded that in comparison to 21st century technology available, such as the bullet train, the speeds used for the Etihad/GCC railway was considerably slow/slower to current market trends and needs. In relevance with technology and its justification towards the Etihad/GCC railway platform, question 6 looks into whether the form of rail, as a new mean of transportation within the GCC, is a feasible option, or if it is considered as going back in time, as in the modern day and age there are better alternatives and upcoming forms of short and long distance mass transportation. Eighty two percent (82%) surveyed disagreed that this notion was going back in time, and there was another form of technologically aided transportation that is available in the market to substitute this form. However, few respondents went on to compare technology that is currently existent, like the bullet train and upcoming modes of transportation such as Elon Musks Hyperloop. To conclude the researcher examined the possibility of further extension of the GCC/Etihad Railway once completed with other railway networks around the world, such as railway networks in South Asia and Europe, to which an astonishing number of individuals went on to

disagree. They expressed that it could be realistic in 100 years' time, whereas in the near future no such development can occur due to routes enabling connectivity to other railway networks would mean services relying through unstable, war-torn countries such as Syria and Iraq which are not realistically prominent countries to have a railway network running through.

### **6.3 Overall Analysis and Findings**

The interviews and the surveys helped the researcher to compare, contrast and collectively conclude on the opinions of industry experts and the general public in relation to the proposed project and hypothesis. While the panel of industry experts interviewed, seem to gravitate more towards a higher potential in the direction of cargo over passenger service, the general public begged to differ, welcoming this new form of transport to the region. In conjunction with the hypothesis, it is conclusive that the industry experts and the general public agree that there will be competition and thereby an effect on the aviation stream from the new railway network. The industry experts' point of view however projects that it would entail some time before human mentalities are convinced to use the passenger rail. Additionally concerns such as border control and security need to be unified and looked into detail to attain success in the passenger sector. Lending support to prior literature and the findings from the current study, the null hypothesis implying that rail sector will have no significant impact on the aviation sector is rejected thereby accepting the alternative hypothesis that there will be a significant impact on the aviation sector with the advent of the Etihad Rail.

## **7. Implications**

### **7.1 Policy Implications**

The GCC railway is connected to the six Gulf countries. With the current policies, it is going to be very difficult for passengers to travel as they would have to get a visa for each of the six countries as there is no single region visa. This is why it is required that some changes in the policies need to occur regarding visas between the GCC countries. Suggested in the recommendations is the introduction of a visa that enables the passenger to travel freely between the GCC countries, and thus policy changes and implementations would be seen, in an all GCC visa enabling expats and citizens to travel freely between the GCC countries.

### **7.2 Academic Implications**

This research is going to be beneficial for any individual or research group intending to do research on the railway or is looking for information regarding the GCC/Etihad Railway. The research conducted provides preliminary data regarding the GCC/Etihad railway network and also includes predictions and forecasts for how it may perform once completed. Therefore the information presented in this paper, with consideration of the limitations and recommendations, will give future academics a reference point to continue further studies.

## **8. Limitation and Recommendations**

### **8.1 Limitations**

The paper is however not free from limitations. Due to the completion of the project study being 12 years away in 2028, certain concrete and confirmed details such as rail timings, stations, names and dedicated routes for the Etihad/GCC railway network were not able to be gathered. The extreme dearth of secondary research to comprehend and acknowledge the primary data collection posed as constraints in unveiling a comprehensive picture of the scenario.

## **8.2 Recommendation for Successful Implementation of the Etihad Rail**

1. Interlining of current modes of transportation with the Etihad/GCC Rail (MRTS): Mass rapid transport system (MRTS) would be a great system that could be implemented into the railway network of the UAE in order to achieve better efficiency rates as well as encourage more people to use the service. MRTS would interlink the current transport system existent in the UAE such as metro, bus, taxi and water taxi with the addition of the railway line.
2. The positioning of railway station and proximity: Railway stations should be positioned with city centres of each city and country with proximity to residential and business districts. This would then be easy for passengers to be connected with their final destinations and encourage them to use the service.
3. Encouraging business interest: Business and corporation, especially in the travel industry, should be invited to participate in the rail service. By this, private entities should be enabled to use the rail lines providing tour luxury tour services encompassing the entire GCC as one package. This model will be seen successful within the GCC rail as it would allow a passenger in a given span of time to go all over the GCC using the railway network in a comfortable, relaxing and luxurious manner.
4. Security: A method of security procedures need to be derived in a manner that will be quick and hassle free unlike what is observed in the airport, or it will discourage passengers to use the service. However, while this derivation takes effect, security should be at the peak of brilliance as it is an imperative artefact of the entire project being a success and continual success.
5. Implementation and development of all GCC Visa for expats: The development and formation of an all GCC visa for expats is key to the entire operation being successful. Most GCC countries being predominantly made up of expats (75%+ average made up of expats), today are required to have a visa in order to visit another GCC country. A scheme needs to be implemented within the GCC, giving both residents and tourist the flexibility and freedom to travel within the GCC using the railway network with complete ease.

## **9. Conclusion**

The introduction of the railway network to the UAE is deemed to bring immense benefits to the people and industries in the UAE and GCC. This project will provide another platform for transporting cargo and passengers whilst being an economic benefactor to the economy. It will aid in reducing carbon emissions and triumphing the air carrier services in price, flexibility and convenience in the near future. As studied from the literature review there are significant benefits that the GCC/Etihad rail can bring to the region. The proposed plan will help build a healthy competition between the rail network and air carriers, however, with factors of the GCC being in play, industrial experts' opinion that the effect will be primarily felt in the cargo segment over the passenger segment. The surveys and interviews conducted with the industry experts helped to conclude that there is a necessity for this form of transportation with consideration to attributes that need to be improved in order to have an optimum operational capability and cargo/passenger turnover as mentioned in the paper. Most corporations and industries will exploit the cargo division of the project, the division being economical as well as convenient regarding intermediate transportation. Eventually, passengers will also benefit from the system which offers a form of transportation that is economical and more point to point based.

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# **The Application of Lean Thinking: An Example of Ground Handling Operations at an International Airport**

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**Abstract:** Lean Thinking (Lean) has emerged as an improvement philosophy and operational methodology for manufacturing organisations to more effectively meet customer requirements. Critics however, question whether Lean is applicable outside manufacturing and question, in particular, a reliance on project-based methodologies to deliver longer-term sustained improvement.

This paper provides examples from both the Health and Aviation sector to discuss Lean implementation outside manufacturing, describes a practical example of specific ground handling operations at an international airport and concludes that while process-focussed improvement can deliver tangible productivity benefits, the sector as a whole would profit from adopting a more balanced integrated approach.

**Key Words:** aviation, aerospace, Lean thinking, customer focus, adding value.

## **1. Introduction**

### **1.1 The implementation of Lean**

Under pressure to remain competitive in the face of global competition the manufacturing sector sought ways in which to address the need to improve customer quality and reduce costs. Based upon the concept of Just in Time (JIT) and the Toyota Production System (TPS) developed by Ohno (1988), and as a result of the study of the Japanese automotive manufacturing industry (Krafcik, 1988) Lean emerged as a more effective way for manufacturing organisations to meet customer requirements; for what they wanted, when they wanted it and at a price that they were willing to pay.

Basically, Lean is about getting the right things to the right place, at the right time, in the right quantities, while minimising waste and being flexible and open to change. Consisting of a philosophy and a set of principles that focuses on the creation of ‘value’ for the customer, delivered using tools and techniques that assist in the identification and elimination of ‘waste’ within the system which leads to the redesign (or design) of the [manufacturing] system. The TPS emerged over some considerable time and as a result of a pragmatic approach to addressing the need for improvement within Toyota’s own production environment (Seddon, 2008). Initially, Lean principles and practices were similarly applied to manufacturing facilities within the automotive sector more globally (Womack et al., 1990) but are now firmly established in many manufacturing and service sectors.

Ohno identified and categorised seven wastes for manufacturing. Adapted to address a service context these include:

1. Overproduction - undertaking activity ‘just-in-case’ and / or in a batch. This also contributes to constraining steps in the customer journey by feeding in inappropriate work or the wrong batch size.
2. Inventory - this refers to materials but can also be translated as the customer. Holding inventory works against quality and effectiveness, making it hard to identify problems.
3. Waiting - refers to a customer or material waiting, instead of moving at the pace of customer demand. Waiting can be a result of variation in the process.

4. Transportation - any movement of a customer or material is wasteful. Although you can't fully eliminate transport, you should aim to reduce it over time. When process steps are located next to one another, it's easier for you to visualise, identify and resolve quality issues.
5. Defects - a defect which is passed along the process can escalate the impact of the initial defect, leading to duplication of effort through rework. The aim is for zero defects.
6. Staff movement - unnecessary movement in the workplace relates to layout and organisation.
7. Unnecessary processing - using complex equipment or processes to undertake essentially simple tasks.

Wastes, (or non-value added) inherent in all processes, if identified, represent an opportunity through the application of Lean to increase efficiency, productivity and profit levels through increased quality, reduce costs and improved delivery of service.

However, as has already been identified; the origin of TPS (and therefore Lean) is not the result of a theoretical framework but of a practice-based approach developed as a result of studying and responding initially to problems within the [Toyota] organisation itself. Work that resulted in a focus on improving the 'flow' or 'throughput' of work within the [manufacturing] system, not simply on the creation of a set of tools to identify, reduce or eliminate waste. According to Narasimhan et al. (2006), more holistic in nature, it is the application of this system-wide perspective within a culture, with a belief and understanding of Lean that exposes the wastes within the system that can then, subsequently be addressed. According to Radnor, (2010) to many within manufacturing, this systems-wide perspective which cuts across functional boundaries has proven to be a challenging concept to apply in practice, requiring more time and using scarce resource to implement and deliver tangible benefits.

This has resulted in a focus on the application of Lean tools and the delivery of improvement through their deployment in support of a series of discrete improvement project or events – often described as Kaizen Blitz (Laraia et. al., 1999) or Rapid Improvement Events (REI's) where results and therefore benefit can be secured more quickly (Morgan, 2006). However, one possible consequence identified is that of delivering a sub-optimal outcome that fails to address root cause (Hines et al., 2007). Despite this concern and while not without its critics (Hines, 2004), interest from other industries and spheres of activity in this particular model has resulted in examples of the successful application of adapted Lean Thinking (Radnor, 2011).

## **1.2 Lean: Application in the Service Sector**

Although the boundaries between product and services are becoming increasingly blurred, with many manufacturers offering services in support of their products (Heineke & Davis, 2007), there are differences between the service and manufacturing function (Bowen, 1989). The most obvious difference is that service industry produces an intangible output, that the production of the intangible product happens simultaneously with its consumption, and that the product does not exist until it is required by the customer. As the service is requested by customers, employees are obliged to meet their needs and provide them with the service, which makes the system labour-and knowledge intensive while the direct interaction between the service receiver and the service provider makes the human elements extremely important. A further important distinction between the provision of manufacturing and service is that in manufacturing, quality is assured through adherence to specification, measured quantifiably

during production, whereas in the provision of service, quality is perceived by the customer and often is not measured until after the delivery through, for example, customer feedback. While these differences have led some to question the value of the application of Lean in the service sector (Arfmann, 2014) practical case studies would suggest that Lean is pertinent to the service sector evidencing successful application in the retail sector, call centre functions, public sector services, healthcare provision and aerospace (Garner, 2009). Lean brings into these industries, as appropriate, concepts, tools and methods that have been effectively utilised elsewhere to improve process flow; tools that address workplace organisation, standardisation, visual control and the removal of non-value added steps in order to address customer expectations by improving flow and eliminating waste.

### **1.3 Lean in Practice**

Behind pensions the biggest single national (UK) expenditure is on Health (circa £130Bn annually). A small incremental improvement in healthcare for example, would therefore have the potential for significant annual savings. Thus, in 2007 as a response to both economic pressures and the requirement to find a way of working smarter rather than harder – and thus freeing up time to focus on the priority areas of care, and putting patients firmly at the centre – a national Lean in Health Care initiative was developed. Led by the National Health Service (NHS) Institute for Innovation and Improvement (now NHS Improving Quality) ‘The Productive Ward – releasing time to care’ provided a structured, effective and supported framework to promote Lean improvement activities in hospitals, with the objectives of empowering staff, releasing time and resources and to provide improved delivery of quality focused, safe clinical patient care (NHS Institute for Innovation and Improvement, 2007). This programme has resulted in a significant number of published case studies of tangible Lean improvement within healthcare providers. Examples include:

Wolverhampton’s New Cross Hospital first implemented The Productive Ward on its Paediatrics unit. The programme helped the unit to increase the direct care time it delivered to patients and their families from 21% to 35%, as well as significantly reducing time staff spent in motion (staff movement) from 100 minutes per shift to just 20 minutes.

Portsmouth Hospitals sought to provide an improved patient experience and greater efficiencies across the service and deliver a reduction in length of patient stay. There were four components to this: ensuring that the right beds were in the right place; reducing the length of specific high risk groups; streamlining a complex discharge process in order to get patients discharged more quickly; and to have a predicted date of discharge for every patient. This initiative contributed 15% to ‘length of patient stay’ savings.

### **1.4 Lean in the Aviation Sector**

The Engineering and Physical Sciences Research Council (EPSRC) in collaboration with forty-five organisations from the Society of British Aerospace Companies (SBAC) funded the UK Lean Aerospace Initiative (UKLAI), a unique and wide ranging national research programme involving a leading consortium of UK universities and the US Lean Aerospace Initiative at MIT. Designed to provide an opportunity for the UK aerospace industry to benefit from the efficiency gains achieved elsewhere using a Lean approach, this design and manufacturing focused initiative resulted in a number of improvement examples throughout the aerospace supply chain.

Within the aviation sector, initial applications of Lean have been established primarily within the Maintenance, Repair and Overhaul (MRO) function that is closely related to manufacturing and while no unified approach to the implementation of Lean has so far emerged – supporting the findings by Petersen (2009) – examples do exist of alternative approaches to Lean being implemented within this area, for example:

As an implementation strategy the Lean Management Programme at Lufthansa Technik identifies most closely with the Kaizen Blitz approach where, as an organisation, they have internally interpreted the Lean concept as a three stage implementation; ‘Lighthouses: focussing on the introduction of tools and techniques’, ‘Steering with Lean: concentrating on the development of monitoring and improvement measures’ and ‘Lean as a Culture: training and development to support changes in attitudes and growth in abilities’.

This represents a single example of an organisation seeking to use Lean to deliver a paradigm shift, however, Aveni et. al. (2011), in a paper designed to provide an insight into the state-of-the-art of Lean within the aviation MRO industry, found the focus on Lean to be predominantly projects-based and directed towards waste reduction; a cost-down approach rather than a focus on the creation or enhancement of [customer] value. For example:

Faced with the competitive challenges of reducing costs to increase revenue, Fedex, in completely redesigning its Los Angeles airport facility, exemplifies this ‘cost-down focused’ implementation strategy, using Lean principles to increase capacity with existing resources (Bartholomew, 2009).

In the same paper, Aveni et. al. also concluded that while industry inhibitors to sustainable implementation do exist, including the vulnerability to both external and internal demands and fluctuations e.g. passenger volume and difficulty in forecasting which, would seem to contradict the ideals of Lean, it never-the-less remains widely interpreted as a viable approach within the aviation sector (Haque, 2004), with further examples of the implementation and application of Lean to wider service functions continuing to emerge. Examples shared at the recent Lean Flight Initiative Conference in Amsterdam (2014) would seem to support this view and include:

Using Project-based, Kaizen workshops with cross-functional teams employing Deming’s PDCA iterative four step model for continuous improvement and using a selection of basic Lean tools and improvement techniques include 5S for workplace organisation, visual management, Poke-Yoke mistake proofing and A3 problem solving, Icelandair have created a Lean cabin success story with on-board supplies reduced by 80kg, an optimised trolley set-up reducing waste in motion and the implementation of visual management and standardised work at one of their handling company providing more effective replenishment.

Fedex used the principles of Lean to establish a new cargo appearance standard to be used world-wide. A team of Fedex and vendor employees undertook a fact-gathering exercise to create a picture of the current situation – a ‘current-state map’ – of current procedures, practices, materials and products and redesigned the process to provide a ‘future-state map’. iPad based, this uses standard operating procedures (SOP’s) to provide standardisation and employs visual management – colour and simple icons for windows, flight deck, jumpseat and hard surface areas, galley and food box areas, toilets

and for the cargo area – to link SOP’s to aircraft cleaning ‘zones’. Additionally, redesigned vendor cleaning verification has also improved the reliability and timeliness of information reporting.

Through case studies, Radnor et. al (2006), identified two models of the implementation of Lean. Full Implementation, a systems wide perspective linking to organisational strategy, embedding Lean principles, associated with the broad use of different Lean tools including the use of Kaizen or Rapid Improvement Events (RIE’s) to deliver improvements. And the more prevalent RIE approach, designed to make small, quickly introduced changes. In the same report while it was noted that this approach provided a faster return for effort (quick-wins), without challenging existing management control styles or structure it may not lead to improvement being sustainable due to the lack of strategic integration.

## 2. Methodology

### 2.1 Research Approach

Literature has been used to evidence the implementation of Lean outside manufacturing associated with the provision of services; including those associated with the aviation industry, along with examples of the typical tools and techniques used. Based on Masters-level study, this paper utilises a case-example to describe the application of Lean, to Ground Handling Operations carried out by Company ‘A’ for narrow-bodied aircraft at an international airport. The findings from this primary research are used to confirm the secondary data provided through literature.

### 2.2 Company ‘A’ Ground Handling Operations

Aircraft turnaround time (TAT) is a crucial element for airline schedule adherence with on-time performance (OTP) a key metric affecting both customer satisfaction – where punctuality is a customer top priority; being able to depart and arrive on time and to retrieve their bags quickly –and economic productivity.

Turnaround is complex, not simply in terms of the many participating agents but also in the factors that can impact on reliability. According to the International Air Transport Association (IATA), who provide a standardised coding method for airlines to report on commercial flight departure delays these factors include those relating to; passenger and baggage handling, cargo and mail, aircraft and ramp handling, technical issues, damage and/or equipment failure, operations and crew, weather, Air Traffic Control (ATC) and crew or aircraft rotation for example.

Using IATA delay codes, information was collected on flight delay occurrence over a period of seven days. Pareto analysis identified that of the seventy-seven reasons recorded eighty percent were attributable to eleven reasons for delay. Of these, Company ‘A’ were identified as responsible for only two associated with Aircraft and Ramp Handling as shown in Table 1.

| Delay Code | Description   | # of Delays |
|------------|---|-------------|
| 33         | LOADING EQUIPMENT, Lack of and/or breakdown; lack of operating staff    | 50          |
| 39         | TECHNICAL EQUIPMENT, lack of or breakdown, lack of staff, e.g. pushback | 35          |

Table 1: Reason for Delay

Through an improvement team approach and using cause and effect analysis – one of the basic Lean problem solving tools – further analysis of the possible causes of loading delay (33) were identified. While a number of factors are normally involved, it was the lack of available equipment (belt loaders) that became the focus of further investigation. The analysis of belt loader usage over a twelve-month period of day-time operation identified an average usage of 18% overall. Further investigation through observation recorded multiple times when staff was waiting, particularly at peak times. The conclusion drawn was that sufficient belt loaders existed however; they were not always in the correct location when needed leading to productivity losses.

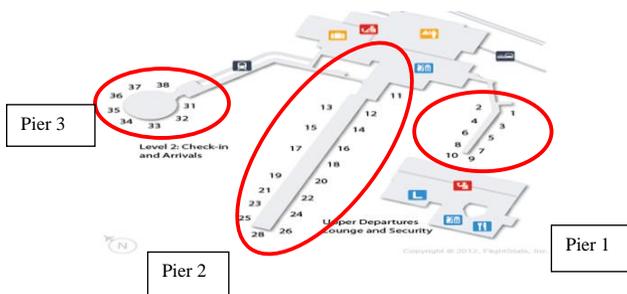


Figure 1: Terminal Piers 1, 2 and 3

Developed by Shigeo Shingo, (1985) Single Minute Exchange of Die (SMED) is a system used in Lean to dramatically reduce machine changeover (or set-up times). In SMED, change-overs are made up of two elements; internal– that must be completed when equipment is stopped and external – that can be completed when equipment is running. This same mind-set can be applied to this situation i.e. making elements associated with the positioning of equipment external, and thus prior to deplaning and baggage offload which are clearly internal elements associated with TAT. And to address the issue of not just when, but where equipment is needed, the broad principles of cellular manufacturing (group technology) can be applied to group or locate/ co-locate equipment needed to perform a particular set of functions (Hill, 1993). In order to minimise transport requirements, each of the three piers, as shown in Figure 1, were designated as ‘cells’. Based on scheduled time of arrival (STA) and scheduled time of departure (STD) equipment (belt-loaders) were allocated to each cell based on actual usage recorded over a ten-day period in the month of August for piers 2 and 3. At a peak during this period, when considered independently, theoretically pier 2 required five belt-loaders and pier 3 required three (a total of eight). Additionally, applying the rules associated with cellular manufacture Piers 2 and 3, due to physical proximity can, if needed, share resources and therefore taking account of scheduled timing requirements that total could be reduced to six. Further analysis revealed that actual arrival and departure times differed from those scheduled. The average variance was thirty minutes for arrivals and fifteen minutes for departures, but delays peaked between the hours of 13.30 and 14.15 during this same sampled period. When this pattern is taken into consideration the number of belt loaders required during this peak period needs to increase by one, to a total of seven, to provide an acceptable margin of safety. If adopted these proposed changes would represent a notional increase in equipment utilisation of circa 14% and a reduction in the recurring cost associated with annual equipment leasing.

### **3. Key Findings**

#### **3.1 The Applicability of Lean beyond the Manufacturing Related Context**

Literature has identified the development of TPS as an empirical process designed to address the need to provide continuity in process flow and offer a wide variety in product manufacture and Lean as the management philosophy derived from it. And while Lean principles have been shown to have wider relevance, literature has also demonstrated that implementation practices that work well within the manufacturing context require adaptation if the necessary balanced integration required between Purpose, People and Process, as espoused by Womack (2006) is to be realised. Further, literature suggests that this adaptation even in manufacturing, but more so outside this environment, is resulting in organisations adopting a project-based methodology, focusing on process to deliver improvement in business purpose while neglecting the people (cultural) aspects associated with Lean. While delivering short-term benefits this has led some to question the longer-term sustainability of this approach.

#### **3.2 Examples of Lean Implementation outside Manufacturing**

Associated with the Health Service, ‘The Productive Ward – releasing time to care’ is atypical of the application of Lean outside manufacturing. While project-based improvement is advocated unusually a unified approach is provided to deliver a structured, effective and supported framework. It also provides to inform, educate and empower staff in support of the improved delivery of quality-focused safe clinical patient care. And while only two improvement examples are provided in this paper many more exist within the wider repository of web-based and other resources available to both health practitioners and those beyond the sector seeking to deliver improvements in levels of service.

In the aviation sector a paucity of published material would suggest that the application of Lean is less mature. And while the Lufthansa Technik step-wise programme acknowledges the need, there is little other evidence of the emergence of an established unified implementation approach, even in the quasi-manufacturing MRO industry and despite the emergence of the UK Lean Aerospace Initiative (UKLAI) to promote Lean practice within the sector and throughout the supply chain. Never-the-less it seems clear that the tools and techniques associated with Lean are being used to deliver improved customer value. The example from Icelandair illustrates the use of Deming’s improvement cycle for continuous improvement, 5S for workplace organisation, visual management, Poke-Yoke mistake proofing and A3 problem solving while Fedex in seeking to improve the cargo area cleaning standard used current-future state mapping to collect data and visualise the improvement opportunity and SOPs to reduce variability through standardisation.

#### **3.3 The Example of Lean Application in Company ‘A’ Ground Handling Operations**

While this example is not part of any concerted initiative by Company ‘A’ to introduce Lean into their organisation it has served to demonstrate the potential for the delivery of improvements and productivity benefits through the application of Lean practice. Tools associated with Lean thinking have been used to provide the systematic collection and analysis of data on the current state, to understand the problem and to propose a cost effective solution involving process change to improve productivity and reduce recurring costs in this particular area. The use of Lean thinking in the scrutiny of this particular area is an approach that has been acknowledged by the organisation as providing potential to deliver improvement and benefits in other areas of their business involving the questioning of a number of their current established practices.

#### 4. Conclusion

Lean is applicable outside manufacturing but not without the adaptation and development of the core principles of Lean that recognises the context in which it is being adopted. Competitive commercial pressure has led organisations to steer away from the development of Lean principles within their sector that would seek to integrate People, Process and Place, and instead adopt project-based methodologies that are directed predominantly towards Process improvement and focussed on delivering near-term productivity gains. That this methodology – most often associated with a cost-down approach has been questioned by some critics as being unsustainable in the longer-term, as teaching Lean as the application of tools and techniques only, can miss the point of a change in culture, instead directing thinking to seek resource reduction which can have the propensity to result in improvements that may merely move the constraints or problem somewhere else along the process chain resulting longer-term, in busier people, who then themselves are less able or willing to engage in improvement activities. Acknowledging that the implementation of Lean in the aviation sector is some way from being considered mature the example of Lean in Healthcare might therefore serve as a sector-led exemplar to inform future practice.

#### 5. Acknowledgements

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# **Airline Accidents and Airline Legislations: A Case Study Approach**

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**Abstract:** Market demand and traffic volume for air travel have significantly risen since the advent of commercial aviation, which in turn has accentuated aviation safety and security concerns in the aviation world. To identify what undermines safety and causes aviation accidents, the researchers have adopted a qualitative approach where both an in-depth analysis of prior literature in parallel with twenty fatal airline accident case studies have been scrutinised, thereby identifying four actors namely pilot error, mechanical failure, weather related factors and sabotage as the prime factors leading to aviation accidents. Additionally, the paper employs the ‘Swiss Cheese Model’, a concept frequently used in critical safety domain to underpin the significant relationship between the identified four factors and aviation accidents. Ironically improvements and amendments in regulatory regimes are implemented only after the occurrences of fatal accidents, therefore the study is also significant in terms of providing a comprehensive picture of the legislation amendments post major accidents.

**Key Words:** aviation accidents, pilot error, weather, mechanical error, sabotage.

## **1. Introduction**

Air travel has become a key driver of economic, social and cultural development worldwide by revamping the traditional means of travel and interaction among people and businesses. Since mid-1980’s commercial passenger numbers have soared by almost 90% and to maintain the vitality of such an industry it is critical to ensure safe, secure, efficient operations at global, regional and national levels. Consequently, commercial passenger aviation safety and security becomes a worldwide concern not only for the aviation industry but also for all the subsequent ancillary industries part of the aviation community.

According to the International Air Transport Association (IATA) safety performance statistics of the commercial airlines released on February 2016, the 2015 global jet accident rate (measured in hull losses per 1 million flights) was 0.32, which was the equivalent of one major accident for every 3.1 million flights. Although the 2015 rate is not as good as the 0.27 rate achieved in 2014, it shows a remarkable 30% improvement compared to the previous five-year rate (2010-2014) of 0.46 hull loss. Despite the decreasing trend in aviation accidents, aviation travel can still be undermined by a variety of safety hazards, which may or may not be already involved in the air transport industry. Hazards may vary from manmade, mechanical, weather and environmental impacts all of which possess immense potential to cause catastrophic aviation accidents or incidents. The severity of each factor determines the possibility of the accident or incident. Several studies have surfaced to identify the key factors, which lead to the accidents so that the necessary defences and regulations can be imposed to discern the causation behind these accidents in order to be proactive and to prevent future recurrences. But considering the complexities of commercial air travel and the diverse range of factors that can influence air travel even with the latest technological defences and stringent regulations and policies, errors penetrate the system leading to accident and incidents such as the recent unfortunate accidents of Fly Dubai (2016), Egypt Air (2016) and the mysterious disappearance of Malaysian Airlines MH370 (2014). Furthermore, extant research focuses on independent factors affecting aviation accidents whilst providing a comprehensive picture of that one particular factor leading to the accident. The importance of a holistic and extensive contextual background of the many factors leading to an accident needs to be overemphasised in this regard without which the necessary actions and mitigation strategies may not be effectively

implemented or possibly even lead to the failure of identifying the vulnerability of the latent factors in the system. This deficiency of identifying and investigating only one of the significant factor of the accident as well as the limited analogy of legislative amendments act as main motivators to undertake this study.

### **1.1 Objectives**

The objectives of the study are three fold. Firstly the paper intends to identify and analyse the major factors that lead to aviation accidents around the world with a case study methodology of each factor. Secondly, the paper employs James Reason's Accident Causation Model to determine the respective latent factors, which precipitated as the major factors causing accidents. Thirdly, in order to further enhance the safety and security factor of air travel the study makes an effort to provide an effective and comprehensive picture of the legislative amendments post major accidents.

### **1.2 Justification**

The existing literature on aviation accidents and the factors causing it has expanded considerably in recent decades, but it is still suffering from two primary gaps. Firstly, nearly all published pieces of research have not studied or considered air crash investigations of accidents and incidents by different regulatory bodies. Most researches have a statistical summary of the factors causing airline mishaps rather than probing into individual accidents caused by the respective factor. Hence, a detailed cognizance of how the factor played a part in the accident or incident remains incomprehensible. Secondly, a severe dearth in studies related to analysis of legislative and regulatory changes caused by accidents hinder the understanding of operational procedures of airports and airlines pre and post an aviation accident. This paucity of aviation studies on prime contributors of aviation accidents and amendments or advancements in aviation regulations inarguably offers opportunities to make significant contributions to extant literature by providing an extensive picture of the leading contributors to aviation accidents as well as pre –post legislations based on several disastrous accidents. This paper also takes credit of being the first paper of its kind to the best of the author's knowledge to address the former issues in a comprehensive manner in related academic research.

## **2. Literature Review**

Aviation accidents are caused by numerous factors; however, the researchers performed in depth study of extant literature on the factors contributing to aviation accidents and identified four fundamental factors from three relevant papers. To begin with, Fajer, M. et al. (2011), discuss the characteristics and significance of James Reason's risk analysis model by considering factors namely misjudgement (80.5%), poor planning (66.7%), poor supervision (66.7%), psychological aspects (44.4%), flight indiscipline (38.9%), poor cockpit coordination (30.5%), adverse weather conditions (25%), lack of experience (22.2%), poor control application (22.2%), other operational aspects (19.4%), poor maintenance (16.7%), poor instruction (8.3%), influence of the environment (5.5%), forgetfulness (2.8%) and physiological aspect (2.8 %), Unsafe acts (36%), unsafe supervision (28.3%), organisational influences (18.1%), and preconditions for unsafe acts (17.6%) as pertinent causes of airline accidents. All of the above factors concomitantly formulate namely as Pilot Error, Mechanical Error, Air Traffic Controller error, or any other form of Human Error. In another study by Johnson, C. et al. (2006), the author tries to identify the role played by human error, environmental factors, technical failures and organisational issues by analysing 164 accidents (case study approach for two eight year periods 1976-84 and 1996-2004) and statistics (number

of accidents within a given period) to determine the frequency of the main causes of aviation accidents. The paper next determines whether these causal factors have changed over time as a result of changes in the aviation industry by analysing year by year (1996-2004) accidents and determine the frequency of each accident cause. In a similar vein, Ukpere, W. et al., (2014) analysed areas prone to certain causes of air crash, in addition to identifying the main causes. They studied accidents from 1920 to 2011 (dividing into 19 year time periods), including all kind of accident causes from most common to rare ones, and divided the accidents among various regions of the world (factor by factor) determining which were the most common reasons for air crashes in each of the periods.

A review of past studies reveal a consensus with regards to the principal contributors to airline accidents which are once again narrowed down to four fundamental factors namely pilot error, mechanical failure, weather and sabotage.

However limited research has surfaced on the severity of specific factors as a contributor to accidents and no studies have emerged providing a comprehensive compendium of legislative and regulatory changes caused by accidents.

### **3. Methodology**

Document analysis, a specific kind of descriptive research, is applied in this study to test our hypotheses. Descriptive research focuses on conditions that exist and when document analysis is employed current documents and issues are the foci. The current paper analyses pertinent airline accident case studies also employed by Johnson et al. (2006) as it allows in-depth, multi-faceted explorations of complex issues in their real-life settings. Case study approach is a tool that is used to facilitate learning, generate in depth understanding of complex issues that are multi-faceted in its real life. A case study can be a published report about a group or a person that has been studied over a time. The case study is a comprehensive and flexible method of data collection, which let us investigate and explore aviation events thoroughly and deeply without any need of sampling and this proved to be extremely beneficial in the process of research. Following an Inductive approach, the research begins with collecting data and observations that is relevant to the topic of interest thereby drawing patters to construct the required hypotheses.

The method that was adopted in this study involved performing an independent analysis of all of the major aviation accident reports related to Pilot, Mechanical Weather and Sabotage errors. A total of 30-40 accident reports were rigorously studied and evaluated, out of which 20 cases were selected. Hence, our analysis of the investigations was based on documents from 1960 onwards, as these cases in the past have triggered crucial safety improvements and have led to safer flying conditions for us today, in the form of improvements and changes to protocol, regulations and innovative technology in planes. In consequence, our sample focuses on those, which have higher risk mishaps, including near misses, which were deemed serious enough to warrant a subsequent investigation and report. The analysis progressed by extracting the causal and contributory factors that were identified in the aftermath of each investigation.

### **4. Hypotheses Formulation**

Aviation accident or incident may be caused by a variety of factors with the influence of each factor leading to the severity of the accident/incident. After narrowing down the variety of causes that may result in an accident to four fundamental key factors, the researchers performed a case study methodology and identified five real life accidents for each of the four factors.

According to Plane Crash 2016 Pilot Error, Mechanical failure, Weather and Sabotage, the four factors led to 96% of aviation accidents or incidents worldwide with individual contribution of 53%, 22%, 12% and 9% respectively. With such high percentage share in global aviation accidents it is extremely important to understand how each factor plays a role in the accident. In particular weather related factors, it is rare to find weather as a standalone factor in an aviation accident. The way the pilots and crew operate the aircraft in the adverse weather condition determines whether the weather induced incident will end up being a serious and fatal accident.

Thus the degree to which each factor plays a role in the accident as well as the unfortunate combination of multiple factors as identified from some the above air crash investigations have varying impacts on how catastrophic the accident may be. This research will further prove and explain the level of involvement of each of the four factors in the identified five accidents using the James Reason's Accident Causation Model or commonly known as Swiss Cheese Model in the following pages. However after careful analysis of the research information and air crash investigations this research paper hypothesises that; *Ceteris Paribus*,

H1: Pilot Error has a significant impact on aviation accidents,

H2: Mechanical failure has a significant impact on aviation accidents,

H3: Weather has a significant impact on aviation accidents,

H4: Sabotage has a significant impact on aviation accidents.

## **5. Results and Findings**

### **5.1 Theory Employed**

The research paper employs James Reason Accident Causation model also known as Swiss Cheese Model to prove the hypotheses. In 1990, James Reason published a risk analysis model, which illustrates how human factors at various levels of the organisation lead to accidents. Reason explains there are certain latent conditions in the organisation that are result of management's action or inaction, before a human failure occurs. Following our certain characteristics to better understand and implement this model to an accident for risk analysis:

- There are multiple layers of defences to protect the System and prevent hazard or system failures from cascading into accidents.
- Safety deficiencies or flaws defined as "holes" may occur in each layer of defences, resembling Swiss cheese.
- The chances of accidents increases as the "holes" in the defences increase.
- An accident occurs when the holes in each layer of defences line up.

The model states, the failures from latent conditions allow active failures to occur. So, the management must focus beyond the frontline employees, i.e. high-level decision makers who make fallible decisions. Thus, management must formulate organisation culture that serves as defence to detect and promptly correct precursor events. The International Civil Aviation Organisation (ICAO) has illustrated a similar model in their Safety Management Manual in coherent of Reason's model, where the defences are more precise, to protect the system against the inevitable human error. Organisational factors could be a strength (defence) or weakness (holes in Swiss cheese) to prevent an accident situation. Table 1 below illustrates some

examples from real world to easily understand the implication of Swiss Cheese Model in the case studies.

| Organisational Influences | Unsafe Supervisions   | Preconditions of Unsafe Acts | Unsafe Acts                      |
|---------------------------|-----------------------|------------------------------|----------------------------------|
| Rapid Expansion           | Risks neglected       | High workload                | Aircraft warning system disabled |
| Lack of regulation        | Fatigue               | Time Pressure                | Omission of Check list           |
| Empty Talk of Safety      | Insufficient Training | Ignorance of system          | Over-reliance on automation      |

Table 1: Swiss Cheese Model Illustration

## 5.2 Application of Theory employed

The hypotheses formulated will be primarily proved by employing James Reason’s Swiss Cheese Model. The chain of contributing latent factors preceding the major cause has then been described for each respective fatality. The following tables will analyse each accident for the identified four factors particularising each latent factor under the four defence layers of the Swiss Cheese Model elucidating how it lead to the accident thus substantiating the alternative hypotheses.

| Airlines            | Organisational Influences                                      | Unsafe Supervisions  | Preconditions of Unsafe Acts  | Unsafe Acts   |
|---------------------|--|--|---|---|
| Eastern 212         | Absence of cockpit discipline regulations                      | Lack of aircraft’s altitude awareness.   | Visually locating airport during dense Fog.                             | Nonessential conversation during approach.                                |
| Tenerife Crash      | Only Runway used to taxi aircraft.                             | Imprecise and out of sight clearance given by ATC and absence of ground radar. | Simultaneous and ambiguous communication in presence of low visibility. | Negligence towards complete instructions.                                 |
| United Airlines 173 | Absence of Crew Resource Management training                   | Failure to monitor fuel levels   | High workload and stress factor to diagnose the obstacle promptly.      | Poor team management and lack of awareness among crewmembers.             |
| Com Air 5191        | Unacceptable takeoff Clearance and Inadequate runway markings. | Inattention to oversee the aircraft  | Violating the Sterile Cockpit rule while taxiing the aircraft.          | Ignorance of aircraft’s position in reference to available cues and aids. |
| Helios 552          | Unchanged cabin pressurisation by maintenance person.          | Flight crew unchecked cabin pressure during pre-flight check.                  | Flight Crew overlooked the system after take-off check.                 | Misidentified warning system.   |

Table 2: Application of Swiss Cheese Model on Pilot Error Related Accidents

| Airlines                     | Organisational influences   | Unsafe Supervisions                                | Preconditions for Unsafe Acts  | Unsafe Acts |
|------------------------------|---|--|--|-------------|
| American Airlines Flight 191 | Decision to jointly remove pylon and engine (negligence)  | Unnoticed damage to the wing/pylon aft attachment. | Plane going into take-off with cracked pylon aft bulkhead                        | NA          |
| Japan Airlines Flight 123    | Improper maintenance training (personnel dividing the splice plate in two pieces and then installing them)    | Unnoticed improper repair                          | Increased damage due to operations thereafter.                                   | NA          |
| TWA Flight 800               | (Inerting was considered too heavy, expensive for commercial operations by the aviation industry)(Negligence) | Ignored impact of heat sources located below CWT   | High ambient temperature because of two running ac packs (located below the CWT) | NA          |

|                           |   |  |  |    |
|---------------------------|---|--|--|----|
| Swissair Flight 111       | No independent switch for deactivating IFEN | The fact that IFEN system could not be depowered using appropriate flight crew emergency procedures went unnoticed | Use of flammable materials in the aircraft.    | NA |
| China Airlines Flight 611 | Improper training of employees              | The initial repair considered minor, but was actually major  | Increased damage due to operations thereafter. | NA |

Table 3: Application of Swiss Cheese Model on Mechanical Failure Related Accidents

| Airlines                    | Organisational Influences                                   | Unsafe Supervisions   | Preconditions of Unsafe Acts  | Unsafe Acts   |
|-----------------------------|---|---|---|---|
| Pan Am Flight 214           | No Regulations for lightning protection                     | Research of lightning majorly aimed at power industry                                   | Little research and work on the protection of fuel from lightning   | NA  |
| Eastern Airlines Flight 66  | No Regulations regarding wind shear and microburst          | Absence of training or procedures on how to tackle microburst                           | Absence of specific flying technique                                | NA  |
| Southern Airways Flight 242 | Turbine Engine tolerance to severe weather not considered   | Failure of the flight crew to avoid or abort landing, misled by false radar information | Aircraft radar had functional limitations in precipitation and hail | Decision to land even though otherwise advised by the ATC   |
| Air Florida Flight 90       | Wrong deicing procedure, airport authorities under pressure | Limited working experience of flight crew in winter operations                          | Ignoring the ice accumulation on the wings                          | Pilot using reverse thrust to push back the aircraft, decision to melt the ice on the wings using heat from the engine of the aircraft in front and not using the aircraft's deicing facility |
| Delta Airlines Flight 191   | No Regulations regarding wind shear and microburst,         | Absence of training or procedures on how to tackle microburst                           | Absence of specific flying technique                                | Flight crew's decision to fly through the inclement weather   |

Table 4: Application of Swiss Cheese Model on Weather Related Accidents

| Airlines               | Organisational Influences  | Unsafe Supervisions   | Preconditions of Unsafe Acts   | Unsafe Acts  |
|------------------------|--|---|--|--|
| Air Canada Flight 797  | Poor resource management   | Fire in the lavatory, was not expected by the crew.                       | Technological Environment: flash fire because of heat of the fire and fresh oxygen.      | Opening the main door and emergency exits                          |
| Pan Am flight 73       | The armed guards didn't check the identity of the hijackers                        | Hijack took place despite the presence of armed agents near the aircraft. | Hijack to pick up prisoners from Cyprus and Israel.                                      | The hijackers were armed with rifles, pistols, grenades and belts. |
| Air India Flight 182   | Organisational Climate: poor working conditions, structure and policies.           | Passenger was able to carry the bombs through the security checkpoint.    | Striking back against India for the operation completed by the Indian Army against Sikhs | Passenger Carrying multiple bombs on aircraft.                     |
| September 9/11 attacks | Poor organisational decisions and rules which resulted In poor operational process | Carrying arms through airport security check points                       | Suicide attacks, carried out by al-Qaeda.  | Hijackers were armed on the aircraft.                              |

|                          |    |  |  |  |
|--------------------------|----|--|--|--|
| German wings Flight 9525 | NA | The Airline didn't know that the co-pilot was declared not fit for work. | Suicidal tendencies and not fit for work | The co-pilot had locked the pilot out of the cockpit |
|--------------------------|----|--|--|--|

Table 5: Application of Swiss Cheese Model on Sabotage Related Accidents

Hence after comprehensively examining the respective latent conditions leading to four major factors through the implementation of the above-mentioned James Reason's Swiss Cheese Model, the study accepts the alternative hypotheses thereby documenting the fact that latent factors leading to the four major factors namely Pilot Error, Mechanical failure, Weather and Sabotage have a significant positive impact on airline accidents.

### 5.3 Legislation and Regulation Amendments

Regulation implementation/ modifications are an inevitable part of any airline accident. Pertaining to the accidents mentioned earlier, the paper makes an additional effort in analysing all the existing regulations with its modifications and new regulations to analyse the changes brought about in the aftermath of the mishaps mentioned above. This analogy as shown in tables below (Table 6-9) will help in examining how the aviation industry responds to such accidents in terms of operational and procedural changes brought about after the unfortunate accidents.

| Factor      | Cases                     | Existing Regulations                 | New Regulations  |
|-------------|---------------------------|--------------------------------------|--|
| Pilot Error | Eastern 212 Crash         | Inexistence of particular regulation | Sterile Cockpit Regulations  |
|             | Tenerife Crash            | Hierarchical Relation in Cockpit.    | Team mutual agreement, Standardised phrases and English as common language. Ground radar installed at Tenerife Airport           |
|             | United Airlines 173 Crash | Inexistence of particular regulation | Crew Resource Management.  |
|             | Comair 5191 Crash         | Inexistence of particular regulation | Procedure to verify aircraft position, Cockpit Maps, Automated Alerts, Stringent Clearance for take-off and monitoring aircraft. |
|             | Helios 552                | Preflight and Take off check list    | Airworthiness directive for B737, revised manual, differentiate warning sound.   |

Table 6: Analogy of pre and post regulations and operational procedures of Pilot Error related accidents

| Factor             | Cases                       | Existing Regulation  | New Regulation  |
|--------------------|-----------------------------|--|---|
| Mechanical failure | American Airline Flight 191 | 14 CFR 25 (various parts) (Airworthiness standards)                            | Modifications of various parts of 14 CFR 25   |
|                    | Japan Airlines Flight 123   | 14 CFR 43.13 (Maintenance, Preventive Maintenance, Rebuilding, and Alteration) | 14 CFR 25.365 (amended), Parts of 14 CFR 91,121,125 and 129 (amended) (Flight rules and operating requirements) |
|                    | Trans World Airlines 800    | 14 CFR 25.981 (Fuel ignition prevention)                                       | "Inerting" procedure (Reduced risk of flammability)   |
|                    | Swissair Flight 111         | Parts of 14CFR 25 (Equipment, installations, test criteria)                    | 14 CFR 25.856 (Thermal/Acoustic Insulation Material), Revision of other parts of 14CFR 25 (test methods)        |

|  |                           |   |  |
|--|---------------------------|---|--|
|  | China Airlines Flight 611 | 14 CFR 121.370 (operating requirements) | Airworthiness Directives (ADs) Issued- inspection of aircraft with similar concerns (as in the accident), and provided recommendations for required changes. |
|--|---------------------------|---|--|

Table 7: Analogy of pre and post regulations and operational procedures of Mechanical Failure related accidents

| Factor  | Cases                       | Existing Regulation                  | New Regulation   |
|---------|-----------------------------|--------------------------------------|--|
| Weather | Pan Am Flight 214           | Inexistence of particular regulation | FAR 25.58, FAR 25.954 and FAR.981                        |
|         | Eastern Airlines Flight 66  | Inexistence of particular regulation | Low Level Wind shear Alert System (LLWAS), Doppler radar |
|         | Southern Airways Flight 242 | 14 CFR Part 33                       | Amendments to 14 CFR Part 33                             |
|         | Air Florida Flight 90       | FAR 121.629                          | FAR 121.629 C & FAR 121.629 D                            |
|         | Delta Airlines Flight 191   | Inexistence of particular regulation | FAR 121.424, FAR121.358                                  |

Table 8: Analogy of pre and post of regulations and operational procedures of Weather related accidents

| Factor   | Cases                    | Existing Regulation   | New Regulation  |
|----------|--------------------------|---|---|
| Sabotage | Air Canada Flight 797    | Inexistence of particular regulation                              | Smoke detectors in the lavatories, and firefighting equipment on the plane                |
|          | Air India Flight 182     | Existence of metal detectors                                      | 24 hour hold on cargo, explosive unit detector.   |
|          | Pan Am flight 73         | Minimum surveillance  | Tighter airport security and increased surveillance                                       |
|          | September 9/11 Attacks   | Most of the regulations took place after the 9/11 attacks itself. | TSA, solid bullet proof doors with cockpit coding   |
|          | German wings Flight 9525 | Cockpit locking system and physical examination.                  | Random checks of pilots' psychological condition and fitness and cockpit door lock system |

Table 9: Analogy of pre and post regulations and operational procedures of Sabotage related accidents

The above tables succinctly summarise the regulatory changes brought as a result of these accidents. As evident, for any misapprehension, error or inaccuracy, the industry reciprocates with stronger and more impenetrable regulations. The changes discerned in these cases just form a few of the many examples further corroborating the fact that the aviation industry had and always will have zero tolerance towards errors.

## 6. Limitations and Recommendations

### 6.1 Limitations

The paper is not free from limitations similar to other aviation research. Firstly the paper does not apply statistical tools to show the statistical significance of the results obtained mainly due to lack of availability of required numerical support. Secondly, the current research examines only existing case studies to verify the hypotheses. Although some of the most significant incidents are taken for analysis, they still only cover a small number of accidents to draw conclusions about all others (although the factors chosen are the most significant ones thus providing reliability). Furthermore, in terms of air crash catastrophes, other reasons such as wildlife (mostly bird strikes), air traffic controller (ATC) errors, other human errors such as fuelling, and runway maintenance amongst others have been excluded in this study which in turn can affect the robustness of the current results in the paper.

## **6.2 Recommendations for Future Research**

Implicit from the limitations, the use of statistical tools on numerical data (relevant to this particular study such as which factor has brought about most regulatory changes or which factor involves most number of safety policies etc.) to solidify the results and conclusion of the research forms the first pivotal recommendation. These kinds of figures can make it easier for readers to understand the overall picture and identify trends of the past. Furthermore, larger sample can be used which will improve the validity and reliability of the data. Finally, other inherent factors causing aviation accidents can be taken into consideration to make the research paper more comprehensive but will also involve a much more detailed analysis of the significant changes in regulations brought about by all the factors.

## **6.3 Academic Implications**

Based on the analysis of the theoretical discourse and findings presented in this study, certain academic implications can be inferred. The study can assist in accomplishing students' academic need by showing the method of applying the theoretical knowledge to the real life events. This paper is useful for lecturers and students associated with areas of aviation quality, safety and security, pilot, aeronautical engineering or even readers fulfilling their respective interest in aforesaid areas of study. Academicians can employ innumerable air crash accidents from Federal Aviation Administration's forum to further elaborate and enhance the understanding of topics ranging from factors causing accidents to impact of those on the industry, use of accident causation model and reasons for new regulations, training and technology that are the key defences of the ICAO Safety Management Manual. Some of the notable changes introduced are sterile cockpit rule, crew resource management, improved mechanical standards and testing, stringent security, technological advancements and beyond, which have now become every aviation professional's fundamental duty in order to operate in safe and sound environment. This will allow future professionals to execute their learning and enhance their skills beyond work-based experience.

## **6.4 Policy Recommendations**

The aviation industry is quite comprehensive in terms of rules and regulations to ensure the best of safety levels. To recapitulate, the analysis section documents the modification of existing regulations post accidents according to new findings. Over the years, the aviation industry has progressed phenomenally in terms of controlling the number of accidents by investigating each air crash in the most meticulous manner to reassure non-recurrence and the industry regulation book addresses all possible scenarios from every possible angle to make it as comprehensible as possible. Having said that, it becomes obvious that recommending policies for an industry which has zero tolerance for safety errors is a not an easy task. Nevertheless the paper makes an effort in providing a general recommendation rather than a policy to enhance safety levels of the industry further more. When it comes to commercial airline operations, there are two main manufacturers of aircraft - Boeing and Airbus. Both of them have different policies when it comes to the kind of aircraft they want to provide and also about how they think the industry should operate. Airbus gives most preference to machines; according to them the machines (aircraft) should do most of the flying itself and the pilots should only take care of landing and take-off. Due to this reason, Airbus aircraft have very complex machinery and it's not easy for pilots to disengage that and take full control. On the other hand, Boeing thinks that the ultimate control should always be within the hands of humans. A Pilot can take control of a Boeing aircraft whenever he/she wants to do so. A plausible way safety can be enhanced is by providing the most efficient live ware-hardware interface. This could be done if both the companies could engage in collaborations with one

another- manufacturing aircraft to provide the best combination of automatic machineries that can fly the aircraft while allowing a certain level of human intervention to maximise the ease of operations.

## **7. Conclusion**

The prime motive of this paper was to review and synthesise prior literature and case studies focusing on airline accidents and legislative changes post airline fatalities from 1960 and onwards. This paper allowed researchers to constructively apply the theoretical knowledge into practice by means of identifying causes of air crash, employing James Reason's model to establish cause-effect phenomena and in evaluating the evolution and significance of legislations in the industry. Nonetheless, statistics has always been explicit on the extent of safety air travel has to offer, of which the most recent manifestations by the Independent Traveler 2016 documenting that 'A person is eight to nine times more likely to be involved in a fatal road accident than in air crash'. For sure, the justification for the former statement can be attributed to the umpteen modifications in existing legislations and introduction of new legislations, radical advancements in technology and a spate of innovations from aircraft manufacturers. Having said that, airplane accidents still happen to occur due to the inevitable involvement of humans in every phase of operations (latent conditions), eventually culminating as human errors, thus attesting the propositions embedded in the James Reason's theory. This research paper is a beginning for further comprehensive studies to examine factors causing airplane accidents in reference to profuse air crash investigation reports and to understand the whole idea behind development in aviation legislations. Moreover, this article is the first of its kind to fill the vacuum present in the similar field of study.

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# **Capacity Building on Safety and Security Training Requirements of the Turkish Civil Aviation**

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**Abstract:** With its growing population, rapid urbanisation and being an active regional commercial base, Turkey is developing its civil aviation and airport infrastructure tremendously. To achieve the goals of the full adoption and implementation of the EU Acquis, Turkey needs to upgrade its institutional framework and to establish highly skilled capacity to manage any future challenges.

This presentation deals with the EU Aviation Strategy impact on our current project. Whereas the running project asks for timely solutions the EU Aviation Strategy presents a comprehensive and ambitious action plan which allows the Turkish Aviation to grow in a sustainable manner by implementing high EU standards for safety, security, the environment, social issues and passenger rights. These significant impacts will be discussed in this presentation.

**Key Words:** Turkish Civil Aviation Academy (TCAA), EU aviation strategy, EU basic regulation 216/2008, major partner countries, key partner countries.

## **1. Introduction**

To further improve and enhance the existing high levels of aviation safety, security and sustainability in Turkey we are to consider three major areas:

1. The running Project,
2. EU Aviation Strategy,
3. Proposal for a revision of the EU's aviation safety rules (Regulation 216/2008)

### **1.1 The Running Project**

The running project “Technical Assistance for Capacity Building on Safety and Security Training Requirements of the Turkish Civil Aviation” was launched in 2010. The actual start date has been delayed to March 2015; the period of implementation of the contract will be 24 months from this date onwards.

The project is part of the EASA IPA 3 – Programme on aviation safety in the Western Balkans and Turkey.

By means of this project, EASA supports the partner countries' integration into the EU system, in fulfilling their international obligations in the area of air safety and by fostering their knowledge of the EU's aviation safety system.

The project focuses on the following aviation safety areas (in extracts):

- Director General of Civil Aviation (DGCA) structure and oversight
- qualification and training of technical personnel
- technical guidance material
- licensing and certification

In 2010 Turkey was among the fastest developing markets in civil aviation worldwide.

Civil Aviation activities have shown a very rapid advance in Turkey, in particular, since the beginning of the 21st century, and it is envisaged that this development will continue. For sustaining this increase and, to enhance flight safety at the same time, the need to take of additional efforts has emerged. There is an increasing need for well-educated personnel capable and willing to adopt these measures. Hence, training is of vital importance for providing these resources.

Flight safety is directly related to the training degrees and skills of all employees in the sector. In other words, exercise of sector employees is a key factor in determining flight safety. Therefore, with various training, employees have to be provided with high levels of professional expertise. In addition, uniformity must be provided in educational contents and procedures and interoperability must be ensured between all experts from the different countries.

The Turkish Civil Aviation Academy (TCAA) is going to be the starting point, the basis and the model to establish a common and structured training programme. Training programmes shall, therefore, be developed using the results and best practices of the European projects, as well as adopting the best methods to ensure the optimal continuous learning process for the different staff at all levels, making the personnel adequate for current and foreseen tasks.

The construction work for the TCAA as a high-tech building with sufficient space for training activities near the ATATÜRK airport in ISTANBUL has started shortly ago and will be finished in December 2017.

The TCAA shall be operated by the DGCA and be functional and sustainable allowing to the highest international standards.

The running project is divided into two components:

The (1) Training Technical Assistance and the (2) Communication Technical Assistance.

The Training Technical Assistance component mainly covers the assistance to the DGCA in establishing the operational details of the TCAA and preparation of all necessary documents such as training policy, teaching programme, curricula, and the other related documents in accordance with international and EU / EASA (European Aviation Safety Agency) standards.

One important part of this component is to improve technical skills and qualifications of the personnel working in air transport sector including national stakeholder such as DGCA, Ministry of Transportation, Maritime Affairs and Communication (MoTMAC), Accident Investigation Body, Air Companies and Air Services. This addresses specifically the technical staff working in the aviation safety and security sector via training and exercise activities delivered in Turkey and the EU countries.

The Communication Technical Assistance component aims to ensure the visibility of TCAA through developing a communication campaign towards the stakeholders and general public in Turkey and abroad.

All training materials developed for the TCAA, information about opening courses, TCAA's working principles, and the training calendar for each year should be explained to all major stakeholders as mentioned above.

The overall objective of the project is

- To ensure maximum safety level and highest standards in civil aviation and air traffic management through fully competent personnel.

The running contract is aiming in two directions:

- To undertake activities that will help to operate the TCAA by developing an effective training policy, teaching and education programme.
- To ensure the visibility of TCAA

The results to be achieved by the Contractor are:

Result (1) The TCAA shall operate with at least 60 well educated and operational experienced trained trainers. This project component aims at:

- Establishing a TCAA which is operating at high international standards to meet the education and skill requirements of the air transport sector by satisfying both private and public actors from Turkey and other countries,
- Offering a wide range of training courses with highest quality which meet international standards and best EU practices for global, regional, national and international civil aviation communities,
- Preparation of all academic and testing material in line with the EU Acquis and EASA standards.
- Providing the capacity building of the DGCA staff by improving their qualifications via various courses and internship activities.

Result (2) TCAA shall be the internationally recognised training appearance of DGCA. This portion of the project aims at:

- Reviewing of the existing communication strategies of DGCA and MoTMAC which will be used for the establishment of the new communication programme.
- Providing a list of the target groups including all major stakeholders and the media and establishing the relevant connections for the promotion of the TCAA and its activities.
- Facilitating and assisting DGCA to promote the TCAA in order to achieve a national and global presence as a provider of high quality education in the civil aviation community via public awareness and communication programmes for each target group.
- Providing the public visibility of TCAA through communication campaigns by assessing major stakeholders in Turkey, searching cooperation with them and increasing their interest for training provided in TCAA via activities such as workshops, seminars, conferences...etc.

## **1.2 EU Aviation Strategy**

The European Commission adopted a new Aviation Strategy for Europe, in December 2015. This is a milestone initiative to boost Europe's economy, strengthen its industrial base and reinforce its presence in international aviation. The Aviation Strategy will – for the first time – create a comprehensive road map towards a more competitive EU aviation sector covering all

areas of EU air transport policy. An integral part of the new strategy will be to further reinforce EU ties with new regions, key partner countries, through new aviation agreements.

EU Aviation Strategy shall be negotiated with key partner countries, explicitly Turkey.

The Aviation Strategy will – for the first time – create a comprehensive road map towards a more competitive EU aviation sector covering all areas of EU air transport policy. The Aviation Strategy calls for coordinated efforts of all the stakeholders involved.

Turkey, currently still being a candidate country for EU Membership and with a population of more than 75 million, a key regional player in the aviation sector, being one of the most strategic and fast-growing markets in Europe. After the US, it represents the largest destination for passenger traffic to and from the EU, with almost 40 million passengers in 2014. Concluding a wide ranging aviation agreement between the EU and Turkey would bring significant mutual benefits, in terms of market access, regulatory convergence with the EU aviation acquis, facilitation of closer cooperation and ensuring a level playing field in the EU-Turkey aviation market. Concluding such an agreement would create opportunities for both industries to rise routes, frequencies and capacity between the EU and Turkey. The full implementation of the EU aviation acquis by Turkey is the ultimate objective for regulatory convergence and will have important influences and consequences on this project.

If fully implemented, the Aviation Strategy will contribute to safer, shorter, cleaner and cheaper flights and give citizens of Turkey the possibility to fly to more destinations outside of the EU. More connections mean more air services and more employment to deliver them. Moreover, the introduction of new technologies such as drones should have a positive effect on growth and jobs. All participants in Turkey's Civil Aviation areas and industry have to be trained accordingly to manage the future challenges.

The threat of terrorism to civil aviation is likely to remain high in the foreseeable future. High aviation security standards are imperative for the functioning and competitiveness of the air transport system. At the same time, it is important to combine effective security measures with methods and technologies that facilitate passenger flows at airports and minimise the inconveniences and delays for passengers.

Furthermore, with third countries the so-called “One Stop Security” will be implemented to increase security of passengers and baggage and to avoid a second set of checks. “One stop security” strategy will affect the TCAA training as well.

### **1.3 Proposal for a Revision of the EU's Aviation Safety Rules (Regulation 216/2008)**

This initiative is part of the 2015 European Commission's 'Aviation Package for improving the competitiveness of the EU aviation sector'. The objective of this review is to prepare the EU aviation safety framework for the challenges of the next 10-15 years and thus to continue to ensure safe, secure and environmentally friendly air transport for passengers. This initiative builds on over twelve years of experience in the implementation of Regulation (EC) No 216/2008 and its predecessor.

The Air Transport in the EU currently holds an excellent safety record. Aviation traffic in Europe is predicted to reach 14.4 million flights in 2035 (50% more than in 2012). Therefore, we are to focus our attention on clearly identified risks that the system continues to maintain the current low number of accidents. This means that the accident rate has to continue

decreasing in proportion to traffic growth. This will be guaranteed by safety education in TCAA.

## **2. Results / Findings**

### **EU Aviation Strategy**

Aviation is a strong and dominating driver of economic growth, jobs, trade and mobility for the European Union. It plays a crucial role in the EU economy.

The international aviation sector outside Europe has also been witnessing some significant developments, characterised by very strong growth in certain world regions. This is associated with the shift of the world's economic centre of gravity towards the East, notably Asia. As a result, several airports have emerged and are posing a new and considerable challenge for European hub airports and carriers, e. g. the new International Airport in Istanbul. To cope with this international challenge, the TCAA has to train the airport staff to control the future tasks.

The Commission has identified three key priorities:

1. Tapping into growth markets, by improving services, market access and investment opportunities with third countries, whilst guaranteeing a level playing field;
2. Tackling limits to growth in the air and on the ground, by reducing capacity constraints and improving efficiency and connectivity;
3. Maintaining high EU safety and security standards, by shifting to a risk and performance based mind-set;

#### **In details:**

#### **Tapping into growth by improving services and access to growing markets**

European aviation is facing new competitive challenges in a rapidly evolving global market, in particular as a result of a shift of economic growth to the East. These new competitors are benefitting from the rapid economic growth of the entire region, notably Asia, and from aviation becoming a strategic element in their home-country's economic development policies. To build the new airport in Istanbul was a forward-looking and wise decision.

The EU aviation sector must be allowed to tap into the new growth markets where significant economic opportunities will be generated in the decades to come. Experience has shown that negotiating EU level comprehensive aviation agreements with third countries is an effective tool to manage the future challenges, e. g. suitable infrastructure, cultural and regulatory systems.

Turkey is one of EASA's Pan-European Partners (PANEP). This is a community of non-EASA European countries with which EASA cooperates on the implementation of the EU aviation safety rules.

In March 2010, the European Union and the Turkish authorities initiated a "horizontal" air transport agreement which removes nationality restrictions in the bilateral air services agreements between EU Member States and Turkey.

This agreement will allow any EU airline to operate flights between any EU Member State and Turkey, where a bilateral agreement with Turkey exists and traffic rights are available. This agreement does not replace the bilateral agreements in place between EU Member States and Turkey but adapts them to bring them into line with EU law.

The agreement is an important step towards further strengthening EU–Turkey aviation relations and will encourage traffic between the EU and Turkey

Furthermore, in order to support worldwide trade in aircraft and related products, the EU should also expand the range of bilateral aviation safety agreements aimed at achieving mutual recognition of safety certification standards. These agreements significantly reduce the transaction cost of exporting aircraft, while ensuring high levels of safety in partner countries and helping to harmonise product standards worldwide.

The EU Commission

- recommends to the Council the issuance of authorisations to negotiate comprehensive EU-level air transport agreements with the following countries and regions (in extracts): China, ASEAN (Association of Southeast Asian Nations), Turkey, UAE (United Arab Emirates), Kuwait and Qatar; and

### **Tackling limits to growth both in the air and on the ground**

The main challenge for the growth of European aviation is to reduce the capacity and efficiency constraints, which are seriously impeding the European aviation sector's ability to grow sustainably, compete internationally, and which are causing congestion and delays and raising costs. Airports together with air traffic management services providers constitute the key elements of the infrastructure of civil aviation. The quality, efficiency and cost of these services have become increasingly important to the competitiveness of the industry.

The Single European Sky is a concrete example of where the EU can make a difference by rising capacity, improving safety and cutting costs while minimising aviation's environmental footprint. This was the initial ambition more than a decade ago, but, the project is still not delivering.

As regards external relations, the Commission will continue to promote cooperative arrangements with key partner countries of the EU with a view to improving the management of air traffic. Thanks to SESAR, the EU is also able to play an influential role at a global level in particular in the context of the International Civil Aviation Organisation's harmonisation activities.

In order to allow for continuity of air traffic management, a minimum level of service in managing European airspace should be ensured, allowing at least for the movement of overflights. In this respect, the Commission will promote the exchange of best practices between Member States. Thus Air Traffic Management is considered an essential part of the running project.

In 2035, according to Eurocontrol, European airports will be unable to accommodate some 2 million flights due to capacity shortages.

These projections on the airport 'capacity crunch' show that in spite of a well-developed and extensive airport network, many of Europe's major airports are severely congested, placing the future sustainable growth of the EU aviation system under threat. At the same time, other airports in Europe are underused and there is overcapacity. It is therefore essential to make best use of existing capacity and plan well in advance to cope with the forecasted future needs. It is also indispensable to ensure a better airport strategic planning at EU level.

This development will affect the project and has to be considered in TCAA training management.

### **Maintaining high EU safety and security standards**

Safety and security are pre-requisites for a competitive aviation sector. With the aviation traffic in Europe predicted to reach 14.4 million flights in 2035, 50% more than in 2012, the first objective is to maintain the current high safety standards alongside growing air traffic. This will allow the EU aviation sector to continue to develop safely in the future. To this end, the regulatory system has to be better equipped to identify and mitigate safety risks, in a quicker and more effective manner. This can be achieved by introducing a risk and performance based approach to safety regulation and oversight, by closing existing safety gaps and by integrating other technical areas of regulation connected to safety more deeply, such as aviation security. This is considered another vital part of the running project to be satisfactorily covered.

While safety is crucial, it cannot be looked at in isolation. The regulatory framework must also set the conditions under which the aviation industry can succeed and remain competitive on the global market. This includes the integration of new business models and emerging technologies, such as electric engines or drones. It also requires additional training measurements in various sectors of civil aviation. Ultimately this will achieve the same or higher level of safety overall.

### **Proposal for a revision of the EU's aviation safety rules (Regulation 216/2008)**

This initiative is a general review of the European aviation safety system and of Regulation (EC) No 216/2008, which is the EU's framework regulation for aviation safety. This activity comprises four components:

1. safety – while the present system has so far been effective in ensuring a high level of safety it may not be able to ensure that the accident rate continues to decrease in proportion to traffic growth (50% increase in the next 20 years);
2. overregulation – the regulatory system is difficult and creates excessive costs;
3. new market developments - the aviation market and technologies have outperformed the regulatory framework (new business models, new technologies) over the last decade;
4. oversight - there are significant differences in capabilities of Member States to effectively implement the aviation safety legislation.

The initiative aims to improve the performance of the European aviation system with regard to safety, security, competitiveness and environmental protection, e.g. by intensive training. It also has to be seen in context of the Commission's new aviation strategy. The initiative pursues the following specific objectives (in extracts):

- Eliminate unnecessary requirements and ensure regulation proportionate to the risks involved;
  - Training on core elements by elimination of obsolete training courses,
- efficient integration and effective oversight of new technologies and market developments;
  - additional training to DGCA employees and industry according new technologies such as drones
- a cooperative safety management process between the Union and MS to jointly identify and mitigate risks;
  - State Safety Programme, GASP, EASp, SMS
- create a system of pooling and sharing of resources between MS and EASA.
  - Requests well trained CAA employees

### 3. Conclusion

Capacity on the ground and in the air is becoming a potentially significant problem in particular for Europe. Decisions need to be taken now to prepare for the future hopefully not being too strongly impacted by the current political developments.

Firstly: A clear and offensive European external aviation policy is necessary. In such a global context of emerging countries, economies and aviation markets, the issue is how to identify and participate fairly in the growth of new third country markets and to break down barriers that are no longer justified in today's global aviation market. The cornerstone of this approach would be the directives to negotiate comprehensive air transport agreements with key partners around the world. Once this has been achieved this is another crucial area of training activities.

Secondly: The high level of safety and adherence to the highest safety standards according the “new Basic Regulation” is a fundamental cornerstone. These can be achieved by training of TCAA.

Thirdly: The fight against terrorism is a global battle where all likeminded countries need to work closely together with clear determination. This means more intelligence sharing, and cooperation between different nations. The one-stop security concept, which allows the passenger to undergo the security controls at the point of origin and then no further security controls are required at transfer points, should be implemented worldwide. This topic needs to be stressed in continued training courses addressing the newest state of the art equipment to be introduced.

Fourthly: It is crucial to maintain a dominant position in aviation through a highly educated, qualified and experienced workforce. Partnerships between TCAA, research, universities and industry on training and education will facilitate the movement of experts between these sectors, which at the end would be very beneficial for the development of the European and Turkey aviation sector. New skills and competences, some of which are not yet broadly available, such as those of drone specialists and flight data analysts will have to be developed. Training should be given priority.

Due to its geopolitical location and the cultural diversity deriving from its historical ties with different nations, Turkey is still a point of global interest.

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# **The Impact of Airline Marketing Mix Decisions on Passenger Purchasing Behaviour in the UAE**

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**Abstract:** Globally, marketing has emerged as an inevitable aspect for the success of service industries. Initially, marketing strategies focused on making customers aware of the existence of a specific product in the market, while more recently, convincing customers to make the final buying decision has emerged as one of the key objectives of marketing. Similar to all other service industries, the dynamic and rapid progression of the aviation industry has realised a need for a well-moulded marketing mix in convincing passengers to arrive at the final buying decision. This paper discusses the marketing mix adopted by both full service carriers (FSC) and low cost carriers (LCC), it also analyses the various attributes of the four main Marketing Mix elements – Product, Price, Place and Promotion; and how these attributes when tweaked and tailored can be beneficial in meeting the needs of the target customers. Surveys were administered to a total of 80 airline passengers residing in the United Arab Emirates (UAE), among which 50 passengers were active respondents. The results revealed that an airline's product and place mix are the most dominant in convincing passengers to make the final buying decision and price and promotion mix function act as secondary factors affecting consumer purchasing behaviour. Moreover, recent trends unfold that customer demands reflect an emotional perspective towards safety, relaxation aspects and customer services, thereby drawing implications for management to increasingly responsive toward these factors in order to retain existing customers and attract new customers.

**Key Words:** marketing strategies, marketing mix, purchasing behaviour.

## **1. Introduction**

Today, the airline industry is one of the most dynamic sectors in the world and like in any other product/service industry; innovative marketing strategies are crucial. Nevertheless, customer behaviour poses as the predominant challenge because there are few chances of customer loyalty unless they are ensured complete satisfaction Ostrowski, O'Brien and Gordon (1993). Hence, it is essential to create a marketing mix that is concurrently most convincing and satisfying as well as profitable to the company. A critical concept that this paper scrutinises is how an airline can create a quintessential marketing mix that coordinates the product, price, promotion and place mix distinctly to attract, serve and satisfy customers from different air carrier types, i.e. Full Service Carriers (FSC) and Low Cost Carriers (LCC). The entire substance of this research paper aims to deduce the impacts of airline marketing mix decisions on passenger purchasing behaviour associated with individual carrier types.

The Airline Product comprises of safety, reliability in terms of prompt arrival and departure, in-flight services such as food, beverages and in-flight entertainment and communication, kind of equipment and aircraft and many other product services. Secondly Price, which is the most versatile, cryptic and decisive element of the marketing mix refers to the value that the airline customers are ready to pay for the service. Thirdly, the place is the process of making the service reachable to costumers and fourthly, the promotions in the airline industry are mainly about advertising, loyalty, and personal selling and give away items. An inherent hurdle airlines face when it comes to creating perfect airline marketing mix is the ambiguity in deciphering which marketing techniques appeal the most to passengers in general and it gets all the more complicated when addressing different passengers preferring FSC and LCC services Broda et al. (2002). Airlines also struggle to identify the most convincing channel of product distribution, what product attributes attract attention, what pricing strategy sustains attention and what medium is the most important to convince the buyers to make a purchase decision.

A detailed analysis of the existing literature reveals that there is limited research which has surfaced on the marketing mix techniques that can be employed to influence passenger-buying behaviour, also a missing link between the airline marketing mix and consumer satisfaction and loyalty is another dilemma eliciting concern in the airline industry. Furthermore, the majority of information currently available is based on individual airlines such as Emirates Airlines or Air Asia and specific routes such as Taiwan to United Kingdom and vice versa. Finally, scarcity of information about the aviation industry's marketing practices and buying behaviour as a whole along with the constrained study of few independent marketing mix elements all serve as strong incentives to undertake this study. In all, this research is among very few studies that have addressed the need to tailor marketing mix based on carrier type and its relevance to eliciting a purchase behaviour from the customer. This study builds on existing research by addressing all the four components of the Marketing Mix (4 P's) namely Product, Price, Promotion and Place in an airline's marketing strategy and to study how an optimal blend of the mix can achieve the airline's marketing objectives.

The objective of this research project is therefore:

- To determine the distinctive combination of marketing techniques that provokes maximum favourable responses from the target customers.
- To analyse how well distribution channels, serve their purpose to generate sales for the airline.
- To identify which characteristics of an airline product the travellers value the most.
- To understand what promotional techniques are capable of attracting customers and to understand if they have a significant influence on the customer's purchasing behaviour.
- To document the relationship between Marketing Mix and Customer Satisfaction.

## **2. Literature Review**

Customer buying behaviour is closely linked to the perfect combination of the four main components of any marketing mix, namely – Product, Price, Place and Promotion. Even the airline industry, being a service industry has to create a perfect blend of the service and the prices allocated and the distribution channels as well as the promotional activities used to attract passengers to make a purchase. Park, Robertson and Wu (2007) conducted a study on the how an airline's perceived price, service quality, perceived value and passenger satisfaction influences future buying behaviour of passengers. The study was conducted on Australian international air passengers using the structural equation modelling method. Findings from the studies indicate that there were significant relationships among the variables. It was observed that there was direct effect of perceived value, passenger satisfaction and airline image on buying behaviour of passengers. Findings also indicate that insignificant relationships exist between 'perceived price and passenger satisfaction', 'service quality and airline image' and 'perceived value and airline image'.

Another empirical study was conducted by Satit et al. (2012), and its main aim was to investigate the relationship between the 4p's and the customer decision- making regarding travel agents in Palembang, Indonesia. A total of 215 respondents were selected from customers of three travel agents. Furthermore, the data collected was analysed using mean analysis, Pearson correlation and regression analysis. The results revealed that only the price and product attributes were associated with customer-decision making over travel agents.

Continuing the chain of study, Wilfing and Bauernfeind (2012) conducted quite an impressive research that explored how passengers prefer to obtain information, the information sources they perceive as trustworthy, the distribution channels used for bookings and the evaluation of distinct product attributes. Emirates Airlines was selected and a survey method was used to obtain a more personalised insight into consumer preference. Results document that passengers perform extensive information searches and increasingly require integrated marketing communication. Findings in the product aspect conclude that Emirates' passengers place the most importance on safety, punctuality, staff and the seat pitch.

More recently, Yasin and David (2014) performed a study on the impact of advertising and the relationship between the advertising and pricing. The study also investigated the level of consumers conducting online purchasing of AirAsia e-tickets. This study conducted only on Students of the Asia Pacific University. A Quantitative method of questionnaire was used for the collection of data. The findings of the study show how AirAsia uses Advertising and Pricing Strategies to impact consumer buying decisions.

Furthermore, another in-depth study conducted by Ostrowski, O'Brien and Gordon (1993) in USA concluded that a significant relationship existed between service quality (the carrier's public image) and customer loyalty.

Baker (1994) also conducted an empirical study that concluded that the service quality of low cost carriers in USA, are considerably higher than that of legacy carriers.

Moving on, Chen, Peng and Hackley (N.D) conducted an empirical and specific study on consumer purchase behaviour on the global route between United Kingdom and Taipei. They studied 60 Taiwanese students based in UK Universities, who used five airlines British Airways, Cathay Pacific Airways, China Airlines, EVA Airways and Royal Dutch Airways to travel to and from their home country. Using several stages of data gathering and well-established framework of service marketing, they came to the conclusion that service quality can be as important as, or more important than, price in influencing students' purchase decisions for long-haul flights.

An overview and analysis of the extant literature suggests that that promotion and pricing strategies play a dominant role in consumer behaviour. Nonetheless, there exists a severe dearth of information regarding the general overview of the marketing practices within the aviation industry and passenger buying behaviour in general. Our study bridges the above-mentioned research gap by performing a comprehensive study of all the four major elements of the marketing mix, namely Product, Place, Price and Promotion and how it can be tailored for different carrier types namely FSC and LCC. This study also contributes to existing literature by evaluating how each of these elements, when moulded together can have an extraordinary effect in convincing the target consumer to make the final buying decision.

### **3. Theoretical Connection**

This research paper aims to establish a theoretical connection with the concept of marketing mix adopted in the airline industry. Two prominent theories, namely, Competitive Advantage (Porter, 1985) and the Theory of Relationship Marketing Day and Wensley (1988) are used to base this research on. Firstly, The theory of competitive advantage states that the competitive advantage of a firm is the position the company holds against its direct competitors by employing three methods, namely:

- **Cost Leadership:** where cost advantage occurs when one firm offers the same products/services as its competitor firms but at a lower cost.
- **Differentiation:** where differentiation advantage occurs when a firm provides better and greater quality of service than its competitors, but at the same price as them.
- **Focus:** where a firm that adopts a focused approach concentrates on achieving a local competitive advantage, rather than industry wide.

Porter's competitive advantage approaches act as the base of the model and can be achieved through generic strategies Porter (1980) when analysing the aviation industry a generic strategy gives any airline the choice between the above-detailed cost leadership, differentiation advantage and the economics focus. A perfect generic strategy while ensuring a competitive advantage of the airline over its competitive advantage also provides the firm with sustainability. Secondly, the relationship marketing approach completes the model by connecting to the strategy Day and Wensley (1988). The more contemporary concept of relationship marketing involves the targeting, attracting, satisfying and retaining good customers of a company. In an airline point of view, it aims at maintaining loyalty of passengers by trying to identify, understand and satisfy these loyal customers by tailoring the best possible products and services for the same.

Citing Prahalad and Hamel (1990), the skills and resources possessed by a firm should be combined in the best way possible to achieve its core competencies i.e. achieve a marketing advantage over its direct competitors. Maintaining loyalty of passengers is a mammoth task but, it is much more cost effective to retain loyal passenger than attract and satisfy new passengers; and, this is where airlines can make use of relationship marketing.

#### **4. Hypotheses Formulation**

The above discussion has led to the formulation of several testable hypotheses, which will either accept or reject the null hypothesis and accept the alternative.

H1: Price has a significant influence on consumer buying preferences

H0: Price has no significant influence on consumer buying preferences

H2: Promotional activities have a significant influence on consumer buying preferences

H0: Promotional activities have no significant influence on consumer buying preferences

H3: Product has a significant influence on consumer buying preferences

H0: Product has no significant influence on consumer buying preferences

H4: Place has a significant relationship on consumer buying preferences

H0: Place has no significant relationship on consumer buying preferences

#### **5. Data and Sample**

As the research was framed around the aviation industry, a quantitative approach was adopted, according to which questionnaires were designed and developed in order to analyse and conclude the extent of influence each independent variable, i.e. the product the price the place and the promotion has on the dependent variables i.e. passenger purchasing behaviour. This process of impact of the independent variable on the dependent variable is further classified and analysed based on air carrier types i.e. FSC's and LCC's. Initially, the questionnaire was assessed by marketing professionals for validity and underwent a pilot test consisting of 20

people to ensure reliability, there after 80 surveys were distributed online while responses were received from only 50 active passengers. The questionnaire consists of 20 questions across 5 sections – General Information, Price, Product, Place and Promotion. Table 1 below states the attributes considered in this paper, which were also employed by Park, Robertson and Wu (2007), Wilfing and Bauernfeind (2012) and Chen, Peng and Hackley (n.d).

| Marketing Mix Components | Attributes  |
|--------------------------|---|
| Price                    | Price Sensitivity   |
| Promotion                | Advertisements<br>Radio broadcasts<br>Loyalty programs<br>Campaigns<br>Social Media   |
| Place                    | Airline website<br>Third party website<br>Travel agency<br>Airport reservation Desk   |
| Product                  | Aircraft appearance<br>Spacious seat<br>Baggage related services<br>Inflight Entertainment System<br>Up-to date news<br>Meals and beverages<br>Loyalty program<br>Fast check-in at the airport<br>Online check-in available<br>Safety<br>Punctuality<br>Reputation of airline<br>Friendly and helpful staff<br>Non-stop flight<br>Short transfer time between flights<br>Various and Convenient Timings |

Table 1: Marketing Mix and the attributes

## 6. Variables

Marketing mix, according to Kotler (2002) primarily consists of 4 P’s – Product, Price, Place and Promotion. Before a product gets introduced to a market, marketing professionals manipulate product features, price, and relevant places for selling the product and related promotional tools in order to appeal to the target market. A similar procedure is used to sell airline tickets to customers. Figure 1 below outlines the conceptual framework encompassing the independent variables and dependent variables employed in the study.

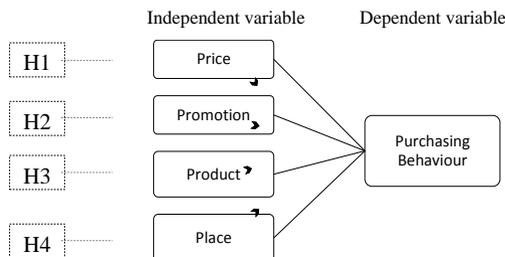


Figure 1: Conceptual framework

## **7. Results and Findings**

In service industries marketing factors like product, price, promotion and place play an important role in influencing purchase decisions. The first section seeks general information pertaining to the occupational status of the passenger, type of air carrier used and purpose of visit. The first question assists to deduce a categorisation in the occupational status of the population. Responses revealed that majority of passengers (65%) were pursuing higher levels of education while the remaining 35% were working professionals. With similar intent, in order to understand the number travellers using FSC's and LCC's, 52.7% preferred using the former while 47.3% used the latter. Finally, a question aimed at understanding the purpose of visit elicited responses from majority of the travellers (81.1%) as Visiting Family and Relatives (VFR) while only 8.1% and 10.8% comprised of those travelling for business and leisure purposes respectively.

It is a common understanding that because LCC's charge lower prices that are generally availed by highly price sensitive and leisure travellers. Questions in section two were developed with an aim of comprehending the relevance of price in passenger purchase behaviour. Derivations from responses to the question framed around price sensitivity depicts that 40.5% of the passengers are highly price sensitive, 48.7% passengers are moderately price sensitive and 10.8% are price insensitive. Building on this, analysis reveals that apart from highly sensitive leisure travellers, 15% of business travellers have sought services from LCC's. This conclusion deviates from the existing norm that business travellers avail FSC services frequently. A major contributing event for this change in trend could be the current economic situation as well as the blurring differences in services offered by FSC's and LCC's.

Following the research objectives, the third section was formulated intending to seek answers in relation to product attributes and the degree of value it holds to passengers. Sixty four (64%) of the passengers valued safety as most important attribute followed by on-board comfort (15%), friendly and helpful staff (14%) and the remaining minority of passengers (5%) value baggage allowance and handling, convenient flight timings, non-stop flights and online check-in services. The attributes considered least important were aircraft appearance (54%), telephone connectivity on board (19%), and the remaining (27%) comprised of inflight entertainment options, Food and Beverages and the reputation of airline. Developing from these findings, it can be concluded that promotional efforts need not emphasise on-board comfort, as it does not hold a significant position for passengers as compared to safety thereby validating Maslow's (1943) argument that safety is consciously or unconsciously the most important assurance required by humans. Therefore, promotional content advertised by airlines could place more emphasis on safety to corner passenger attention rather than side-lining it. Subsequently, another question in a similar context mirrored the aforementioned responses with 40% of the respondents stating that they received messages of on-board comfort from the airlines promotional content whilst only 20% received a message on safety.

The fourth section in the questionnaire was developed to apprehend the most convincing promotional techniques used by airlines to promote their products. Consecutive analysis shows that the most effective technique perceived by the respondents were Word of Mouth (63%) and Frequent Flier Programs (27%) rather than cost intensive billboards and radio broadcasts (0%) and sponsorships (10%). Subsequently, a question aimed to understand customer awareness of promotional tactics used by airlines disclosed that 30% of passengers were unaware of any advertisements/broadcasts and its contents. This indicates that while mass promotion may assist in spreading awareness of the product, there is a phenomenal increase in demand for customised promotional tactics in the aviation industry. The face of service industries is their

staff, and this is being acknowledged by passengers as revealed in the analysis of product attributes, hence airlines investing in human capital would reflect in terms of increased passengers because of word of mouth promotion due to better services that would offered.

Finally, the last section aimed to understand the distribution channel that appealed widely to passengers to purchase an airline service. It seeks answers to questions that will help draw conclusions in terms of the most effective distribution channel, 77% of the passengers availed an airline service through online distribution channels while the remaining were through travel agents. This shows that an airline with the closest, easiest and quickest distribution channel(s) will influence the passenger to engage in purchase behaviour. Numbers are trickling down with regard to purchasing tickets through airport desks and reservation counters because technological advancements have driven the same function closer to the customers. These findings echo the fact that, even if an airline price and product attributes meet the requirements of the passenger, without a smooth and seamless booking process competitors can win over the passenger.

## **7.1 Overall Analysis**

This analysis reveals that an airline's Product and Place Mix are the most influential for inducing purchase decisions while price and promotion serve as secondary motivating factors that encourage the customer to pursue a purchase decision. In addition, the FSC's and LCC's are increasingly offering similar services subsequently diminishing differences in the definition regarding services offered by either carrier's. Based on the findings it would be advantageous for airlines to promote itself through emphasising on safety as a significant product attribute with on-board comfort, friendly staff and affordable prices at side-lines. In addition, heavy investments in technology and R&D for offering easy, seamless and user-friendly airline interfaces will have a positive return because, as customers thrive towards technology the same should be mirrored by airline organisations to gain a competitive edge. Once these 3 P's are in place, price comes into motion to finalise the purchasing behaviour. Hence, it is clearly depicted how the null hypothesis is rejected and how the alternative hypothesis stands true that price, promotion, place and product has a positive relation on customer purchasing preferences.

## **7.2 Managerial Implications**

Small changes in dynamic industries can have tremendous consequences. Trends in passenger attitude influence purchase behaviour and managers should act accordingly. Deducing from the research, Promotion and Price mix should frame Product and Place offerings so to induce a favourable decision. For example, direct mails to working mothers spending their summer vacations in the UAE, by combining emotional constructs associated with safety and relaxation along with affordable prices or group discounts is most likely to induce a purchase behaviour. Increasingly, customers are moving towards personalised options; hence it would be advisable for managers to allocate their resources in investing in custom promotion techniques such as discounts for a destination that has been frequently searched by the customer through information capture databases. In addition, due consideration should also be paid to make interface between the airline and the customer easier, accessible, updated and smooth the interface the more likely to retain and attract travellers. With regard to price, the variances between FSC and LCC are diminishing with competition being centred on services. Product attributes for a price reflects worth. Customers recognise the importance of qualified staff as well as revenue lost while creating additional room for seats and safe operations as compared to aircraft appearance and cellular connectivity.

## **8. Limitations and Suggestions for Future Research**

While all efforts have been made to ensure that this research paper is free from all limitations, future research can target a sample broader than 50 to get an extensive picture of the entire scenario. Future research can cover, specific markets globally, because, passengers from different markets will have a different characteristics and living conditions which will all impact the formation of an ideal marketing mix. Research can also be done on passengers of a specific airline(s) and what their most appealing marketing method is. Marketing techniques most appealing to target customers on the basis of purpose of travel ranging from business to leisure to visiting friends and relatives can also be studied. Different travel classes such as First, Business, Premium Economy and Economy Classes can be analysed too with many airlines providing lower costs for all the three major classes. Application of statistical techniques such as Correlation, Average, Probability and the likes, can help future researchers draw more relevant and concrete inferences.

## **9. Conclusion**

The airline marketing mix elements plays a crucial role in influencing consumer-buying behaviour, as proven in the course of this paper. Every element of any marketing mix has a distinct role to play in the process of a final purchase being made. The paper concludes that, of all the marketing mix attributes; safety is the most important characteristic of an airline product. Furthermore, Word Of Mouth and passengers personal experiences are the most convincing and effective promotional techniques. Furthermore, Passengers at a large-scale prefer online channels to get access to airline services. And finally, irrespective of the target customers' price-sensitivity levels, it is evident that passengers prefer an airline with a better combination of product, place and promotional attributes. Given these findings, it has been inferred that it is far too early to provide generalised findings, based on the small sample size and much more needs to be done as ongoing advances in marketing techniques rapidly influence consumer buying behaviour.

## **10. Acknowledgement**

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# Design of a Sweeping Jet Actuator for Improved Aerodynamic Performance

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**Abstract:** Currently, in our globalised world, the air transportation is a critical and important system for our economy. The fuel consumption has become recently a problem for environment and for the operational costs. Therefore, new technologies are needed. The active flow control is crucial way to enhance aerodynamic performance of commercial aircraft that will consume less fuel. For this reason, a specific type of active flow control method using sweeping jet actuator is studied. Preliminary results for the optimisation of the SWJ in Fluent Ansys program are done for the study of the feedback channels.

**Key Words:** sweeping jet actuator, active flow control, advanced aerodynamics technology, aircraft fuel consumption, computational fluid dynamics.

## 1. Introduction

### 1.1 Context and Objectives

Nowadays, air transportation system is an indispensable and a key part of worldwide connected economic and transportation systems<sup>1</sup>. Commercial aeronautical sector has been looking for a new balance between public expectations of cheaper fares, and reducing environmental impact of the commercial aviation mandated by regulatory agencies. In order to achieve such a balance, innovative technologies<sup>2</sup> are required in design, operation and reliability of the next generation aircraft.

This vision cannot be achieved without adding ground-breaking technologies in the areas such as aerodynamics, materials, and manufacturing. Improved aerodynamics will increase aircraft performance, and will decrease fuel consumption. In this context an innovative active flow control concept using Sweeping Jet Actuator (SWJ)<sup>3</sup> is proposed to suppress flow separation and improve aerodynamics performance<sup>4</sup>. This device will allow designing a smaller vertical tail which in turn will reduce aircraft weight, required thrust and fuel consumption. As a result, it will enable the design of environmentally friendly aircrafts with high performance. Some airplane manufactures like Boeing have already been working on this technology to include in their different programs like ecoDemonstrator<sup>5</sup>.

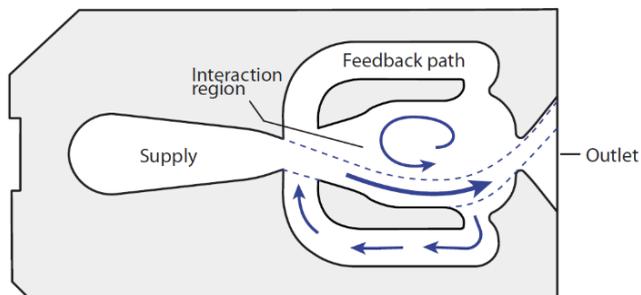


Figure 1: Schematics of a Sweeping Jet Actuator<sup>3</sup>

## 1.2 Flow Control

Flow control technology includes a large variety of technologies that can provide performance improvements much more than modification of external surfaces alone. Improvements include increasing lift, reducing drag, reducing noise, or delaying turbulent separation. Other benefits of the flow control are reducing the system complexity, weight, maintenance, and most importantly fuel consumption. Many studies<sup>1-6</sup> reflect the achievement of reduced fuel consumption in civil aviation and this trend is shown in Figure 2.

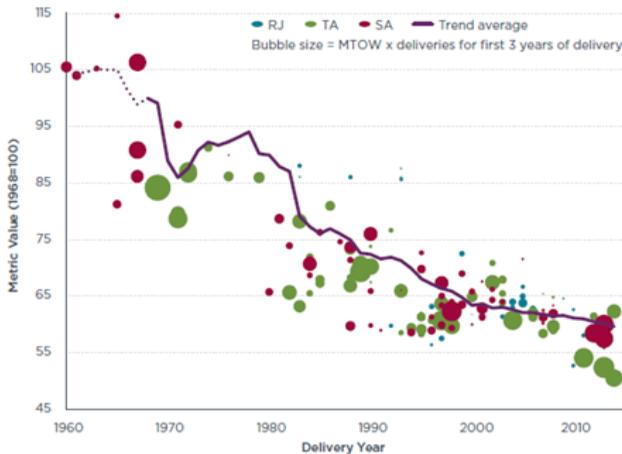


Figure 2: Fuel consumption for different commercial aircraft metric value from 1960 to 2014, normalised to 1964.

The passive flow control devices do not require a power input for their operation, but they have a disadvantage of increasing drag force during the cruise operation. On the other hand, the active flow control devices require external input such as power or fluid supply to work, but their effectiveness for increasing aerodynamic performance are much higher than the passive flow control devices. For this reason a fluidic oscillator called sweeping jet (SWJ)<sup>3</sup> actuator for active flow control is studied in this paper. Fluidic oscillators are devices that generate a pulsed jet when supplied by pressurised fluid. The normal configuration involves no moving parts and the frequencies are controllable. These actuators exploit fluidics technology usually via Coanda effect<sup>8</sup> (Coanda 1936). Due to this effect, the pressure increases in the feedback loop and this process repeats in cyclic fashion and the jet flow switches between the curved surfaces, for this reason the optimisation of these surfaces is a critical thing. These devices are also called sweeping jet actuators. For many years, they have been used in windshield washers and in irrigation systems with water as main working fluid. The principles of operation are understood; but the detailed flow physics of these actuators are not.

The major objective of the Sweeping Jet Actuator is that controlling separated flow around vertical tail at high angle of attacks, and enhancing the aerodynamic performance to enable future smaller vertical tail designs. In 2012, Seele<sup>15</sup> et al. set up experiment in the wind tunnel with the purpose of seeing the improvement in the rudder effectiveness with Sweeping Jet Actuators in the tail of typical twin-engine aircraft. The result of the experiment showed that the use of sweeping jets placed on the rudder can increase the controllability around 20%,

furthermore the mass flow necessary to operate is reasonable and they can be placed in the airplane.

In spring 2015, the first flight test of the Boeing 757 ecoDemonstrator of the NASA ERA<sup>17</sup> project was performed. The 757 ecoDemonstrator included 31 sweeping jet actuators on the starboard side of the vertical tail. The main purpose of the flight test was to demonstrate the effectiveness and the integration of the active flow control into the airframe. Pilot feedbacks and engineering analysis confirmed that the active flow control is effective and it enhanced the rudder controllability with force increase up to 16% for high rudder deflection angle.

The results of ecoDemonstrator<sup>17</sup> test verify the application of the active flow control for the vertical tail; however the complex flow inside the SWJ has to be understood for designing optimised actuator geometry with minimum pressure loss. Numerical studies using computational fluid dynamics method are performed to investigate the effects of feedback channel geometry. The methodology and results are presented in the following sections.

## **2. Methodology**

### **2.1 Geometry Definition and Set up**

The set up compressible flow are solved using computational fluid dynamics software, Ansys Fluent v17. The Sweeping Jet Actuator geometry and computational domain are created in a parametric way using Design Modeller software.

The SWJ actuator geometry is provided by Kara<sup>3</sup> and has an exit nozzle throat height of 6.35 mm. A semi-circular domain with a radius of 600mm is place at the downstream of SWJ actuator geometry. In Figure 3, parameters D1 and D2 represent feedback channel height and width. The parameters are varied systematically to investigate the effect of feedback channel geometry on jet oscillation frequency. The origin is located at the cross section of the SWJ actuator symmetry line and exit plane as shown in Figure 3. To perform detailed analysis, data sampling points are placed at the downstream of exit nozzle, namely, at (3 mm, 0), (6 mm, 0), (6 mm, 10 mm), and (6 mm, -10mm) as shown in Figure 3. Three lines are set up in order to measure the mass flow rate in the feedback channels and at the exit nozzle throat. In each of these lines, mid points are created to record the variations of total and static pressure with respect to time.

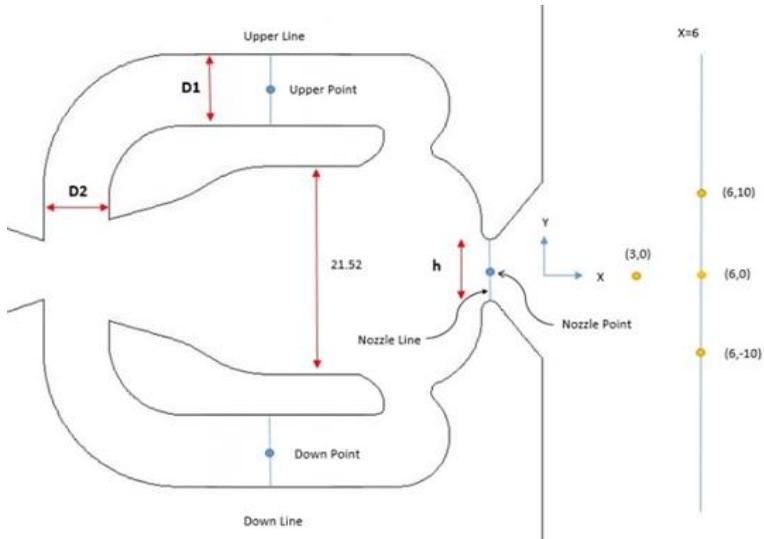


Figure 3: Geometry and sampling points of SWJ

## 2.2 Meshing

The Ansys Meshing software is used to create meshes in a semi-automatic way for various geometric parameters. The mesh has two levels of element refinement using sphere of influence method as shown in Figure 4. The Body Sizing number one of the SWJ actuator geometry has a radius of 37 mm with element size of 0.2 mm, and Body Sizing number two has a radius of 130 mm with element size of 1 mm. Boundary-layer mesh is created on the solid walls using 20 layers with a growth rate of 1.15. The first layer height is set as  $5 \times 10^{-3}$  mm. The average value of  $y^+$  is found ranging between 0.2 and 5.

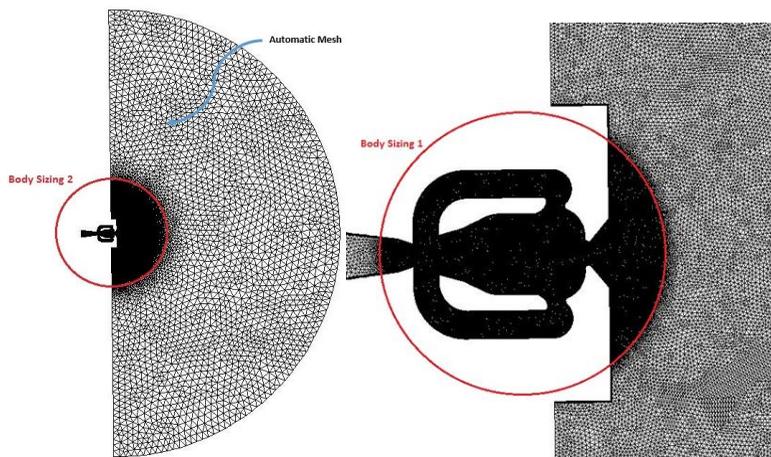


Figure 4: Meshing representation

## 2.3 Fluent Set Up

The boundary conditions for all of the solid surfaces are defined as no-slip, no-penetration for velocity, and adiabatic for temperature. The mass flow inlet (implemented using mass flux) is 0.0015 lb/s, pressure outlet is 101327.5 Pa and inlet velocity 37.2 m/s. The pressure outlet is assumed to open to the ambient environment at  $p_{\infty}=101,325$  Pa and  $T_{\infty}=298.16$  K. In addition, a pressure gradient of 5 Pa is applied between outlet boundaries to create a surrounding flow in the axis +x in order to help the flow to develop across the outlet area. The simulation is sampled for 5000 steps without sampling and after 10000 steps with sampling the points and lines represented in the Figure 2.

## 3. Key Findings

### 3.1 Effect of Feedback D1 and D2 Channels Dimensions on Jet Oscillation Frequency

The feedback channel height (D1) and width (D2), as shown in Figure 3, are identified as key parameters for optimisation the SWJ. In the reference SWJ actuator geometry, feedback channel height D1 and D2 are measured as 7.42 mm and 6.83 mm. The SWJ actuator geometry is symmetric about the x-axis. The study will compare this two parameters with the velocity magnitude frequency in the sampling point (6mm,0) after the Fast Fourier Transform (FFT) of this signal as showed in Figure 5. The feedback channel height (D1) was studied and performed by J. Slupski<sup>11</sup> but the study of parameter D2 is the objective of this section. The Figure 6 represents the previous study of the parameter D1 for three different mass flow rates 0.010 lb/s, 0.015 lb/s and 0.020 lb/s.

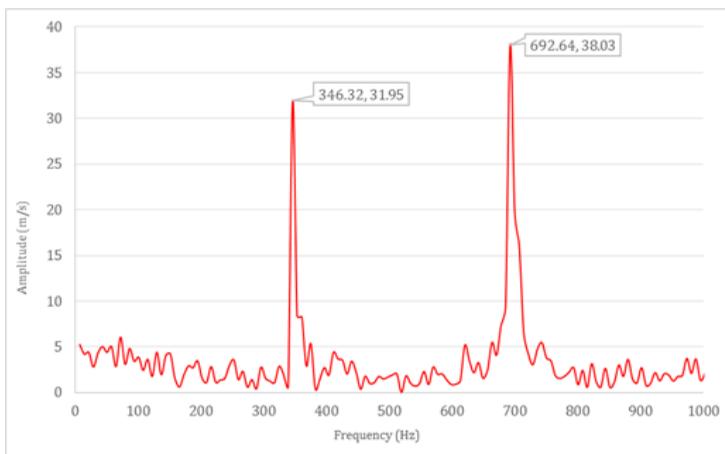


Figure 5: Example of FFT analysis

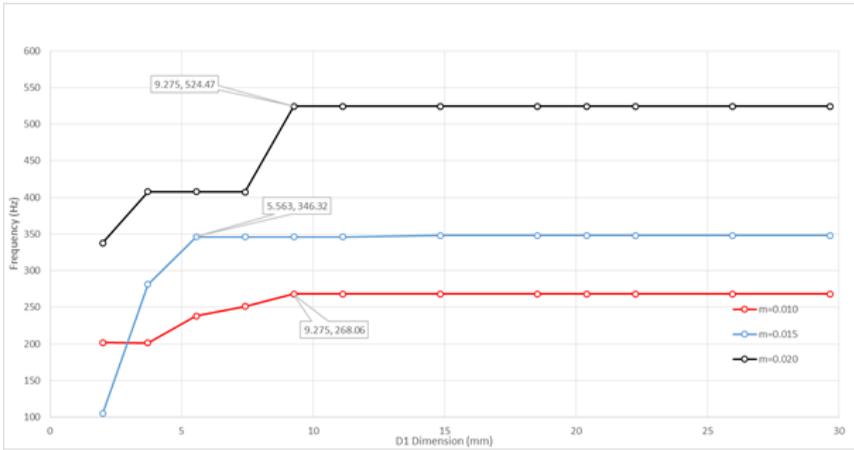


Figure 6: Values of the Frequency for different D1 and different mass flow rates

Using the results of J. Slupski<sup>11</sup>, five new geometry with different D2 are created, meshed and simulated using three mass flow rate of 0.010 lb/s, 0.015 lb/s and 0.020 lb/s. Time histories of different parameters at the points and lines showed in Figure 2 are recorded and sampled. The results of the FFT frequency in the point (6mm, 0) are showed in the Figure 7 for the different three mass flow rates. For the mass flow rate 0.010 lb/s, the frequency magnitude of the velocity remains almost constant with the dimension of D2. In the other cases, 0.015 lb/s and 0.020 lb/s decrease with the dimension of D2. This behaviour is opposite that represented in the Figure 6 when D1 is changing.

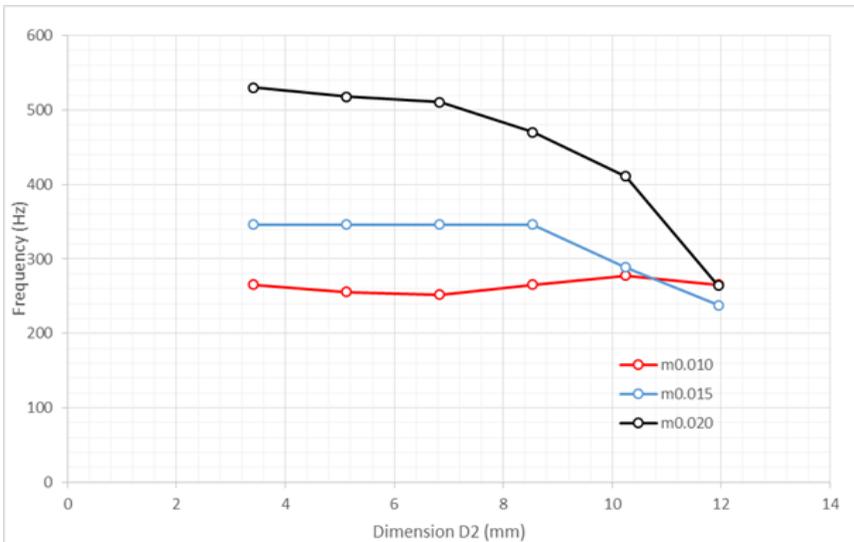


Figure 7: Values of the Frequency for different D2 and different mass flow rates

### 3.2 Pressure Losses

The Total Pressure and the static pressure are two parameters very important in order to optimise any oscillator. In the Figure 8 is represented the Total Pressure of the sweeping jet actuator. The range of the values is between 74542Pa and 1297703 Pa. The internal surface, called Coanda surface, are critical in this case as the jet try to attach to this internal surfaces when it is near and creates an internal vortex. The relief of this Coanda surfaces is a critical feature and has to be optimised in order to decrease the pressure losses.

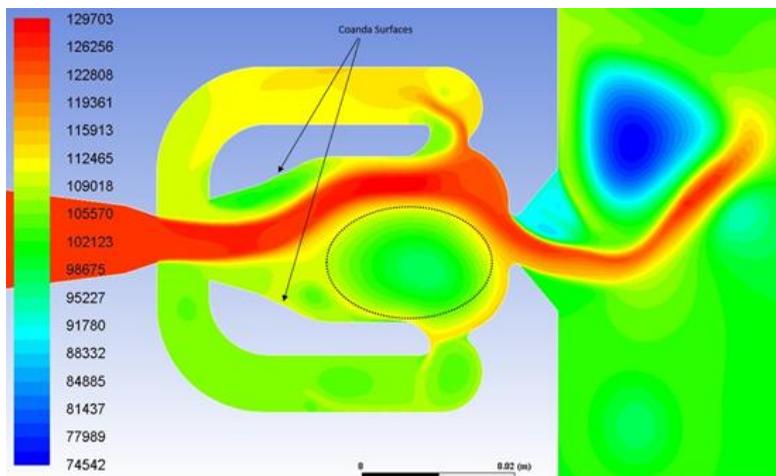


Figure 8: Total Pressure Contour of the Sweeping Jet Actuator

### 4. Conclusion

In the current and future aviation industry, reduction of fuel consumption will be the game changer for successful businesses. For that reason a specific technology called Active Flow Control has been studied with the Sweeping Jet Actuator (SWJ). The Active Flow control performed by the sweeping jet actuator (SWJ) is beneficial for the boundary layer in the vertical tail as it emits a continuous but spatially oscillating jet when pressurised with a fluid. The oscillations are entirely self-induced and self-sustaining. In this study, unsteady flow fields generated by a SWJ actuator are investigated using two-dimensional, unsteady, Reynolds-Averaged Navier Stokes simulations with Fluent Software v17 over a range of feedback channel geometric parameter called D2. The effect of varying feedback channel height and width is a critical and feature of the SWJ. Preliminary results show that the jet oscillation frequencies decrease with increasing D2 parameter of feedback channel. This device is has many advantages in the aircraft for civil aviation as doesn't have moving parts, is easy to integrate ion the airframe and the reduction of the fuel consumption can be as to 16%. Future optimisation in the internal surfaces has to be done in order to reduce the pressure losses.

### 5. Acknowledgements

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