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THE EFFECTS OF REDUCING AIRCRAFT WEIGHT ON PROFITABILITY AND FUEL CONSUMPTION

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ABSTRACT

This paper represents an estimation of the annual profits generated by minimizing fuel burn during a flight by reducing the amount of weight carried prior the departure of an aircraft. Operational costs are one of the main factors affecting profitability in any aviation industry thus, it is vital to find a strategy to reduce such cost. One of the factors increasing operational costs is fuel consumption which is mainly triggered by weight carried during a flight. This study improves the fuel efficient of an aircraft through reducing baggage weight carried by passengers. The weight carried by an aircraft must be frequently managed and monitored. An equation taken from Flynas airlines will be used to determine the number of annual profits generated from an aircraft's weight reduction and its effects on fuel consumption. A new baggage policy will be suggested and tested then a new pricing strategy for flight tickets will be implemented in order to support the changes in the new baggage policy. A numerical and an analytical study will be conducted to Flynas airlines, the leading low-cost carrier of the kingdom of Saudi Arabia. A mixed method approach will also be followed including an in-depth investigation and observation of the airline. The result demonstrated proposed strategy can increase the annual profits about 90 million riyals and 14 million riyals for the economy-extra light category and business class respectively.

INTRODUCTION

The airline industry became synonymous with ongoing losses and insolvency, it is historically known for being a non-profitable industry. The continuous depression in airline profitability is due to the various political and economic incidents accruing globally. Airline profitability is directly affected by multiple factors including the upward trend in the cost of fuel during the past

decade, high consumption of such factor might determine the sustainability of the entire business if not managed and monitored appropriately. Due to the growing demand over airfares the airlines still find hope as they try to find rational solutions and better strategies to do business in order to increase profitability, makeup their losses and pay their debts. The airlines industry still operates regardless of the profit deficiency it faces as governments and stakeholders cannot afford such losses as losing an airline would involve the unemployment of thousands of employees, inconvenience for hundreds and possibly thousands of travelers, increase pressure among other airlines as they would have to fill in the gap of the lost airline not to mention the amount of money that will be lost for the airline's creditors. Governments try to push such airlines in their time of crisis with financial aid by long term loans with low interest rates, exceptional fuel prices, purchasing or low rental of plains in order to keep them in business as the countries reputation is at stake if it was perceived of unsupportive of its vital mode of transport.

The aviation industry has become ever more challenged by the competitive market surrounding it, airlines are trying to come up with new strategies to reduce costs incurred in order to cover up their expenses and generate profits. Private Saudi airlines in specific are facing the challenge of inequality of services and incentives provided by the general authority of civil aviation of Saudi Arabia (GACA). Such challenges include higher fuel prices than provided to local airlines, expensive ground services, inflexible runway selection, limited destinations to choose from, tax and rental of old used plains, creating an environment that is not conductive to fair competition. Therefore, these airlines should find new strategies to overcome obstacles faced, find new ways to reduce their operational costs, develop its political relations to ensure their sustainability and develop new strategies to maximize their annual profitability.

There have been many published researches investigating aviation fuel efficiency and consumption [1]. Many factors thus influence fuel consumption for a given flight. Studies in airline operation and aerodynamics have identified some of these factors to be: aircraft capacity utilization, the operational weight of the plane, speed optimization, the center of gravity optimization to reduce trim drag and freight carried. Aircraft capacity utilization is achieved through increasing the load factor especially for long distances and has been greatly improved by the ever-growing demand for air travel. Fuel consumption determines the efficiency of the plane and therefore should be kept at its most minimum possible to maximize profits and reduce the negative impact on the environment [2].

According to a study commissioned by the American materials may also be used if the improvement in fuel efficiency in the course of the plane's life justifies the cost of the materials Airlines in 2015, every 1% reduction in weight translates to about 0.75% reduction in fuel consumption. It is therefore clear at this point that the weight is directly proportional to fuel consumption and hence mobility efficiency [3]. A ten percent increase in weight results in a ten percent increase in fuel consumption. This then translates to lower fuel efficiency for the plane and a reduction in profits due to the higher operational

costs [4]. The deviations from standard passenger weights significantly affect aircraft performance [5].
The first major commercial aircraft to make use of lightweight materials to reduce the non-payload was the Boeing 787 Dream liner which had a composite fuselage, composite wings with many other parts of its airframe being made of composites [6]. Virgin Atlantic airlines claim redesigning their in-flight serving trays to be smaller and lighter allowing more of each of the trays to fit into a meal cart. This then resulted in fewer meal carts being needed for each flight [7].

Lower the aircraft weight, the lower the power needed to take-off, cruise and maintain speed and hence the less the fuel flow required to supply the needed power and vice versa [8]. American Airlines has recently gotten permission from the Federal Aviation Administration (FAA) to replace their enormous paper flight manuals with ipads. The manuals usually contain all necessary information about the plane being flown and weigh about 35 pounds (approximately 16 kilograms). The Airline claims that by replacing its 35-pound manuals with an ipad which weighs just about 1.5 pounds it will be able to make savings of up to 1.2 million dollars in fuel consumption every year. This and other weight reducing measures it has undertaken will lead to fuel saves of up to 10 million gallons of fuel per year [2].

The main intension of this study is to increase profitability through understanding the relationship between weight and fuel consumption with developing a new pricing strategy that is aligned with the new baggage policy created that insures the airlines' sustainability and continuous generation of profits.

METHODOLOGY

A numerical and analytical study will be implemented which will include an in-depth investigations and observations of the current aviation market in the case of Saudi Arabia. An airline will be selected and a detailed analytical study of its situation will be established. A mixed method approach including both quantitative and qualitative data will be used to better understand the environment surrounding the airline and where its profitability and expenses.

Company Background: Flynas Airlines

This study will be applied on Flynas airlines, the leading low-cost carrier of Saudi Arabia. With its low operating cost structure Flynas airlines operates over 1000 scheduled flights per week (an estimated + 56,000 flights per year) with its 30 aircraft fleet each designed in 2 configurations, business and economy. Flynas provides flights to 80 different locations worldwide by joining other airlines, 17 for which are domestic s and 53 international destinations.

Flynas airlines operated 59,687 flights during 2017. With joint venture with other airlines, they succeeded to create 80 traveling destinations worldwide with its 28 operating air fleet (2 not in service). In the case of Flynas airlines the number of seats are custom designed to allow more comfort for traveling

passengers, an Airbus A320CEO has a seat capacity of 164 PAX (8 Business class (B/C), 156 Economy class (E/Y) not to mention, the Airbus A319CEO has 128 PAX (8 Business class (B/C), 120 Economy Class (E/Y). Such large number of flights requires millions in riyals on fuel. Flynas uses Jet A-1 fuel type which meets the requirements of ASTM D1655 Standard Specification for Aviation Turbine Fuels, it also complies with U.K. DEF STAN 91-91, and the JIG (Joint Inspection Group) Aviation Fuel Requirements for Jointly Operated Systems (Check List).

Fuel Cost

Jet Fuel varies on a day-to-day basis as it is aligned with crude oil prices [9]. According to Flynas airlines flight operators we will use 2.6 SAR/Liter as the average fuel price for their network for the year of 2017.

Passengers Load Factor

Passengers load factor is the utilization capacity of an aircraft [10, 11]. It is used as an assessment of the airlines capability to fill out the seats of an aircraft per flight. According to the International Air Transport Association, the worldwide load factor for the passenger airline industry during 2015 was 79.7% [12, 13]. Passenger load factor is the dimensionless ratio of passenger-kilometers travelled to seat-kilometers available. In the case of Flynas airlines a 67% load factor in applies and is not succeeded per flight.

Research Hypothesis

There is a positive correlation between weight and fuel consumption. Minor changes in an Airlines' baggage policy can dramatically affect profitability and fuel consumption.

RESULT AND DISCUSSION

This study analyzes the situation of the airline selected which is Flynas Airlines during 2017 using their data history and records.

New Baggage Policy (Economy- Extra Light and Light) And Pricing Strategy

According to Flynas airlines engineering performance department about 50% of current travelers are traveling without a hold baggage and are treated as usual economy passengers as they are paying the same amount to book a flight. If split the economy class into two categories (Economy- Extra Light and Economy-Light) to the current baggage policy of Flynas airlines, by which travelers are given the option to carry a single carry-on bag of 7 kg only for the regular price (economy-extra light) or pay an additional fee for the hold baggage carried (economy-light class) Thus, a new mean for profit generation will be established.

Such new policy will attract consumers from different backgrounds and social levels to take advantage of such better prices compared to other airlines,

current travelers will also consider not taking a checked in baggage for the lower priced flight ticket not to mention the frequent travelers that were not planning to take a checked in baggage in the first place either because they are traveling for business or a one day trip for any case to prefer such airlines that provided this option with a more convenient price. On the other hand, hold baggage carriers will consider paying the additional amount as an incentive is created by the idea of getting more value (20 Kg bag) for what is being paying (30 SAR) which shown in Table 1.

Table 1: New Suggested Hold and Carry-On Baggage Policy (Economy-Extra Light)

Baggage/ Flight Class	Economy class		Business class
	Extra light	Light	Premium
Hold Baggage	X	20kg	20kg
Carry-On baggage	7kg	7kg	7kg

A new pricing strategy must be implemented in order to cover the costs incurred and insure the continuous generation of profits. This increase is vital as various governmental costs were added and forced upon the Saudi aviation market, such costs include the application of 5% VAT, an increase in the monthly fees upon expatriate workers from 200 to 300 and another 100 will be added by the beginning of next year not to mention the increase in the costs of goods and services supplied by suppliers such as (ground services, maintenance, catering, etc.). In this study a new baggage policy and pricing strategy are created to insure the airlines sustainable profitability. Minor changes were done in terms of ticket pricing. This study suggests that the original economy ticket pricing will be applied to the passengers traveling without a hold baggage (Economy-Extra Light) and an additional 30 SAR fee is added on the original ticket pricing for hold baggage carriers (Economy-Light). The pricing strategy is also applied to the business class by adding 30 SAR for both carriers and non-carriers of a hold baggage which shown in Table 2.

Table 2: New Pricing Strategy Suggested To New Baggage Policy

Flight Class/Pricing	Economy class (X)		Business class (Y)
	Extra light	Light	Premium
Pricing	X	X+30	Y+30

Implementation

A fixed calculation created by Flynas airlines representing the amount of fuel reduced per weight reduction is applied.

$$\frac{28.5}{1000}$$

Flynas Airlines current load factor per flight is does not exceed 67% of capacity loaded. First, calculate the expected number of annual profits generate by the new baggage policy while taking into consideration the current load factor percentage of passenger per flight which is 67% and taking into consideration a 50% of economy passengers not carrying a hold baggage. The average number of seats for both fleets of A320CEO and A319CEO are 108 seats.

$$320 = 67\% * 164 = 109.88 \approx 110$$

$$319 = 67\% * 128 = 85.76 \approx 86$$

$$= \frac{110(26) + 86(2)}{28} = 108.2857 \approx 108$$

An aircraft's utilization is the average number of hours an aircraft flies during a 24-hour period. Average utilization for 26 Airbus A320CEO during 2017 is 10.42 Hrs while the average utilization for 2 Airbus A319CEO during 2017 is 10.20 Hrs. Thus, the total average of 28operationg aircrafts during 2017 is 10.4Hrs.

According to Flynas airlines operation center and engineering department, Saudi Arabia, an equation for network fuel savings was taken. This equation was used in a confidential weight reduction experiment back in 2016 and it has proven to give an estimated amount of the profits generated from weight minimization. The experiment was a success and is still performed until today. In this study, the same equation will be used in order to test the hypothesis (New baggage policy, Economy- Extra Light). Where, W is weight per kilo grams, U is the Utilization, AC is number of operating aircraft and daysperyear is 365days

$$= \frac{\Delta}{1000} * 28.5 *$$

Figure 1 show the seating distribution including economy-extra light category. By assuming 50 passengers book their flight under Extra Light category, the fuel saving can be calculated.

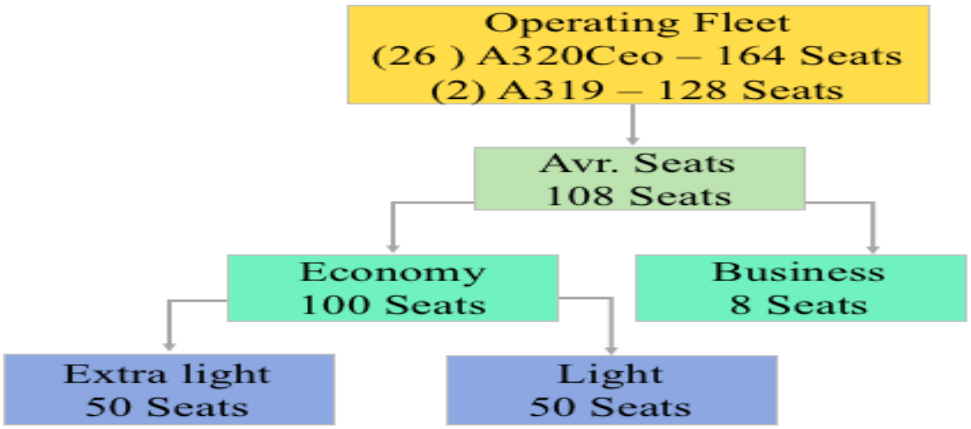

Figure 1: Seating Distribution Including Economy-Extra Light Category

$$= \frac{50 \ldots (20 \ldots)}{1000} * 28.5 * 10.4 * 28 * 365$$

$$= 3029208 \ldots * \frac{\ldots}{0.78 \ldots}$$

$$= 3883600 \ldots$$

Taking into consideration that Flynas airlines average fuel price per liter for the entire network during 2017 is 2.6 SAR/Liter. Thus, the annual profit for extra light is 10,097,360 SAR/year, which is considered as the estimated current profits that the airlines will generate from applying the new baggage policy (Economy-Extra Light) assuming 50% is booked from economy class in the form of extra light category. If an increase in the current load factor (67%), meaning more passengers books a flight without a hold baggage, an increase in the annual profits will occur due to the decrease in fuel consumption required for a flight.

To implement the suggested new baggage policy and insure cost incurred are covered and profits are still generated an adjustment to the current pricing strategy must be made. In this study a new pricing strategy was suggested which shown in Table 2. By consider 60000 is the annual number of flights where, the annual additional profits for Economy-light and Business can be calculated.

$$\ldots h \ldots = 50 \ldots \ldots 30 \ldots \ldots 60000$$
$$= 90{,}000{,}000 \ldots$$

$$\ldots = 8 \ldots \ldots 30 \ldots \ldots 60000 = 14{,}400{,}000 \ldots$$

Therefore, 90,000,000SAR and 14,400,000SAR represent the additional profits generated other than the previous profits established from the old baggage policy.

CONCLUSION

In conclusion, a positive relationship between weight and fuel consumption is resigns. Minor changes in the airlines' baggage policy and pricing strategy can insure the sustainability of the business. A new baggage policy was created for Flynas airlines in order to create more options for traveling passengers. This new baggage policy was created with a new pricing strategy for an airline to cover the costs applied and generate profits. After testing the newly developed policy and strategy an estimation of annual profits from the economy-extra light category is generated, another 90 million riyals in profits is established from the economy-light travelers and an additional 14 million from the new pricing strategy for the business class. A continuous monitoring procedure on factors affecting operational costs is required to insure the profitability of the airline.

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