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Research paper



General Aviation in Iran - Challenges and Opportunities

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Abstract

One of the development indicators in different countries is the development of the transportation infrastructure. Aviation, as one of the transportation networks, plays an important role in the economic, social and cultural development of every countries. In this paper, Iran Aviation Network has been studied and reviewed based on domestic flight parameters such as flight frequencies of airport and the average number of passengers per flight. It is concluded that Iran's Aviation Network does not have a uniform dispersion of traffic and this lack of uniformity can be seen in the ineffectiveness of some airports and the load factor in some regional flights. This problem can be handle using general aviation aircrafts. The use of airplanes with less passenger capacity will increase the flight frequency and load factor. So, increasing these two parameters will increase profit, especially in small airports and short routes. This process can balance the air transport network cycle in Iran and increase its efficiency and uniformity.

Keywords: *Air transportation, General Aviation, Iran Aviation*

1. Introduction

The rise in the speed of life and the value of the time parameter have caused the use of aircraft to travel more demanded. The ideal aviation network can be considered as one of the development indicators in different countries. This development involves several parameters including ticket costs, airplane availability at the time of travel, and the culture of using the aircraft. Iran's air transportation network study shows the network is monopolized by the main airports of the country in Tehran, Mashhad, Kish and several other major cities, and most Iranian airports, especially in small cities, are inefficient. Currently, many of the routes in Iran do not have direct flights and passengers must travel by road or rail. This can clearly be seen at small city airports. The low flight frequency in these cities is due to the low number of passengers. Airlines reduce their frequencies due to the low number of passengers. Increasing the frequency of flights in these cities reduces the load factor and this is not economically feasible for airlines. Several parameters in allocating an airplane to the flight routes should be considered. One of these parameters is the consistency of the capacity of the aircraft with the number of passengers. This parameter has a great impact on the load factor and the profits of the airlines. On routes with low passenger numbers, one of the ways to raise the load factor is to use low capacity aircrafts. Using aircraft with a passenger carrying capacity of less than 20 passengers can increase flight frequency while improving the load factor. This paper will attempt to analyze the use of general aviation (GA) aircrafts as a solution to improve the efficiency of airlines and airports at the airport, small cities and short routes.

Several articles and activities on general aviation and the use of light aircrafts have been published so far. Richard (2002) suggests that while passenger volume and consumer surplus decrease on the aggregate, some markets benefit from welfare gains once merger-induced changes in flight frequency are factored in [1]. How mergers may affect frequency decisions and consumers. Although the analysis here focuses only on flight frequency, extensions to models with additional quality measures or passenger types would be worthwhile. Wei and Hensen (2005) claimed that airlines can obtain higher returns in market share from increasing service frequency than from increasing aircraft size, and our study confirms an S-curve effect of service frequency on airlines market share. Also the available capacity per flight—net of capacity absorbed by connecting passengers—affects market share in the same manner whether it is derived from a larger proportion of a smaller aircraft or smaller proportion of a larger one [2]. In Figure 1, the airline profits are compared in terms of increasing frequency and increasing aircraft size. In the figure, it can be seen that the increase in flight frequency will have a greater impact on airline profits.

Giovani and his colleagues (2006), aims to investigate and explain the choice of relatively small aircraft [3]. It seems that this choice is associated mainly with the benefits of high frequency service, the competitive environment in which airlines operate and the way airport capacity is allocated and priced. To keep load factors high while offering high frequency service, airlines tend to reduce the size of the aircraft they use. At many of the world's largest airports there are fewer than 100 passengers per air transport movement, although congestion and delays are growing.

Pai (2007) assesses the determinants of aircraft size and frequency of flights on airline routes by considering market demographics, airport characteristics, airline and route characteristics [4]. The results shows that frequency and aircraft size increase with population, income, and runway length. An increase in the proportion of managerial workers in the labor force or the proportion of population below the age of 25 results in greater frequency with the use of small planes. An increase in distance between the endpoints leads to lower frequency and the use of larger planes. An increase in delay at the route endpoints leads to lower frequency and smaller planes. An increase in cancellations, however, leads to higher frequency and the use of larger planes.

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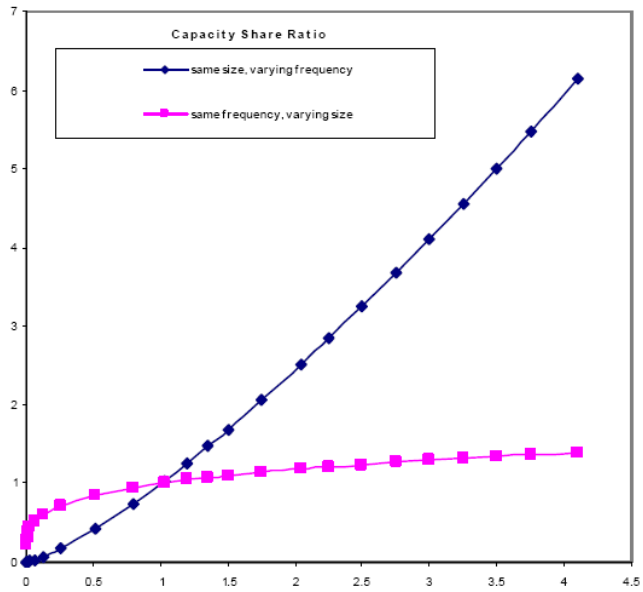

Fig. 1: Frequency and passenger capacity vs. airline market share [1]

In 2017, Khidhr examines the commercial aviation industry in the Islamic Republic of Iran and the effects that sanctions have had on the country's airlines, airports, and aviation technology, as well as on the greater society, culture, and economy [5]. The paper shows that overall the sanctions had a negative impact on the industry and asserts that now, in the wake of the lifting of sanctions, that there will a new period of rapid development of the commercial aviation industry and many opportunities for western commercial airline and aircraft manufacturers to develop relations with Iran.
This article, presents challenges and opportunities for launching General Aviation in Iran's aviation network, using statistics and status of domestic flights in Iran. The GA fleet will complete the country's aviation cycle and increase the efficiency of the airports especially in low-population regions.

2. Air Transportation Network in Iran

According to the latest census, the population of Iran is more than 80 million and its area is about 1648 thousand square kilometers. The transportation network between the cities of Iran includes three types of roads, railways and air transportation. Among these three types, the road transport network has a relatively good development but the rail transport network is not fully developed. According to the latest statistics released by the Iranian Civil Aviation Authority [6], there are 191727 sortie flights per year in Iran and around 22 million passengers travel through Iranian airlines. On average, there were 114 passengers per flight. Over the past five years, the number of domestic airline passengers has grown steadily (Figure 2). According to statistics, 54 airports are operating under the Iranian airports and Navigation Company (Figure 3 shows the distribution of Iran airports). The maximum distance between two Iranian airports is about 2500 kilometers and many Iranian airports have relatively little distance, so there are good conditions for regional flights in Iranian airports. Based on figure 3, among the airports in Iran, there are nine international airports and the rest are domestic airports. There are also 6 airports to be developed.
Figure 4 shows the average number of daily flights from Iranian airports. It can be observed that 38 airports in Iran have fewer than 10 takeoff and landings per day. A closer look at statistics shows that flights from small airports are limited to main airports (Mehrabad Tehran, Mashhad and Kish) and if these flights are eliminated, small airports have not flight to other cities. This indicates an imbalance in Iran's aviation network. This is due to the lack of economic flight between small cities.

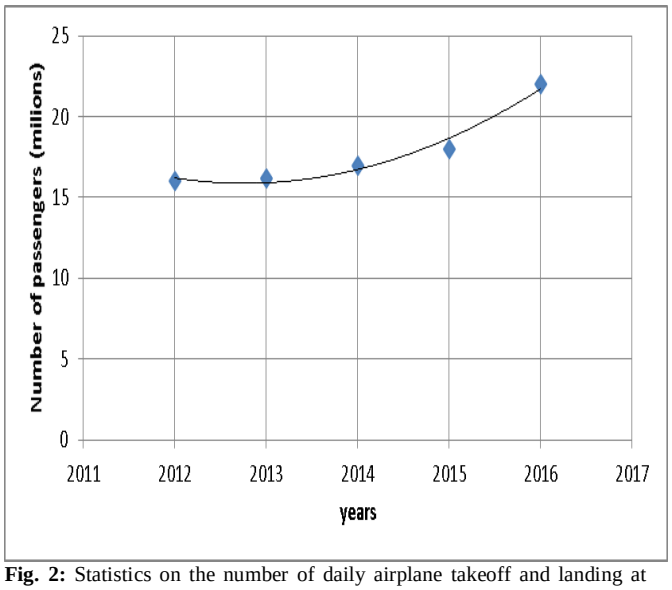

Fig. 2: Statistics on the number of daily airplane takeoff and landing at Iranian airports.

The experience of airlines companies shows that flying with narrow-body airplanes on these routes is carried out with low load factor and so airlines do not prefer to fly high frequency on these routes. Based on available statistics the fleet of active planes in Iran in 2015 includes 166 aircrafts with a capacity of 20,596 seats. These statistics show an average 124 seats for each aircraft. A closer look at the Iran Aircraft fleet shows that narrow body planes such as Airbus 320 family, Boeing 737, MD 82 & 83 and Fokker-100 have formed the main body of the Iranian air fleet in domestic flights. These planes have a capacity of 100 to 150 seats. Table 1 showed the Iran aviation fleet from 2010 to 2015. It is observed that while the number of active aircrafts is increased, the number of active seats is decreased due to grounding wide-body airplanes and implementing more efficient smaller airplanes. It is notable that nearly 40% of available aircrafts were not active in 2015 and this percentage was increased from 2010 to 2015 due to international economic sanctions.

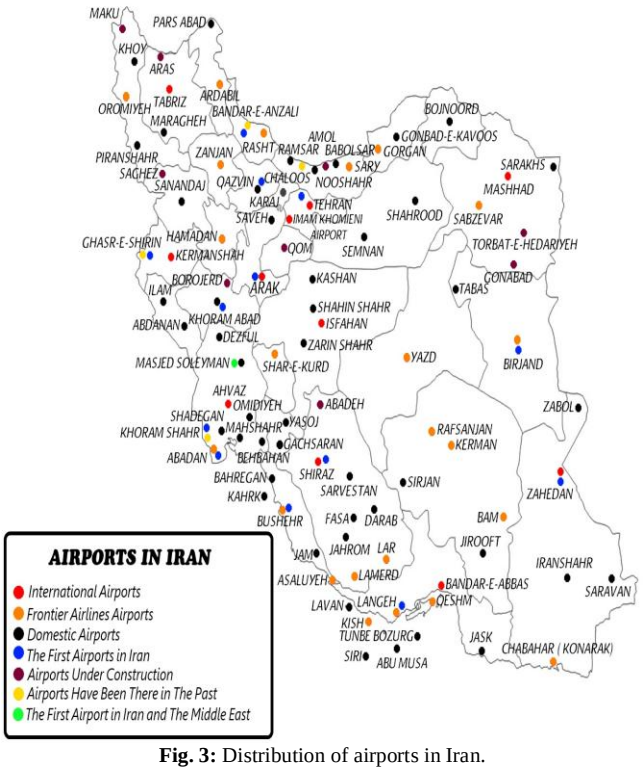

Fig. 3: Distribution of airports in Iran.

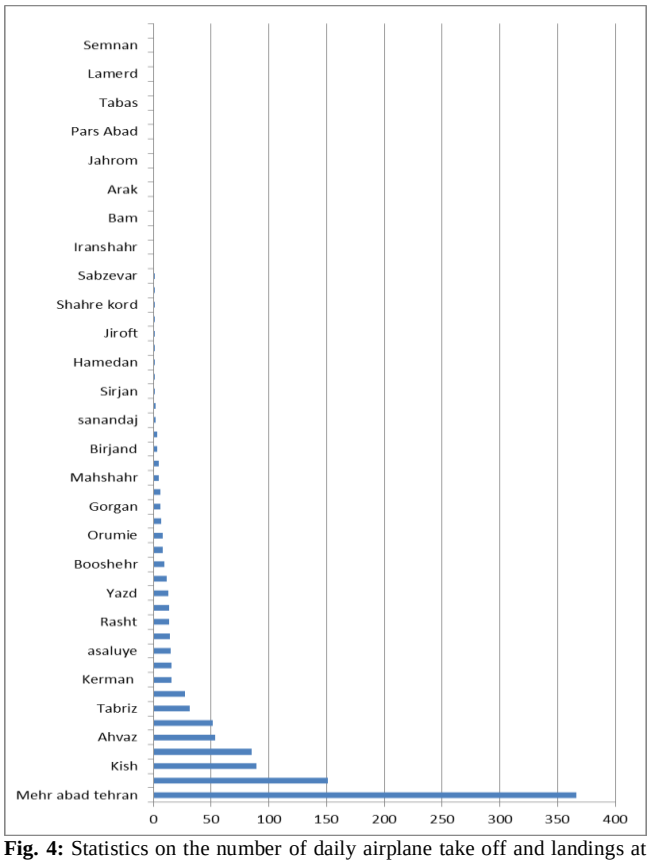

Fig. 4: Statistics on the number of daily airplane take off and landings at Iranian airports [7].

Figure 5 shows the city's population chart based on the average passenger per flights. It shows that the increase in the population of cities will increase the average number of passengers per flight. In this chart, several cities have grown out of the growth trend. These points relate to the cities of Tehran, Mashhad and Kish, indicating the concentration of flights in these three cities. According to the previous section, one of the important parameters in increasing the efficiency of airlines is the allocation of airplanes to flight routes. Allocation of a plane to the flight routes must be done based on a proper capacity for increasing the performance of airlines. Figure 6 shows the important parameters in allocating airplanes to the flight routes.

Table 1: Specifications of the Iranian passenger aircraft fleet

	2010	2011	2012	2013	2014	2015
Number of available aircraft	193	208	223	254	242	262
Number of active aircraft	128	142	132	147	148	166
Number of available seat	31734	34185	36624	40666	40999	44889
Number of active seat	27605	24642	22066	20617	23106	20596

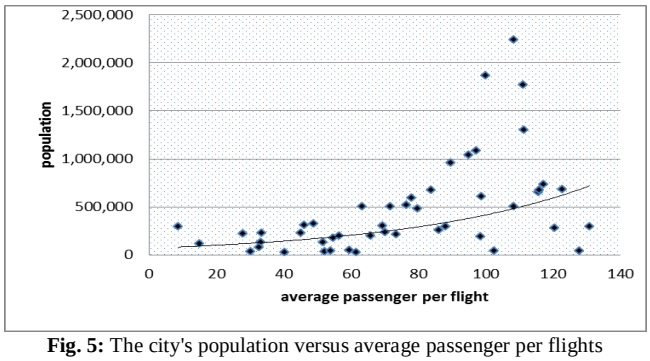

Fig. 5: The city's population versus average passenger per flights

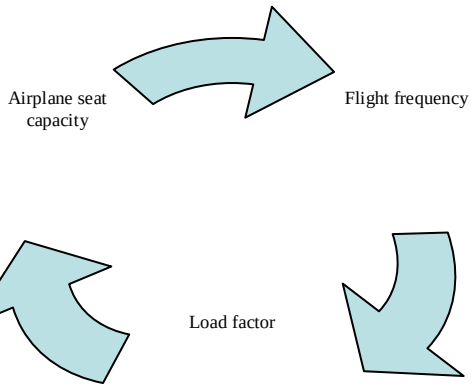

Fig 6: Indicators of airplane allocation to flight route.

Figure 7 shows that 76% of Iranian airports have fewer than 10 flights per day and only 9% of the country's airports have more than 50 flights per day. Due to the fact that the main destination for most flights in Iran is the airports in the cities with high population, it can be seen that the route between small cities is being removed.

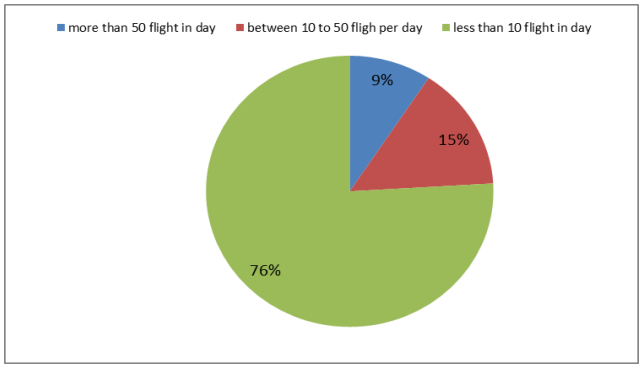

Fig 7: Average number of daily flights at Iranian airports

Figure 8 shows the average number of passengers in different flights based on the flight frequency of the airports. Figure 8 shows that increased frequency has led to an increase in the number of passengers per flight. It is also apparent that many Iranian airports have an average passenger number of less than 80 people per flight. According to the statistics, it is suggested that in many flight routes, general aviation planes with a lower capacity and higher flight frequencies can be used instead of planes with a more seat capacity. Another important point that can be seen in Figure 8 is a significant number of flights with an average passenger of 100 to 140 people at airports with low flight frequencies. This indicates that the airplane size (seat capacity) is not proportional to the flight route and it is advisable to use less capacity airplanes on these routes.

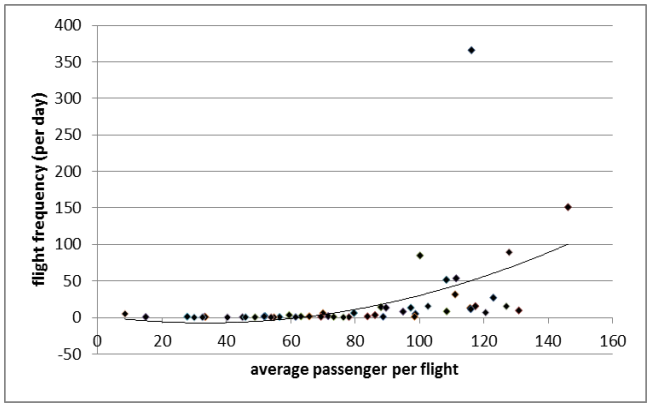

Fig 8: Average passenger per flight versus flight frequency

3. Challenges and Opportunities

Based on provided data in recent years, the number of passengers on domestic flights has increased. Iran also has 54 airports, which about 76% of these airports are inefficient and the number of take-off and landing in these airports is less than 10 in a day. The flight frequency at Iranian airports is low, which has led to a reduction in the number of passengers at these airports. At the same time, the capacity of the aircraft is high and this has reduced the load factor. Under these conditions, flights between airports in low-population cities are eliminated and flights at small airports are limited to airports in high populated cities. On the other hand the average age of Iran's aviation fleet has increased and international sanctions against Iran have prevented the purchase of commercial aircrafts. Under these circumstances, large companies are not planning to sell aircraft to Iran due to international sanctions. This is while Iran has a very good market for aircraft manufacturers. In this context, given the opportunities for the use of small aircraft, general aviation aircraft manufacturers have a good opportunity to enter the Iranian market. These companies have fewer restrictions to enter the Iranian market and Iran can use this opportunity to complete its aviation network. This opportunity has been created in a situation where demand for the general aviation fleet is growing (figure 9) and Iran still has a lot of shortages in this area.

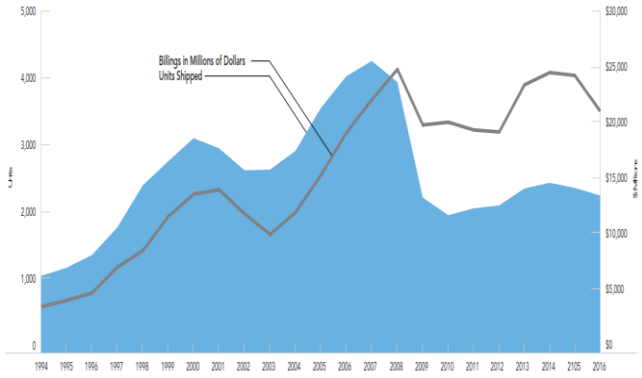

Fig 9: General Aviation Airplane Shipments and Billings Worldwide (1994–2016) [8]

Table 2: Comparison of different countries in terms of GA aircraft fleet

Country	Number of commercial fleet	Number of GA aircrafts
Brazil	500	24256
Canada	500	36588
Australia	300	15424
USA	7000	229000
Russia	400	9000
Iran	200	150

According to the statistics, the number of general aviation planes in Iran is very low (150) compared to other countries (table 2). Currently, small planes have no place in Iran's air transportation network but given the gap in Iran's aviation network, it can be claimed that general aviation airplanes with a capacity of less than 20 passengers can operate on short routes and low frequency airports to increase airport performance. These airplanes can fly on short routes between small cities and, while having a high load factor, also increase the flight frequency of airports will increase customer satisfaction as they will have the more options of travel time. A comparison is made between the general aviation fleet of different countries based on their Gross Domestic Product (GDP) per capita (Fig 10). In this figure, it is clear that countries with a higher GDP per capita have more general aviation fleet. Of course, in some countries, such as Japan, despite a high GDP per capita, general aviation has not been developed, due to the fact that these countries are investing in other transport platforms, including rail transportation.

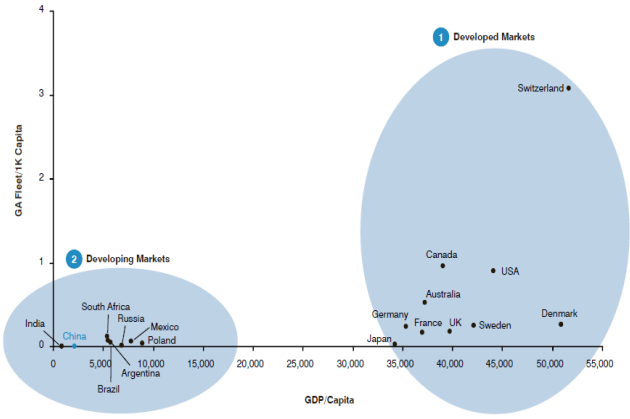

Fig 10: GA fleet versus GDP per capita in different countries [9]

Another important parameter in choosing a plane for flight routes is the type of aircraft. On short routes, propeller aircrafts has less fuel consumption and lower operating costs than jet aircraft. On routes less than 100 miles, the cost of flying Prop aircraft is about 20% lower than regional jet aircraft. On routes around 200 miles, the cost of flying the Prop and Jet Airplane is equal. On routes over 400 miles, a regional jet plane has a 20% lower cost than planes (Figure 11).

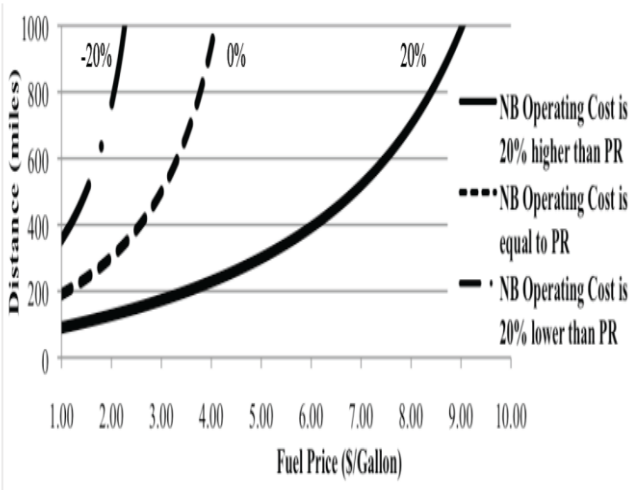

Fig 11: Compare the flying jet and prop aircraft at different distances [10]

There are many flight routes without direct flights to Iran's domestic air transportation network between airports in low-population cities. General aviation prop (piston or turboprop) aircraft can increase the flight frequency of small cities airports and profit share of airlines because these planes have a high economic cost and their load factor will be high in regional flights. Table 3 summarizes the challenges and opportunities of the general aviation network in Iran. As seen in the table, the most important challenge for General Aviation development of Iran is the international sanctions. On the other hand, the best opportunity is the appropriate infrastructure in terms of airport quantity and distribution for the Iranian general aviation expansion.

Table 3: Challenges and Opportunities of Iran General Aviation

Challenges	Opportunities
- International sanctions against the Iranian aviation industry - High cost of air travel compared to road and rail - Lack of general aviation culture - Inefficiencies of airports - Aging of the current fleet	- Less impact of sanctions on GA aircrafts - Appropriate infrastructure in terms of airport - Increasing customer satisfaction due to increased flights - Possibility to increase the flight frequency of airports - Ability to renovate aircraft fleet

Table 4: Number of general aviation fleet based on public indicators of countries

Country	Number of airplane/ population (million)	Number of aircraft/GDP (billion dollar)	Number of aircraft/ area (0/001 square kilometers)
USA	641	11.7	22
Canada	1041	20.4	4
UK	310	6.7	81
Czech Republic	658	35.3	92
Germany	262	5.5	59
South Africa	229	34.7	10
Australia	591	9.4	2
Brazil	101	8.6	2
Average	479.125	16.5375	34

Based on indicators such as population, area and GDP, the number of required general aviation aircrafts of different countries can be determined. Table 4 shows the number of general aviation fleet in different countries based on these indicators. Based on the above statistics, with a GDP of 393 billion dollars, the population of more than 80 million and area of 1648 thousand square kilometers, the number of aircraft needed by Iran should be at least 6500 general aviation planes. The numbers presented in Table 5 are extracted from the average of the studied countries. It is tried to construct non-dimensional numbers to determine the ideal conditions for the case of Iran. Based on the area index, at least 6,500 general aviation planes are needed for Iran .Also, based on the population index, Iran needs nearly 38,500 general aviation aircraft. Finally, if the GDP index considered as the main factor, the required number of GA planes for Iran will be more than 56000! As a conclusion, even assuming the number of 6500 GA fleet for Iran, there is a lack of 6350 general aviation airplanes to meet an international standard.

Table 5: The number of general aviation aircraft required by Iran according to the various indicators

Number of GA aircrafts needed in Iran based on GDP Index	56032
Number of GA aircrafts needed in Iran based on population Index	38425
Number of GA aircrafts needed in Iran based on area (0/001 Km^2) Index	6500

4. Conclusions

In this paper, the status of Iran's aviation network in domestic flights was analyzed. The results of the research showed that Iran's aviation network is not in balance. This is due to the high frequency of flights at large city airports and very low frequency of flights at small city airports. The routes between small cities in Iran do not have direct flights and most flights are limited to large and populated cities. A closer analysis of this issue shows that airlines in Iran tend to use more capable aircraft for all routes. However, increasing the size of the aircrafts and reducing the flight frequency will decrease the load factor. Reducing the load factor causes non-economic flights between small cities. This has led to the elimination of direct flights between small cities. However, the use of general aviation aircraft can increase the load factor, while increasing flight frequency. Growing flight frequency will increase air travelers, because they will have more choices for traveling at different times of the day. The use of small aircraft on short routes, will complete the incomplete cycle of aviation network in Iran. On the other hand, due to international sanctions against Iran for buying commercial airplanes, general aviation planes have less sensitivity and restrictions. Considering the good aviation market in Iran, small aircraft manufacturers are willing to participate in the Iran market. According to estimates, Iran needs at least 6,500 general aviation aircrafts. Therefore, Iran can take advantage of this opportunity and, while modernizing its fleet, the existing gap in the air transportation network will be covered. Moreover, the flight cost of prop aircraft is less than regional jet ones in short routes and a significant number of airports in small cities in Iran are within a distance of less than 500 kilometers of neighboring cities. There is currently no direct flight between these cities but equipping Iran's transportation network with general aviation can make it possible to fly on these routes.

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