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THE USE OF LIGHT AIRCRAFT IN DOMESTIC TRANSPORT IN POLAND

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Abstract

The work concerns the analysis of the possibilities of using light aircraft in the regional passenger transport. This analysis was based on the existing airport infrastructure in Poland. Between 43 existing airports with paved runways and length more than 1,000 meters potential routes of aircraft traffic were set. The study compared the light aircraft transport to the car transport. One of the benchmark criteria was the travel time between different destinations, using both means of transport. The second criterion is the financial aspects of travel. For this purpose, a statistics of light aircraft and calculated their Direct Operating Cost as a function of various parameters such as maximum weight, the number of passenger seats, cruise speed were created. Analysis also included air navigation charges on the routes and the operator profit. The calculations allowed identifying potential routes where the plane would be competitive with the car in terms of travel time and costs by one person. The number of these routes was dependent on the speed of travel, the number of seats on the plane as well as the fill factor of these seats. The analysis also applies to determine the number of passengers traveling between the regions. In 2013, domestic air transport handled less than 2.5 million passengers, which in comparison to the countries of Western Europe is a poor result. This is caused mainly by a small amount of domestic routes as well as a small number of regional airports. The implementation of the concept of using light aircraft in regional connections aims to increase the speed of travel, increase the safety in passenger transport, cost reduction and partial replacement of road transport by air transport.

Keywords: *transport, small aircraft transport, domestic air transport, routes analysis, passengers flow*

1. Introduction

Air transport in Poland is currently focusing mainly on international connections while connections between regions are performed rarely. There are many reasons of this situation. This concerns mainly the cost of these travels, which often exceed the cost of travel by alternative kinds of transport. Another reason is the mobility of travellers in the destination place and the number of airports in Poland (domestic services were held in 2013 with 12 airports). Passengers wishing to get from point A to point B must, in addition to air transport, travel a distance from the airport to the destination with the help of a car or other means of transport. Due to the rare grid of communication airports in Poland, the journey is often longer and more expensive than travel directly from point A to B using transport other than air. Moreover, it is an additional waste of time because the passenger has to adapt to the existing schedule of connections from the airport to the destination, unless it is chosen a taxi or rent a car, but this is associated with an increase in the cost of travel. In addition, quite important is the necessity of check-in, which takes valuable time. Last but relatively important aspect is the attitude of people to travel planes. Although air transport is the safest form of transport, many people think differently and resign from this form of travel. Only about 3% of travellers prefer air transport, as a way of movement. The fact of little interest to air transport in domestic travels is easily noticeable based on statistical data. Tab. 1. presents domestic passenger traffic (regular and charter) in 2013, divided into the each airport.

Tab. 1. Passenger traffic in 2013 (number of checked-in passengers) [5]

Bydgoszcz	EPBY	22 664
Gdansk	EPGD	351 560
Krakow	EPKK	303 021
Katowice	EPKT	53 285
Lublin	EPLB	4 995
Lodz	EPLL	59
Poznan	EPPO	80 715
Rzeszow	EPRZ	125 064
Szczecin	EPSC	77 505
Warszawa	EPWA	1 133 262
Wroclaw	EPWR	262 760
Zielona Góra	EPZG	12 109
	TOTAL	**2 426 999**

Nearly 2.5 million passengers during the year is a result below the European average. Compared to highly developed countries such as Germany, it is almost 10 times less [11].

Currently in Poland, most travels between regions are carried out using road or rail. Especially often travels are done using a car. Because of the low-developed road infrastructure, a part of the car transport can be replaced by the light aircraft transport.

2. Conception

In this paper is presented the conception of the use of light aircraft in the implementation of regional connections. The concept involves the use of existing airport infrastructure in Poland. It was assumed that flight operations will be carried out from paved runways with a length of not less than 1000 m. There is a 43 airports in Poland which meet this assumption. They have been shown in Fig. 1. together with their catchment areas.

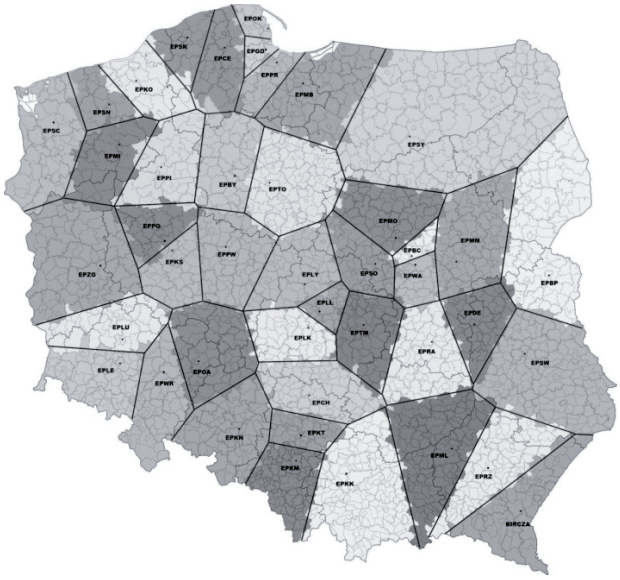

Fig. 1. Airports in Poland together with their catchment areas

In this work, it is assumed that transport using light aircraft has to be an alternative to business travels using cars. The main objectives of this concept are:

- reduction of travel time,
- reduction of costs,
- increasing the safety of traveling,
- partial replacement of road transport by air transport.

As part of the work, calculations have been carried out in order to compare aircraft transport to the car transport. In the first place, as a comparative criterion was adopted a travel time. Second criterion was a travel cost attributable to one person.

3. Calculations

In order to determine the competitiveness of both means of transport in terms of benchmark criteria the routes between the destinations were set. It was assumed that passenger traffic takes place between the towns of the district-level or voivodeship-level closest to the airport. These destinations form a grid of 897 connections (calculated one way). Some connections have been skipped, such as between the Modlin Airport and Okecie Airport because they both lie near one of the city – Warsaw, which means that the start and end of the route is in the same place. The Fig. 2. is an example of a route between point A and B using car transport and aircraft.

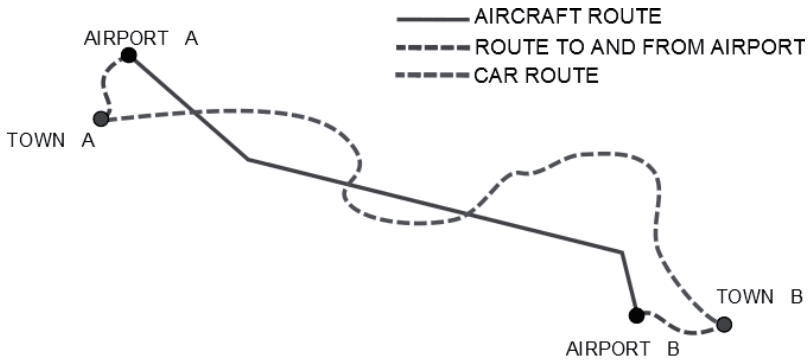

Fig. 2. Example of connection made using aircraft and car

3.1. Travel time

Competitiveness of both means of transport in terms of time depends mainly on the speed of movement of these means of transport. For air transport, the time to get from one destination to another is increased by the time of travel (i.e. by car) at the airport and from the airport and delays e.g. caused by the check-in, inadequate airspace management, etc. In addition, flight routes do not take place in a straight line between the airports because of construction of airspace. From the statistics, arise that flight routes compatible with the procedures and airspace restrictions in Poland are averagely 16.62% longer than the same routes carried in a straight line. In the case of car transport travel time were determined using common websites [12, 13], which give the travel time between destinations taking into account the currently existing road infrastructure as well as the speed limits. Similarly, the length of each route for car transport and aircraft transport were set. The longest traveling distance by car is 840 kilometres, it is a route between Industry and Szczecin, the shortest is 22.4 kilometres between Gdansk and Gdynia. Average for car connections is 325.8 kilometres. Under the terms of travel time in analogy to the previous longest route takes 11 hours 52 minutes (Industry – Świdwin), the shortest 25 minutes (Wałcz – Pila), while the average value is 4 hours 31 minutes. In the case of aircraft longest route EPAR – EPSC is 813.5 kilometres, the shortest EPLE – EPLU 24.0 kilometres, the average route measured 317.7 kilometres.

After preparing statistics of lengths of routes and travel time on this routes simulation has been made, which specifies on how many routes the plane is more competitive (execute the route in less time) from the car. In this simulation, the cruising speed of the aircraft was a variable. It also examined, how the number of those routes changes when time of check-in is changing. Sample results are shown in Fig. 3.

The calculations assume the time of activities associated with the flight and the delays in accordance with Tab. 2.

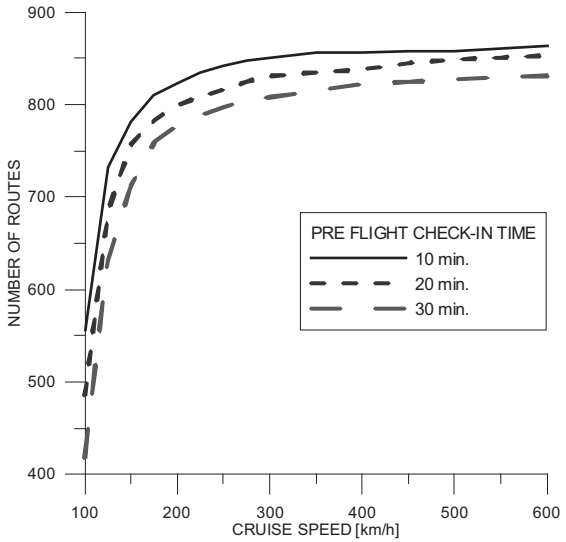

Fig. 3. The number of routes on which the aircraft is faster than a car in the function of cruise speed

Tab. 2. Times associated with flight operations and delays

AVERAGE TIMES OF OPERATIONS RELATED TO FLIGHT AND DELAYS [min.]	
PRE-FLIGHT CHECK-IN	10-30
APPROACH TO LANDING	5
DELAYS	5.5[3]
AFTER FLIGHT CHECK-IN	0
TOTAL	20.5-40.5

In Fig. 3. it can be concluded that in order to maximize the number of routes on which the aircraft can compete with the car in terms of time its speed must be greater than 200 km/h.

3.2. The cost of travel

In order to define the competitiveness of the light transport aircraft in financial terms, the cost of the plane operations, as well as the car travel costs between destinations was determined. For both types of transport, the calculated cost of travel on the route was assigned to one person, and then compared. In the analysis of travel, costs were considered only those routes where the aircraft performed the carriage in less time than a car.

For the car, travel cost of one kilometre was adopted as 0.84 PLN, which is equivalent to the cost of a kilometre using a car on a business trip [10]. Statistical data say that the fill factor of car seats ranges from 0.24 to 0.26. On the basis of these data, the cost of travel between the destinations was determined. In the case of aircraft, the cost of travel on a particular route is the sum of the following components:

- DOC (Direct Operating Cost),
- Navigation fee,
- the cost of travel to and from the airport.

In the calculations of DOC, the following relationship was used:

$$DOC = \text{Fuel cost} + \text{Flight deck and cabin crew cost} + \text{Total airframe maintenance cost} + \cdots + \text{Total engine maintenance cost} + \text{Landing fee} + \text{Depreciation, Interest, and Insurance}, \quad (1)$$

Calculations of the individual components of DOC were made based on [2, 6, 7, 9]. The navigational costs of flight were calculated for each route on the basis of relationship [4]:

$$Navigation\ fee = \sqrt{\frac{MTOW}{50}} * DIST * UR, \quad (2)$$

where:
MTOW – Maximum take-off weight [in thousands of kilograms],
DIST – Route distance [km],
UR – Unit rate, which in the case of Poland is € 35.42 [1].

The statistics of light aircraft have been made and then their DOC was calculated. Direct costs were referred to a characteristic parameters relevant to this analysis such as cruising speed and the number of passenger seats. The resulting dependence is shown in Fig. 4. and 5.

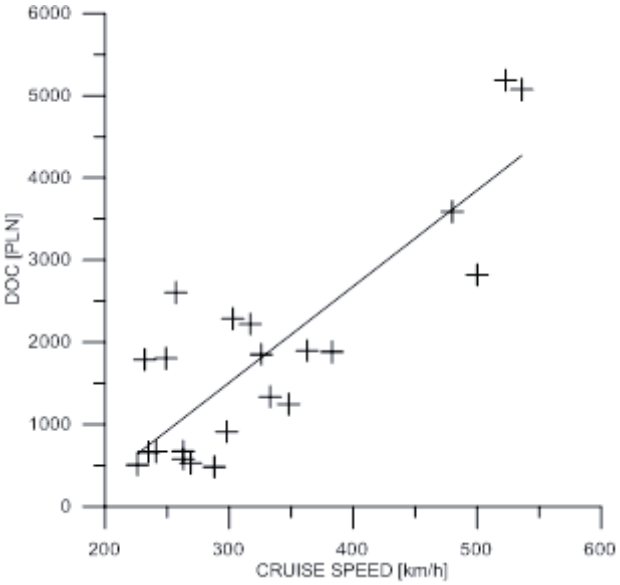

Fig. 4. Dependence of DOC from the cruise speed

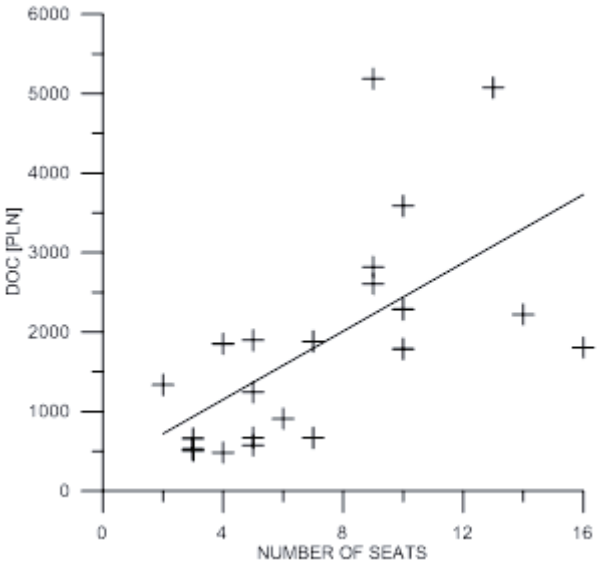

Fig. 5. Dependence of DOC from the number of passenger seats

As can be seen increase of cruising speed as well as the number of seats is accompanied by an increase in direct costs. After calculating the cost of air travel per one person a simulation of dependency of the number of routes (on which air transport is cheaper than a car) in the function of these cost was made. The simulation was also conducted for different cruising speeds. An example of such a simulation is shown on Fig. 6. To simulation was adopted aircraft with 10 seats.

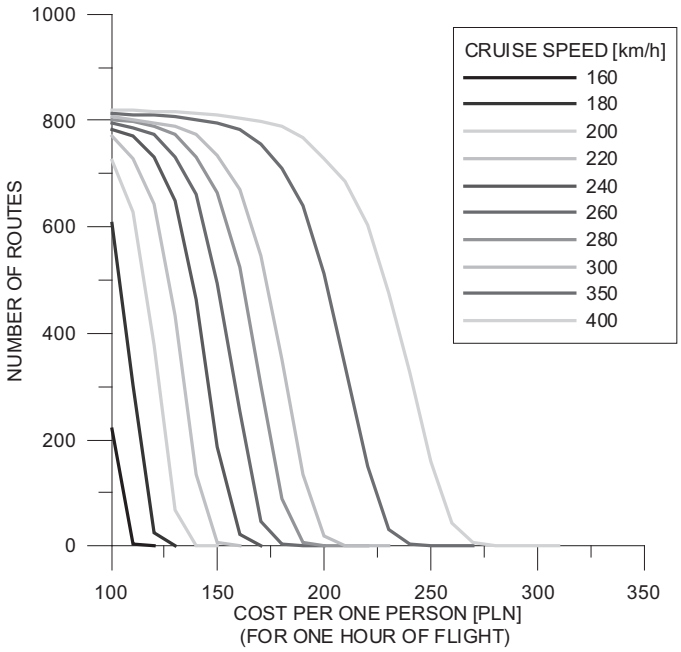

Fig. 6. The competitiveness of the aircraft in terms of cost per person for one hour of flight

From the graph, it is clear that the decline in the cost per person at a steady cruising speed causes an increase in the number of routes on which aircraft is financially more beneficial from the car. Also, the increase in speed causes an increase in the number of routes in this aspect. For example, increasing the speed of only 20 km/h from 240 to 260, at a cost per person equal to 150 PLN causes two and a half times increase in the number of routes on which aircraft is more competitive than the car.

An important factor influencing the cost attributable to one person is the fill factor. As shown in Fig. 5. increase of the number of seats is accompanied by an increase in direct costs of performed air operations. To minimize the cost per person for light aircraft transport, it must be ensured that the available seats were fully utilized. Therefore, the fill factor has influence on the number of routes on which aircraft competes with the car in financial terms. This relationship is shown in the basis of three aircraft on Fig. 7.

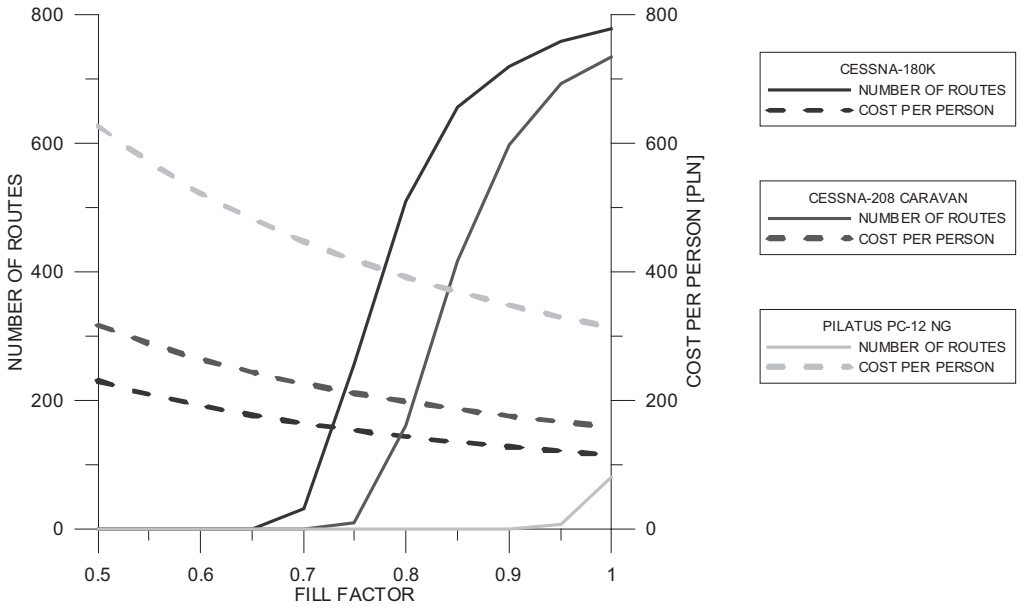

Fig. 7. The dependence of the number of competing routes and the cost per person as a function of fill factor

Tab. 3. Summary of the number of seats in aircraft and the cruising speeds

Aircraft	Number of seats	Cruising speed [km/h]
Cessna 208 Caravan	14	317
Cessna 180K	5	263
Pilatus PC 12 NG	9	500

From the simulation, it can be seen that the aircraft Pilatus PC-12, despite of its high cruising speed, will be competitive only on few routes, even with a high fill factor. The reason for this is the high cost per person based on the direct costs of using this aircraft. In two other cases (Cessna 180 and 208), the fill factor 0.85 or more provides the competitiveness of those aircraft on most routes.

4. Other aspects of the use of light aircraft in regional transport

In addition to the direct benefits that come from the use of light aircraft in regional transport, such as the above-mentioned reduction of travel time and reduction of costs, there are also additional benefits – indirect. In relation to analysed here business travels one of indirect benefit is increase in efficiency of the employee. By reducing travel time, the time in which the employee is not working is also reduced. Another important aspect is the reduction of costs associated with business travel, such as hotels. Business trips carried out using the car for long distances, because of its longevity, are associated with the necessity to rent the hotel. The average cost of the accommodation in Poland on a business trip is 258 PLN, which is a significant part of the cost of the entire trip [8]. By using light air transportation these costs can be avoided at one day long travels (they account for about 26% of all business trips), or reduced at long trips. The most important aspect of using aircraft for transport between regions is an increase in safety. Travelling by air is much more secure than other means of transport.

The analysis also aimed to determine the number of passengers traveling between the regions that will use the aircraft transport instead of the car. The calculations assumed that 3% of persons who travel by car are likely to take advantage of the aircraft. On the basis of data about business trips and the number of population in different catchment areas, it was determined that domestic air traffic in Poland would increase about 2.2 million passengers, which almost doubled to the current passenger traffic.

5. Conclusions

The above analysis shows that the implementation of the concept of using light aircraft in the realization of regional connections can bring real advantages. Usage of more airports (43) than now (12) makes that lengths between airports and destination points are shorter, thus requiring less time to travel them. Furthermore, aircraft are moving with much higher average speed than the cars, which also influences on travel endurance reduction. With properly selected plane to the realization of the route, cost of such a journey can also be reduced. The analysis and simulation shows that in order to ensure the maximum number of routes on which aircraft would be a competition to the car in terms of time and costs, following must be done:

- reduce the cost of the flight attributable to one person less than 250 PLN,
- reduce check-in time,
- ensure the fill factor in aircraft above 0.85,
- air operations performed by aircraft with a cruise speed of over 200 km/h.

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