PROPOSITION OF A MORE SUITABLE TYPE OF AIRCRAFT FOR BASIC PILOT TRAINING

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Abstract. The topic of the article is the assessment of aeronautical technology for basic pilot training. The article discusses the possibility of using ultralight aircraft in basic pilot training. It shall include an analysis of the current system and the state of pilot training. Furthermore, the aeronautical technology currently used in basic pilot training is specified. It focuses on the calculation of the price of the flight time of the aircraft types currently in use and makes a proposal for the introduction of newer, more suitable types of aircraft, which should be introduced into the basic training system. In our work, we also refer to the calculation of the price for the operation of the aircraft and the economic evaluation of the newly proposed aircraft type and its comparison with the types of aircraft technology used so far for basic pilot training.

Keywords: pilots training; basic aeronautical training; aircraft technology

1. INTRODUCTION

The choice of aircraft technology is an essential factor in the conduct of training. Aeronautical technology should be as appropriate as possible for carrying out tasks arising from the pilot training curriculum. Several factors prevent companies from having a holistic perspective during product development. Some important aspects are increased complexity of the products, development, cycle time, significant technological uncertainty and communication and human issues. [1] It should contribute to the best possible acquisition of the required training points, from piloting techniques to navigational flights. At the same time, financial cost is also an essential fact when conducting training. The airline itself, which provides such services, seeks the best possible ratio between the cost of aeronautical technology in relation to the performance of the tasks arising from the training syllabus. Developments and changes are also evident in the aviation sector. Aerospace technology is constantly evolving and delivering progress. This work highlights the aircraft technology used so far and newer types of ultralight aircraft, which are also suitable for aerial training purposes. The work focuses on the analysis of the economic aspect of the operation of either group of technology and results in a comparison of the technique and the transfer of the design of more suitable aircraft technology for basic pilot training.

2. METHODOLOGY OF SOLVING RESEARCH PROBLEM

The research team respects the usual practice of scientific work and the experience that based on the study of literature, personal interviews, observation, study of the results of previous research, we specify our research topic and conceptually shape the situation into a problem. After creating an overview of the aircraft technology of training schools in Slovakia, we identified three entities for analysis. We have selected an analysis of the three most frequently used aero planes for the Privat Pilot License PPL(A) training. For the purposes of our work, we selected Diamond DA20 from the first category of aircraft. By its characteristics and economic characteristics of operation, this aircraft type is most like the newly proposed Viper SD4 RTC aircraft type. Aircraft are compared in terms of technical parameters, flight

parameters and operating parameters. The main factor in comparing these types of aircraft was the economics of operation of both types of aircraft.

3. RESULTS

Commonly used aircrafts used for flight training are manufactured by companies like Cessna, Diamond, Piper, Cirrus, Technam, and the like. There have been multiple models from these companies that are used for initial flight training.[2] To conduct basic pilot training, it is important to select the appropriate aircraft type. The aircraft in question shall meet certain requirements required during basic pilot training. However, pupils are often limited by the choice of aircraft technology, as aviation schools have their own aircraft technology. Therefore, one aspect in the selection of an air school is also the fleet of aircraft of a given air school. The aviation schools have their own aircraft, we will imagine the selected types of aircraft in detail.

1. Diamond DA20

The Diamond DA20 Katana is a lower-decker aircraft that has been designed and constructed primarily as a cheap two-seater training aircraft. The design of this aircraft was designed to inspire gliders from the Diamond manufacturer itself. The aircraft is characterized mainly by its relatively easy maneuverability and sensitive controls. Katana has been manufactured with the greatest possible fuel economy and easy maintenance. Katana provides favorable flight quality while providing the necessary range of maneuverability for pilot training. Katana uses individual flight control, which together with the key engine controls is located on the central base. [3]

2. Diamond DA40

Diamond DA40 is a plane very similar to the Diamond DA20. Diamond DA40 is available with multiple types of engines, so it is possible to configure the aircraft according to the purpose of use. Below we will describe the parameters of version D, which has a Mercedes-Benz engine. The plane's dragon is also, as with the DA20, made up of a composite. The aircraft is very efficient for its size and performance, so it has a very low fuel consumption, which allows a longer range to sit. With additional tanks, the D version can fly for 7 hours and 30 minutes, which at a cruising speed of 120 kt represents a range of about 900 NM. Some of the pieces are made with Garmin Synthetic Vision Technology (SVT), which restores the visual topographic landscape from the field warning system database. [4,5]

3. Viper SD4 RTC

Viper SD4 RTC is a two-seater with a side-by-side configuration allowing for better pilot-instructor cooperation in aeronautical training and fixed tricycle landing gear with steerable nose wheel. It’s aerodynamically controlled, single engine. This is the dynamic elegance of an all-metal low-wing aircraft that will take you to your destination in the leather seats of the most modern carbon cabin with a panoramic view. It is suitable for conducting advanced aerial training, namely for the training and conduct of acrobatic flying, training in night and instrument flying, or conducting aero lift. [6]

3.1. Evaluation of the price of flight hour

For the purpose of calculating the price of the flight time, the cost of the flight hour and the profit of the company providing the lease of the aircraft had to be taken into account. It is the type of aircraft that plays the biggest role in the differences in flight hours prices of specific types of aircraft. Each calculation of the flight time price for basic pilot training consists of the same cost items, but their amount varies depending on the type. The costs of operating aircraft can be divided into two groups – fixed costs and variable costs. Fixed costs are costs that are regular according to the time, are

independent of the number of hours flown or the quantity of persons transported, etc. [7] Variable costs are costs that are directly affected by the number of hours flown, the types of exercises that were carried out in flight, or possible service operations.

Fixed costs include:
1. Write-offs.
2. Insurance.
3. Salaries and costs of pilots and on-board personnel.
4. Hangar rent.
5. Payments for the radio station.

Variable costs include:
1. Aviation fuel and oils.
2. Airport charges.
3. Aircraft maintenance costs.
4. Consumables material.

3.2. Evaluation of the price of flight hour of type currently in use

For a specific calculation of the price of the flight time, we chose Diamond DA20 aircraft from the currently used types.

Insurance

The fact that it is a training aircraft played a role in calculating the price of the fuse for our aircraft type. This category of aircraft is riskier, and the premiums are higher than for aircraft operated for private purposes. We asked HEUREKA Brokerage & Consulting, s.r.o to calculate the insurance price, which operates the www.poistenie.sk website, which has several partner insurances companies and deals with aircraft insurance. For calculating the price of the fuse, it was necessary to add several data influencing the calculation, namely the maximum take-off mass of the aircraft, the number of seats and the price of the new aircraft. For this article are also important documents stated by decree of the Ministry of Transport, Posts and Telecommunications of the Slovak Republic which establishes the minimum amount of liability insurance coverage in civil aviation at their website www.slov-lex.sk.[8]

Insurance cost include:
1. Territorial validity of insurance: the whole world.
2. Activities carried out by the aircraft: pilot training, hire, sport and recreational use, sightseeing flights.
3. Liability insurance for 1 500 000 EUR.
4. Passenger Liability Insurance 250 000 EUR.
5. Accident insurance for the sum insured amount 280 000 EUR.

The resulting insurance amount was quantified by HEUREKA Brokerage & Consulting, s.r.o. at EUR 4374,61. Given that this is a fixed part of the costs, this amount must be divided by the number of aircraft hours flown per year. The result is an amount that forms part of the cost per flight hour. For the purposes of our work, we will operate with a raid of 800 flight hours per year. Formula:

$$X / Y = Z \tag{1}$$

X = sum insured
Y = annual raid
Z = sum insured, converted into one flight hour

The sum insured, converted into one flight hour based on the data found, amounts to EUR 5,47.

Recovery fund and other irregular expenditure

The operation of each aircraft may entail unexpected and irregular costs associated with its use. For example, increased tire wear during student training, increased brake wear, oil consumption costs, payments for a radio station may be included in this expenditure. Irregular expenditure may include, for example, the maintenance of a hangar intended for training aircraft, the overhaul of the engine or its replacement for the purposes of our calculation, we have chosen EUR 20 per flight hour, with which the air school would regularly contribute to the fund of repairs and other irregular expenses. This amount should be a sufficient to cover all the costs covered by this section.

Depreciation

For the purposes of our work, we will work with an aircraft depreciation value of 10% per year. This means that the aircraft loses 10% of its value compared to the previous year. Example: the purchase price of a Diamond DA20 aircraft in 2022 is EUR 280 000. The amount of depreciation is 10 %. In a year's time, the aircraft in question will be worth 90 % of the original amount. i.e., EUR 280 000 * 90 % = EUR 252 000. For the following year, EUR 252 000 * 90 % = EUR 226 800.

We reckon the flight school would have planned to operate the aircraft for 20 years. The resulting value of the aircraft decreases by EUR 34 041 each year after the depreciation is subtracted. The value of the aircraft after the first year of use corresponds to EUR 280 000 - EUR 34 041 = EUR 245 959. For an annual raid of 800 hours, the loss caused by depreciation is converted to EUR 15.37 per flight hour (EUR 245 959 / 16 000 = EUR 15.37).

Formula for multi-yearly evaluation of depreciation:

$$N = N_0 * (1 - \frac{p}{100})^n \tag{2}$$

N_0 = acquisition price
N = Residual (resulting) price P = amount %
n = number of seasons (years)

Evaluation:

$$N = 280\,000 * (1 - 10/100)20\ N = 34\,041\ \text{EUR} \tag{3}$$

Salaries and expenses of pilots and cabin crew

The price of the flight lesson at JetAge, s.r.o. flight school does not include expenses per instructor, which is necessary for performing several tasks within the PPL(A) curriculum. The expenses of the instructor are paid by the student more than the price of the flight lesson.

Airport charges

Like the salaries and costs of pilots and cabin crew, airport charges are not included in the flight hour price. These costs are paid by the student in excess of the price of the flight lesson.

Aviation fuel

Training school JetAge, s.r.o. calculates fuel consumption during training hours at Diamond DA20 18 liters of fuel per flight hour. This type of aircraft has Rotax 912 propulsion equipment. According to the operations manual, this engine can be powered by Natural 95 E5 fuel or Avgas 100LL aviation fuel.[9] Fuel Natural 95 E5 company JetAge, s.r.o. is taken from the distributor Slovnaft, a.s. The price of this fuel for the 17th week of 2022 is EUR 1.88 per liter.

Formula:

$$A * B = C \tag{4}$$

A – average consumption
B – fuel price
C – price of fuel consumed
Formula: 18 * 1,88 = 33.84 EUR
(Fuel price when using fuel Natural 95 E5)

Regular service

The cost of regular service of the aircraft also forms a certain component of the flight time price. Each aircraft has prescribed service intervals, which are determined by the number of hours flown. For aircraft of type Diamond DA20, this regular service interval is intended for 100 flight hours. The price of this service tour may vary from one airline school to another. Some aviation schools have their own service, which can perform most service operations. Thus, the price of service may be lower than at the aviation school, for which the aircraft service is performed by an external company. JetAge Air School, s.r.o. for the needs of our bachelor's work quantified this amount at 1.000 EUR/100 flight hours. This means EUR 10 per flight hour.

3.3 Flight hour price calculation

The tables quantify (see Fig.1,2) the calculation of the cost of the flight hour at diamond DA20 and the rental profit under the conditions: - the price of the new aircraft was EUR 280 000. Yearly flight time of the aircraft is 800 flight hours - the annual amortization of the aircraft is 10 %. For the calculation of the flight time price, data have been selected, the values and calculation of which are contained in the previous section.

Item	Value
Insurance	5,47 EUR
Maintenance fund and other irregular expenditure	20,00 EUR
Depreciation	15,37 EUR
Fuel	36,00 EUR
Regular maintenance	10,00 EUR
Summary	86,84 EUR

Figure 1 Evaluation of expenses for a flight hour

Rent cost	132,00 EUR
Expenses for a flight hour	86,84 EUR
Profit	45,16 EUR

Figure 2 Profit evaluation from rent – Diamond DA20

Based on the results, we can conclude that the cost of the flight hour at Diamond DA20 under the above-mentioned conditions is EUR 86.84. The remainder of the amount consists of the airline's profits. However, it should be noted that the calculation of the price of the flight time affects several values entered and the resulting amount may vary, for example, according to the fuel price, the number of hours flown per year, unexpected service costs and others.

4. PROPOSITION OF A MORE SUITABLE AIRCRAFT TYPE FOR A BASIC PILOT TRAINING

The aviation industry is constantly moving forward, including in aircraft manufacturing technology. This shift helped to design and construct a new type of aircraft by TomarkAero. This company has designed the Viper SD4 aircraft type. Its version of the RTC is suitable for pilot training purposes. As a result of the shift in aviation industry technology, it was possible to construct a significantly lighter aircraft for pilot training purposes than the types used to date. The empty weight of the Viper SD4 RTC is 159 kilos lower than the Diamond DA20. Already this type was fundamentally lighter than other training aircraft, which continue to be used for pilot training purposes. The low weight can be due to the design of the aircraft consisting of an alloy of aluminum with additives. The aircraft could be built thanks to the use of state-of-the-art laser technology, which can carve parts of the highest quality. This activity is followed by a change in shape and bending of sheets to the target form for the purpose of aircraft construction. The disadvantage to the type DA20 is a smaller wingspan that affects the flight characteristics of an aircraft. Due to the narrower wingspan, the Viper SD4 RTC is less stable in the transverse axis and therefore this type of aircraft is more sensitive to steering deflections in this axis. The difference in flight characteristics is not fundamental, the aircraft is able to handle all the tasks of pilot training. [11]

Viper SD4 RTC

The Viper SD4 RTC is an ultralight aircraft of Slovak production. It is a single-engine, all-metal two-seater lower-seater, in a two-seater configuration conceived with seats side by side. It is suitable not only for training, but also for sports, entertainment, and recreational flying. Alloy aluminum with additives is used in the design of the aircraft, creating a solid and durable structure, increasing the level of safety, and guaranteeing the long life of the aircraft. The avionic equipment on board the aircraft shall be sufficient to travel under VFR conditions or to conduct aeronautical training. The Viper SD4 RTC can also be used to tow non-motorized aircraft.

This type of aircraft has successfully passed the test of the aircraft design under various loads, the so-called strength tests. At the same time, as one of the few sports aircrafts, it has mastered the so-called "20th century". Flutter tests that test the flexibility of the aircraft structure and all its parts. Cockpit aircraft consists of analogue or digital instruments consisting of individual or combined flight and engine instruments. The Viper SD4 RTC can also have a comprehensive flight control system, an automatic control system (autopilot). LCD displays included in the cockpit provide data to control motor data, navigation, and communication systems. [11]

The calculation of the price (see Fig.3,4) of the Viper SD4 RTC flight time is influenced by the same items as those reported in the structure for the Diamond DA20 aircraft, which allowed us to follow a comparison of the economic factors of the aircraft types studied.

Item	Value
Insurance	3,91 EUR
Maintenance fund and other irregular expenditure	18,00 EUR
Depreciation	7,14 EUR
Fuel	36,00 EUR
Regular maintenance	10,00 EUR
Summary	75,05 EUR

Figure 3 Evaluation of expenses for a flight hour

Rent cost	118,00 EUR
Expenses for a flight hour	75,05 EUR
Profit	42,95 EUR

Figure 4 Profit evaluation from rent – Viper SD4 RTC

Comparison of aircraft types examined

From a student-pilot's point of view, it is more financially advantageous for training to choose the type of Viper SD4 RTC aircraft, as the price of the flight hour and rental is EUR 14 lower than with the Diamond DA20. As it is necessary to fly for at least 45 hours to complete the training, the student can save EUR 630 by selecting a Viper SD4 RTC aircraft. Another point that may be more financially advantageous for the student is the fact that the Viper SD4 RTC has a lower maximum take-off weight and, considering that airport charges are paid by the student himself, this is more advantageous, as many airports charge landing fees by weight. Since training tasks in terms of aircraft flight characteristics can be performed very similarly, the aspect of the choice of aircraft technology according to flight characteristics is irrelevant. For a comparison of the cost of flight time for diamond DA20 and Viper SD4 RTC aircraft, please refer to the following graphs. (see Fig.5,6)

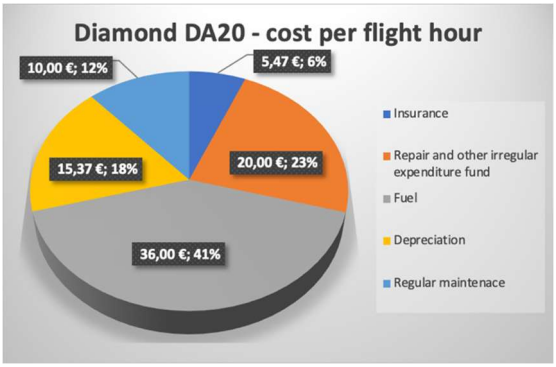

Figure 5 Cost per flight hour Diamond DA20

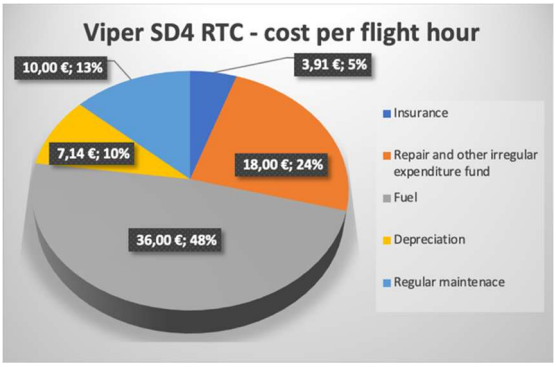

Figure 5 Cost per flight hour Viper SD4 RTC

From the point of view of the flight school, the choice of aircraft technology, under the conditions we have set for our calculation, is very demanding, as the resulting profit was almost the same for both aircraft. In choosing aircraft technology for pilot training by an aeronautical school, the fact that, for the same profit, the air school can offer for training an aircraft that is financially more acceptable to the student.

5. CONCLUSION

The aim of this article was to create a proposition of a more suitable type of aircraft for basic pilot training. For this part of the work, we have chosen the Viper SD4 RTC aircraft. This type of aircraft is quite new and despite being already in the fleet of some air schools in Slovakia, it is not as well-established aircraft in basic pilot training as the aforementioned Diamond DA20. As a result of the comparison of individual calculations, it is more advantageous to choose viper SD4 RTC aircraft as an aircraft training technique for training a Viper SD4 RTC aircraft from a financial point of view. For an aeronautical school, looking at the profits from the lease of an aircraft, the choice of aircraft technology does not play an essential role for these purposes, since the profit difference for the types under the conditions chosen for the calculation in the article was negligible. An interesting criterion in the choice of aeronautical technology by the air school may be the fact that the selection of the Viper SD4 RTC aircraft can make the flight school more attractive to applicants and allow them to complete aerial training at a more advantageous price.

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