

# European airports usefulness analysis to develop European Personal Air Transportation System (EPATS)

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## **ABSTRACT**

The paper presents results of survey of European airports and civilian landing fields. The most important features, such as location, airport category technical characteristics of the runway, and equipment were collected in a database form. Moreover, a broad demographic analysis has been performed, the objectives of which included the determination of the number of population living in the immediate vicinity of airports of various categories. Catchment areas for airports of various categories have also been specified. Based on the analysis of the results, the suitability of airports for use within air transport system operated with light transport aircraft has been evaluated.

**KEYWORDS: transport, airplane design, optimization**

## **1. Introduction**

Europe is one of the most densely populated continents of the Earth, with the area of 4,324,782 km<sup>2</sup>, inhabited by 712,000,000 people (a forecast for 2008) [4, 5]. Europe's latitudinal and longitudinal extent is 4,200 km and 5,600 km, respectively. The highest peak reaches 5,642 metres above the seal level. These figures also characterise the area of functioning of European market of air freight. A typical feature of this market is the coexistence of few, albeit large transport hubs providing for intercontinental connections, and a dense network of local connections among majority of small towns and tourist resorts. Europe has a huge, although partly unused, potential of airports and landing fields, which can be a basis for developing a

competitive offer of travelling around Europe by light personal aircraft, using the less burdened airports and adequately adjusted and requalified airfields, the offer being aimed at people travelling by passenger cars thus far.

There are 1,270 airports and 1,300 landing fields in Europe (Fig. 1 and 2). Among the airports, there are 43 main airports (large and medium hubs) and 450 national and regional airports (commercial service airports). European airports have 1,336 hardened runways (concrete or tarmac), and 737 airports have the necessary equipment for making IFR flights [7, 8, 9].

Air transport, as part of passenger transport sector, features a considerably higher average speed of conveyance, which accounts for its advantage over other means of transport. Requirements in terms of infrastructure are



Fig. 1. Locations of all European airports  
Source: [9-17]



Fig. 2. Locations of all European landing fields (airports are included)  
Source: [9-17]

largely limited to airports as infrastructure by location. In order to be able to utilize the mobility and potential of transport performed by aircraft, it is necessary to determine the possible available locations of take offs and landings – i.e. location, operational and technical data, possibility of utilisation, etc.

Possibilities to carry out flights along straight lines using the RNAV navigation are often limited by allotted, reserved, restricted, or dangerous zones. RNAV channels are most frequently laid out in areas that are not on collision course with TSA and TRA. The higher the flight level, the higher the possibility of freer planning of direct flights. Starting with a certain altitude, however, there is an increased density of traffic due to flights of passenger jet cruise planes. Assuming an unlimited possibility to carry out direct flights among particular airports, it is possible to determine distances between pairs of airports as orthodromic distances from the following equation:

$$L = 111.12 \arccos((\sin \phi_1 \sin \phi_2) + (\cos \phi_1 \cos \phi_2 \cos \Delta \lambda)) \quad (1)$$

where:  $\phi_1, \phi_2$  - latitude of the start and end point,  
 $\Delta \lambda$  - difference of longitudes.

Fig. 3 shows the distribution of distances between European airports – a distribution of potential flight connections. The maximum of the distribution of distances between airports occurs for approximately 1,000 km, and very few potential flight routes are longer than 3,000 km. If one also assumes that with distances not exceeding 300

km the air transport cannot compete with other means of transport due to costs and completion time, the scope of distances of potential connections and distances over which the possibility of carrying out flights is the highest can be determined on the basis of the distribution analysis in Figure 3.

The principal technical criteria determining the possibility of using airports are as follows:

- technical and usability requirements – determining the suitability of an airport,
- accessibility of an airport for air transport.

## 2. Technical and usability requirements of airports

One of more significant characteristics of an airport is the type of runway surface. One can distinguish airports with artificial surface (hardened runway – tarmac/concrete) and airports with a natural surface only (grass runway). The type of surface directly affects its load bearing capacity, specified using the PCN-ACN method or through supplying the highest permissible aircraft weight, or the maximum permissible tyre pressure [8].

Another parameter is the runway length. The percentage of airports with runways longer than the length required for aircraft of a specified type is the indicator of its efficiency through the possibility to use a large number of airports. The run up, the landing run, as well as the take off and landing distances are very important parameters

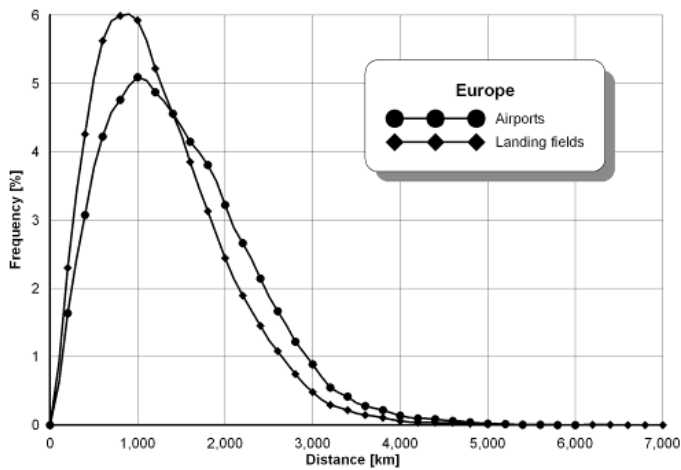


Fig. 3. Distribution of distances between pairs of European airport

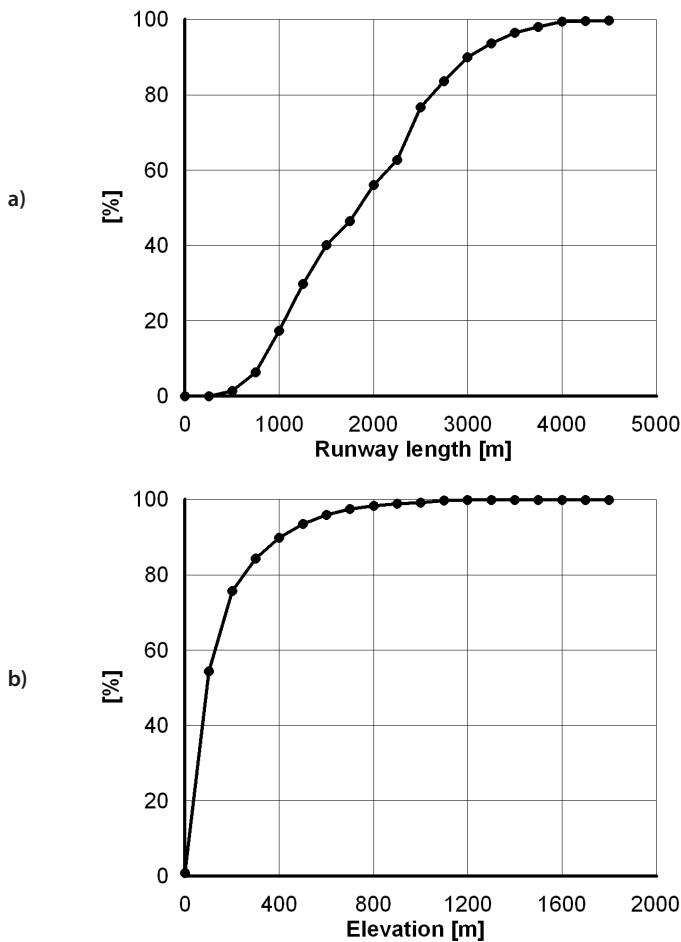


Fig. 4. Cumulative distribution function of the city distance to the nearest airport

determining the airports at which a plane can land and take off. The longer the run up and the landing run, the smaller the number of airports the plane can possibly use. Figure 4a shows the distribution of runway lengths of European airports. More than 80 % of runways are longer than 1000 m, which makes it possible for most light aircraft to use them for landing and taking off.

Another parameter affecting the takeoff or landing distance is the airport elevation above the sea level. As for Europe, airports are located at a considerably low level (Fig.4b), practically 99 % of airports are located below 1000 m above the sea level.

Cumulative distribution function of European airports runway length and elevation

The infrastructure of a typical airport must include [1, 2, 3, 8]:

- a runway long enough to ensure safe takeoff and landing for most planes as well as taxiways and parking plates ensuring safe moving and parking at the airport,
- an appropriate lighting system,
- a main building consisting of a place for the passengers waiting for the flight,
- operational infrastructure, such as people and radio-communications equipment ensuring safety and providing supervision of the facility,
- basic technical facilities,
- airport traffic area comprising a system of VFR and IFR flight procedures.

### 3. Accessibility of airports

An airport of regional significance or an aerodrome used for passenger air transport should meet a number of basic requirements. The airport must have good transport

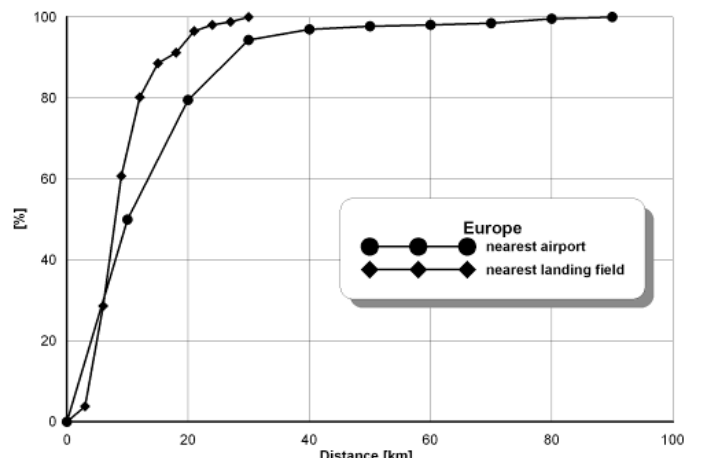


Fig. 5. Cumulative distribution function of the city distance to the nearest airport

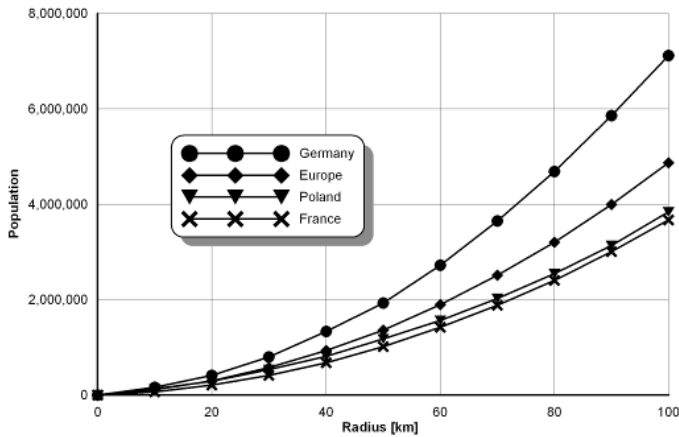


Fig. 6. Population within particular radius of airport

links with urbanised areas so it is possible to move quickly from the airport to the centre of an agglomeration or another area.

Figure 5 shows a cumulative distribution function of the distribution of distances from centres of European cities with above 50,000 to the nearest airport. It follows from the graph that for 80 % of European cities the nearest airport is located within 20 km. Such small distance enabling people to move quickly between city centres and airports proves their high accessibility in Europe.

An airport should comprise within its reach an area of economic significance in terms of transport (city, population groups, and tourist areas) – for ensuring an appropriate passenger target group, which may constitute an element of development of a specified region included in fast air transport. Figure 6 shows the number of people inhabiting areas around airports for three selected European countries (Poland, Germany and France) with the highest airport density for the whole Europe. It follows from the graph analysis that at least 1 million people – potential passengers – live within a 40 kilometre radius of European airports.

Due to a large number of airports in Europe, fierce competition for passengers, new carriers, and new air connections develops among them. The areas of competition among airports are the overlapping catchment areas of neighbouring airports. The size of the catchment area of an airport – the area from which passengers begin their journey from a given airport or in which their destination is located – is mainly determined by the airport access factor. The size of a catchment area resulting in potentially larger number of passengers thus increasing the area's competitive advantage also depends on other factors, such as: the development of low cost carrier flights offered from a given airport, convenience of land transport connections, etc.

If one assumes a simplifying stipulation that the size of a catchment area is mainly shaped by the time factor

and the access time is a function of distance, catchment areas for four categories of European airports have been determined (Fig.7). The analysis of results allows stating that for airports that can be the basis for functioning of a transport system using light passenger aircraft, the size of catchment area is approximately 60 km. Within this area, competition may occur between GA type airports and GA Towered Airports – which catchment areas are twice as large. As for the two remaining types of airports, cooperation between them is more probable due to a different scope of transport services provided by them.

## 4. Conclusions

Europe is a special area with unique features favouring the development of regional passenger air transportation system, since:

- it has about 1,270 airports and 1,300 landing fields, which means that for the most densely populated regions there is one airport per 2850 km<sup>2</sup> (one landing field per 1200 km<sup>2</sup>), and 390 000 inhabitants per one airport (170 000 inhabitants per one landing field),
- in the most densely populated regions, the nearest airport lies within a distance of less than 40 km for more than 95 % of population (within less than 20 km for 60 % of population),
- for most European cities, the nearest airport is located within 15 km (90 % of cities),
- there are many airports in the vicinity of the greatest European cities (not fewer than 10 airports within 50 km radius of each city) – passengers can freely choose the most suitable airport,

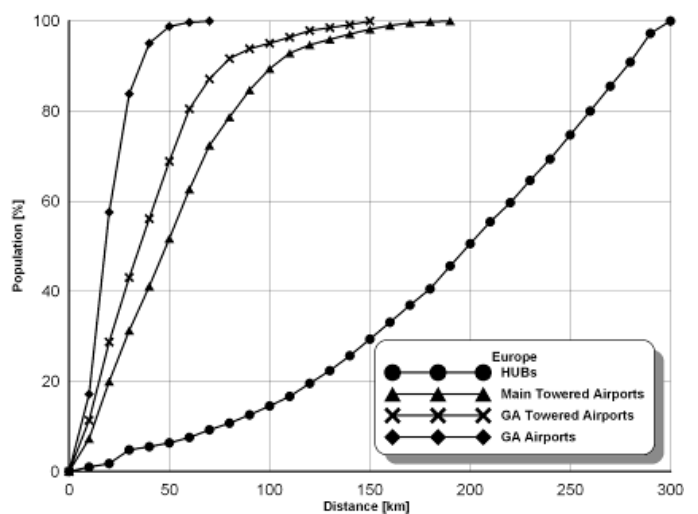


Fig. 7. Cumulative distribution function of the population within catchment areas of aerodromes

- a lot of European population (potential passengers) live close to airports – approximately 1 million inhabitants within 40 km radius of aerodromes,
- most European airports have sufficient technical conditions for being utilized for normal operational purposes by GA aircrafts (other landing fields should be modernized).

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### Aviation Organizations and Airports Data Web Sites

	Name	Web site adress
[9]	Airports Council International	<a href="http://www.aci-europe.org">http://www.aci-europe.org</a>
[10]	Eurocontrol	<a href="http://www.eurocontrol.int">http://www.eurocontrol.int</a>
[11]	European Civil Aviation Conference	<a href="http://www.eraa.org">http://www.eraa.org</a>
[12]	Federal Aviation Administration	<a href="http://www.faa.gov">http://www.faa.gov</a>
[13]	German Airports Association	<a href="http://www.adv-net.org">http://www.adv-net.org</a>
[14]	International Air Transport Association	<a href="http://www.iata.org">http://www.iata.org</a>
[15]	International Civil Aviation Organization	<a href="http://www.icao.int">http://www.icao.int</a>
[16]	Polish Air Navigation Services Agency	<a href="http://www.pata.pl">http://www.pata.pl</a>
[17]	Polish Airports' State Enterprise	<a href="http://www.polish-airports.com">http://www.polish-airports.com</a>

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