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## Horizontal En-Route Efficiency in the European Airspace

### ABSTRACT

The dynamically increasing European air traffic, which has economic advantages, has resulted in the gradual saturation of airspace. The quantitative development under the present conditions is not sustainable because of the limited capacity of the airspace. Although during development, for safety reasons, qualitative developments had to be paid attention to continuously, it did not prove to be satisfactory. In certain areas, air traffic control service, which comes very near to the limit of its ability, is only workable because of the recession in the economy and the declining air traffic. But it is expected that traffic will increase again after the end of the economic crisis, which, under present circumstances, might be able to ensure the safe operation of heavy air traffic only with enormous time-lag, and hence it might hinder economic process.

This paper with the data of flights in air traffic assesses the typical flying data regarding space, since the geographical projection of the factors affecting en-route efficiency is closely connected to aeroplanes using European airspace, and their routes, apart from the size of planes and the number of passengers. This study, by exploring the spatial connections, examines the geographical arrangements of route extension and the relation between horizontal en-route efficiency and the social-economical development.

### ABSZTRAKT

A dinamikusan növekvő európai légiforgalom, annak gazdasági előnyei mellett a légtér fokozatos telítettségét eredményezte. A légtér korlátozott befogadóképessége miatt a mennyiségi fejlődés jelen körülmények között nem fenntartható. Bár a fejlődés során biztonsági okokból folyamatosan kiemelt figyelmet kellett fordítani a minőségi fejlesztésekre is, az mégsem bizonyult elegendőnek. Az egyes térségekben a teljesítőképességének felső határolót súroló légiforgalmi irányítói szolgáltatás jelenleg csak a gazdasági, és az ennek hatására bekövetkező forgalombeli visszaesés miatt működőképes. Számolni kell azonban a gazdasági válságból történő kilábalás utáni újbóli forgalomművekedéssel,

ami a jelenlegi körülmények között feltehetőleg majd csak hatalmas késéssel fogja tudni biztosítani a nagyszámú forgalom biztonságos üzemeltetését, így komoly hátráltató tényezője lehet a gazdasági folyamatoknak.

A légitforgalom vizsgálata során a járatok adataival foglalkoztam, az egyes járatok jellemző, térbeli vonatkozású repülési adatait értékeltem, ugyanis az útvonalhatékonyságra ható tényezők földrajzi vetületei az európai légiteret használó légitjárművek közlekedésével, azok útvonalával vannak szoros összefüggésben, függetlenül a járművek méretétől és az utasok számától. A tanulmány a térbeli összefüggések feltárásával az útvonaltöbblet földrajzi elrendeződését, valamint az útvonalhatékonyság és a társadalmi–gazdasági fejlettség közötti összefüggést vizsgálja.

*Keywords: air traffic; flight efficiency; horizontal en-route efficiency; airspace*

## INTRODUCTION

Year after year an increasing number of publications comes out about the topic of en-route efficiency in the international literature. This information serves as a starting point for different researches, but these researches refer to limited geographical area and apply different methods (REYNOLDS, T. G. 2008). Because of the current problems of the European airspace and the increase of air traffic in the future, the role of route efficiency will be more and more significant, so the thorough examination of the problem is essential (BUCUROIU, R. 2014).

En-route efficiency consists of a horizontal and a vertical component. The thorough examination of the spatial dispersion of the horizontal component might reveal the problems of the present airspace and contribute to handling future problems (SZTRUNGA E. 2011). In 2004, the Performance Review Commission (Performance Review Report, 2005) and in 2007, the Directorate Network Management (Flight Efficiency – A Route Extension Analysis, 2007) started examining the horizontal en-route efficiency by working out the proper method. The method has changed a lot during the years but its basic objective has always been to measure the route efficiency of the flights between European cities.

## OBJECTIVES

By exploring the spatial connections, the objective of horizontal en-route efficiency examinations is to reveal the geographical arrangements of route extension and to state what the relation is between en-route efficiency and the social-economic development in the European airspace. By this, my aim is to examine what role the number of flights, hence the size of traffic has in the measure of horizontal route extension. Also my aim is to examine seasonality and the effects of the economic crisis on horizontal en-route efficiency.

## METHOD

I basically try to assess horizontal en-route efficiency, which is one of the factors of flight efficiency. As a first step to take, I made horizontal en-route efficiency analysis, based on the daily air traffic data of European Civil Aviation Conference (ECAC) member states, which data are stored in the database of EUROCONTROL Demand Data Repository. I made the horizontal en-route efficiency analysis from

these data with the so-called SAAM (System for traffic Assignment and Analysis at a Macroscopic level) software.

According to the daily flight data, I have calculated the route extension regarding the 60 busiest airports in the ECAC area. My calculation was based on the Great Circle distance between city pairs and on the difference between the length of the actual routes. When calculating this, it had to be taken into consideration that between city pairs more than one flight might travel on a daily basis, so these flights had to be calculated more than once.

I have calculated the route extension by weighting, regarding the airports, according to the actual route of the flights. So I have not averaged the route extension of every single flight, but I have calculated the difference between the lengths of Great Circle distance and actual route of each and every flight departing from and arriving at the airport. So the extension of flights with longer distance – in accordance with the facts – is more weighted in the total value.

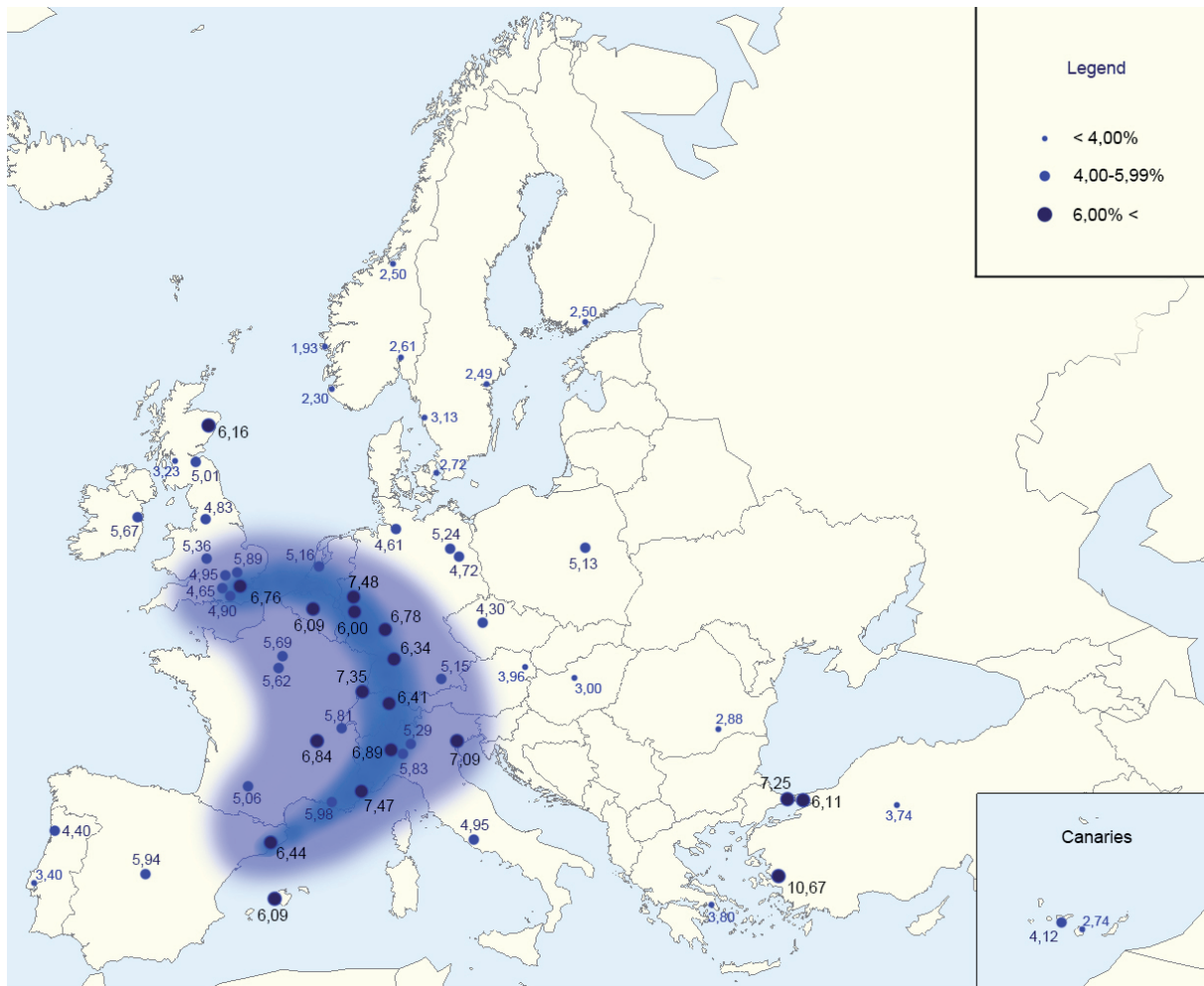
## **RESULTS REVEALED DURING THE COURSE OF RESEARCH**

### **Geographical arrangements of route extension**

The most significant route extensions accumulate in the regions with heavy traffic. For example in the big cities of Europe, in the most developed centers from social and economic point of view, and – in a smaller degree – in the tourist destinations with significant numbers of guests. High route extensions are the most frequent along the Milan-Stuttgart-Brussels line, but higher than average values are typical around London, Paris and Amsterdam and also around Munich and Venice (eastern part of the developed center area) and also around Nice, Marseille and Barcelona (southern part of the developed center area). So cities with heavy traffic and with worse horizontal en-route efficiency completely cover the nuclear area called "blue banana" (*Figure 1*). At newer areas joining to it from the East, the generally higher route extension, which is typical of the overburdened areas, probably will only appear later on. Nevertheless the reversed correlation can be proved; along with the increase of development there are unfavourable factors, in this case the higher route extensions and the process leading to it. In order to improve en-route efficiency around these areas, developments must be carried out around those more remote areas on the continent as well which are affected by air traffic, because flight planning has an effect on each and every section of the routes. Hence, making an effort to reduce route extension is the imperative and interest of every member state.

Moreover, the most developed centers, I also found high route extensions for Aberdeen and for some Turkish cities. The bad outcome in case of Aberdeen is due to the several military airspaces over the North Sea, while in case of Turkey the reason is the old version of route network, on the Asian part of the country there are still airways instead of the ATS routes.

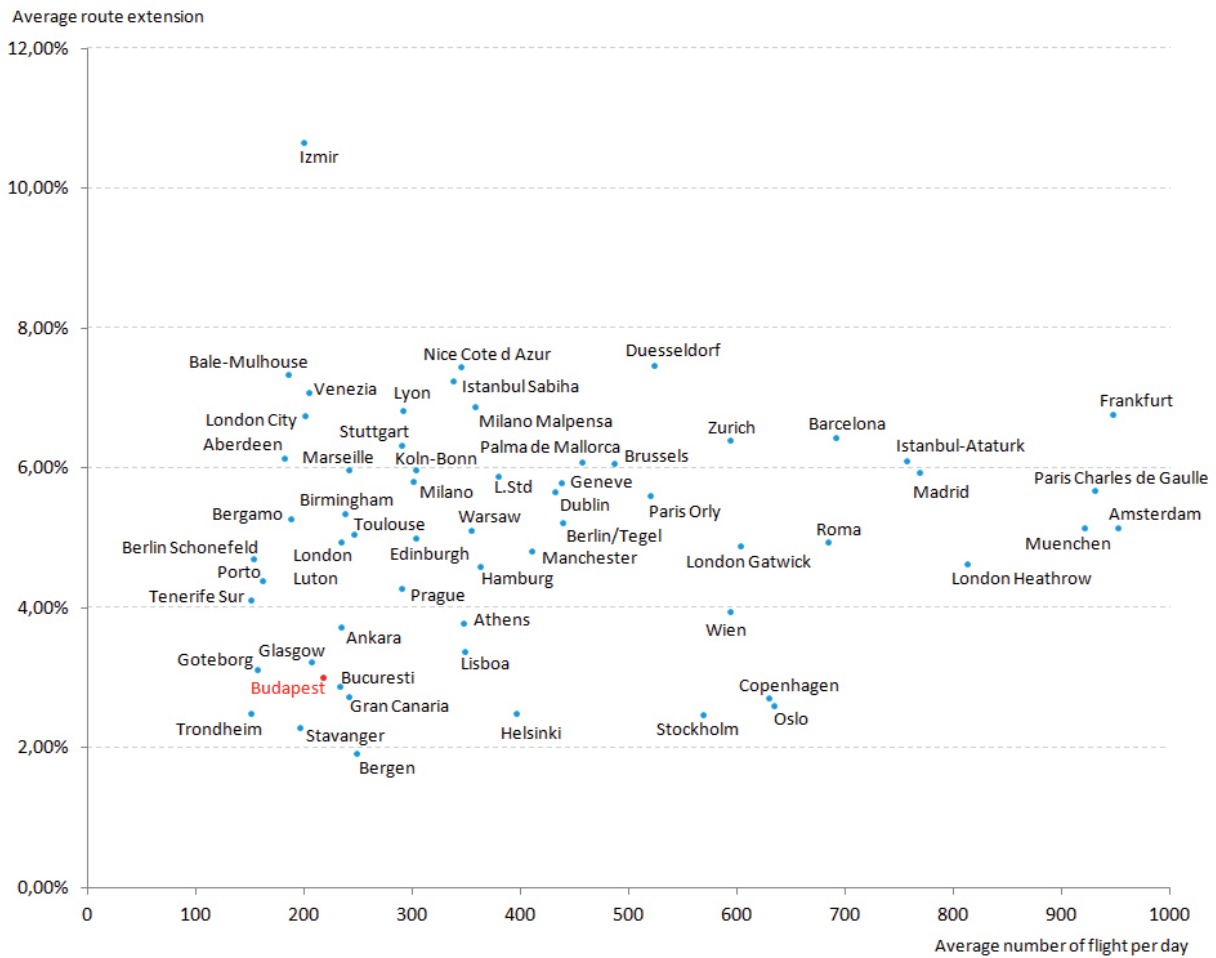
Figure 1. The route extensions of the 60 busiest European airports (ed. by the author)



### Seasonality and the effects of the economic crisis

After examining the numerical values of route extensions, I examined if there is detectable association between the daily average number of flights of airports (i.e. airport traffic) and the occurred route extensions (*Figure 2.*). It can be seen in the figure that there is no significant association, because in the case of airports with lower, middle, or higher traffic, there are more than one cities whose route extension is high and there are cities whose route extension is low, although with the increase of the number of flights the deviation of route extension values is smaller. Overall it can be also established that the en-route efficiency of the flights of the airports depends not only on the size of local traffic but on the traffic of the wider environment as well.

Figure 2. Relations between the average route extension and the average number of flights for the 60 busiest European airports (ed. by the author)



After the annual route extension of certain cities, I examined the seasonal trend of route extensions. As it was expected, in many cases, the busier summer season has higher rates, but it is true only for about half of the cities. The composition of those cities which have higher route extension in the winter season, is mixed – similarly to the reverse case –; these cities include Mediterranean tourist destinations (where the favourable weather justifies the busier traffic in winter), Northern cities (where the climatic conditions can cause bigger route extension in winter) and world capitals with heavy traffic, too. Consequently, it cannot be established clearly – as it can be seen in the case of traffic data – that the route extension of flights belonging to certain airports would be directly proportional to the seasonal traffic of the given airport. It also proves that lower efficiency does not depend on exclusively busy traffic but it also depends on organizational, technical, geographical, legal and political factors.

After analysing the year 2013, I examined the data of 2007, which was the last year before the economic crisis. By comparing the two years I wanted to analyse specifically what effect the crises had had on European air traffic. If, in the case of an airport, the route extension decreased but only by equal or less measure than the total length of the number of flights and/or flights, then it cannot be justified that real route extension decrease and at the same time (sustainable) efficiency increase occurred.

I established as a first thing that – as it was expected – there was a huge decrease in the number of flights by 2013 compared to 2007. The downturn regarding the 60 busiest cities was 9% on average, but within it, the deviation was big, because in the case of certain airports (for example Madrid) the downturn reached 40%. In spite of global trends, there are cities whose number of flights increased, and in the case of some airports (all of which are in Norway) it increased sharply by 20-30% (Stravenger, Trondheim, Bergen). In the case of Budapest airport there was a 43% decrease.

On the basis of interrelation I have examined the ratio of decreases. According to it, it can be established that there was a minor decrease, in the value of the distances covered by flights than in the number of flights, hence by 2013 mainly the shorter route had disappeared, and the longer routes remained.

As a result of the detailed examination of route extensions, it can be established that in 2013, compared to the same period in 2007, route extensions decreased by 20% on average. So it was confirmed that the decrease of European air traffic, which was due to the economic crisis, had some beneficial effects too, because route extensions, which are accompanied by significant environmental impact and additional costs, sharply decreased, however it had some other reasons regarding the development of airspaces.

### CONCLUSION

On different parts of Europe the saturation of airspace is not the same. Whereas on the western part of the continent the route extension is fairly high and air traffic controllers are on the verge of their potential, on the Northern and Eastern parts of Europe this problem is less significant. At the same time, difficulties related to overload might affect other areas as well. That is why this situation must be managed on a complex European level.

During the second performance reference period of the Single European Sky Initiative, we must be provided with a clever picture of the spatial place of the formation of route extensions. That is why it is no longer sufficient to measure horizontal en-route efficiency only between city pairs, as it is being done nowadays, since a flight crosses several countries, it is only possible to establish exactly what the efficiency is like regarding a given area if we examine the complete route and its lines. That is why I think it is important to examine what the horizontal en-route efficiency of the certain area unit is like, besides city pair analyses. For doing this data are available.

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