IS ECONOMY OF SCALE IN AIR NAVIGATION SERVICES PROVISION REALLY ALWAYS THE BEST CHOICE?

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Abstract *– Professional and general public believes that the effective provision of air navigation services is most easily achieved by the economy of scale. Similar consideration is also supported by various air transport associations. In order to test the feasibility of the economy of scale in real life a simulation and analysis of the response to the forecasted change in air traffic volumes and consequently the income of the selection of air navigation services providers in Europe has been done. Results show that in these particular cases, potential integration of providers into one larger "virtual" service provider, in order to achieve economies of scale, did not automatically result in the business optimization.*

Driven by the results of the simulation obtained, second part of the paper focuses on potential areas of optimization and provides an overview of suggestions on what can be done outside of the scope of the economy of scale and can potentially indeed lead to short-term or even long-term optimization of the business.

Key words *– Air Traffic Management, Air Navigation Services provision, economy of scale, efficiency.*

I. INTRODUCTION

Professional and general public usually believes that the effective provision of air navigation services can easily be achieved by the economy of scale. Similar consideration is also supported by various air transport associations, IATA (International Air Transport Association), AEA (Association of European Airlines) and ERA (Association of European Regional Airlines), which in their proposal titled "A Blueprint for the Single European Sky " [1] carried out a comparison of European air navigation service providers to an American air navigation services provider, the FAA. Key figures for comparison are collected in Table 1.

Table 1 *- Key figures for comparison EU to USA* [1]

	EU	**USA**
Surface	11,5 million km^2	10,4 million km^2
Airports	450	509
ANSPs	38	1
En-route centres	63	20
Traffic	9,5 million	15,9 million
Non-ATCO staff	40.300	20.600
Air Traffic Controllers	16.700	14.600
Controlled flight hours	13,8 million	23,4 million

Key figures show that the US air traffic management (ATM) system is capable of processing about 67% more operations with approximately 38% fewer staff. This is to be, according to the authors of the above mentioned comparison, attributed to the fragmentation of European services, as in Europe, currently 63 area control centres operate, whereas in the United States only 20. They also estimate that a reduction in the number of regional air traffic control centres from 63 to 20 would provide huge additional investment in technical solutions and mobility of the workforce, which probably would not make sense, therefore they propose that the European air traffic management system is organized in a way that it would be able to process twice the amount of flight operations (20 million) with only 40 regional air traffic control centres and the same amount of air traffic controllers (16,700) and considerably smaller number of additional staff (26,720). In this way, the following objectives could be achieved:

- 20 million operations per year;
- The accuracy of landings within one minute;
- A reduction in average duration of flight of 10 minutes;
- An annual reduction in costs due to the inefficiencies of the system by €3 billion;
- Savings of €6 billion due to better flight efficiency;
- Annual saving of 18 million tons of CO_2 emissions;
- Additional €419 billion in gross domestic product between 2013 and 2030.

All the above is the perfect story for political pressure on European air navigation services providers, but no one so far provided any valid suggestion on how all this could be implemented in practical terms or whether it is at all feasible.

United States have many advantages over Europe in particular in the following:

- They are one, homogeneous nation, with one language, one law and with minimal influence of cultural heterogeneity;
- Air navigation services are provided by a monopolistic organization in the public sector, more specifically as a part of the state administration;
- Provision of air navigation services is not excluded from the state, as is the case in the European Union;
- Air traffic management is uniform, with uniform standards since its beginning;
- Air navigation services provision is not separated from the oversight function of these services (both functions are carried out by the same government institutions);
- The content and the methodology of air traffic controllers, pilots and other aviation personnel training throughout the territory is uniform, so they consequently all think and react in the same way;
- Financing is still carried out according to the principle of full cost recovery and not according to the principle of risk-sharing, as in the case of the European Union, where air navigation services providers bear a share of burden of financial loss in the event of decrease in air traffic;
- Safety standards are more loose, and consequently significantly more responsibility for the safe conduct of operations is delegated to the pilots;
- Tolerance to the different business solutions is significantly higher - e.g. equal treatment of small private aircraft and aircraft of the biggest airlines at major international airports;
- They have one army, military flying on the entire territory is unified, also rules of the game related to mutual sharing of the airspace are unified;
- Technical and technological solutions are uniformly determined and supported through one government, on the other hand evaluation of these solutions and approvals are done by only one supervisory authority.

Europe is in all the above-mentioned significantly more chaotic and will probably need several generations to be able to set the same starting point as the United States.

In order to test the feasibility of the economy of scale in real life, a simulation and analysis of the response to the forecasted change in air traffic volumes and consequently the income of the selection of air navigation services providers in Europe has been done. Although the air navigation services providers in this study are de-identified, the data for calculation are taken from their respective real-time Performance plans [2]. For the purpose of this study data form Reference Period 1 (RP-1) has been taken as the period has just been concluded and the facts and figures can be scrutinized. Data for the current Reference Period 2 (RP-2) [3] are still at the level of estimates only. On the other hand, for the purpose of this study the only significant difference in the two mentioned reference periods is in the cost recovery principle, which in RP-2 will have even more negative effect on the air navigation services providers in case of negative business result.

II. JOINT OPERATIONS BUSINESS RESULTS

Analysis of potential in the economy of scale was done based on the assumption that Functional Airspace Blocks (FABs) are by default more efficient since they provide a potential for joint service provision over a larger territory with a greater amount of traffic. For that purpose, based on the data provided, simulation of integration (joint service provision) with the following scenarios has been done:

- One big and one small air navigation services provider;
- Two small air navigation services providers and;
- Five air navigation providers of the mixed size.

As a starting point the data on forecasted traffic and determined unit rates were collected from the respective Performance Plans of the Member States of the European Union, which were in 2012 submitted to the European Commission [4]. As a second step forecasted corrections in traffic volumes were taken from European Organization for the safety of air navigation (EUROCONTROL) available data [5]. Virtual unit rate used in calculations represents the statistical average value depending on the proportion of the costs of the individual service provider in the amount of total determined costs of the virtual service provider. This unit rate which in practical terms represents the common unit rate for a virtual service provider, providing joint air navigation services provision was calculated with the help of the following formula:

$$\overline{UR} = \frac{\sum_1^n UR*SU}{\sum_1^n SU} \tag{1}$$

Where:

- $\overline{UR}$ is common unit rate;
- UR is respective unit rate of a single air navigation services provider;
- SU is amount of forecasted service units (traffic);
- n is number of air navigation services providers.

As a first example one big (Provider A) and one small (Provider B) neighbouring air navigation services provider were grouped into the Virtual operator 1, which in practice would make quite logical and expected connection in particular due to the fact that they operate with similar unit rates. Results are presented in Table 2.

Results show that such merger does not make much sense, especially in case if the bigger air navigation services provider ends up in loos. In this case a smaller service provider subsidizes the bigger one, in addition, it appears that the final business outcome of joint operations of the service providers is even slightly worse than the sum of the results of both individual providers.

In the same way a simulation for the Virtual provider 2 was carried out, where two smaller providers were joined (Provider B and Provider C). Such combination would be logical and easily anticipated by the experts and general public. Results are presented in Table 3.

***Table 2** - Comparison of business result of Virtual provider 1*

Year	2012	2013	2014
Virtual provider 1			
Planned SU	3.146.792	3.255.730	3.420.976
Determined cost (income)	204.094.863,00 €	207.426.312,00 €	205.687.132,00 €
$\overline{UR}$	64,86 €	63,71 €	60,13 €
SU correction, sept.2012	2.923.000	2.974.000	3.076.000
Difference in SU	-223.792	-281.730	-344.976
Actual income	189.580.145,29 €	189.476.968,88 €	184.945.354,20 €
Profit/loss	**-14.514.717,71 €**	**-17.949.343,12 €**	**-20.741.777,80 €**
Provider A			
Planned SU	2.720.000	2.814.000	2.947.000
Determined cost (income)	175.389.738,00 €	178.548.762,00 €	177.105.559,00 €
UR	64,48 €	63,45 €	60,10 €
SU correction, sept.2012	2.486.000	2.518.000	2.604.000
Difference in SU	-234.000	-296.000	-343.000
Actual income	160.297.280,00 €	159.767.100,00 €	156.500.400,00 €
Profit/loss	-15.088.320,00 €	-18.781.200,00 €	-20.614.300,00 €
Provider B			
Planned SU	426.792	441.730	473.976
Determined cost (income)	28.705.125,00 €	28.877.550,00 €	28.581.573,00 €
UR	67,26 €	65,37 €	60,30 €
SU correction, sept.2012	437.000	456.000	472.000
Difference in SU	10.208	14.270	-1.976
Actual income	29.392.620,00 €	29.808.720,00 €	28.461.600,00 €
Profit/loss	686.590,08 €	932.829,90 €	-119.152,80 €
Cumulative profit/loss	**-14.401.729,92 €**	**-17.848.370,10 €**	**-20.733.452,80 €**

Table 3 *- Comparison of business result of Virtual provider 2*

Year	2012	2013	2014
Virtual provider 2			
Planned SU	1.367.592	1.419.230	1.491.676
Determined cost (income)	81.870.072,00 €	83.083.097,00 €	82.639.385,00 €
$\overline{UR}$	59,86 €	58,54 €	55,40 €
SU correction, sept.2012	1.378.000	1.432.000	1.496.000
Difference in SU	10.408	12.770	4.324
Actual income	82.493.140,66 €	83.830.665,15 €	82.878.936,15 €
Profit/loss	**623.068,66 €**	**747.568,15 €**	**239.551,15 €**
Provider C			
Planned SU	940.800	977.500	1.017.700
Determined cost (income)	53.164.947,00 €	54.205.547,00 €	54.057.812,00 €
UR	56,51 €	55,45 €	53,12 €
SU correction, sept.2012	941.000	976.000	1.024.000
Difference in SU	200	-1.500	6.300
Actual income	53.175.910,00 €	54.119.200,00 €	54.394.880,00 €
Profit/loss	11.302,00 €	-83.175,00 €	334.656,00 €
Provider B			
Planned SU	426.792	441.730	473.976
Determined cost (income)	28.705.125,00 €	28.877.550,00 €	28.581.573,00 €
UR	67,26 €	65,37 €	60,30 €
SU correction, sept.2012	437.000	456.000	472.000
Difference in SU	10.208	14.270	-1.976
Actual income	29.392.620,00 €	29.808.720,00 €	28.461.600,00 €
Profit/loss	686.590,08 €	932.829,90 €	-119.152,80 €
Cumulative profit/loss	**697.892,08 €**	**849.654,90 €**	**215.503,20 €**

Also in this case results show that joint operations through the economy of scale do not bring any special improvement in profit or loss, and that obviously the main room for the improvement of business outcome lies elsewhere.

Joining the service provision does not lead to remarkable reduction of operating costs by default. Both service providers should almost certainly retain all air traffic controllers and other operational personnel. They must also retain all the technical resources with all the associated on going operating costs, maintenance and depreciation. Quick savings could only be achieved by the reduction of administration personnel (duplicate management functions), which would in most cases be less than ten persons or much less than 1% of total estimated costs. This would only be a single (one time) measure which would only have the effect in the first year of operations.

As the last simulation a combination of five service providers (for two of them data was not available since they are/were not members of the European Union and they were not obliged to deliver the Performance plan) was carried out. Results are presented in Table 4.

Results show that despite of the fact that in theory such collaboration or integration, promises a number of advantages, for the majority of air navigation services providers it is not supportive and they will therefore probably resist it in every possible way.

In this case, the clear winner is the biggest Provider A, which at the expense of the other air navigation services providers almost halved its planned loss. Biggest losers of such integration are the two smallest air navigation services providers, Provider B and Provider C, which instead of having profit, ended up in loss. Such philosophy of integration is therefore by default not logical and implies further pressure and potential unfair burden on small air navigation services providers.

Table 4 - Comparison of business result of FAB Virtual provider

Year		2012	2013	2014
Provider A	**Autonomous**			
	Planned SU	2720000	2814000	2947000
	Determined cost (income)	175.389.738,00 €	178.548.762,00 €	177.105.559,00 €
	UR	64,48 €	63,45 €	60,10 €
	SU correction, sept.2012	2486000	2518000	2604000
	Difference in SU	-234000	-296000	-343000
	Actual income	160.297.280,00 €	159.767.100,00 €	156.500.400,00 €
	Profit/loss	**-15.088.320,00 €**	**-18.781.200,00 €**	**-20.614.300,00 €**
	As part of FAB			
	$\overline{UR}$	51,11 €	50,70 €	48,84 €
	Share of costs in FAB	40,08%	39,98%	39,74%
	Actual income	168.444.569,49 €	169.087.446,66 €	168.112.896,99 €
	Profit/loss	**-6.945.168,51 €**	**-9.461.315,34 €**	**-8.992.662,01 €**
Provider B	**Autonomous**			
	Planned SU	426792	441730	473976
	Determined cost (income)	28.705.125,00 €	28.877.550,00 €	28.581.573,00 €
	UR	67,26 €	65,37 €	60,30 €
	SU correction, sept.2012	437000	456000	472000
	Difference in SU	10208	14270	-1976
	Actual income	29.392.620,00 €	29.808.720,00 €	28.461.600,00 €
	Profit/loss	**686.590,08 €**	**932.829,90 €**	**-119.152,80 €**
	As part of FAB			
	$\overline{UR}$	51,11 €	50,70 €	48,84 €
	Share of costs in FAB	6,56%	6,47%	6,41%
	Actual income	27.568.445,44 €	27.347.325,97 €	27.130.323,09 €
	Profit/loss	**-1.136.679,56 €**	**-1.530.224,03 €**	**-1.451.249,91 €**
Provider C	Autonomous			
	Planned SU	940800	977500	1017700
	Determined cost (income)	53.164.947,00 €	54.205.547,00 €	54.057.812,00 €
	UR	56,51 €	55,45 €	53,12 €
	SU correction, sept.2012	941000	976000	1024000
	Difference in SU	200	-1500	6300
	Actual income	53.175.910,00 €	54.119.200,00 €	54.394.880,00 €
	Profit/loss	**11.302,00 €**	**-83.175,00 €**	**334.656,00 €**
	As part of FAB			
	$\overline{UR}$	51,11 €	50,70 €	48,84 €
	Share of costs in FAB	12,15%	12,14%	12,13%
	Actual income	51.059.695,46 €	51.333.190,07 €	51.312.987,75 €
	Profit/loss	**-2.105.251,54 €**	**-2.872.356,93 €**	**-2.744.824,25 €**
Provider D	**Autonomous**			
	Planned SU	2351760	2419960	2499820
	Determined cost (income)	98.119.353,00 €	99.960.020,00 €	101.993.998,00 €
	UR	41,72 €	41,31 €	40,80 €
	SU correction, sept.2012	2317000	2333000	2413000
	Difference in SU	-34760	-86960	-86820
	Actual income	96.665.240,00 €	96.376.230,00 €	98.450.400,00 €
	Profit/loss	**-1.450.187,20 €**	**-3.592.317,60 €**	**-3.542.256,00 €**
	As part of FAB			
	$\overline{UR}$	51,11 €	50,70 €	48,84 €
	Share of costs in FAB	22,42%	22,38%	22,88%
	Actual income	94.233.974,94 €	94.663.129,33 €	96.815.179,47 €
	Profit/loss	**-3.885.378,06 €**	**-5.296.890,67 €**	**-5.178.818,53 €**
Provider E	**Autonomous**			
	Planned SU	2122692	2154532	2186850
	Determined cost (income)	82.224.708,00 €	84.997.223,00 €	83.968.263,00 €
	UR	38,74 €	39,44 €	38,40 €
	SU correction, sept.2012	2042000	2058000	2149000
	Difference in SU	-80692	-96532	-37850
	Actual income	79.107.080,00 €	81.167.520,00 €	82.521.600,00 €
	Profit/loss	**-3.126.008,08 €**	**-3.807.222,08 €**	**-1.453.440,00 €**
	As part of FAB			
	$\overline{UR}$	51,11 €	50,70 €	48,84 €
	Share of costs in FAB	18,79%	19,03%	18,84%
	Actual income	78.968.733,85 €	80.493.212,32 €	79.704.714,11 €
	Profit/loss	**-3.255.974,15 €**	**-4.504.010,68 €**	**-4.263.548,89 €**

III. ALTERNATIVES TO THE ECONOMY OF SCALE

Simulation and analysis of the response of European air navigation services providers to changes in announced air traffic volumes and the resulting differences in the estimates of revenue, show that the potential integration of service providers into one larger "virtual" service provider, in order to achieve the economy of scale, does not necessarily lead to business optimization. In the three cases presented the final outcome of operations, assuming unchanged entry conditions, of the combined (virtual) air navigation services provider, is no better than the sum of the results of individual air navigation services providers.

As an alternative, real synergy of integration could potentially be achieved through joint procurement, joint staff training, staff mobility and joint use of at least part of the technical resources. In order to bring this to life to a greater extent, at least in Europe, a lot of time will be needed (as already written, probably several generations).

The immediate problem is caused already by potential joint ownership of the assets, as the country, in order to be able to declare flight information region (FIR) in accordance with International Civil Aviation Organization (ICAO) standards, is obliged to provide at least Flight information service (FIS) and Alerting service (AS). In order to do that it needs at least basic communication, navigation and surveillance resources and, of course, means for (automatic) data processing. These resources should be at any time unconditionally available, which in principle can be ensured only through the individual ownership.

The biggest obstacle related to joint procurement lies in the local legislation and political unwillingness at the national level, since the potential liberalization of this domain may jeopardize the interests of the lobbies, or even influential individuals.

The joint staff training is usually not well accepted by the bigger nations with long tradition in this domain, since they are convinced that their way of training is the only proper and adequate one, leading to a high-quality end result. Sometimes they do not see that their learning processes are unnecessarily lengthy and costly, their teaching content, and teaching materials somehow archaic, since they always find an excuse in the tradition.

In the case of staff mobility at a given moment the greatest barrier is the language proficiency. Air traffic controllers, at least in the lower part of the airspace and airports are expected to be in particular for safety reasons in addition to English, fluent as well in the local language. Non-professional pilots can be in Europe in this respect quite unpredictable and dangerous.

As far as the common use of at least part of technical resources is concerned, air navigation services providers are often faced with the fact that the technical staff needed for the immediate intervention on safety critical technical resources should be located close to these resources, therefore decentralized. The latter reduces the effect of the joint, that is, centralized management of technical resources. Although operating in a "cloud" probably also in the field of air traffic management is a close reality, the one that will provide the infrastructure for such operations, will have absolute domination over those that will only utilize the services of the "cloud". As appealing as it may look like at the first instance it could become a nightmare from which there may be no escape over the time.

Even when the above-mentioned potential for the synergy comes to life, the question arises whether it will be large enough, to enable the air navigation services providers to follow the guidelines of the European Commission on the final results of the business impact.

As already indicated, the real synergy effects can be largely attributed to the non-operational part of business of air navigation services providers (administration, training, cost of purchase and maintenance of technical equipment, etc.). According to publicly available information found in the various publications of EUROCONTROL, Civil Air Navigation Service Organization (CANSO) and air navigation services providers (ACE reports, performance plans, etc.) [6], the cost of non-operational part of the business in the proportion to the total cost amounts to about 35-40%, which also includes the depreciation of fixed assets. If air navigation services providers want to follow the requirements of the European Commission, the Member States of the European Union are required to reduce their costs by at least 3,5% per annum (Single European Sky Performance Scheme for the first reference 2012-2014 [7]). This means that they should achieve average savings of about 10% in each of the above mentioned domains by achieving synergistic effects. This certainly represents a fairly high requirement, especially bearing in mind that these savings should provide long-term effects, throughout many years and not just one single year.

In training, saving of roughly 10% can be achieved for a short term period, a year or two, through the integration of training institutions by joint development of teaching materials, literature and courses. The number of staff needed in such a way can almost immediately be halved. Savings in their earnings or their more economical utilisation can immediately be achieved. However, this effect is present only until all the courses are designed and training documentation produced. Thereafter large savings are gone, especially in the training of the operational staff, which is to a considerable extent practical, including simulations, and on-the-job training, where immediately a greater number of candidates (which would consequently get into the training process through the economies of scale) requires a larger number of lecturers and instructors (or at least the same number as would be necessary for the training of the same amount of candidates divided into smaller groups).

The same applies to the joint acquisition and maintenance of equipment. Operational equipment is renewed on average at least every seven years. With proper maintenance records provided to the regulatory authority, lifespan of each piece of operational equipment can also be extended (but not forever). Therefore savings in purchase of the relevant equipment can only be achieved every seventh year or so. Indeed, it is potentially possible that more favourable offer is obtained provided that the volume of orders is higher. The minimum discount that should be obtained should not be lower than 10%.

Another story is in the maintenance of the equipment. Potential for savings is in the combination of the services provided through specialization of the individual technical departments within the individual air navigation services providers to only one technical field of expertize. By specializing one service provider only in communications, next one in navigation, the third one in surveillance and the fourth one in automated systems, each technical area in a wider range of participating air navigation services providers, can be covered by a group of »flying experts«, thus achieving certain savings in the number of highly qualified personnel. On the other hand quantity of experts responsible for the daily maintenance of technical resources remains more or less the same. Such group of »flying experts« provides maximum savings only in case of purchase and installation of new technical systems, or in case of major routine maintenance while sufficient number of properly qualified experts who are able to instantly respond to unplanned malfunction of technical resources is still required by the respective air navigation services provider. The response time in these cases is required in minutes, not more than few hours, but not in days.

IV. Conclusion

From the above it can be concluded that the economy of scale by itself does not, by default ensure more cost-efficient operations. Most of the effort would generally provide only short-term savings, for a period of about one year, but not systemic, long-term savings. In order to be more efficient, fair business environment is mandatory, which in Europe is obstructed by a whole lot of political and international particularities. To support the economy of scale, European Union has designed functional airspace blocks, which are already the reality. Unfortunately in creation of particular functional airspace blocks a whole series of factors that could make the business environment more efficient (e.g. the creation of functional airspace blocks in a way to compensate for the variability of air traffic or air traffic complexity, etc.) has been ignored. As proved in this simulation also a creation of common unit rate, so favoured by the European Commission, can have a significant draw back effect.

Possibly more appropriate way of development will be evident in the introduction of new technical and technological solutions that are being developed through the Single European Sky programme, by the Single European Sky ATM Research (SESAR).

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