

The Analysis of Changes in Exploitation Characteristics of the World Civil Aviation

Joanna Hawlena

*University of Economics in Katowice, Poland
Akademia Ekonomiczna w Katowicach, Polska*

Maciej Mindur

*Warsaw School of Economics, Poland
Szkoła Główna Handlowa w Warszawie, Polska*

The world economical development at the turn of the century, which gave rise to the possibility of intensification of many economical activity aspects, has resulted in new challenges for civil aviation, in both passenger transport and cargo shipment. In order to satisfy the continually growing demand there is the necessity to enlarge the fleet and modernize the infrastructure being a precondition for the further development of the aviation sector. These processes have so far been inhibited both by financial limitations and construction barriers. The article makes a characterization of separate aircraft producers and the transportation vehicles produced by them. It also presents groups and types of aircrafts popular in different world regions.

1. INTRODUCTION

The turn of the 20/21st centuries is a period of significant changes in civil aviation resulting from the rapid economic growth, creation of fast developing economic centres, strong integration and liberation tendencies and more definite company part-taking in the globalization processes causing unprecedented market competition, which secures the leading position of this branch in the transportation market. These processes are also integral to Polish aviation, the more so as it has to comply with the regulations and pre-conditions involved in our EU membership. The anticipated average annual world economic growth for the period of nearest 20 years (2009 – 2029) will probably amount to 3% as a result of which the anticipated increase in the number of passengers carried may reach the level of 4.5%, cargo 6.0%, and the tonne-kilometres by air may be rising even at the rate of 5.0% in passenger transportation and 6.0% in cargo shipment.

2. THE MARKET OF PASSENGER AIRCRAFT PRODUCERS

According to the 20 year period forecast the number of air passengers using air transport will

grow considerably. This is why the aviation industry is going to face and greater challenges. The increased transportation volume will definitely require a greater number of airplanes. The anticipated increase in the number of flights also needs to be reflected in passenger-kilometres, whose scope will allow for forecasting the type exploitation capability of the aircrafts produced. The tonne-kilometre structure presented in Fig. 1 indicates that the majority of the fleet will be involved in the passenger transportation sector and 1/3 will serve the purposes of cargo shipment and mail transportation.

Economic growth implies the necessity of considerable broadening the network of flight connections. It is connected with the world business tendency to enter new economic activity areas as well as the dynamic increase in the internal demand for air transportation services. It is imperative in this sector to determine priorities and, in particular, dynamics and the type of the anticipated changes, which are clearly noticeable when we compare the 2006 – 2008 data, as presented in Table 1.

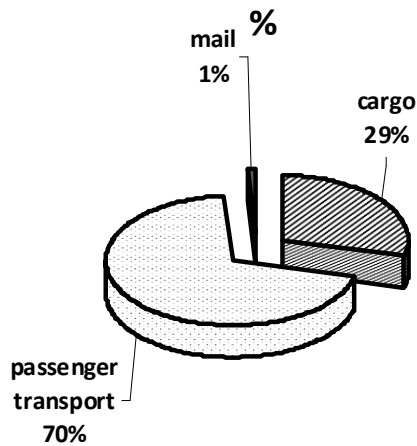


Figure 1. The passenger-kilometre / tonne-kilometre structure in the world air transportation.

Source: Personal study based on the Annual Report ICAO. Dokument Doc 9898 *Annual Report of the Council 2008*.

Table 1. The air transport exploitation data for the years 2006 – 2008.

Specification		2006	2007	2008
Number of passenger and cargo airplanes (1 July)	Total*	25 750	26 340	26 950
	Belonging to ICAO**	22 133	22 685	22 980
Flights (mln)		25	25,5	26,2
Passengers (bln)		2	2,2	2,3
Cargo (mln t)		38	40	40,5
Single transportation capacity	passengers (mln)	3,0	3,5	3,6
	cargo (K t)***	85	90	95
Total of tonne-kilometres (bln Tkm)		487,5	514,7	550,0

* Airplanes of the seating capacity of 18 or equivalent cargo weight (i.e. of the ramp weight over 7 tonnes)

** Aircrafts of 9 tonne ramp weight or more

*** the total weight of passengers, their baggage, cargo and mail

Sources:

Doc. ICAO Doc 9876, *Annual Report of the Council 2006*.

Doc. ICAO Doc 9898, *Annual Report of the Council 2007*.

Doc. ICAO Doc 9916, *Annual Report of the Council 2008*.

Civil Aviation Bulletin 2008: *Rynek transportu lotniczego w Polsce i na świecie*.

J. Liwiński (ed.) ULC. Warszawa 2009, p. 80-89.

In order to determine the scope and direction of the anticipated air fleet distribution it is essential to know the air fleet status in each world region in regard with the necessary aircraft replenishment in the already existing activity areas, as well as the extension of the market by new destination routes. The information data presented in Table 2 shows that North and South America market has the biggest number of communication aircrafts at its disposal. Hence, the vast majority of aircrafts are constructed to satisfy the needs of this market, and then the customers in Europe (including CIS) and Asia, Australia, and Middle East. Within the fleet volume rating, the US carriers rank the highest with American Airlines – 616 planes, Southwest - 537 and Delta - 450 planes.

Table 2. The airline fleet in world regions in the years 2006 – 2008 (the numbers of 1 July each year)*

Region	Number of airplanes	Share in the world fleet (%)
2006		
North and South Am.	1 0915	42,4
Europe CIS	8 170	31,7
Asia, Austr., Middle East	5 220	20,3
Arfica	1 445	5,6
World	25 750	100,0
2007		
North and South Am.	10 910	41,4
Europe CIS	8 390	31,9
Asia, Austr., Middle East	5 530	21,0
Arfica	1 510	5,7
World	26 340	100,0
2008		
North and South Am.	10 770	40,0
Europe CIS	8 340	30,9
Asia, Austr., Middle East	6 250	23,2
Arfica	1 590	5,9
World	26 950	100,0

* Communication aircrafts of seating capacity at least 18 or equivalent cargo (ramp weight over 7 tonnes)

Sources:

J. Liwiński: *Flota Linii Lotniczych 2006*, Lotnictwo 12/2007, p. 18-21.

J. Liwiński: *Flota Linii Lotniczych 2007*, Lotnictwo 11/2008, p. 12-15.

J. Liwiński: *Flota Linii Lotniczych 2008*, Lotnictwo 11/2009, p. 18-22.

Over one year period the world number of planes has risen by 2.3%, and tonne-kilmeres performed by 5.5%, which is indicative of the

enhanced intensivity of aircraft exploitation. The share of separate world regions in the global tonne-kilometre performed is presented in Fig.2.

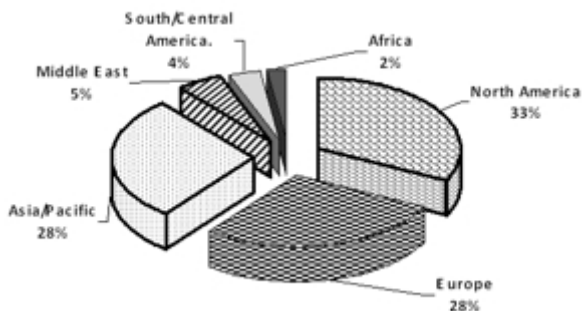


Figure 2. The share of separate world regions in general tonne-kilometres.

Source: Personal study based on: Annual Report ICAO. Doc 9916 *Annual Report of the Council*.

The aircraft construction methods and distribution paths require accurate knowledge of the number of most widely used communication airplanes and the extent of the needs in both the short run and the long run. In the large aircraft rating of 2009, Boeing 737 ranks the highest – 4928 planes, Airbus A320 ranks second – 3737 planes, and then Boeing 757 – 970 planes, Boeing 747 – 947 planes, Boeing MD – 886 planes, Boeing 767 – 827 planes, Airbus A330 – 607 planes, and Airbus 300 – 376 planes. Within the group of regional aircrafts Bombardier CRJ 100/200 ranks the first – 925 planes, then Embraer ERJ – 840 planes, Bombardier DASH 8/Q – 756 planes, and ATR 42/72 – 729 planes. The planes in exploitation are constantly subject to modernizations of various types, whereby there are more and more new versions of the planes coming into the market. In 1990 the new versions of Boeing 737 labeled Next Generation Boeing 737-6,-7,-8 came into operation, and in 2001 model 900 came into use. The changes in the construction of the plane mainly consisted in extending the wing span, increasing the fuel tank capacity, wide use of composite construction materials, and the application of modern avionic systems, among others large liquid crystal displays in the cockpit. The latest Boeing 737-900 ER model has the increased seating capacity of 215 as well as the extended flight range of 5900 km. Currently the greatest user of Boeing aircrafts is American South West Airlines operating on 468 Boeing 737 planes in 737-300/5/8 versions. Polish Airlines operate on 17 Boeing 737-300/-4/-5 planes.

The most popular Airbus company planes are: A318 – 107 seats, A319 – 124 seats, A320 – 150 seats, A321 – 185 seats. On the whole 2761 such aircrafts are being used by 150 airlines. Operating since 1988 A320 planes are amongst the new type aircrafts offering higher standards within flight comfort and economic efficiency. Airbus is the first aircraft production company to have introduced the revolutionary solution in the airplane navigation which was the fly-by-wire electric system. A320 machines are gaining increasing popularity with traditional air carriers, which is perfectly reflected by the replacement of Boeing 737 with Airbus A320 by 44 carriers. The reverse action, however, has been done by only two carriers. Airbus A320 has been the basis for the development of the ACJ family functional planes (Airbus Corporate Jetliner) with specially equipped VIP cabins and additional fuel tanks allowing for long distance flights. Aircrafts of this type (A318 Elite – flight range 7600 km, A319 – 11,100 km, A320 Prestige – 7600 km) have been purchased by Brazil, France, Italy and the Czech Republic for presidents, prime ministers and government members. They have also been purchased as functional airplanes by big corporations. The value in use of individual aircraft types is strictly connected with their construction alterations, which make for the improvement of flight comfort and exploitation economy. The overall policy realization finds its reflection in the alterations in aircraft propulsion system, as presented by the data in Table 3.

Tab. 3 The air fleet quantity and quality changes in the 25 year period 1983-2008.

Engine type	1983		2008		Quality change
	Number of planes	Share (%)	Number of planes	Share (%)	
Jet engine	6596	73,4	18 759	82,7	+12163
Turbine-propeller engine	1483	16,5	3812	16,8	+2329
Piston engine	908	10,1	114	0,5	-794
Total	8987	100,0	22 685	100,0	+13698

Source: 1. Document ICAO, Doc 9876 *Annual Report of the Council 2006*.

2. Civil Aviation Information Bulletin 2009 No 2, J. Liwiński (editor); *Rynek lotniczy w Polsce i na świecie 2008*. ULC. Warszawa 2009.

The last quarter of a century is characterized by the definite withdrawal from uneconomical piston propulsion, maintenance of turbine-propeller propulsion at a relative stable level, and a considerable increase in the number of jet airplanes, which already in 2008 accounted for 82.7% of the world air fleet.

3. THE CHARACTERISTICS OF LARGE COMMUNICATION AIRPLANES

The fast developing world economy leaves aircraft producers faced with unprecedented challenges of mass transportation of people and shipment of goods. The global air transportation market is now dominated by biggest aircraft producers, who are focusing on the construction and modernization of large flying machines able to carry on board several hundred passengers or 250 tonnes of cargo at a time. Airbus and Boeing are now two biggest companies to be reckoned with and to decide on the aircraft supply volume or satisfaction of the needs in this market sector. The biggest quality changes in large aircraft exploitation are noticeable in the Boeing group (esp. Boeing 737) and Airbus group (A320 and A319). Each project of a new airplane within the large aircraft group is bound to incur great multi-billion dollar costs, the return on which comes on selling at least 600 models, which may take the time of 8 to 12 years. It is due to this fact that launching a new model plane into the market is a precarious enterprise and it requires a broader international cooperation as well as the assistance of various specialist firms. The increasingly fast growing demand for air transportation services in the last decade has been reflected by the adequate production of large communication aircrafts by the world biggest aircraft producers: American Boeing and European Airbus.

In 1998 the Boeing production volume surpassed Airbus production almost twice. In 2003 the Airbus company for the first time broke the long lasting Boeing production supremacy and is now constantly maintaining its prevalence in the production volume. In 2007 Boeing released 441 planes whereas the Airbus company assembled 453 machines securing its market position as the world biggest aircraft producer (the Airbus sales worth were 24.3 bln USD whereas the Boeing sales worth amounted to 20 bln USD). A great breakthrough in the large aircraft construction sector was the year

2004 commencing the programme of the new generation aircraft construction – Airbus A380 and Boeing 787 Dreamliner. The new solutions here have also been transferred to the production of other narrow and wide-body airplanes. The new aircraft types have aroused a great interest from the users, mainly because of their high standards of comfort and exploitation economy.

Of the two competitors Airbus fares much better as its new generation airliner A380 has already entered the market. Its coming into operation in October 2008 reoriented the air transportation quality standards. It has become the most modern spacious passenger airliner, comparable to the old most exclusive transatlantic liners, when it comes to luxury, innovative equipment and comfort of the journey. The A380 project culminates great technique – technological efforts and has good chances of becoming the banner airplane of the 21-st century.

The Airbus A 380 construction rests upon several basic assumptions:

- long distance transportation service
- the use of transitory airports (hubs) located around big city agglomerations
- reaching full client's satisfaction
- maximizing the safety
- minimizing the exploitation costs.

The realization of the above mentioned objectives in the construction of an aircraft of such dimensions has been the greatest challenge in the history of civil aviation. The cost of the whole project amounted to approximately 17 bln USD. In the category of aerodynamics the aircraft has reached level 6 surpassing the already operating machines, which is strictly connected with the use of newest fiberglass Glare composites (laminated composite of aluminum and fiberglass alloys) and artificial materials reinforced with carbon fiber.

The navigation system has been modernized by the application of EBHA (Electrical Back-up Hydraulic Actuator), which acts as the fourth additional steering channel. Traditional riveting has been replaced with special laser welding. The total application of modern technologies has contributed to the reduction of its weight by 15 tonnes maintaining at the same time its high durability. The economical benefits result mainly from maximizing its seating and cargo capacities. The

aircraft has passed the airport infrastructure compatibility tests (has proved its ability to use the 45 metre wide runway). The application of new generation engines and wide wing span has made its landing and take-off way shorter than that of the majority of large communication aircrafts, and the F category requirement, necessary for servicing A380, is now complied with by an increasing number of airports in the world. Out of the 22 special airport vehicles used for servicing A380 only two need to be replaced: the aircraft tractor (for a more powerful one) and the top deck servicing vehicle. To reduce the noise level the airplane will be taxiing with only two engines operating. Also thrust reversers were installed in only two engines, which aims to reduce the aircraft weight. According to its constructors the machine emits 35% less noise than other long distance airplanes and complies with the strictest noise protection requirements QC2. Moreover, its low petrol use reduces the pollution of higher atmospheric strata. The commencement of the A380 commercial operation marks a new route in the development of air transportation. The analysts, however, are not in agreement as to the rightness of the large dimension airplane exploitation concept as the market has not proved its correctness in practice yet. The divergence in the scenarios as to the use of large dimension aircrafts results from a different approach being realized by the Boeing company. It consists in the exploitation of smaller aircrafts of versatile land infrastructure compatibility and minimizing the exploitation costs.

This approach was the basic concept in the construction of a new airliner Boeing 747-8 Intercontinental. The airplane construction will be based on its predecessor – Boeing 747-400, whose solutions will be applied in 80 % of the new model, which is going to bring down the costs considerably. The seating capacity with the 3 class configuration will be 450, which makes it the biggest jet plane of this company. Its flight range will be 14,815 km. The load capacity will also improve thanks to its broader wing span and the replacement of triple-slotted flaps with the newest version of double and single-slotted ones. The wings will be built up of highest durability new generation materials and terminated with winglets dispersing air whirls. The cabin crew will have at their disposal a modern cabin equipped with large crystal liquid displays showing flight parameters. The aircraft propulsion system Genx – 2367 will be

supplied by General Electric company, which complies with the world noise and pollution norms: Stage4 and QC2.

According to the BCG (Boston Consulting Group) assessment the costs of the new generation airplanes will approximate these of the so far exploited large aircrafts, which means that the smaller ones will be more frequently purchased by the carriers as they offer a broader range of commercial applications, more convenient flight connections and more frequent and shorter flights, but it is now still too early to forecast the routes of development for these machines.

4. CONCLUSIONS

The analysts of the world market are unanimous that the air transportation will be developing faster than other types of transportation. There are, however, different opinions as to the routes and ways of air transport development. The biggest uncertainty in the developmental prognosis is connected with diagnosing the tempo and scope of rising fuel prices being the main component of airline exploitation costs. The financial situation of air transportation companies will also be substantially affected by the aircraft price and its capacity, which translates into units cost volume. The improvement of the economic situation within air carrier companies will much depend on their ability to adjust their purchasing procedures so that separately acquired aircrafts could accurately correspond to the services demanded by concrete markets.

BIBLIOGRAPHY

- [1] Dierikx M., *Clipping the clouds. How air travel changed the world*, PRAEGER, Westport, Connecticut, London 2008
- [2] *Global Market Forest 2007-2026*. Publisher Airbus. Tuluza. December 2007.
- [3] Głowacki B., Sobczak G., *Współczesne samoloty pasażerskie*, Lampart, Warszawa 2002
- [4] Jarrett P., *Najnowsze samoloty*. DK. A Darling Kindersley Book, Solris, Warszawa 2003.
- [5] ICAO Doc 9876, *Annual Report of the Council 2006*.
- [6] ICAO Doc 9898, *Annual Report of the Council 2007*.
- [7] ICAO Doc 9916, *Annual Report of the Council 2008*

- [8] ICAO Journal: The magazine of the International Civil Aviation Organization. 5/2007.
- [9] Liwiński J., (redakcja): Biuletyn Informacyjny Lotnictwa Cywilnego 2/2009
- [10] *Rynek lotniczy w Polsce i na świecie 2008*. ULC. Warszawa 2009.
- [11] Liwiński J., *Flota Linii Lotniczych 2006*, Lotnictwo 12/2007.
- [12] Liwiński J., *Flota Linii Lotniczych 2007*, Lotnictwo 11/2008.
- [13] Liwiński J., *Flota Linii Lotniczych 2008*, Lotnictwo 11/2009.
- [14] Liwiński J., *747 – 8 nowe samoloty Boeinga*, Lotnictwo 2/2006.
- [15] Liwiński J., *Airbus – Boeing 2007*. Lotnictwo 3/2008.
- [16] Liwiński J., *Airbus A380 – flagowy samolot pasażerski XXI wieku w służbie*. Lotnictwo 12/2007.
- [17] Liwiński J., *Airbus czterdzieści lat innowacji*. Lotnictwo 12/2009.
- [18] Markowski M., *Polskie lotnictwo sportowe*, Krajowa Agencja Wydawnicza, Kraków 1987.
- [19] Mikulski M., *Komunikacja lotnicza w świecie*, Wydawnictwo Naukowe Polskiej Akademii Nauk, Kraków 1972.
- [20] Makowski T., Wojalski W., *Samoloty transportowe i komunikacyjne świata*, SIGMA- NOT, Warszawa 1992.
- [21] Pilecki S., *Lotnictwo i kosmonautyka*, Wydawnictwa Komunikacji i Łączności, Warszawa 1984.
- [22] *Outlook for Air Transport to the Year 2020*. International Civil Aviation Organization. Bruksela. September 2007.
- [23] Schier W., *Pionierzy lotnictwa i ich maszyny*, Wydawnictwa Komunikacji i Łączności, Warszawa 1980.
- [24] Simons D., Withington T., *The History of aviation* Parragon Books Ltd., Nowy Jork. 2008.