

STRATEGIC MANAGEMENT OF AIR TRANSPORT RESOURCES IN FUEL CRISIS CONDITIONS

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Abstract:

The article is a report of predictive testing, conducted as part of the assessment of world's petroleum resources. One aspect of the depletion of oil resources and reduction of the supply of jet fuel is a systematic increase in the cost of air transport and the increased unavailability for most users of the transport. The study raises a number of proposals to mitigate crisis in air transport. The most important ones are discussed in this article and include the following areas:

- Non-renewable petroleum strategic resource
- Air Transport in the background of the global oil crisis
- Easing of restrictions and the effects of oil crisis in the operation of air transport.

The conclusions presented in the work could have implications for strategic decision-making in the use of air transport.

Keywords: air transport, fuel crisis.

1. INTRODUCTION

Social awareness of adverse effects on Nature caused by economic growth and the attainment of temporary prosperity in the name of civilization matured for years. The problem of destroying the environment by man got serious attention in countries belonging to the group of world's economic leaders. "In 1974, the Government of Canada has approached researches with the question about the consequences of continuing the current direction of national development and possibilities of changing it. World Future Studies team – GAMMA, from Montreal has conducted extensive research on the issue" (Danecki, 1998, p. 5). The study was published in 1976. There were four volumes containing a synthesis of the collected views and their documentation in terms of: the physical and technological capabilities, institutional aspects and the cultural aspect. Three separate scenarios of the conservation of resources were analyzed – three different intensities of resource depletion. From those analysis, documented observations emerge: there is the threat of depletion of non-renewable and renewable resources, high costs of their extraction, high energy demand related to their extraction, high costs of production from an environmental perspective.

Another country that deals with the protection of nature and its resources is France, which institutionally has launched several initiatives, "the General Council of Roads and Bridges, along with the General Inspectorate of Finance carried out an audit of infrastructure projects in transport at the turn of 2002–2003. Consequently, attention was drawn to the need of developing a study providing the forecast for the transport sector until 2050" (Ucieszyński, 2007, pp. 12–14). The study has been launched, in which the authors do not intend to provide a precise vision for transport by 2050, but wish to point out the possibility of action to overcome the fuel crisis and halt climate change. "It is expected that the activities undertaken will be split into four stages: awareness of the changes that happened so far, visualization of future possibilities in various scenarios, quantifying the proposed scenarios and the conversion of transport streams and greenhouse gas emissions for each scenario. Two primary variables were defined as the most meaningful to explore future opportunities in the field of transport. These are: the European and global efforts to develop alternative energy sources and taking control of global climate change and the rate of population growth in the global competition scenario" (Ucieszyński 2007, pp. 12–14).

These problems significantly determine the operation of air transport now and in the strategic future. Aviation fuel costs are a major indicator of the economic problems of air transport. Global oil reserves are estimated at around 2,000 billion barrels, and to date we have used about 1,000 billion barrels. In 2005, the world consumed about 30.7 billion barrels. A simple calculation shows us that we can only use our oil resources in the next 32.5 years (1,000 billion divided by 31 billion barrels consumed annually gives 32.5 years). In practice, however, the statement "we have oil for 30 years" is incorrect because it implies that for 30 years we will consume it at a constant rate until 31 December and on January 1st in the 31st year, our use will be zero.

But the problem is not so much in the exhaustion of oil, as in the exhaustion of cheap oil, upon which our modern civilization is based. Oil plays such a fundamental role in the global economy, that the exhaustion of fuel and petroleum products will cause a very serious global crisis. When will it happen?

Like most of the mining and processing of raw materials, crude oil extraction is based on a bell curve which shows that the peak of the curve falls on the moment at which 50 % of

resources were used. The curves describing individual wells or the raw material-producing countries are often irregular due to different turbulence, primarily geopolitical, however the sum individual curves forms a bell curve.

Regardless of the exact shape of the bell, the most important is that the production of oil increases, peaks and declines. Peak production does not mean that "oil is over." It marks the end of the first, easy half of extraction and entering the second half, which becomes more difficult every day, more expensive and of lesser quality.

Studies done so far, showed very diverse consumption of energy resources in different economic and social systems. "The average American or Canadian consumes an amount of energy that is contained in fifty barrels of oil (more than twice the average European). Per capita consumption is distributed as follows: living purposes - 16 percent, business and administration - 12 percent, industry - 23 percent, transport - 20 percent, the energy industry - 25 percent, using energy for non-energy purposes - 4 percent. The cost of extracting, refining and transporting of three barrels of oil to the retailer is equal to the cost of one barrel of oil" (Ucieszyński 2007, pp. 70–71).

The statistics quoted above show that transport, including air transport, is only a small fraction of world energy consumption. We could say, „let others worry about oil depletion because transportation is only one fifth of global demand for oil" (Raport BP, 2009). But in practice, especially in aviation, from year to year, the situation is becoming more and more serious because in aircraft propulsion systems, fuel based on oil is dominant and we do not know any propulsion technologies yet, which could do without this resource. The question is when and how the air transportation (aviation) industry will begin to feel the fuel crisis? The need to find the answer to this question is the motivating factor in starting the research and formulating the theme of this article. Strategic management of the world aviation resources becomes the need of the moment, mainly in the area of how we use the resource potential and minimize operating costs.

2. CRUDE OIL NON-RENEWABLE STRATEGIC RESOURCE

The invention of internal combustion and diesel engines was a momentous event, elevating the status of oil as a strategic raw material. In the late nineteenth and early twentieth century, that invention started the era of oil – the most important raw material of modern civilization, which continues to this day. This process has contributed to the development of aviation and defense industry.

During the Second World War, the arms industry's demand for oil forces reached 40 % of the total domestic production in the United States. Due to its strategic importance, oil became a bargaining chip in international politics. The rapid growth of oil consumption in the world created concerns about rapid depletion of non-renewable resources, and started the process of their estimation.

Estimating the size of oil resources is very difficult and contentious, because it is based on conflicting information contained in the reports of major oil producers (not always objective) as well as assessments of different experts. Their actions are deliberate and designed to influence the market, control of demand and supply of this raw material, which may have different objectives: political and economic. Political translates into putting pressure on

countries dependent on oil imports and world public opinion. Economic are all steps to achieve financial gain through speculation about the resources and production capabilities.

OPEC countries have recognized the problem of excessive oil production levels which lead to rapid depletion of deposits. They decided to decrease oil production by 2–3 % per year.

Another worrying phenomenon is the excessive exploitation of old oil fields and lack of investment in the discovery of new fields in Russia. At the current rate of exploitation of resources, Russian resources will be exhausted in 6.5 years. Discovering new fields and preparation for the industrial operation requires at least 10 years and very large investments. That matters a lot to the world economy because the exploitation of deposits in Russia today makes up 12.4 % of world production.

Regarding world resources, two opinions dominate - a pessimistic one, which estimates the resources that we are currently exploiting at 45–50 years. Optimists argue however, that in nature will never run out of oil as it can be produced from other minerals and biomass. There are also unconfirmed theories, however, that nature produces oil, but at great depths and under high pressure, which puts into question its extraction, which even with current technology is impossible and unprofitable.

Since 2007, world production of crude oil fell by 0.2 %, while demand increased by 1.2 % and from that year on the world market, this trend is maintained. The ratio of world production to the total global resources ranges from 0.43 % to 0.6 % and it is an indicator illustrating the rate of consumption (depletion) of all deposits currently being extracted. In Russia, this figure stands at 1.9 %.

With unbalanced supply and demand, there are crises appearing that might be political, military or economic in nature (like global financial crisis). Subsequent crises may occur in the future, when the global oil peak is passed and the deposits are depleted. Those would be raw material based crises.

Europe is heavily dependent on oil-exporting countries. Therefore, steps are being taken in the European Union countries to protect against the effects of crises on oil markets. Increasing stocks of crude oil by EU countries is one of the ways to protect themselves from the crisis. Experts estimate that the countries of the EU are able to save up to 20 % of current energy use.

3. AIR TRANSPORT IN THE GLOBAL OIL CRISIS CONDITIONS

Availability of fuels (quantitative, qualitative and price) on world markets has a significant impact on the financial performance of air transport companies and the state of the economy. Introduction of jet engines in air transport in 70ties resulted in an increase in demand for aviation fuel and raising the price of air services and service standards. The share of fuel costs in the prices of services reached 30-40%. Studies have been undertaken leading to improved transport economic indicators both in the field of aircraft construction and organization of services.

Passenger air transport today competes with rail transport for long transportation routes, mainly intercontinental. For short routes, passenger transport is being replaced by high-speed train transport. The development of air transport has been started in 1940's. In 1990's, it has

reached its peak organizational level. During the development of air services, many specialized functions emerged, that cannot be replaced by other means of transport. For example: crane services, transportation of over-sized structures, moving dangerous cargo, medical & rescue transportation. From the analysis and evaluations of the solutions used, we know that the increase in demand for social functions of air transport depends on population increase and its status in a given area, economic development, wealth of the society and the prices of services. Examples of population status and population growth rate include countries such as Uganda or Yemen, where we see higher rate of population growth, countries which are demographically stable like Thailand or South Korea and countries where the population growth declines like Italy, Ukraine and other European countries.

Demand for air services in countries with a high population growth will depend on migratory movements (people leaving the country and going to more wealthy countries). In demographically stable countries, the demand for air services will be also on a stable level, without major changes. In countries where population declines, we can expect increased demand for air services caused by people from poorer countries, interested in coming over and getting a job.

Countries which recorded rapid economic growth (China and India) have a high rate of growth in demand for oil and air transport services.

In the actual activities of civil air transport sector, we have considerable variations of costs of services in different countries. In the European Union, legislative efforts have been made towards standardization of the components of the cost of air services, in which aviation fuel accounts for 39 % of all costs associated with passenger air transport. Aviation fuel prices are shaped by supply and demand in world markets and they largely depend on the economic situation. So the regulations adopted by the EU in practice cannot be fully respected.

During the preparation of military operations the military demand for transport fuels is increases four times in relation to a stable, peaceful period. Oil consumption in the economy in times of peace is shaped according to the following proportions: 14 % consumes transport in general, air transport alone is 1.3 % and 0.34 % is consumed by military. With the distribution described above, it shows that the biggest consumers of oil are not in the aviation sector.

From the research that has been conducted, it would make sense to make a comprehensive study of how air transport impacts the economy on local and country level, taking into consideration the competition that exists between different kinds of transport.

4. EASING OF RESTRICTIONS AND THE EFFECTS OF OIL CRISIS IN THE OPERATION OF AIR TRANSPORT

Undoubtedly, fuel crisis will have impact on the functionality of aviation. We are looking for savings in fuel consumption by proper route planning for flights. According to European experts, currently, every route is from 40 to 50 kilometers longer than it could be. Another avenue is to bring improvements to the movements of airplanes with airports to reduce the time airplanes have to spend with the engines turned on.

During the last 60 years, six major symptoms of the oil crisis have occurred, which exhibited themselves in a high increase in oil prices. More and more frequent oil price increases are not

without influence on air transport, because every fuel crisis causes substantial impact on air transport industry, leading to the collapse of the weaker airlines. Experts determine the limit of viability of air transport at oil prices at \$85–115 per barrel.

In the process of refining of crude oil, the aviation fuel is only one of the seven obtained products. From one barrel of oil with a capacity of 159 liters we get about 14 liters of aviation fuel (4 gallons). The scale in the aviation fuel consumption is quite stretched because cargo planes consume 4 to 15 liters per one kilometer of a route that is one barrel per kilometer. Higher oil consumption takes place in various sectors, among others in land transport.

A major recipient of petroleum fuels is the military, including aviation. It consumes about 50 % of total demand in the form of aviation fuel. A significant part of the aviation fuel is consumed by airlift support for military missions and humanitarian operations.

Due to periodically increasing demand (during the preparation of troops for armed conflicts), the military transport is supplemented by civilian carriers that help in the implementation of the tasks. In order to ensure continuity of combat operations in armed conflicts, the army maintains a fleet of aerial refueling aircraft that are able to transport aviation fuel in places where it is difficult to distribute it using other methods.

The depletion of oil resources is certain. Transportation, especially long-distance air transport, may cease to exist or it will be limited due to high costs. So everything depends on the aviation resource management strategies in crisis situations.

Crises prevention is possible if they have a political or economic base, while in the case of a crisis caused by the shortage of raw material, it is only possible to mitigate it by introducing new technologies which are not based on oil. The methods of crisis prevention is saving, creating inventories, contracts for the supply of oil and increasing international control over the exploitation of the world's oil. It is possible to increase stocks of crude oil by adapting the salt mine closed under an agreement with the Arab countries. The agreement is treating the deposits as deposits of the Arab countries and NATO. In addition, pursuant to Regulation of the European Union, Member States have been required to keep oil stocks to cover demand for oil for the period from 90 to 120 days.

Studies have shown that in the face of a clearly impending raw materials crisis, either complete or limited, based on the depletion of oil, is it necessary to undertake systematic steps, however expensive they might be. Steps like developing alternative energy sources (substitutes). So far these steps have not been entirely successful and failed to produce expected results.

Recent studies have proved that both hydrogen fuel and biofuel substitutes have not gained the role of substitutes because of the economic and technical reasons, they are not able to fully replace petroleum products especially in air transport.

So now in the face of crises, in order to mitigate their adverse effects, the world's airlines combine in alliances (mergers) which help them to survive a crisis. The result of their activities can be and currently is, the reduction of aviation fuel costs and other charges (airport and air space use), which reduces the cost of their operations.

The discussions and investigations of the problem show that the effects of mild crises of oil depletion can be limited by: the modernization of aircraft equipment (purchase of aircraft with lower fuel consumption), elimination of unnecessary costs - creating low-cost airlines, conducting marketing activities to increase the seat utilization ratio, the implementation of some restrictions in the military use of air transport services regarding air transport of troops and armaments, participation in creation and functioning of the joint international air transport unit providing services for EU and NATO troops and the improvement of the laws governing the use of civil air transport for military purposes.

5. CONCLUSIONS

XXI century is the era of modern technology, new discoveries and inventions that constantly change the world, in which crude oil, however, remains the driving force behind the development of industrialized societies and is a "bloodstream of civilization." It forms the basis for the most important sectors of the economy, which hides a high degree of risk and financial resources, while remaining the cause of many conflicts and frictions between countries, private companies, and governments. The Gulf crisis has clearly shown that the power of individual nations depends on the size of their oil reserves which also greatly influences the international situation.

At this point the question arises - what is the future of the civilized world, especially in the area of interaction of the global community using air transport? It is no secret and it is confirmed by this study that life brings many surprises, which allowed the creation of many scenarios of the impact of crises on air transport, and all are based on oil. Therefore, an extremely important phenomenon is the need to limit the fuel crisis. This is done by a rational, efficient management of existing resources, but also in crisis situation, making correct, containing even some risk decisions, but allowing aviation industry to function in crisis conditions. Analyzing the experience we have so far on the use of oil resources, we may expect events that become understood after they happen. At any time, as a result of continuous and uninterrupted competition for access to oil, events may happen like violence, war, technological risks, political expansion, a variety of economic phenomena and ethnic, religious and social conflicts. Taking into account the dynamics of the global economy and the current trends shaping the political systems, each of the above events may be a complete surprise, and each of them can impede access to oil - the raw material, which already today, is not a generally accessible resource. Quite a surprise can also be a form of transformation in the global economy and technological breakthroughs in the search for alternative sources of energy, or unexpected environmental crisis that could lead to a total change in energy policy, as well as events and processes occurring in the countries that are dominant producers of natural gas and oil, such as Russia and the Middle East countries.

The situation that occurred in 1973 clearly showed that oil companies are not able themselves to face and deal with the next wave of crises but must be assisted by government. Those experiences led to the establishment of the energy security system by the developed countries, the system which is supervised by the International Energy Agency. The project of strategic reserves in the U.S., Germany and Japan has been created, which could be used if necessary, to prevent a panic in a crisis situation.

In the twentieth century, oil has been the decisive factor in maintaining peace or causing a war, so it boosted the power of some countries while diminishing the importance of others. It has been the driving force behind political and economic actions.

The main challenge in this study is to identify the role of air transport in order to show social, economic and military dependencies on the efficiency of its management. Through an analytical perspective on transport in terms of quantity, quality, location of the tasks, time, cost, the intensity of energy demand, the study attempts to provide an environment where we can discuss the implications of a sudden decline of air transport market.

Connecting different crisis situations with problems in air transport, has allowed us to find answers to several important questions. The conclusions emerging during this study created the base for coming up with ways to prevent crises and improving the management of air transport functionality when faced with a next wave of fuel crises, which may, in contrast to crises that happened so far, may be caused by raw material depletion – irreversible exhaustion of oil resources in Nature.

The high sensitivity of air transport to any changes in supply and price of oil and fuel on world markets brings us to the conclusion that the problem lies in the structure and proportions of the products that may be obtained from one barrel of oil. Aviation fuel, produced from one barrel is only a little over 8% of its capacity. From the same barrel of the same capacity, for other means of transport, 22% is used to make diesel and 43% gasoline. The proportions speak for themselves. Land transport consuming diesel fuel and gasoline is more likely to maintain the stable operation during a fuel crisis, because more production related to land transport enables the creation of larger stocks, which in turn translate into a longer period of operation in comparison to air travel. With regard to oil prices on world markets, Experts sharing opinions in the columns of air transport aviation periodicals, argue that the price limit at which an air transport operation is still profitable is \$ 85–115 per barrel. Other means of transport will not be so much impacted by that price and they may reach for available fuel substitutes. The situation is quite comfortable for rail transport, which as a result of further technological modernization mainly consumes, still low-cost, electrical power and reaches speeds comparable to the average speed of a transport aircraft. As a consequence, this brings the important conclusion that air transport in the future will be replaced and even eliminated by the rail transport for routes within the same continent.

The impact of the cost of air transport services on passenger demand is obvious. The demand for passenger transportation, regardless of the price of air transport services, also depends on the economic development in the area in which aviation operates, and the concentration of world population in that area. The increase in costs and prices in an air transport crisis will eliminate less affluent users, even whole social groups, from a regular customer group using air transportation. With, the demand for aviation services being significantly lower, air transport will shift more to elite activities. The study shows some hope, however, associated with the search for ways to reduce transportation costs through changes in the organization of air traffic and putting new airplanes into service that provide better efficiency of operation (e.g., A380). Intercontinental air transport has no competition today and everything indicates that will not change as long as a sufficient supply of fuel is provided to air carriers at reasonable prices. In the global scale, the idea is emerging to abandon air transport for local connections – even connections within same continent and replacing it with rail transport. The savings than can be allocated to the intercontinental air transport.

The situation in Europe after a volcanic eruption in Iceland, which has interrupted air traffic in European airspace for nearly two weeks, was an excellent opportunity to highlight the social and economic impacts resulting from the lack of access to the air transport services.

The history of recent conflicts and wars, which were characterized by significant involvement of aviation and air transport confirms the importance of aviation in achieving military victory, arising mainly from active participation of air transport (military and civilian) in the preparation phase (operation logistics). For the world economy, every military operation is associated with some limitations in the use of air space above the war area (Yugoslavia, Iraq). Fuel consumption during the preparation and later conducting military operations is significantly increased, up to four times, compared to stable peacetime military training activities. Experience shows the need for stockpiling fuel and seeking organizational solutions aimed at minimizing the cost of maintaining full-time aviation units within the Armed Forces. Solutions should be sought in better cooperation with civilian air carriers and the creation of the coalition, international air transport units.

To summarize the content of this study, it should be noted that there are still new facts to come and information about the looming threat of an approaching oil crisis. Recent reports of disasters and the tense political situation in many regions of the world, bring less optimistic scenarios closer to our reality.

Identification of possible, highly probable, crises arising from the unbridled, systematic depletion of the world's oil reserves should raise awareness of the need to include in the further forecasting the imminent reduction of oil supply on the free market. Most forecasts for the development of transportation today, does not include the possible effects of the impending fuel crisis. Possible scenarios for the future operation of air transport, show the dynamics of accumulation of the negative effects of the oil crisis in the social, economic and military aspect. Situations described in this paper require acceleration of our search efforts for alternative technical solutions, organizational improvements, saving strategies, mainly in the area of air transport.

REFERENCE LIST

1. Bąk, M. (2009). *Koszty i opłaty w transporcie*. Gdańsk, Wydawnictwo Uniwersytetu Gdańskiego.
2. Chalupiec, I., & Filipowicz, C. (2009). *Rosja, ropa, polityka*. Warszawa, Prószyński i Ska.
3. Craig, J. R., Vaughan, D. J., & Skinder, B. J. (2003). *Zasoby Ziemi*. Warszawa, PWN.
4. Danecki, J. (1988). Słowo wstępne do Valaskakis, K., Sindell, P. S., Smith, J. G., & Fitzpatrick, M. I. *Propozycje dla przyszłości społeczeństwo konserwacyjne (p.5)*. Warszawa, PIW.
5. Fundusze inwestycyjne. (2008, June 20). Retrieved from <http://www.fi.com.pl>
6. Gazeta. pl. (2007, November 25). Retrieved from www.gospodarka.gazeta.pl
7. Główna Biblioteka Komunikacyjna. (2008, February 10). Retrieved from <http://gbk.net.pl>
8. Kaczmarek, T., & Jarosz, R. (2006). *Czy ropa rządzi światem?*. Bydgoszcz, Oficyna Wydawnicza BRANTA.
9. Klare, M. T. (2006). *Krew i nafta*. Warszawa, Agencja Wydawnicza i Reklamowa Akces.
10. Klein, N. (2008). *Doktryna szoku*. Warszawa, Warszawskie Wydawnictwo Literackie Muza SA.
11. Kuciński, K. (2006). *Energia w czasach kryzysu*. Warszawa, DIFIN.
12. Lotnicza Polska.pl. (2008, July 17). Retrieved from <http://www.lotniczapolska.pl>

13. Łęgowska, B. (2007). *Polityka naftowa państw arabskich Zatoki Perskiej*. Łódź, IBIDEM.
14. Pawłowska, B. (2000). *Zewnętrzne koszty transportu*. Gdańsk, WUG.
15. Peak oil. (2008, September 10). Retrieved from <http://www.peakoil.pl>
16. Pierwszy Serwis Międzynarodowy Transportu i Spedycji. (2006, December 31). Retrieved from <http://www.ue.psm.pl>
17. Portal Dplnośląskiej Agencji Energii i Środowiska. (2008, January 30). Retrieved from <http://www.cieplej.pl>
18. Portal Edukacji Ekonomicznej. (2008, March 17). Retrieved from <http://www.NBPortal.pl>
19. Raport BP (2009).
20. Ucieszyński, M. (2007). Prognoza dla transportu w perspektywie do roku 2050: w jakim celu?, Główna Biblioteka Komunikacyjna *BI Nr 2007/04*, wg Gressier, C. (2007). Une prospective pour es transports a l'horizon 2050: pour quoi faire? *Le Rail*, 133, 12–14.
21. Valaskakis, K., Sindell, P. S., Smith, J. G., & Fitzpatrick, M. I. (1988). *Propozycje dla przyszłości społeczeństwo konserwacyjne*. Warszawa, PIW.
22. Wąsowska, K. (2011). Rozprawa doktorska – *Wpływ światowych kryzysów paliwowych na funkcjonowanie transportu powietrznego*. Warszawa, AON.
23. Yergin, D. (1996). *Nafta, władza i pieniądze*. Warszawa, Wydawnictwo Philips Wilson.