

AIR TRANSPORT EFFECTIVENESS

Elena Zheleznaia

National Aviation University, Kiev, Ukraine

E-mail: your_kukushka@bigmir.net

Abstract. Attention is paid to the assessment of air transport effectiveness considering the risk of its malfunctions.

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1. Introduction

In the development of air transportation systems it is necessary to predict the efficiency of their operation. The level of actual performance is controlled in the operational process and its compliance with the determined requirements is also defined. Quantitative evaluation of the effective functioning of such systems is multi-criterial. The knowledge of the performance level allows the development of a performance management system in order to ensure that the efficiency of air transport is required or close to its possible maximum. A system of air transport efficiency criteria which considers the application of productivity and quality criteria for air transport services has been developed. Estimated volume of air transport productivity is defined by volume of passenger and freight traffic during a certain period of time and the economic result of its operations. Quality of realizable air transportation operations is evaluated according to safety, performance, efficiency, timeliness, availability to users and environmental indicators of performance. This approach is somewhat different to that recommended by the International Civil Aviation Organization (ICAO) and is used in Ukraine (Manual ...2006; Manual ...2009), as it takes into account air transport performance indicators in terms of volume and quality of transportation services performed more fully.

2. Research object

Nowadays different kinds of purpose-designed aviation are used:

- air transport of various purposes (passenger, cargo, passenger-cargo);
- special-purpose aviation for different kinds of economic (agricultural) and production tasks (agricultural, meteorological usage, aerial photography operation, surveillance over gas pipe line and oil pipe line, forestland, road traffic, geological exploration, communication reconnaissance, surveillance over electromagnetic and radiation emissions, etc.);
- military aviation for various purposes;
- space-air transport;
- sport aviation, etc.

For these purposes both manned and unmanned aviation is employed. Different hybrid aircraft are developed and used for their aerodynamics. Each type of aviation is designed to perform certain functions. Specific criteria are used for the assessment effectiveness of each aviation type. Ability to perform its function is defined as functional reliability. If the level of performance reliability of each function corresponds to assignment requirements, it means that a potential level of effectiveness may be expected in the case where the conditions of this implementation type are normatively favorable. Failure in performance of some functions or under adverse conditions impairs the level of effectiveness.

Air transport is the most used branch of aviation applications. It's a complex and multifunctional branch, which includes airline companies, airports, air traffic control system, etc.

Aviation, including air transport, is under constant development and improvement. Items of its effectiveness have, not only state, but international value as well. ICAO and Eurocontrol documents are the evidence for it. Some more concrete examples are the assessment of methodology of air transport on Single European Sky (SES), and of program Single European Sky ATM Research (SESAR) realization, etc.

The purpose of air transport functionality lies in the gratification of state wants, population and business enterprise development in air transportation, performance of a range of economic tasks which are involved in operation of air transportation.

All types of air transport perform the function of transportation of passengers and cargo of different character. Air transport has the advantage in speed of spatial movement.

Air transport effectiveness is assessed by its efficiency, which is expressed by volume of passenger and cargo transportation and also by profitability, the difference of profit and utilization costs. High quality of air transportation service is the main criteria.

Production and quality of air transport service are inseparable characteristics. The criteria of air transport effectiveness are interdependent and are indicated below.

1. Criteria of production:

- volume of transportation (number of passengers, cargo per month, season, year);

- practical and traffic carrying capacity of air transport;
- economic performance (income, utilization costs, profit) per month, season, year.

2. Air transport service performance criteria: flight safety, possible risk, actual data of aviation service quality, regularity, flight effectiveness, effect of flights on the environment, service availability for air transportation.

“There is a wrong belief from the point of priority about the role of transportation safety within the effectiveness criteria. This wrong belief passed into stereotype: in aviation safety of transportation is the priority task. Socially, psychologically the stereotype in this question is irreproachable since human life is the worth-while point (Manual ...2006; Manual ...2009; Effectiveness...2010; Bykovtsev *et al.* 2010).

In all aviation enterprises, whatever the specialty, the business component can be observed. That is why they are considered business organizations. In this case the topical issue is: what is the main purpose of business organizations which provide air transportation and what for primarily were they created? What are the main production tasks?

3. Flight safety

There is no aviation organization, which would be established for air transportation service only since the safety of air transportation is not the primary task of an aviation enterprise. Air safety management may be the organizational issue, which is the key for aviation enterprises in order to reach the goal of providing services of high quality and safety. That is why flight safety management is just one of the business functions supporting the main function - effective production of air transportation” (Manual ... 2009).

Resources supporting air transportation are limited. Distribution of resources in order to provide main business functions is of the highest priority. In providing air transportation it is very important to maintain balance between production and flight safety. Without balance, the profitability of an air enterprise can get lower or visa versa if the level of distributed resources is too high for flight safety management.

That is why the issues of air safety management are not the main criteria in aviation activities and are only connected with service production. Insufficient level of flight safety will lead to decrease in air transport production. Decrease of air incidents will be the highest priority for aviation in order to support its production.

“Aviation is the safest type of mass transportation. This question is actually taking into consideration the growth of aviation, which includes decades while the history of many other branches includes centuries. With great efforts in flight safety area aviation has traveled a distance of a century from an unstable system to the first ultra safety system in the history of transport” (Manual ...2009). The commission of Standards and Recommended Practices ICAO (SARPS) indicate that effectiveness of air companies operations in flight safety has to be assessed using the following indices:

- The number of air crash in a definite date and time of flights;
- The rate unauthorized entry on the RW in a definite number of operations;
- The rate of aircraft collisions with obstacles on the ground in a definite number of operations;
- The number of rule discrepancy (reduction degree of its number) while approach and landing;
- The number of unauthorized entry onto the TW of airdrome etc.

4. Research results

It has been identified that approach and landing phases pose the most serious problem for flight safety. An allowable value of 10 unstable (or incongruous) approaches and landings per 1000 landings has been set. It was identified that the number of unauthorized entries on RW must not exceed 0,5 in one million operations on the airdrome. As for the obstacles during operations on the TW and apron, there must not be more than 15 cases in 10^3 operations and not more than 20 cases of unauthorized entries on the RW and TW in 10^3 operations.

In the process of air transport effectiveness assessment, the definition and understanding of risk plays an important role. The risk in this case is the process of air transportation which is characterized by the possibility of a threat to flight safety and possible consequences in case of such an aviation event. The consequences of possible threat realization can be characterized by:

- costs of damage due to an aviation event;
- damage from air transport production losses or flight safety;
- natural environment damage;
- damage from decreasing regularity or flight availability for clients, etc.

The risk for flight safety is defined as the possibility of the implemented hazard on consequences of its effect.

The risk for flight effectiveness is defined as the possibility of occurring hazard on the size damage and consequences of its effect. First definition encompasses a part of the second one since flight safety is one of the effectiveness criteria.

Over the last ten years world statistics has assumed that air incident rate is equal to less than one crash in a million flights (Manual ... 2009).

Considering the fact that most probable aviation collisions are related to close approach of two aircraft, ICAO calculates that in ten million hours the risk of collisions is less than 0,5. Then per 10^6 hour of flight the risk will be less than 0,05 and per hour of flights $0.05 \times 10^{-6} = 5 \times 10^{-8}$ hour⁻¹, with an allowance for possible infringements of one of three spatial minimums. The probability of potential aircraft collisions in the case of one set minimum breakdown will then be $5 \times 10^{-8} : 3 = 1,71 \times 10^{-8}$. ICAO proposes to calculate the possible risk of aircraft collisions as $1,55 \times 10^{-8}$ hour⁻¹.

Often in a case of realization one hazard produces different consequences, which may have different dimensions in assessment. It would be better to include all types within a single dimension, for example, assess all economic aspects of the consequences. This would simplify

assessment of air transport effectiveness. An example could be the tendency to assess economic aspects of air crash consequences which then results in problems of economic assessment of psychological and ecological damage.

Usage of several criteria for air transport system effectiveness assessment set the task of determining the level not only of flight safety but also of a range of other criteria including a reasonable level of effectiveness. For factual analysis of air transport effectiveness there should be a possibility to perform factual level assessment of each criteria and their execute comparison with the set meaning as well.

The most important criterion of air transport effectiveness is the stability of air transport functionality under normal conditions and under the conditions with possible influence of destabilizing factors.

To be considered stable a system, a system must operate normally under normal conditions or if it is under the influence of destabilizing factors, or if the system manages to in the permitted time to recover to a stable functioning condition by itself. It is defined as the containment of system probability under normal conditions of functioning even under influence of destabilizing factors.

For solution tasks of system-character the assessment of air transport effectiveness is more fruitful if complex factors are included. It is necessary to set its functional expression, which must be the general expression of all effectiveness criteria.

Methodological aspects of conceptual predictions and assessment of factual condition of air transport effectiveness are not developed enough. That is why active participation of all air transport branches: air companies, airports, organizations of air traffic management, is required.

5. Conclusions

Until recently in the official literature on air transport effectiveness such issues like safety, regularity and efficiency of flights were considered as the key performance indicators. Therefore, it was taken as granted and there were no doubts about this interpretation as the lives and healths of people who may be affected by plane crash are priceless. However, the concept of safety concerns not only crashes but other incidents as well (e.g. accidents).

Safety is a complex characteristic of air transportation and other aviation operations which defines the ability to operate without danger to life and health. Flights are considered to be safe when the risk of harm to a person or damage to property is reduced to an acceptable level and supported at a lower level by the systematic detection of the source of danger and by control of risk factors.

On the other hand, air transport since the beginning of its creation was aimed to meet (at the maximum or the necessary extent) the needs of a State, population and businesses to transport objects (passengers, freight and

mail) through time and space. Therefore, the purpose of air transport is to provide the maximum or required level of its performance (or to achieve the maximum or required profitability). But, of course, for civil aviation a priority and prerequisite are to provide, support and ensure the necessary levels of quality of services (such as security, efficiency, regularity, availability to consumers, environmental friendliness, etc.).

The concepts of productivity and quality of air transport services are inextricably linked. This interpretation of the performance criteria, which was officially introduced for the first time in (Manual ... 2009) in 2009, is now supported and developed in this article as well as in other works of authors (Effectiveness...2010; Bykovtsev *et al.* 2010).

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