Calculation of city airport terminals capacity in the high missile alert risk environment of Ukraine

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Abstract

With the beginning of russia's direct military aggression, it became clear that Ukraine will forever be one of the countries with the high military risks. Historically, it is obvious that with a capable russia, Ukraine will be at risk of attacks by missile or unmanned systems, as well as unobvious but highly probable terrorist acts and sabotage. The above-mentioned risks will lead to the need for technological changes in the operation of airport terminals in terms of passenger service to provide the less possible risks. The main goal in this case is to reduce the number of passengers in airport terminal complexes and minimize the time spent by aircraft at Ukrainian airports. An effective solution designed to significantly improve passenger safety is to redistribute the technological stages of passenger service using urban airport terminals: compactness (possibility of simultaneous handling of one flight to avoid passengers mixing); convenient location near bomb shelters, for example, metro stations could be a good logistics and safety option; mobility - permanent parking of at least 6 buses and auxiliary transport for luggage; optimized number of staff for the necessary services. In this context, it is important to plan calculate the capacity and throughput of these terminals in order to correctly plan them and optimize the costs of their organization and operation. This paper proposes a modified methodology for calculating the planned capacity of these terminals in accordance with possible scenarios for the development of air transportation on the example of Kyiv.

Keywords

airport, efficiency, military risks, terminal, service technology, mobile terminal, safety, security

1. Introduction

According to the Resolution of the Cabinet of Ministers of Ukraine On Approval of the National Transport Strategy of Ukraine for the period up to 2030 and Approval of the Operational Plan of Measures for its Implementation in 2025-2027 No. 1550 of December 24, 2024, one of the main goals is to ensure the resilience and sustainability of Ukraine's transport infrastructure against acts of aggression and negative man-made phenomena by developing main and alternative logistics routes, and implementing electronic systems with a high degree of security.

From the point of view of passenger safety at airports, the risk is increased by:

- the lack of bomb shelters in the airport complexes of Ukrainian airports, which could ensure the safe stay of passengers of the maximum passenger flow;
- lack of a sufficient number of evacuation routes in airport complexes;
- lack of the necessary multi-level air defence to protect airports from threats;
- lack of clear technologies to optimize the time for passenger service in the face of possible shelling;

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- inadequate design of airport terminals to protect against terrorist and sabotage attacks.

The weak point in this case is the passenger terminal construction itself. For example, the Terminal "D" at Kyiv Boryspil Airport. The area is 36,035.2 square meters, and the capacity for international flights is: 1200 passengers/hour (for departures) and 1100 passengers/hour (for arrivals). Domestically: 650 passengers/hour (for departure) and 600/hour (for arrival). It is easy to calculate that the density of passengers (not including terminal staff) will be 1 person per 10 square meters.

Accommodating such a number of passengers at the same time during peak load time, the terminal, made of lightweight structures, cannot currently provide any safety guarantees against these factors of influence, and it has large open service areas that ensure maximum spread of munitions in case of attack. Small entrances will not allow to exit quickly, correct timing for exiting is approximately 3-5 minutes in case of ballistic missile alert.

Terminal tasks are performed within the terminal buildings, and are usually centred around passenger service. Tasks in this category include manning check-in counters, boarding and de-boarding assistance. These tasks are performed within the terminals, in or adjacent to passenger areas [1–6]. Therefore, the main task is to eliminate the risk of the passenger terminal as such. The average time a passenger spends in the airport terminal is 45 minutes (range 20-70 minutes, depending on the factors of influence), and the passenger spends this time on [7–10]:

- completing formalities;
- checking in checked baggage;
- parking a car, transferring from ground transportation;
- security check;
- shopping and entertainment, etc.

In classic airport terminals passengers are dealing with moving, ques, and entertainment the most of time.

2. Changing the service technology

The current service technology is based on the principle of check-in and formalities in a certain time corridor until the scheduled departure of the flight. At the same time, the technology forces the passenger to stay in the terminal area [11, 12].

Thus, it is necessary to remove all the above-mentioned technological stages of service from the airport terminal (Figure 1).

In this case, a simple way out of the situation should be offered: the creation of mobile terminals in the city, which:

- would be compact (able to handle one flight at a time);
- located near bomb shelters, such as metro stations, parking lots, etc.;
- provide permanent parking for at least two buses and auxiliary transport for luggage;
- have 2 employees of the necessary services;
- create conditions for a confined space - the need to ensure that people board buses immediately after security checks.

The technology for servicing passengers for departure in this case will be as follows [13–18]:

- the passenger goes through all the controls and formalities at the mini-terminal in the city, checks in his/her luggage;
- sealed transport with luggage goes to the airport 20 minutes earlier than passenger buses;
- passengers, after all formalities and security control, take their seats in the buses;

- the buses proceed to the airport accompanied by security personnel;
- the bus arrives at the airport directly to the aircraft parking. At this time, the plane is ready for departure. Passengers disembarking from the bus take a seat on the plane through 2 stairway ramps to increase the speed of boarding.

The technology for arriving passengers will be reversed (Figure 2.)

Figure 1: Scheme of passenger movement Mobile Terminal – Aircraft.

Figure 2: Scheme of passenger movement Aircraft - Mobile Terminal.

Thus, the above technology will ensure maximum passenger safety against military risks.
In addition to safety, this technology will have the following obvious advantages:

- creation of additional jobs;
- improvement of passenger logistics;
- Reducing the costs of airlines for the delivery and accommodation of personnel at airports;
- Improving passenger discipline;
- reduction of aircraft parking duration at the airport;
- increase in the turnover rate of airline aircraft;
- relatively low project implementation costs.

3. Calculation approach

Current methods for calculating the capacity of airport terminal facilities are based on the approach of flight operations in relation to existing demand and in-depth forecasting. The construction of mentioned Terminal "D" at Boryspil Airport, which took 37 months to build and 41 months to finish and provide the necessary equipment.

In the case of mobile city terminals, passenger traffic forecasting loses its significance. Mobile terminals are constructed of temporary lightweight structures (usually in the form of tents) and are not capital structures. This makes the process of calculating easier.

For our approach we need to be driven by the principle of limited commercial rights: none market with high missile attack risks can allow a full access to the market. Only limited marked allowance will make disciplined and the highest safety level of all the process of ground handling.

From the point of view of improving safety, all additional terminal functions should be eliminated, which is what this technology provides. Therefore, the calculation of terminal capacity is based on the number of simultaneous flights. At the same time, we create a standard terminal size, and in case of an increase in the number of flights (in accordance with airline plans), we just add

new terminals in a new location: in fact, the capacity limit is removed and the system flexibility increases.

The approach to initial demand for air transportation can be formed on the basis of the programs developed by the Government to restore air traffic. Since Kyiv International Airport is currently significantly damaged, the Government's scenarios are based on the passenger traffic indicators based on the forecasts of Kyiv Boryspil Airport. Thus, the Explanatory Note to the Financial Plan of Boryspil Airport for 2023 states that the planned number of international flights per year is 20505.

Accordingly, the estimated average daily number of flights will be Nd = 56.

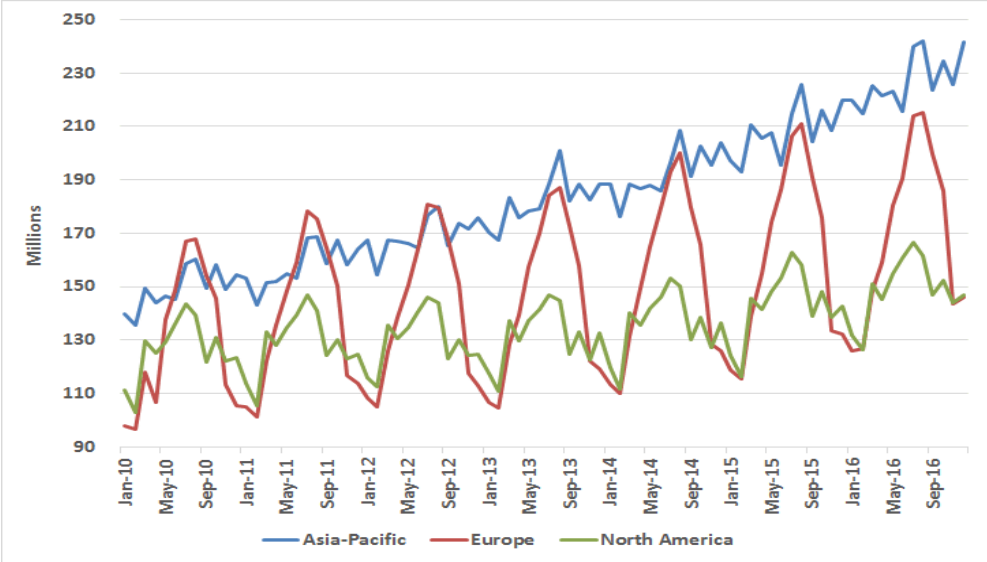

Figure 3: Seasonality of key world markets, 2010-2016 [11].

According to the peak loads during the period of high demand [11], the average daily capacity of airlines should provide a surge in demand by Δh = 18% - this figure will be a deviation towards high demand.

That is why the calculation of the peak values of the average daily capacity Nd MAX will be as follows:

$$Nd\ MAX\ =\ Nd\ +(Nd\ \Delta h). \tag{1}$$

In this case 66 flights per day as a peak load will be resulted.

To service 1 flight of a medium-haul aircraft with an maximum single economy cabin capacity of 190 passengers for Boeing 737 or Airbus 320 types, the estimated time for passenger service will be 45 minutes, but it is necessary to set the time for the distribution of flights - a break between flights - 15 minutes to ensure short rest for personnel and shifts. Accordingly, taking into account the curfew, one mobile terminal will be able to handle 17 flights between 6 a.m. and 23 p.m.

Thus, the total capacity of one terminal will be 190 passengers per hour for departures and 190 passengers per hour for arrivals.

Therefore, the maximum peak load must be maintained to ensure service:

$$CMAX\ =\ Nd\ MAX\ /17. \tag{2}$$

We get a value of 3.88 or 4 terminals.

During periods of reduced demand, we will get 46 flights according to the formula:

$$Nd\ MIN\ =\ Nd\ -\ (Nd\ *\Delta h). \tag{3}$$

According to a simple formula:

$$CMIN\ =\ Nd\ MIN\ /17. \tag{4}$$

We get a value of 2.7, or 3 terminals.

This will make it possible to suspend the operation of one of the terminals for a period of low demand, thereby optimizing the costs of organizing work.

To participate in the Slot Coordination process, each fully coordinated airport must specify a declared capacity, which indicates the number of slots available per hour (or other specified unit of time), i.e., the number of aircraft movements that the airport can accommodate in each such interval [6]. In our case, aircraft slots will be regulated by the operating schedule of these terminals, not by the airport's capacity. Such a scheme will make it possible to minimize the number of aircraft at the airfield at the same time, to use the runways of all nearby airfields, as the airport reduces its own functionality to aircraft maintenance and loading and unloading. This will allow for unprecedented flexibility of the service system with maximum safety for passengers and crews, as well as for aircraft and maintenance personnel.

Four terminals mean 4 aircrafts in the airfield at the same time. It is possible to spread all these aircrafts at the airfield avoiding their close basement. Buses with passengers will arrive to the particular aircraft and the time difference between close aircraft standing and far aircraft standing differs by a few minutes.

These calculations prove that 4 terminals will allow to provide the estimated passenger traffic of Kyiv in the first year of operation. All of these mobile terminals can be located near the metro stations that could allow a space for terminal placement and necessary transport stop. Described scheme “flight by flight serving” and 15 minutes gap will also safe a space for bus stop without mixing of passenger flows.

Checked baggage fill arrive separately to the mobile terminal. That will allow to make time savings for unnecessary reloading of baggage and deliver baggage directly to mobile terminal.

4. Conclusions

Ensuring the safety of passengers on the ground after the reopening of air traffic in Ukraine will be the biggest challenge for the authorities. A technologically correct model of passenger service in city mobile terminals will minimize military risks as it mentioned above. This model will spread the time of passenger in a much safe way, avoid a huge number of passengers in a weak building and decrease of risks for the aircraft at the airfield.

We need to temporary decrease the influence of commercial approach on all stages of passenger serving and focus on flight as it is, with the aim to provide minimum risks for passengers. Mobile terminals are safety-effective from the point of passengers’ minimization at the same place, with real chances to get to the city-shelters. On the other hand, airport terminal will not give a chance to get to the any shelter quickly. Traveling by bus to airfield can allow passengers to stop any time or get to the safe place (parking, bridge etc.).

Such a model is relatively simple in terms of organization and feasible in terms of relatively quick implementation. Terminals can be created on the principle of prefabricated tents based on the experience of European low-cost carriers. There are technologies of quick-building constructions commonly used at warehousing or field-serving.

All of them are simple and even can be branded to provide additional revenue for authorities.

However, this technology needs to be developed presently, including staff training and planning of sites for these terminals. This model demands high level of security staff on each chain of the process. Besides that, it worth mentioning the preliminary finding of necessary terminal equipment to be contracted and purchased.

Checked in baggage transport must be planed carefully with principles of quick load and unload. For these reasons modified low-deck buses could be used as an option.

The above technology in line with the modern informational support will definitely offer the quickest way of passenger serving from home to aircraft. Creating an effective passenger protection mechanism will only increase the chances of a rapid resumption and development of air traffic.

Declaration on Generative AI

The author(s) have not employed any Generative AI tools.

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