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IMPLEMENTATION PROSPECTS OF THE REMOTE TOWER CONCEPT IN UKRAINE

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***Abstract*—*The real cost of the air travel and air transportation has been decreasing over the past years making air transportation more accessible and thus leading to an increase in the demand for it. This allowed to expand the air connectivity network and provide more destinations for the air travel, including smaller regional airports. One of the components of the cost of the air travel is air navigation service costs for the provision of services by air navigation service providers and these costs are flat-rate costs. For small regional airports with low and/or irregular traffic these costs might be a burden limiting their development. Remote tower concept developed as part of the Single European Sky air traffic management Research program aims at optimising and reducing costs for the provision of air navigation services at small airports allowing them to better utilise resources and improve their profitability. Most of the air traffic in Ukraine is handled by a few strategic airports while small regional airports handle only a few flights a day and in order to provide air traffic services for those flights the regional airports are equipped with local aerodrome control service facilities. Due to the low traffic at the regional airports, resources and facilities aren't used in the most efficient way. The purpose of this work is to investigate the feasibility of implementation of the remote tower concept at Ukrainian airports to improve the cost efficiency of the provision of air traffic services at the airports and correspondingly decrease the cost of the air travel to the regional airports in Ukraine.*

Index Terms—Aerodrome; aerodrome flight information service; air traffic control; air traffic management; air traffic service; airport; remote tower concept; Single European Sky air traffic management Research.

I. INTRODUCTION

Due to the steady decrease in the real cost of air travel, the accessibility of it has significantly increased with consequently led to the increase in the demand for air transportation. This growth of air traffic allowed to expand the air connectivity network to include smaller airports in remote locations to provide more options and destinations for airlines and cargo carriers since the main airport hubs are already overloaded with the traffic.

One of the components of the cost of the air travel is air navigation service (ANS) costs for the provision of ATM services by an air navigation service provider (ANSP). The ANS costs are flat-rate costs which makes it hard for small airports with low and/or irregular traffic to cover these costs. That's why ANSPs has faced with a challenge for optimisation and reduction of operational costs, especially for small and medium airports.

One of the issues for the Ukrainian air transportation is the small amount of flight to regional airports of Ukraine which limits their development ability. [1] One of the ways to increase the number of flights to regional airports is to reduce costs for the ANS services which will consequently make the airports more attractive for airlines and cargo carries.

Under Single European Sky ATM Research (SESAR) programme a number of solutions have been developed to enhance the current airport operations and air traffic services (ATS) provided at an airport to increase the operational efficiency to allow the reduction of costs.

A remote tower concept is a basis for a number of SESAR solutions that aim at increasing the cost efficiency of provision of air traffic services at the airports of different operating environments. It offers a possibility to enhance efficiency and safety at airports where it is too expensive to build and/or maintain a conventional ATS tower and its facilities. The remote tower concept has been already deployed by a few small airports and is being tested for medium-sized airports.

II. CURRENT METHOD OF OPERATION

A conventional tower is responsible for provision of a range of air traffic services (including air traffic control (ATC) and flight information services) in accordance to ICAO Doc 4444, 9426 and EUROCONTROL Manual for AFIS by local air traffic control officers (ATCO) or aerodrome flight information service officers (AFISO) from local tower facilities [2].

Aerodrome control tower is responsible for the provision of information and clearance to the flight crew to achieve safe, orderly and efficient flow of air traffic at the aerodrome and in the vicinity of it. ATCOs at tower should continuously monitor all flight operations on the aerodrome and its vicinity as well as vehicles and personnel on the manoeuvring area through visual observation (augmented by ATS surveillance system in low visibility conditions if available).

Functions of the aerodrome control tower may be performed by different control positions, such as:

- aerodrome controller – responsible for operations on the runway and in the area of responsibility (AoR) of the tower;
- ground controller – responsible for traffic on the manoeuvring area (except runways);
- clearance delivery position – responsible for delivery of start-up and air traffic control clearance to departing instrument flight rule (IFR) flights [2].

Two main operational requirements for aerodrome control tower to be able to properly control air traffic on and in the vicinity of the aerodrome are:

- the tower must permit the ATCO to visually survey the portions of the aerodrome and its vicinity over which he has control;
- the tower must be equipped to permit the controller rapid and reliable communications with aircraft with which he is concerned [4].

Similarly, to ATCOs at the tower, AFISOs are responsible for the provision of information to aircraft in there are of responsibility to achieve safe, orderly and efficient flow of air traffic on the aerodrome and in its vicinity. The objective of this is to assist pilots in preventing mid-air and ground collisions of aircraft with other aircraft, vehicles or obstructions on the manoeuvring area. However, AFISOs are not ATCOs, they only pass information and warnings to pilots (except for cases when relaying clearance from ATCO). Thus, pilots are fully responsible for maintaining proper spacing in accordance with the rules of the air.

Aerodrome flight information service officers should continuously monitor the situation at the aerodrome (including operations of vehicles and personnel on the manoeuvring area) through visual observation and an ATS surveillance system when authorized by appropriate authority. [5]

As can be seen, ability to visually monitor operations at the aerodrome and its vicinity is an important condition for the provision of air traffic control and aerodrome flight information services. The visual “out-the-window” (OTW) view is one of the main sources of information for ATCOs and AFISOs for the provision of ATS. The airport sounds, e.g. engine noise, wind noise, etc. is obtained directly at the tower since it’s not usually soundproofed.

In addition to the OTW view, the conventional tower should be equipped with the manually operated binocular in order to allow the ATCO / AFISO to check rapidly the certain items of interest, like extension / retraction of the landing gear, aircraft engine, runway conditions, etc. if necessary [4].

The staffing for conventional towers is usually provided by ATCOs and AFISOs living within a reasonable range of the aerodrome. Sometimes local facilities have to be open and staffed for the whole day even though the number of IFR flights is quite small. This, as well as the need for maintenance of physical facilities, contribute to rising of the costs for the provision of ATS in small or medium aerodromes making them less attractive to airspace users.

III. Remote Tower Concept

One of the ways to improve the cost efficiency of the provision of ATS and reduce costs of maintenance and upkeep of local facilities is the implementation of the remote tower concept at the aerodrome.

The main change introduced by this concept is that the ATS services won’t be provided from a local tower located at the aerodrome and ATCOs and AFISOs won’t necessarily be located at the local aerodrome.

As described above, one of the operational requirements for the provision of ATS at aerodrome is that the aerodrome control tower permits ATCO / AFISO to visually survey the portions of the aerodrome that is under their AoR. Thus, in order to comply with this requirement, remote locations for provision of ATS should be equipped with necessary means (e.g. cameras or sensors) to reproduce the aerodrome OTW view and to allow ATCO / AFISO to be able to visually survey the aerodrome and areas in the vicinity of the aerodrome. The data obtained through the cameras or sensors can be overlaid with the surveillance data (aircraft tracks from surface movement radar, multilateration system, ADS-B, etc.) where available to improve situational awareness of the ATCO / AFISO and thus their capability to provide the service.

Additionally, to the OTW view, the remote location should be equipped with binocular functionality to replace manually operated binocular which is currently used at the conventional tower. This functionality should enable ATCO / AFISO to check at certain items of interest in case of necessity.

Certain 'hotspots' might be configured at the remote location to enable quick access to the frequent areas of interest like waypoints, threshold, etc. to allow the operator to quickly check the area [6].

Another important part of the remote tower concept is controller working position (CWP) that enables provision of ATS by the ATCO / AFISO from a remote location. All the systems and tools should be available to the operator at the remote CWP to efficiently, safely and orderly provide ATS. Thus, all the ATC systems (e.g. flight strips, air-ground / ground-ground communication, navigation aids, etc.) that are used in the conventional tower should be connected to the CWP in the remote location.

Due to the physical absence of ATCO / AFISO at the aerodrome, some external tasks that are not directly related to ATS, e.g. physical inspection of the runway, will be impossible to perform by ATCO / AFISO thus they can be performed by non ATS personnel at the aerodrome and ATCO / AFISO at the remote location can focus on ATS tasks only.

In general, the concept relies on the use of the modern and enhanced technologies together with digital information. This allows to make a wider range of information available to ATCO / AFISO and improve sharing of information with other stakeholders, like airport operators, airspace users and other ATS units.

SESAR programme has defined three possible options for implementation of the remote tower concept:

- remotely provided ATS for a single aerodrome;
- remotely provided ATS for multiple aerodromes;
- remotely provided ATS for contingency situations at aerodromes.

A configuration with the remotely provided ATS for a single aerodrome contains a remote tower module (RTM) which includes both CWP and visual presentation display screens dedicated to a single aerodrome. The RTM used for the provision of ATS at a single aerodrome might have more than one position (for a second operator or supervisor) depending on the complexity of the traffic at the aerodrome.

The remote provision of ATS to multiple aerodromes might be performed in different configurations –sequential and simultaneous. In the sequential configuration, the RTM is connected to two or more aerodromes but provides ATS service to one aerodrome at a time. In case of the simultaneous configuration – multiple aerodromes are served by RTM at the same time.

A contingency configuration allows to set up an RTM as a redundancy for a conventional tower as part of contingency plans. [2], [7]

A set of RTMs might be grouped into a centralized facility that is known as remote tower centre (RTC). The RTC might house one or more RTMs providing ATS for one or several aerodromes from the same location allowing to optimise resources and costs (Fig. 1).

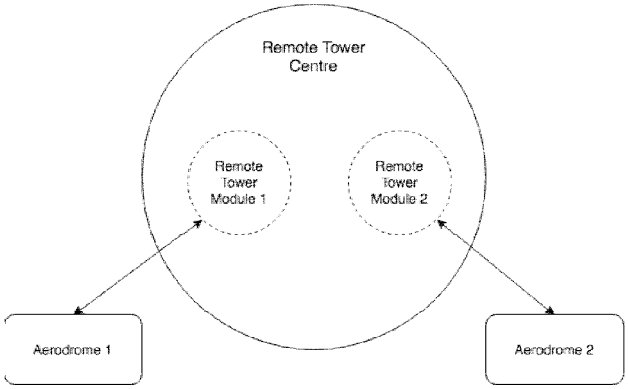

Fig. 1. An example of set up of the Remote Tower Centre

Usage of RTC can contribute to cost savings and optimisations in the following areas:

- facility – an existing tower can be re-used by other departments of the airport;
- operations – instead of maintenance of all the equipment of the tower, only maintenance of cameras and sensors at the aerodrome is required;
- resources – instead of under-utilised resources due to the low air traffic at the local aerodrome, centralised resources can handle a few aerodromes ensuring a steady workload.

Remote centres can be located in more populated areas with better access to skilled and educated people which simplifies significantly staffing and recruiting and provides higher flexibility of the human resources [7].

IV. Examples of Implementation of Remote Tower Concept

Remote tower concept is slowly becoming a reality in Europe. London Heathrow airport has implemented a contingency remote tower in 2009 that is capable of proving 70% of capacity using ground surveillance display system. However, it is not equipped with OTW view.

The first fully operational remote tower has been deployed in Sweden at Örnsköldsvik airport in 2015. The ATS is provided from Sundsvall, a city that is 150 km away from Örnsköldsvik. Since then the remote service has been extended to Sundsvall Timrå airport and it is planned to provide ATS to Linköping as well. The provision of ATS to the aerodromes is done in multiple modes meaning that those aerodromes are served from a single RTC.

Following the example of Sweden, Norway has launched a project to start providing ATS from a centralized facility in Bodø. The goal is to operate 15 remote towers by 2020 [8].

Another example can be found in Germany. Deutsche Flugsicherung (DFS), German ANSP, is planning to implement an RTC at Leipzig that'll provide remote ATS to international airports at Saarbrücken (15.000 movements / year), Dresden (30.000 movements / year) and Erfurt (10.000 movements/year). The project has started in 2016 and it is planned to be completed by the end of 2020 [9].

Irish Aviation Authority has performed a series of operational trials to support and validate the concept of the remote tower. During the trials, ATS was provided in sequential and simultaneous modes to Shannon and Cork airport from the centralized facility in Dublin. Results of the trials showed that the ATS provided from a single RTC for single or multiple aerodromes by a single ATCO in sequence and simultaneous modes is at least as safe as the ATS provided from a local facility. It has been confirmed that the implementation of multiple remote tower solution provides better utilisation of human resources during periods of low air traffic [10].

National Air Traffic Services (NATS), the UK ANSP, has announced that the existing London City Airport tower will be replaced by a remote one, operated from Swanwick, a village where London Area Control and London Terminal Control Centres are located. Taking into account that London City Airport has over 4 million annual passengers, it will make it the biggest airport to implement the remote tower concept.

In addition to the abovementioned, other remote tower projects are underway in Europe and all around the world, e.g. in Hungary, Italy, the Netherlands, Australia, etc.

V. Implementation Prospects of Remote Tower Concept in Ukraine

The airport network in Ukraine consists of 29 certified airports, 16 of which have international checkpoints. Odesa, Kyiv Zhuliany, Kharkiv, Dnipropetrovsk and Lviv airports are considered as strategic airports in Ukraine, however, the main international airport is Boryspil airport. It provides ATS to over 44% of all IFR operations at Ukrainian airport/aerodromes and it handles over 67% of the total annual passenger flow in the airports of Ukraine [11].

The aerodrome control service is provided at 17 civil aerodromes in Ukraine (Chernivtsi, Dnipropetrovsk, Uzhhorod, Ivano-Frankivsk, Kharkiv, Kropivnytskyi, Kryvyi Rih, Kyiv (Boryspil), Kyiv (Zhuliany), Lviv, Poltava, Kherson, Odesa, Rivne, Sumy, Vinnytsia, Zaporizhzhia) and aerodrome flight information service at 4 aerodromes (Mykolaiv, Ternopil, Kaniv (Pekari) and Cherkasy). Considering that 44% of IFR flights are handled by Kyiv (Boryspil) tower, the rest of the flights are spread among other 16 towers in Ukraine (Fig. 1).

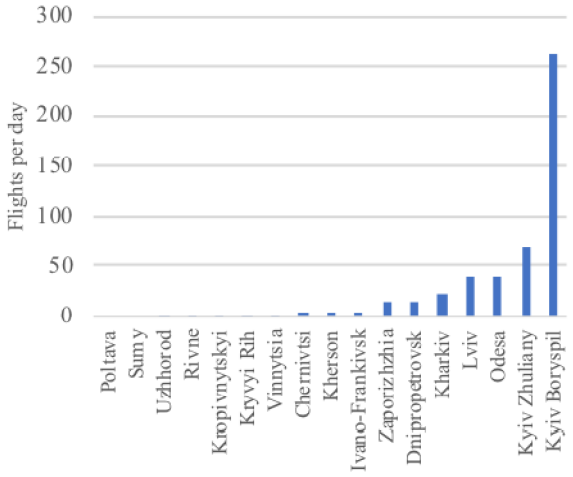

Fig. 1. Average amount of daily flights (only for aerodromes with more than 1 flight/day) for Ukrainian aerodromes (from June 2016 to November 2019) [12]

Taking into account that Boryspil airport is the major airport in Ukraine, it may not be considered as a candidate for implementation of the remote tower concept. Other towers provide ATS to 65 or less flights per day thus may be considered as good options for implementation of the remote tower concept to improve the cost efficiency and reduce costs for the provision of ATS at remote locations (Fig. 2).

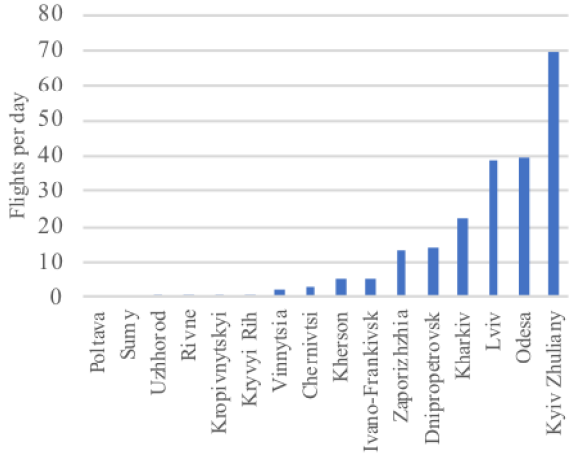

Fig. 2. Average amount of daily flights (only for aerodromes with more than 1 flight/day) for Ukrainian aerodromes without Boryspil airport (from June 2016 to November 2019) [12]

All the towers of the strategic aerodromes have undergone modernisation or have been built from

scratch (e.g. towers of the Kharkiv and Kyiv Zhuliany aerodromes) and equipped with the state-of-art technologies for the provision of ATS thus it might be economically inexpedient to introduce remote towers at those airports. Therefore, the focus of the implementation of the remote tower concept could be made on the small regional airports with low levels of traffic.

In the period from June 2016 to November 2019, regional airports that provide aerodrome control service (Sumy, Rivne, Poltava, Kropyvnytskyi, Uzhorod, Kryvyi Rih, Vinnytsia, Kherson, Ivano-Frankivsk, Zaporizhzhia and Chernivtsi) have served in average 4 flights a day meaning that the local resources of the tower were used to provide ATS just to a few aircraft [11]. Additionally to that, some of the airports are affected by seasonal traffic variability, for example, Vinnytsia and Kryvyi Rih airports having just a few or none flights during the winter season (Fig. 3).

Therefore, it's not economically expedient and efficient to maintain facility and resources locally at aerodromes. The remote tower concept could allow to optimise resources at regional aerodromes and provide more flexibility with staffing and allocation of resources. It's been confirmed through trials that implementation of remote tower centre serving multiple aerodromes is more efficient than the implementation of separate remote tower modules per aerodrome at different locations.

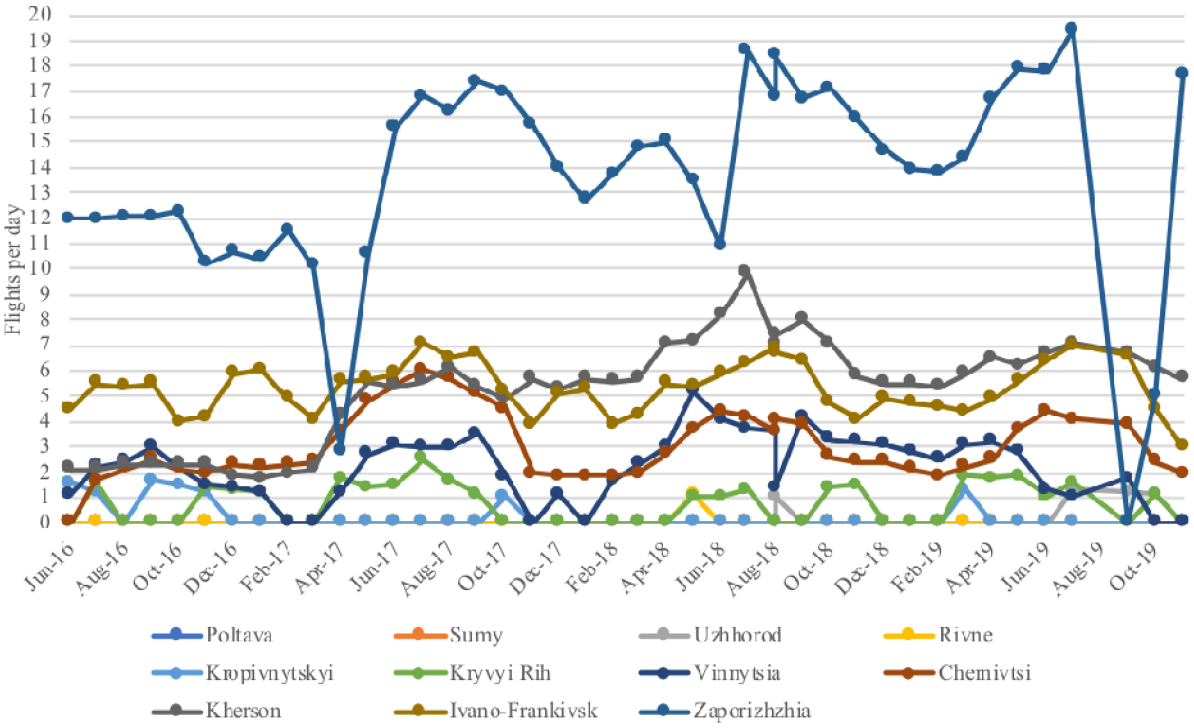

Fig. 3. Average amount of daily flights (only for airports with more than 1 flight / day) for regional airport (from June 2016 to November 2019) [12]

Considering low levels of traffic at the Ukrainian regional airports, it is possible to set up RTCs in sequential configuration meaning that three airports can be monitored by only one controller and supervisor instead of three controllers and three supervisors in case of the conventional tower. With the growth of traffic, the sequential configuration can be turned into the simultaneous configuration to have dedicated controllers providing ATS to certain aerodromes.

Ukrainian airspace is divided into 5 flight information regions (FIR): Kyiv, Lviv, Odesa, Dnipropetrovsk, Simferopol. The remote centres might be set up at the main cities of each FIR to provide aerodrome control services to regional airports within the corresponding FIR. In such configuration, aerodrome control services will be provided from the following RTCs:

- Kyiv RTC with tower modules for Vinnytsia TWR, Kropivnytskyi TWR, Cherkasy AFIS and Kaniv AFIS
- Dnipropetrovsk RTC with tower modules for Zaporizhzhia TWR, Kryvyi Rih TWR, Poltava TWR and Sumy TWR.
- Odesa RTC with tower modules for Kherson TWR and Mykolaiv AFIS.
- Lviv RTC with tower modules for Ivano-Frankivsk TWR, Chernivtsi TWR, Rivne TWR, Uzhorod TWR and Ternopil AFIS

In such a way, each RTC will provide ATS to 3–5 aerodromes allowing to optimise resources and reduce costs. RTC located at centres of FIR might benefit from existing infrastructure and utilise free facilities available on site.

Deployment of RTCs and migration of local aerodrome towers to the remote modules can be done incrementally starting from aerodromes with less traffic and adding more RTMs after successful operations for small aerodromes. For example, Kyiv RTC initially can be set up with one RTM for Kropivnytskyi TWR and Cherkasy AFIS since Kropivnytskyi TWR serves less than 1 flight a day on average. Low traffic at Kropivnytskyi aerodrome will allow a controller to serve and provide AFIS to Cherkasy aerodrome as well. With the growth of traffic at Kropivnytskyi aerodrome a separate RTM for Cherkasy AFIS can be set up. In such a way, a smooth and gradual transition from conventional towers to remote towers at regional airports can be achieved.

However, this is just one of the possible implementation options that could be used to deploy the remote tower concept in Ukraine. To explore all of the possible implementation options of remote tower concept and support the decision-making regarding the deployment of it, there is a need for profound research to be carried out to address several of questions:

- What would be the structural impact (on the current systems, infrastructure, networks, etc. of Ukrainian ANSP and airports)?
- What would be the costs and benefits of different implementation options?
- What would be the impact on the performance of the airports?
- What would be the most effective way to utilise resources and meet airspace users demand?

It is worth mentioning as well that a number of reconstruction projects are foreseen for the regional airports such as Kherson, Uzhhorod, Ivano-Frankivsk, Chernivtsi, Ternopil, Vinnytsia, Mykolaiv, Poltava, etc. to ensure that the airports can serve the modern and widely used aircraft. The implementation of the remote tower could be included into the reconstruction projects to decrease the cost of the provision of ATS at regional airports and make those airports more attractive to airspace users such as airlines, cargo carriers, private pilots, etc.

VI. CONCLUSION

To support the development of regional aerodromes and the increase of traffic to them, there is a need to find a solution to decrease the airport service costs for airspace users. One of the ways to decrease those costs is to reduce costs for the provision of ATS at airports.

Implementation of remote tower concepts allows to reduce the ANS costs through optimisation of resource and increase of cost efficiency of the provision of ATS at the aerodrome. Grouping of multiple remote towers into Remote Tower Centre can result in better utilisation of resources due to a common pool of facilities and resources.

Most of the traffic arriving or departing in Ukraine is concentrated at strategic aerodromes (Kyiv Boryspil, Kyiv Zhuliany, Lviv, Odesa, Kharkiv and Dnipropetrovsk) leaving a small portion of flights to regional airports. To increase air traffic influx to the regional airports in Ukraine, it is necessary to make them more attractive and affordable for airspace users like airlines (traditional and low cost), cargo carries, etc. One of the ways to achieve that is the implementation of Remote Tower Centres to provide ATS to those aerodromes from remote locations. This will allow to better utilise available resources and facilities and lower the costs for airport services to airspace users.

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С. М. Креденцар, М. І. Яструб. Перспективи впровадження концепції віддаленої аеродромної диспетчерської вишки в Україні

Реальна вартість авіаперевезень знижувалась за останні роки, роблячи авіаперевезення більш доступними, що призвело до збільшення попиту на них. Це дозволило розширити мережу повітряного сполучення та надало більшу кількість напрямків для авіаперевезень, включаючи невеликі регіональні аеропорти. Одним із компонентів вартості авіаперевезення є вартість аеронавігаційних послуг наданих провайдером з аеронавігаційних послуг, і ці витрати є фіксованими. Для невеликих регіональних аеропортів з низьким та/або нерегулярним трафіком ці витрати можуть бути тягарем, що обмежує їх розвиток. Концепція віддаленої аеродромної вишки, розроблена в рамках дослідницької програми в сфері організації повітряного руху «Єдине небо Європи» спрямована на оптимізації та зменшення витрат на надання аеронавігаційних послуг в малих аеропортах, що дозволяє їм краще використовувати ресурси та збільшити їх прибутковість. Більшу частину трафіку в Україні обслуговує кілька стратегічних аеропорті, а невеликі регіональні аеропорти обслуговують лише декілька рейсів в день і задля надання аеронавігаційних послуг ці регіональні аеропорти обладнанні локальними аеродромними диспетчерськими вишками. Через малу кількість польотів в регіональних аеропортах ці ресурси та обладнання використовуються не ефективно. Метою даної роботи є вивчення можливості впровадження концепції віддаленої аеродромної диспетчерської вишки в українських аеропортах задля підвищення ефективності витрат на надання аеронавігаційних послуг в аеропортах та відповідно зменшення витрат на авіаперевезення до регіональних аеропортів України.

Ключові слова: аеродром; аеродромна служба польотної інформації; керування повітряним рухом; організації повітряного руху; служби повітряного руху; аеропорт; концепція віддаленої аеродромної диспетчерської вишки; дослідження організації повітряного руху «Єдине небо Європи».

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С. М. Креденцар, М. И. Яструб. Перспективы внедрения концепции удаленной аэродромной диспетчерской вышки в Украине

Реальная стоимость авиаперевозок снижалась за последние годы, делая авиаперевозки более доступными, что привело к увеличению спроса на них. Это позволило расширить сеть воздушного сообщения и предоставило большее количество направлений для авиаперевозок, включая небольшие региональные аэропорты. Одним из компонентов стоимости авиаперевозки является стоимость аэронавигационных услуг, предоставляемых провайдером с аэронавигационных услуг, и эти расходы являются фиксированными. Для небольших региональных аэропортов с низким и / или нерегулярным трафиком эти расходы могут быть бременем, что ограничивает их развитие. Концепция удаленной аэродромной вышки, разработанная в рамках исследовательской программы в сфере организации воздушного движения «Единое небо Европы» направлена на оптимизации и уменьшения расходов на предоставление аэронавигационных услуг в малых аэропортах, что позволяет им лучше использовать ресурсы и увеличить их доходность. Большую часть трафика в Украине обслуживает несколько стратегических аэропорту, а небольшие региональные аэропорты обслуживают лишь несколько рейсов в день и для предоставления аэронавигационных услуг эти региональные аэропорты оборудовании локальными аэродромными диспетчерскими вышками. Из-за малого количества полетов в региональных аэропортах эти ресурсы и оборудование используются не эффективно. Целью данной работы является изучение возможности внедрения концепции удаленной аэродромной диспетчерской вышки в украинских аэропортах для повышения эффективности затрат на оказание аэронавигационных услуг в аэропортах и соответственно уменьшение расходов на авиаперевозки до региональных аэропортов Украины.

Ключевые слова: аэродром; аэродромная служба полетной информации; управления воздушным движением; организации воздушного движения; службы воздушного движения; аэропорт; концепция удаленной аэродромной диспетчерской вышки; исследование организация воздушного движения «Единое небо Европы».

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