

ABSTRACT

This doctor's dissertation focuses on the Airport Collaborative Decision Making (CDM) concept, project which is designed, implemented and developed at airports in order to provide airport operative infrastructural capacity enhancement, aeronautical traffic capacities unhindered usage, airport passing ability enlargement and aviation safety level improvement.

CDM is just one of the numerous EUROCONTROL's development projects for improvement of aeronautical operative transport systems in Europe. At the beginning of the new century, EUROCONTROL started with intensive development of projects for aeronautical capacities and systems improvement, to be able to endure the expected aviation intensity in the future and to avoid their turning in bottle-necks. Great part of such improvement are EUROCONTROL's development projects referring to the airports, included in Airport Operations Programme (APR) - programme for increasing of the airport capacities and airport's traffic safety. APR is a part of the European Air Traffic Management Strategy for the Years 2000+ (EATMS), which should be realized through the European Air Traffic Management Programme (EATMP). EATMP is complex interactive programme of EUROCONTROL, for improving the aeronautical operative transport systems in Europe, which incorporating a great number of different developing projects. The final goal of EATMS, through completely realization of started and the next developing projects, is creation of the Single European Sky.

Statistical data shows that in year 2000, airports operative limitations were reason for only 23% of the total number of flights delays, and aeronautical capacities limitations for 77% of them. Only 4 years later, in year 2004, this relation is considerable changed, because 46% of the total number of flights delays are made due to airports operative limitations, v.v. 54% due to aeronautical capacities limitations. The conclusion is that airport's operational and infrastructural capacities are more and more the main reason for in Europe. The relevant air traffic irregularity statistical data are very important segment of the information, needed for a "common situational awareness" (CSA) platform to be established at each airport. As all airport's partners involved will have a global overview, they can improve their own and common planning processes and be able to make appropriate and adequate decisions. One of the most convenient tools for such process is exactly the CDM.

The initial studies and up to now examinations in the European frames showed that:

- most relevant information exists somewhere around the airports in various systems, but is not readily available to all business partners;

- the information systems of the various partners have been developed and built independently, without mutual cooperation;

- certain partners are reluctant to share information which they consider "commercially sensitive", therefore restricting information sharing;

- agreed relevant data should be shared between all business partners involved at the right time;

- data shared should be of sufficient quality to facilitate improved traffic predictability for all partners involved;

- decisions should be made by the partner best placed to make them;

- decisions made should be shared with all other partners;

- through the project management of the new collaborative processes should be enabled an accurate disposition of all pre-take-off activities, which means bigger accurateness in disposition of the aircraft estimated time of departing and delays reduction.

The examination of reasons, duration and influence of the aircraft delays and the conditions and possibilities for their reduction through usage of CDM model is the **problem** of this doctor's dissertation researching.

The **scientific hypothesis** in the dissertation is defined the next way: the level of the regularity, orderliness and safety of the airport's traffic could be raised with CDM project plan implementation, which will enable an efficient, accurate and on-time information sharing and all partners involved will have a global overview for traffic at the airport; the results of that should be an aircraft delays reduction, improvement and raising of the efficiency of the existing airport's procedures and optimal usage of the airport operative infrastructural and technological capacities.

The **subject** of this doctor's dissertation is foreseeing of the CDM characteristics and operational performances, which should enable aircraft delays reduction at the airport. The **specific objective** of the researching is identification of the advantages and benefits of the implemented CDM project plan at Ohrid Airport, in order to reduce the aircraft delays, based on the systematically engineering approach for the airport characteristics analysis. The **common objective** is identification of the conditions and

possibilities for CDM implementation in real-time frames, regarding the need of aircraft delays reduction.

In the thesis, in the beginning, the history and the background of the CDM are given. Further, the aeronautical traffic capacities and airport technological processes are elaborated, the basic characteristics of the air traffic flows, the basic characteristics of the airport infrastructural system, the aircraft ramp handling process, creating of the airport logistic chain system during the realization of the technological processes and there is short review about the role, functions and meaning of the Central Flow Management Unit (CFMU) within EUROCONTROL. Today's aircraft operations are based on 3 different planning processes for each flight: airport operations, ATC/ATFM operations and airline operations. There is no interface between these 3 planning processes. Airport operations are faced with airport slot discrepancies, ATC/ATFM operations are faced with slot non adherence and airline operations are faced with the fact that their commercial, technical and operational needs are not taken into account by airports or ATM services providers. Therefore, the awareness of the current and the newly happened conditions is very important for the decision making process of the each partner involved. That could be accomplished only if each partner has all relevant information. These are reasons for airport CDM existing.

Further, the CDM and CDM project plan basic characteristics and performances are elaborated, together with detailed elaboration of all CDM developing levels and their joined applications. Also, the aviation delays reasons and European aviation delays statistics from 2000 till 2005 are given, with complete analysis of the delays influence to the regularity, orderliness and safety of the airport's traffic. Statistics show that the airports more and more are becoming the bottle-neck of the air transport network. With the increase in traffic, the workload of operators and planners is increasing as well, making their task of ensuring safety and efficiency harder every year. The most of the problems are related to the inefficiency of daily airport operations and the non-availability of reliable information. Considering the possibilities for airport CDM usage, the most significant influences has been joined to the aircraft departing delays. With annulling the reasons for aircraft departing delays, there is a real possibility for influencing to the reduction of the aircraft arriving delays. The analysis of the delays reasons are enabling determination of the main goal's reasons for aviation traffic irregularities, that should be subjects for the local CDM developing process at the airport. Those reasons should be found within every day activities of ATC/ATFM

services provider, airport operator, CFMU, handling services providers and aircraft operators.

In the central part of this dissertation, the usage of the comparative, inductive and deductive methods of scientific researching and the probability theory, during the processing and analyzing the relevant statistical data, are given, as well as the determination of the aviation delays genesis probability. Analysis has been performed on the existing airport infrastructural, operational and transportation capacities, data collection for the physical volume of the traffic and their statistical analysis and processing, terrain surveillance, as well as an appropriate methods for collecting the relevant data.

First of all, the analysis of the Ohrid Airport basic characteristics is brought out, from the aspect of the airport's catchment area, realized traffic, existing airport's infrastructure, airport's operational facilities and traffic statistical data. Analyses are showing that in some of the airport's peak time periods, the bottle-necks in the technological processes should be expected, due to lack of some infrastructural or operational capacities. Also, every delayed operation usually causes further delays on some other activity realization, through "domino effect". Therefore, the need of Common Situational Awareness (CSA) common platform establishing, for all CDM project partners at the airport, could be foreseen.

In the continuance, a detail traffic-technological analysis of the airport's infrastructural and operational capacities is brought out. That way, the determination of the capacity of the next few airport's infrastructural and operational elements is brought out:

- car parking places within the airport area;
- terminal building (useful area for passengers, check-in counters, passport control counters, custom control counters, security control points and systems for check-in, security control and claim of the passenger's baggage);
- apron;
- runway.

The identification of the characteristic bottle-necks is brought out, which produce certain limitations of the total airport capacity. At the same time, the passport control counters (at arrivals and departures) and the baggage claim system at arrivals are in fact the bottle-necks which produce additional limitations in the other airport's infrastructural and operational capacities usage.

The detailed statistical data analysis of delays at Ohrid Airport in the period from year 2000 till 2005 shows that around 38% of the departures and around 42% of the arrivals were realized with certain delay. At the same time, the greatest number of the delayed operations are within the time interval of 10 - 20 min. The total time loss is about 91 821 minutes or 1 530 hours, which means in that six years time period there were realized 64 days more than planned working time.

The analysis also shows that:

- the subjective (human) factor is the essential for the accuracy and punctuality of the aircraft delays evidenced data;*
- the existing system evidence of the irregularity reasons isn't giving the accurate and precise picture of the concrete delays reasons, due to internationally accepted codification with grouping of some particular reasons in the same uniform group;*
- the characteristic data of identical nature should be compared for the relevant comparative analysis (aircraft delays at the airport should be compared only with identical data of other airports, but not with the EUROCONTROL's delays data);*
- the irregularities in arrivals at the airport are almost entire result of the airline's delayed arrivals;*
- airport services delays reasons have the biggest influence to irregularities in aircraft departures;*
- there are real possibilities for an acute mitigation with partial activity only to the departures delays reasons, which are connected to the capacities and activities of the airport's services providers and handlers.*

The analysis shows that about 70% of the number of delayed departures are significant for the mentioned six years time period, , which means that there is need and possibility to act to the next few segments:

- airport services provider, with 58% participation in the total number of delayed departures;*
- state agencies services providers, with 8% participation in the total number of delayed departures;*
- meteorological reasons, with 2% participation in the total number of delayed departures;*
- airlines, with 1% participation in the total number of delayed departures;*

- other (miscellaneous) reasons, also with 1% participation in the total number of delayed departures.

According to the fact that the aircraft's delayed departures are incidental events, the probability theory could be applied in their examination. Statistics shows that the probability for appearance of one or more authoritative delayed departures, in the days with departures at Ohrid Airport, is around 40%. Therefore, the conclusion is followed that should and could be made efforts for taking some appropriate and adequate measures and activities for reduction of the number of the authoritative delayed departures.

In the continuance, the proposed CDM project plan for Ohrid Airport is given, with all their's developing functional elements, levels and their's joined applications, all taken measures and activities, as well as the benefits of their implementation and developing dynamique and the directions for the future development.

The entry project data are refereeing to the defining and the description of all data, indispenably for regular working activities realizing of every CDM project partner:

- statistical data for the authoritative delayed departures at the airport,
- data about technical, infrastructural and personnel feasibilitys of all CDM project partners in the realization of needed working activities;
- data about utilization of the transport, technical, aeronautical and infrastructural capacities;
- statistics about traffic realization within regular and peak time periods with traffic;
- data about the real capacity of each operational and infrastructural airport element, v.v. the defined needs for traffic realization;
- experienceable data for the duration of each working activity of the project partners, v.v. expected, recommended and standardized time norms;
- data about the retrears, irregularities, deficiencies, problems and exceptionally situations regarding the realization of safety management system at the airport;
- data about the retrears, irregularities, deficiencies, problems and exceptionally situations regarding the realization of existing collaborative process among the all CDM project partners at the airport.

Based on the relevant entry project data, a respective number of corresponding measures and activities were assumed, for influencing the reasons for the authoritative delayed departures. This was considering the next processes:

- airport operative infrastructural capacity enhancement;
- optimal usage of the airport's terminal operative infrastructural and technological capacities;
- improvement and raising of the efficiency of the existing airport's technological procedures;
- purchasing of the appropriate airport ground handling equipment;
- improvement of the information sharing process among the CDM project partners at the airport;
- introducing and realization of new operational procedures and instructions for optimal usage of the disposal airport resources;
- planning of the future necessary measures and activities.

Through the CDM project plan implementation at Ohrid St. Paul The Apostle Airport till this moment, some benefits are already achieved and some are expected to be achieved:

- increased departures and arrivals punctuality and airport slot adherence;
- efficient use of airport infrastructure;
- accelerated operational recovery in adverse conditions or other disruptions;
- optimal utilization of available capacities;
- improvement of the informing and information sharing process among the CDM project partners at the airport;
- flexible pre-departure planning;
- reduced apron and taxiway congestions;
- rising of the level of the airport services quality;
- smooth flow of traffic eases ATC's workload;
- enhanced calculated operations times compliance;
- enhanced punctuality of operations;
- optimised resource management;
- fuel and time savings as well as the improvements in the environmental protection through the reduction of emissions and noise level;
- rising the level of the regularity, orderliness and safety of the airport's traffic;
- reduction of the number and duration of the aircraft delays at the airport.

In the continuance, the evaluation of the efficiency of CDM project plan implementation is brought out, through the comparative analysis of all reliable relevant delays statistical data, before and after CDM project plan implementation. Those evaluation shows that CDM project plan implementation has a significant contribution for the reduction of the number and duration of the aircraft delays:

- reduction of the number of delayed departures in the total number of departures for about 10%;*
- significant reduction of participation of the "airport" delays reasons (almost 35% regarding airport facilities and capacities and state agencies services) and rising of the "non-airport" reasons, in the total number of delayed departures;*
- reduction of the duration of delayed departures (about 12%);*
- reduction of the average delay time for one delayed departure (about 10%);*
- mitigation or even annulling of the influence of some of the traffic operations irregularity reasons;*
- identification of the authoritative delayed departures.*

From the other side, this means confirmation of the justification for the undertaken measures, activities and investments through airport CDM project plan implementation.

The respected results from the comparative analysis lead to preliminary conclusion that CDM project plan accomplishing and implementation gave the expected results: the measures and activities were taken have a significant influence to the reduction of aircraft delays at the airport. This preliminary conclusion is more important than this, because the accomplishing and implementation of the CDM project plan is only the first step in the future airport CDM development.

The future CDM development at Ohrid "St. Paul The Apostle" Airport would be determined by the traffic volume at the airport in the next period. The airport CDM implementation would be realized by stages, through the defined developing phases.

The CDM developing dynamics would depend of the concrete conditions, the achieved standards, and the technical improvement and upgrading feasibilities of the existing airport operational systems in the future. The most important thing is the fact that the CDM future development bases are already established, appointed and lined.

The future examinations and researchings might be realized, generally speaking, into two directions:

1. Further CDM development at Ohrid "St. Paul The Apostle" Airport, which would be determined by the traffic volume at the airport in the next period;

2. The CDM project plan accomplishing, development and implementation at Ohrid "St. Paul The Apostle" Airport could be a very solid base for starting of researchings for CDM development at Skopje's airport.

The future researchings, connected with the airport CDM applying, should be realized by the following recommendations:

- corresponding analysis and evaluation of the efficiency of the all relevant information distribution, for improvement the airport partnership business process;

- researching about the level of mutual coordination and collaboration among airport business partners;

- researching about information sharing processes among airport business partners involved;

- leading the airport business partner's common activities to rising the mutual synchronization, to forcing the individual capabilities for situational predictions and improvement of the relevant information sharing transparency.

The proved, confirmed and applied EUROCONTROL transport models should be use for further continuing determination of all functional elements of the existing airport infrastructure and operational capacities. Also, the progressive technologies and procedures should be implemented, such as data-link or GPS technology.

Further, some relevant mathematical tools from the area of probability theory, mathematical statistics and operational examinations should be applied, for further researching the number and duration of aircraft delays.

Next step should be continuing and coordinated evaluation of the efficiency of the implemented CDM project plan.

Therefore, a conclusion could be made that this doctor's dissertation presents a stable and solid base for any further examinations in the area of future airport CDM development and it's final goals. The identified conditions and the obtained results from the traffic-technological analyses of this doctor's dissertation just confirm the justification and impossibility of adjournment of such approach.