COLLABORATIVE ENVIRONMENTAL MANAGEMENT (CEM) AS BASE FOR GREEN AIRPORT CONCEPT

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ABSTRACT

The reduction of the negative impact of air transport on the environment has become a strategic issue of sustainable airport development. The biggest impact of air traffic on the environment can be seen in the airport area, which brings to a direct synergy of many stakeholders. Although the aircraft noise at the end of the 20th century was one of the main negative elements that was continuously monitored, today, besides noise, other parameters such as emissions, water pollution, soil pollution and electricity are being observed. In order to achieve significant results in terms of reducing the negative impact of air traffic on the environment, it was determined that only a joint collaboration of all the stakeholders can lead to significant environmental protection with an increasingly effective control of all operations in the air traffic. As the attempt was to create a system of environmentally friendly airport, the project named "Green Airport" was developed. The categorization of the airport as a "Green Airport" in an ecological sense was a recognition for the airport in its dedication to a higher level of environmental protection and responsibility to the local community, but it was also used as the basis for a successful marketing promotion. One of the guidelines for the realization in the view of the "Green Airport" status has been recognized in the implementation of Collaborative Environmental Management (CEM) into the operations of all the stakeholders related to the airport. Defining the parameters for the implementation of CEM, as well as phasing of its implementation and benefits, will be part of this paper.

KEY WORDS

Environmental protection, airport, collaborative environmental management, aircraft noise, emissions in aviation, air transport ecology

1. INTRODUCTION

Air transport industry is a globally competitive sector which provides efficient transportation of people and goods on the global level and generates employment of more than three million jobs in Europe [1]. In the history of air transport there have been many ups and downs, but looking at a longer period, the demand for air transport services is growing continuously. These growing trends have generated certain negative effects on the environment, out of which the most influence, in terms of noise and emissions, comes from the air transport. The first significant problems related to the negative impact of air transport on environment appeared at the early 1960s, and those problems were related to noise issues generated by aircraft engines. After the deregulation of air transport in 1978, the demand for air services increased, which led to an
increasing number of jet aircraft, and increased simultaneously the intensity of the noise. The first research of the noise in the aviation started in the late fifties of the last century, with the aim to detect the characteristics of the noise source and its impact on the environment. Noise reduction and airofoil research were particularly developed in the wind tunnels in the United States, where the air flow around the airframe, landing gear and engines have been tested. At the end of 2007 in Europe a research project codenamed "ERAT - Environmentally Responsible Air Transport" was launched, with the aim to develop a concept that would allow reduction of the negative impacts of aviation on the environment, as one of the major generators of noise and emissions at the airport surroundings. The noise level of a modern aircraft today is 75% lower than the noise level of aircraft operated 40 years ago. The goal in the future is to reduce the present noise level by 50% in the period till 2020. Although the aircraft noise tries to be reduced at all segments, the implementation of operational procedures by the airports and ATCs can have a significant impact on the airport business and its secondary stakeholders in its operational and financial way. As the noise and emissions are the most important elements of environmental pollution in the aviation sector, there are several others which must be taken into consideration when talking about aviation pollution, such as soil and water pollution, as well as waste which is mostly generated by the airport and the aircraft. The international document that covers the aircraft noise and emissions on a global level is ICAO - International Civil Aviation Organization Annex 16 Volume 1 & 2, and beside this document there are several directives of the European Union which cover the noise topics, such as the "Directive 2002/49/EC relating to the assessment and management of environmental noise" and the "Directive 2002/30/EC on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Community airports". In 2014 the Directive 2002/30/EC was replaced by the "Directive 598/2014 on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Union airports within a Balanced Approach". From the national point of view, every country brings its own directives, laws and regulations concerning noise which must be complementary to the documents on the global and regional levels. In Croatia there are several laws and regulations on the subject of noise protection, such as the Law on Noise Protection (Official Gazette 30/09, 55/13, 153/13, 41/16), Regulations on the maximum permissible noise levels in areas where people work and live and the Ordinance on the establishment of the rules and procedures regarding the introduction of operating restrictions on aircraft noise at airports in the territory of the Republic of Croatia (Official Gazette 39/13).

2. IMPACT OF AIRPORT OPERATIONS ON ENVIRONMENTAL SUSTAINABILITY

The aircraft noise can be defined as unwanted sound produced by the aircraft, and it is considered differently from any other pollutants. The aircraft noise can be divided into three groups by its source. The first group is aircraft engines, the second one aircraft airframe, while the third group presents an interference between the first two. The noise can also be divided by the types of operations that are carried out, such as noise generating from aircraft take-off, landing, taxing, ground handling or engine testing. For each aircraft operation phase, there is a difference of intensity of noise by source at the time of take-off or landing (Fig. 1). During the take-off, the most common sources of noise are generated by the fan exhaust, blades, combustion chamber and jet engine exhaust. During the landing the main sources are the fan inlet and fan exhaust, but also a large part of the noise is generated by the aircraft airframe that occurs due to a high drag.
When referring to the noise at the airports, such noise can be divided into two main parts related to its sources. The first part is airside and it includes runways, taxiways, aprons and passenger terminal after security check. In this part the main noise sources are aircraft, ground handling vehicles and airport infrastructure buildings located on airside. The second part is landside. The landside area covers roads and parking lots, airport heating and cooling plants, as well as the infrastructure for freight transport. On the landside area, the main noise sources are those where noise comes from vehicles used by the passengers, employees (from all stakeholders), and noise from the infrastructure (such as the heating plant). Noise is one of the biggest problems but in the second place on the list are emissions which are equally important. Main emission pollutants at the airport are aircrafts, and the most harmful emissions from the aircraft engines are CO₂, NOₓ and UFP (Ultrafine Particles). All aircraft operations have some consequences which affect the existing wildlife and the human population. It is estimated that the aircraft are responsible for about 10% of greenhouse gas emissions, out of which 2% are CO₂ [2]. Although the noise and emissions are the main negative elements that affect pollution around an airport, waste pollution is another important segment that is largely generated by the airport and its stakeholders. Airports generate significant amounts of waste; thus it is very important to know the origin and the structure of the waste, with the aim to handle it appropriately and according to the local regulations. The typical waste generated by the airport can be divided into six categories:

1. hazard waste that comes from the airport maintaining (colour, cleaning fluid, oil, antifreeze, cans of spray, lamps with mercury);
2. waste generated by the passengers and tenants of the terminal and other infrastructure space, food scraps, plastic, aluminium, batteries, glass;
3. various waste generated at the security check which comes from passengers and hand luggage;
4. waste from the apron, taxiways and runways (aircraft parts and parts of equipment for aircraft ground handling, pallets);
5. waste water and storm water contaminated by petroleum, glycol and other de-icing fluids;
6. land contaminated by different liquids and materials that come into it with the manoeuvring area (the remains of tires, paint residues, de-icing fluid).
Although the air traffic impact on the environment is very large, all the stakeholders in aviation industry are continuously improving the equipment, procedures and infrastructure to reduce the negative effects to a minimum. One of the newest and most important processes nowadays is the implementation of Collaborative Environmental Management (CEM). What CEM is, its implementation phases and benefits, will be elaborated in the next chapter.

3. IMPLEMENTATION OF CEM AT AIRPORT

The CEM is a commonly agreed strategic management process for establishing an airport environmental partnership between the key operational stakeholders at an airport. This partnership will prioritise and meet environmental challenges caused by the direct environmental impacts of aircraft operations. The CEM can be initiated by the airport (airport operators), air navigation service providers (ANSPs) or aircraft operators. This partnership is based upon four levels of collaboration: shared understanding; shared information; consultation and joint implementation. It is essential that all the stakeholders make decisions in a common and unique way to improve the environmental performance of the very airports. The CEM key objectives involve unification and better coordinated interface between airport stakeholders, reducing the risk of environmentally related conflicts between the stakeholders and improving the communication between the airports involved in the processes of the CEM to share information and good practice. The CEM is not an alternative to individual stakeholder Environmental Management Systems (EMS), but it is augmented by these and complements them. Aircraft related environmental impacts, primarily noise, local air quality and climate change, contribute significantly to the total adverse impact of an airport. Furthermore, the efficient use of scarce resources, such as fuel, is becoming increasingly important from both environmental sustainability and cost-reduction perspectives. The CEM can help in developing a shared vision of the environmental impact by the airport and assist in prioritizing, implementing or approving awards for each operational improvement that can mitigate environmental impacts. There is a list of topics which are supported by the CEM. These topics are: Continuous Descent Approach and Low Power Low-Drag; more efficient airfield operations (e.g. Collaborative Decision Making); improved adherence to noise routes; preferred runway configuration management; airspace changes and new navigation methods (e.g. P-RNAV) [3]. Following business and operation processes of each stakeholder, it is clear that no single stakeholder can achieve these ATM environmental improvements unilaterally. Only the collaboration of each stakeholder can lead to the results which can have a significant positive impact on the environment. If the stakeholders do not
collaborate, there are numerous negative results which can happen, such as increasing operational costs, environmental-related conflicts between the stakeholders and many more. By analysing the CEM in an operational way, there are many potential topics for it, such as: Departure-track keeping; Noise preferred runway; Arrival management; Continuous descent approach (CDA); Departure noise abatement; Fleet management; Operational restrictions; Market-based measures; Airspace design and many more [3]. The CEM process comprises two phases and several sublevels:

1. **Pre-implementation phase** - whereby the CEM is initiated and developed to a point where full top-level commitment to implement the CEM is achieved. The CEM phase one can be initiated by any airport stakeholder.

2. **Joint implementation phase** – is phase which is conducted by four CEM ‘levels’ as following:
   - **CEM Level 1: Understanding** - This achieves a common understanding of all local environmental issues.
   - **CEM Level 2: Information Sharing** - Based upon the common understanding, the CEM Level 2 ensures that appropriate performance information and monitoring systems are established to track progress.
   - **CEM Level 3: Consultation and Planning** - provides processes to facilitate joint decision making. This level determines the overall plan to address the priorities agreed in Level 1. The CEM Level 3 also establishes the two-way communication channels with the interested parties.
   - **CEM Level 4: Action Level** - is where the stakeholders implement the planned operational improvements agreed in the CEM level 3.

It can be said that the airports in the Republic of Croatia with its operations are environmentally conscious in a way to invest some effort in environmental protection according to their specific characteristics, aircraft operations number and distances from populated areas. Although, Republic of Croatia has 7 international airports. The main airport, Zagreb International Airport over the years has invested the most in its sustainable development and environmental protection. This refers primarily on implemented system for 24-hour noise monitoring (installed 4 noise monitoring stations) with a developed action plan for any noise increase above the legally defined limits around the airport. The airport has installed a system for stationary measurement of emissions and it is also active in the ACI Airport Carbon Accreditation program which currently holds the Certificate Level 2 "ACA Reduction". In addition, significant investments over the years have been made in the rain water system (36 km of pipes around the airport). Zagreb International Airport introduced an integrated management system ISO 14001:2004. Although in each company (airports, air traffic control, Croatia Airlines) environmental protection system is very developed, but it is still not enough for reaching a level of each company participating in the program, such as CDM or CEM. Little progress has been made between the Zagreb International Airport and Croatian Air Traffic Control but with the minimal segments, such as the introduction of “one engine taxi ‘and the partial use of CDA procedures.

4. **CEM AS PART OF GREEN AIRPORT CONCEPT**

The CEM as part of the Green Airport concept appears in different segments which are associated with air transport. The Green Airport concept is a new program which starts to become very popular between the airports, and it is based on innovation, cooperation and joint actions. Accordingly, with stated it’s recognizes and encourages the airlines, airports, ANSPs and aviation professionals to collaborate in terms of exchange of knowledge, experience and support in the implementation of measures for environmental improvements. The CEM as part of the Green Airport concept allows suggestions for reducing environmental pollution in each of the segments (airports, airlines, ANSPs), and considers the visual interconnection between all the stakeholders as very important in achieving an interaction for the successful implementation of the CEM. The important factor in the area around the airport is the previously mentioned “noise”, to which the local population is most exposed during the landing and take-off operations. Very often the population at the airport surrounding area perceives the aircraft noise as the noise produced by the airport. It is important to bear in mind that...
an airport produces a certain level of noise during the ground handling operations, but such noise is much quieter than the noise produced by the aircraft owned by airlines. Due to this reason, several measures are adopted to decrease the aircraft noise as much as possible, while keeping the safety level on a very high level. Those measures can be divided by stakeholders showed in table 1.

![Figure 3. Diagram of CEM Process phase 1 and 2](image)

Table 1. Procedures which are supporting CEM implementation for environmental sustainability

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Actions for reducing noise and emissions</th>
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| Aircraft manufactures| • Using composites materials with aim to reduce aircraft weight  
                          • Airframe is made from advanced materials (combining composites with titanium and aluminium alloys)  
                          • New structure and technology lead to higher fuel efficiency  
                          • Innovation items as high-bypass engines and a raked wingtip  
                          • Incorporated new sound absorbing materials, lighter and quieter system, improved engine acoustics |
| Airports             | • Incentive and penalty systems to encourage airlines to use quiet aircraft  
                          • Use of preferred runways where possible (in consultation with ATC)  
                          • Taxi power control and TQM (taxi queue management)  
                          • Noise quotas on night flights  
                          • Ban on aircraft engine testing or training flights at certain times  
                          • APU management - encouragement of minimum use of APU’s  
                          • Sound insulation grants: double-glazing in the noisiest areas  
                          • Hush houses and engine run up management  
                          • Noise monitoring systems – monitor noise level of each aircraft  
                          • Public complaint services  
                          • Movement limits  
                          • Forbidden reverse thrust during night (where it’s possible)  
                          • Being part of Airport Carbon Accreditation Program (reducing emissions) |
| ANSP’s               | • Continuous Descent Approach (CDA/CDO)  
                          • Increased Glide Slope on Approach  
                          • Low Power - Low Drag (LP/LD) Approach  
                          • Curved Approach (advanced CDA)  
                          • Displaced threshold  
                          • Preferential runways  
                          • Continuous Climb Operation (CCO) |
| Airlines             | • Changing fleet with quieter aircraft (less noise)  
                          • Implementation of Hush kit (less noise)  
                          • Follow Noise abatement operational procedures (less noise)  
                          • Using GPU instead APU (saving fuel / less emissions)  
                          • Implementation of one engine taxi procedure (saving fuel / less emissions) |

Source: Stimac, I.; presentation „Ecological Viability of Air Traffic”; 2nd Aviation Business Arena, Zagreb, 2012 and official websites from aircraft manufacture, airlines, airports and aviation organisations (ICAO, AC)

Noise and emissions are not the only pollutants although they are major ones. European airports are also investing in renewable energy sources such as biomass, geothermal power, solar panels and windmills. Companies that provide ground handling services replace their existing vehicles with more environmentally friendly - electric vehicles, hybrid vehicles, vehicles on LPG (Liquefied Petroleum Gas) technology such as towing tractors for baggage and cargo, towing aircraft between terminals and maintenance hangars. Just saving on the aircraft movement between the terminal and hangar brings savings of more than 15 million litters of fuel and cuts CO2 emissions by 40 million pounds per year. On figure 4 and 5 it is shown which procedures were used in 1990 and what procedures are being used nowadays reloaded to reducing noise, emissions and saving fuel.
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5. EUROPE CEM BEST PRACTICES

There are two airports that were one of the pioneers in the implementation of CEM and can be characterized as the best examples of CEM and Green Airport concept. These airports are Manchester Airport and Budapest Airport. Manchester Airport, serves more than 70 airlines and has 24 million passengers a year. The current airport capacity is 55 million passengers per year which are being handled in three passenger terminals and two runways. Given the large number of passengers and cargo traffic, Manchester Airport currently has more than 21,500 employees. The importance of the airport stands out in a number of destination/countries, what airport servers. In 2015/16 it was carried out 175,645 flights to 210 destinations connecting 60 countries. The most...
desirable destinations from Manchester Airport are Dubai, Dublin, Amsterdam, Tenerife and Mallorca. Each airport must be well connected to the city, but in Manchester Airport case it supports connectivity by rail, bus and metro which is an additional benefit when applying CEM. Due to the large number of people (22 million) living in a catchment area of two hours driving, Manchester Airport has recognized the importance of the CEM implementation and the creation of a "Green Airport" concept. Manchester Airport was awarded for best airport in the United Kingdom two years in a row, which was certainly a great incentive for further progress and development. CEM at the airport Manchester was implemented five years ago, and it gathers a small group whose focus is aimed at improving the environment, but also to maintain the operational focus and high level of efficiency. The topics of discussion related to CEM at the airport Manchester are CDOs (Continuous Decent Operations), CCO (Continuous Climb Operations, PRNAV trials, Approach procedures, Ground power, SID truncation, Performance reporting, Intersection departures, Airfield lighting, Optimised flight, Legislative updates, Reduced engine taxiing, Night noise review, APU use, Airspace change, Aircraft de-icing, Departure track adherence, Climate change adaptation. In the first five years of adaptation CEM Manchester has made improvements in several categories:

- optimization of flight routes by implementation of direct routes, CDO and CCO,
- SID (Standard Instrument Departure) Truncation enabled fuel savings of 19,000 tons per year,
- implementation of reduced engine during taxiing, which allowed the reduction of CO2 emissions by 30% [4].

The second best practice airport is Budapest Ferihegy International Airport which was opened in 1966. Budapest Airport is mostly focused on inter Europe flights, but also has flights to Africa, Asia, Middle East and North America. Currently Budapest Airport has 850 employees, more than 200 vehicles, consumes 33GWh of electricity per year and generates 950 tonnes of waste. At Budapest Airport, there are 200 different entities which have in total 8,500 employees, using more than 600 vehicles on airside, consuming 13GWh of electricity per year and generates 550 tonnes of waste. The preparation before implementation of Green Airport Program at Budapest Airport was: detailed analysis of most significant tenants, creation of attractive brand logo, active involvement of all business units from beginning in all discussions. The main objective of the program is to reduce carbon dioxide emissions, with the following measures: reducing energy consumption at the airport, creating opportunities for the use of renewable energy sources, development electric mobility, expanding selective waste collection at the airports. It is significant to emphasize that CO2 emissions in 2010 were 3,75 kg/passenger while in 2014 this amount was reduced by 32.5% and now is 2,53 kg/passenger [5]. Regarding statement from Budapest Airport management benefits from implementation of Green Airport Programs was following: regular information on the environmental performance of the airport and related opportunities; Quarterly meetings between the partners to exchange experience; Access to environmental training and communication materials; joint media events relating to environmental developments; Professional support for the organisation’s environmental measures, from launch to implementation [6].

6. CONCLUSION

The purpose of this paper is to point out the problems of the airline industry related to the environment and air traffic increase. The main feature of the aviation industry is safe and fast transport that has a great upward trend. However, it is important to pay attention to the impact of air traffic on the environment. Due to increasing traffic, there is a problem of the noise impacts, waste water and engine emissions by aircraft and other vehicles. It is extremely important to comprehend the degree of environmental pollution by air transport stakeholders. Airlines, airports, aircraft manufacturers and air traffic control in the recent years have been focusing portion of the business on the implementation of regulatory measures, restrictions and new technologies on
reducing the impact of air traffic on the environment. Technologies and restrictions which are being used in the recent years greatly assisted ecological balance. Due to restrictions, subsidies and projects made possible in recent years, harmful emissions and noise were reduced by 80%. Green Airport program which is trying to reduce the harmful effects on the environment by all stakeholders of the air traffic, also indicates awareness of the stakeholders on the ecology importance. Green Airport offers many advantages, the most important ones are: possibility of joint decision-making and innovation, use of new technologies and information exchange. Given the current situation, the implementation of various innovations and projects may indicate that air traffic tends to sustainable development.

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