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Transportation Research Procedia 24 (2017) 58–64

Transportation Research Procedia

www.elsevier.com/locate/procedia

3rd Conference on Sustainable Urban Mobility, 3rd CSUM 2016, 26 – 27 May 2016, Volos, Greece

Optimization of ground vehicles movement on the aerodrome

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Abstract

This paper deals with the process of management of ground vehicle movement at aerodromes. It is a huge challenge to provide the growth of airport capacity which is required due to the increasing number of passengers and goods flow, without good management in aircraft operations, including the standing time of aircraft on the ground. In the first part of this Article, the current trends in the development of airport ground processes and control techniques are considered. Official IATA (International Air Transport Association) documents and scientific publications are the source of new ideas in this field. In the second part of this Article, the use of computer simulation is prescribed for the purpose of testing new methods of transport movement control. Also, the methodology of the simulation model, which has been designed to optimize work flows arising during movements of airport ground vehicles, is demonstrated. The developed model is a test bed for conducting experiments, which may help in finding more effective airport ground processes control techniques. A similar model can be created for any other airport, on the basis of which is scheduled to verify the possibility of technical implementation of new control technologies of ground vehicles. The practical implementation of these new technologies should be solved taking into account the requirements of ICAO and IATA, in particular ICAO Annex 14.

Peer-review under responsibility of the organizing committee of the 3rd CSUM 2016.

Keywords: A-SMGCS; Airport movement area; Ground handling; Optimization; Simulation
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1. Introduction: Current trends in the development of airport ground processes control techniques

The innovations in airport design are created for the provision of services in aviation. The service providers in aircraft operations usually focus not only on the quality of the service, but also on the efficiency. The innovation in airport design involves complex predictions and involves a high degree of competition and aviation equipment development, with new methods, tools and materials, with sustainable technologies and well organized airport infrastructure. It is particularly important, for reasons of passenger security and safety, that all aspects are considered for effective air operations and also for effective ground handling

There is a huge demand for increasing airport capacity, caused by the increasing number of passengers and goods flow. Air travel has become accessible to billions more travelers in recent years. In 2012, 2.8 billion passengers used air travel (IATA Vision 2050 Report, 2011). According to the IATA 2050 report, it is expected that 16 billion passengers and 400 million tons of cargo will be transported by aircraft in 2050. It is a huge challenge to provide the growth of airport capacity which is required due to the increasing number of passengers and goods flow, without good management in aircraft operations, including the standing time of aircraft on the ground.

2352-1465
Peer-review under responsibility of the organizing committee of the 3rd CSUM 2016.
10.1016/j.trpro.2017.05.068

There are many analyses and much research regarding this subject and many publications have been issued in this field. Some of them are legislative acts only, and others are NOTAMs (Notice(s) to Airmen) and instructions to all operators.

Bonnefoy et al. (2010) carried out research entitled 'Evolution and Development of Multi-Airport Systems', the core of which is the solution that creates "Multi-Airport Systems". The multi-airport system is defined as a set of two or more significant airports that serve commercial traffic within a metropolitan region. But with this solution they stated that the congestion problem at the three major airports in New York could also drive the emergence of a new secondary airport. However, the development of a multi-airport system poses several challenges in terms of planning and development.

De Neufville (2003), Professor of Engineering Systems and Civil and Environmental Engineering at Massachusetts Institute of Technology, also carried out research in this area and published his article 'Airports of the Future: The Development of Airport Systems'. Worldwide development presents some emerging trends towards focused specialization in airport operations, and the major types of airport are there defined:

a. Intercontinental airports, serving the global international passenger traffic, functioning 24 hours a day, 7 days a week;
b. Cheap Fare, short haul airports, that strive to be inexpensive, to match the demands of their clients; and
c. .Cargo airports, dedicated to serving integrated freight operators.

Price et al. (2013) issued an article 'Design led innovation: Shifting from smart follower to digital strategy leader in the Australian airport sector'. The article described the proposed future aerotropolis airport model and argues that airports act as cities; they are home to people, businesses, industries, and are a pivot point for economic growth. A cultural and organizational transformation within the airport sector supported by business model innovations will be required to accompany such a monumental shift toward the future operation of airports.

As stated in the low and regulation of aerodromes, Abeyratne (2014), there are five main factors which play major roles in improving airport capacity:

d. Integration of GNSS use;
e. Integration of arrival/departure/surface management;
f. Optimization management;
g. Improvement of surface surveillance;
h. Airport collaborative decision making.

It is impossible to improve items number (b) and (d) without good management and optimization of ground vehicles movement and operation.

On the other hand, the accidents and incidents which take place at aerodromes involving ground vehicle operations and impact with aircraft by these vehicles, are rapidly increasing.

ICAO and EUROCONTROL defined the "Advanced-Surface Movement Guidance and Control System" (ASMGCS) to ensure the safety and the efficiency of surface traffic at the airport movement areas (runways, taxiways and apron area).

The most extensive researches were provided by a Portuguese team of scientists, Casaca et al. (2008). They explain that the present level of technological development in the information and communication Technologies allows the definition of a low cost platform for the vehicle navigation component of A-SMGCS, and present good ideas regarding how to use and integrate all the known communication network systems like WiFi, TETRA, CDMA and WiMAX, to optimize ground vehicle movements within the local area network.

Gonzalez et al. (2013) and a group of researchers issued a publication in 2013, where they stated that the optimization of future ground operations for aircraft cannot be understood without the study of the main platform, the Sky. For said purpose these two projects stand out; Next Gen and SECAR..

The Next Gen Air Transportation System, (Next Gen), aims to move America's air traffic control system from the current ground based system to a satellite based system with GPS technology. They assume that when dealing with airport operations, some points override others; they grouped these points in the following way:

a. A-CDM (Airport Collaborative Decision Making)
b. Unambiguous communications
c. Runway entrance control
d. No confusing lights • Less stop and go