Transportation Research Part A 57 (2013) 64–86

Contents lists available at ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

Single European Sky and Single European Railway Area: A system level analysis of air and rail transportation

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ARTICLE INFO

Article history:
Received 27 July 2012
Received in revised form 13 September 2013
Accepted 17 September 2013
Available online 1 November 2013

Keywords:
Air transportation
Rail transportation
Single European Sky
Single European Railway Area
System capacity management

ABSTRACT

Air and rail transportation systems are characterized by important common features: they serve a significant share of passenger traffic in Europe; their functioning relies on the cooperation of many stakeholders operating a fixed timetable, often with competing objectives; and they have been characterized by quite a fragmented development following national borders. For these systems, the European Commission envisages a common future in terms of an increase of efficiency and elimination of national borders. In this paper, we analyze the two systems in the perspective of their common development and we underline the main existing differences linked to the management of the infrastructure. These differences concern the processes implemented for specifying and allocating capacity, both in strategic planning and in real-time intervention. Our analysis suggests that the air transportation system is moving in the direction indicated by the European Commission, as well as the rail transportation system for what concerns international train paths (typically high-speed trains). However, a substantial separation still exists between conventional rail transportation systems of different countries.

1. Introduction

Air and rail are two extremely important, and sometimes competing, means of transportation. Air transportation allows very long distances to be covered in a rather short time. Rail transportation allows rather long distances to be covered in a reasonable amount of time at a relatively low economic and environmental cost. According to Eurostat (2009), in 2006 air traffic served 8.6% of passengers per kilometer in Europe, and rail traffic 6.1%. The corresponding figures for freight are 0.1% and 10.5%, measured in tonnes per kilometer. Although road traffic serves a much higher percentage of both passenger and freight, its great environmental impact necessitates the investigation for effective alternatives.

Due to historical and institutional reasons, European air and rail transportation systems are managed, to some extent, at a national level, with sometimes significant differences between countries. The consequent fragmentation imposes evident limitations on the development of the systems.

For coping with the need of efficient European transportation systems, the European Commission has launched two ambitious programs: the Single European Sky (European Commission, 1999) and the Single European Railway Area (European Commission, 2010a). The Single European Sky establishes targets in key areas of safety, network capacity, effectiveness and environmental impact for what concerns the European air transportation system. Moreover, it envisages a technological modernization and optimization of the system through the Single European Sky ATM Research (SESAR) Programme (SESAR Consortium, 2008), where ATM stands for Air Traffic Management. The Single European Railway Area intends to create a unique efficient inter-European freight and passenger market, favoring cross-border competition.

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http://dx.doi.org/10.1016/j.tra.2013.09.004

In the optic of this common target, we propose an analysis of the main peculiarities of air and rail transportation systems. In particular, we consider the main elements and processes in the two systems for what concerns the infrastructure management, and we report the main legislation and research trends which concern them. This analysis allows the identification of similarities and differences between the two systems, and of the level of development of the European homogenization process. Other studies focus on the two transportation systems together, but from very different perspectives. When this happens, the main focus is typically the identification and the tentative explanation of market shares of air and high-speed rail transportation (Adler et al., 2010; Buckeye, 1992; Dobruszkes, 2011; Ehrenberger and Fischer, 2011; Janich, 2003; López-Pita and Robusté Anton, 2003; Park and Ha, 2006; Román et al., 2007; Steer Davies Gleave, 2006). Other studies (Chen and Cheng, 2010; Davidsson et al., 2005) propose a review of agent based techniques applied to different transportation modes, including air and rail transportation.

The rest of the paper is organized as follows. Section 2 discusses the main steps which have characterized the evolution of air and rail transportation systems from a historical and institutional point of view. Section 3 describes the main elements composing the infrastructure of the two systems. Section 4 presents the process implemented for allocating infrastructure capacity in the strategic planning, which typically takes place months or years in advance (Barnhart et al., 2012). Section 5 details the research trends and current practice for what concerns real-time intervention. Finally, Section 6 concludes the paper.

2. Historical and institutional framework

Historically, both air and rail transportation systems have developed in a rather fragmented fashion, mostly following national borders. The development of the two systems has been negatively impacted in distinct ways as a result of this fragmentation. Moreover, different institutional roles have been attributed to the two systems: air transportation is mostly a commercial framework, and rail transportation is often intended as a service to be made available to the population. In this section, we describe the evolution of the systems and the main developments which are currently envisaged.

2.1. Air transportation

In Europe, commercial aviation started in the 1920s, with private airlines benefiting from governmental subsidies. The first commercial flights were performed between London and the Continent by four airlines: a Dutch, two French and a Belgian airline. Over the years, the market has grown markedly: annually, commercial airlines operate approximately 9.5 million flights in Europe (Eurocontrol Performance Review Commission, 2010). Besides commercial airlines, air traffic is populated by military and general aviation operators, such as private individuals operating their own aircraft.

The definition of an air traffic control system came with the increase of the number of aircraft populating the sky. The International Convention for Air Navigation (also known as the Paris Convention), established in 1919, stated the sovereignty of each state over its own airspace. Moreover, it declared that "Every aircraft in a cloud, fog, mist, or other condition of bad visibility shall proceed with caution, having careful regard to the existing circumstances". At that time, the only aid to pilots was represented by flags waved at airports to signal permission for landing or take-off, and successively by signaling lamps located at strategic positions. In Europe, the first modern air traffic control center was the control tower at Schiphol airport, in the Netherlands, thanks to the modernization brought about in occasion of the Olympic Games held in Amsterdam in 1928. Here, after its complete destruction which occurred during the Second World War, the control tower was equipped with a control radar, and controllers employed novel techniques for sequencing landing and take-offs (Cook, 2007). Since then, general air traffic control (ATC) rules quickly spread throughout Europe, even if the equipment of the control centers and some specific criteria employed are still managed at a national level (see Section 4.1).

Nowadays, five main direct stakeholder groups operate within the air transportation system (SESAR Consortium, 2008):

1. The end-user customers: passengers and freight.
2. The airspace users: commercial airlines, military, general aviation (all flights other than military and scheduled airline and regular cargo flights) and business aviation (any general aviation aircraft used for a business purpose).
3. The air navigation service providers (ANSPs): providers of air traffic control, airspace management and air traffic flow management services. In Europe, these services are mostly provided by national ANSPs, typically one per State. The provision of some services has been delegated to a single European organization, namely EUROCONTROL.
4. The aerodrome community: airports and aerodromes, including major hub airports, regional airports, local aerodromes and military airfields.
5. The supply industry: aircraft manufacturers, suppliers of supporting systems.

In this paper, we will focus on the stakeholders which have a major impact on the air transportation system as a whole and whose behavior may be to some extent controlled through regulation: airlines, ANSPs and airports. In particular, we will focus on how they cooperate for efficiently exploiting the system capacity.

ANSPs are often managed by national civil aviation authorities, although they should be managed by independent entities (International Civil Aviation Organization, 1996). European airports are mostly private (Cook, 2007). For airlines, the situation is more controversial. They are private companies, and governmental subsidies have been officially forbidden since