20th EURO Working Group on Transportation Meeting, EWGT 2017, 4-6 September 2017, Budapest, Hungary

Framework for centralized and dynamic pedestrian management in railway stations

Bachar Kabalan[a],*, Fabien Leurent[a], Zoi Christoforou[a], Marin Dubroca-Voisin[a,b]

[a]Université Paris-Est, LVMT, Ecole des Ponts ParisTech, Champs-sur-Marne, France – Chair ENPC-STIF
[b]SNCF Transilien, Paris, France

Abstract

The significant growth of pedestrian flows through stations of mass public transport has turned the two issues of passenger comfort and safety into major concerns for railway station operators. Managing these issues is a challenging task due to the complexity of in-station pedestrian facilities, of passenger behaviors and of train and railway operations. Therefore, station management can no longer be limited to the management of train traffic. Several research studies have been developed in recent years that aim to evaluate pedestrian infrastructure within railway facilities by monitoring pedestrian flows and/or modeling them ("crowd dynamics" models). However, the way from these studies to the management of train stations remains to be paved. This paper brings about a framework for station management with special focus on passenger flows. The framework is twofold, including first a general understanding of station as a system with specific transfer function and ad-hoc topology, second the dynamic supervision of system performance. We also address observation requirements and the toolbox available for modeling.

1. Introduction

Demand on massive public transportation modes, mostly rail-based, has been growing in a strong and persistent fashion. According to HS2 Ltd Catapult (2016), demand in the UK by 2043 will reach twice the 2008 level. Under

* Bachar Kabalan. Tel.: +33 1 81 66 88 62.
  E-mail address: bachar.kabalan@enpc.fr

the pressure of continued urbanization and population concentration in the largest cities, the challenge for public transportation is to provide a satisfactory passenger experience while maintaining its economic, social and environmental advantages. Failure to do so puts at risk both the economic growth and trip-maker safety.

The age and heritage of major stations in European countries limit the possibilities to increase their capacities. The stations were designed for different objectives and very different traffic volumes. Therefore, several constraints in these stations interrupt the free flow of crowds and leads to overcrowded and congested pedestrian facilities. The effect of congestion is threefold. First, it negatively influences the quality of service due to queuing on vertical elements (stairs, escalators) and gate lines. Second, it may disrupt modal operations since overcrowded platforms increase train dwell times and impede train departures. Third, potentially dangerous situations can occur on platforms at high densities: sudden movements or an accidental push can throw a passenger on the track.

For a train station to run as an efficient flowing system, effective station management seems to be crucial. It would increase the operational efficiency of the station and also improve the overall system performance (at the level of lines and between lines) by rapidly reporting critical information relating to local operations and incidents. It would also decrease crowding, particularly so at train doors, thereby reducing dwelling times and queuing times as well as preventing safety hazards. According to Rail Safety and Standards Board (2003),train station staff are usually aware of their roles during planned crowd events and evacuations: yet they have no clear idea about their responsibilities for crowd management during daily operations. The report also states that the literature review that was done identified 37 standards and guidelines on crowd management, none of which is exclusively dedicated to crowd management at railway stations. Though the report was published in 2003, no major change or contribution concerning this subject has been found in a recent literature review.

Crowd management is to plan and execute the orderly movement of a crowd through infrastructure. It has five main aspects: (i) managing information (mobile applications, traffic conditions, etc.), (ii) managing space (bottlenecks, signage, furniture, etc.), (iii) flow control (controlling flow rates, directing crowds, etc.), (iv) value development (by suitable development of "adjacent" services and amenities), and (v) emergency response. Managing crowds requires basic skills concerning planning and risk assessment, Cf. Still (2014).In the context of train stations, the specific functionalities must be considered. In a railway station, high passenger flows often in the form of crowds enter through multi modal access points, spend a relatively short amount of time, move in multi directions in a space administered by a train operator, and interact with trains. In order to manage crowds in railway stations, a planning and monitoring phase is required. The objective of this paper is to propose a framework for planning, monitoring and managing the movement of individual users in train stations. This framework will allow stations staff members, who are responsible for crowd management, to understand the ways in which individuals use the pedestrian facilities inside the station, how are crowd flows distributed, where does congestion build up and where are security issues being violated. The crowd management team will then have the necessary information in order to propose plans and solutions that will improve safety, security, convenience, continuity, comfort, system coherence, and attractiveness of the station.

The rest of the paper is divided into four sections. Section 2 addresses the "general understanding" of a station as a transportation system for station managers. Section 3 deals with the dynamic performance of the system, to be summarized by a suitable set of indicators so as to enable for dynamic management on the basis of specific instruments. Section 4 reports on a number of technological solutions to monitor pedestrian facilities. Conclusions and perspectives are discussed in section 5.

2. Basic system understanding

Before monitoring and managing crowds in a train station, the staff must have a full and deep understanding of how the station functions. Collecting and analyzing data on all the aspects and functionalities of the station allows to examine the latter's access, a traveler's ease of journey through it and the station to train interface. To manage the daily operations in a train station it is important to know how crowds arrive, understand how they move through the station, identify which areas they use and not use, and localize congestion due to queuing or the interference between the queuing (static) areas and the moving (dynamic) areas. Acquiring this knowledge allows to diagnose the sensitive areas of the station that will later need to be monitored. For a full comprehension of how a complex