



Pedestrian Traffic Operations in Urban Networks

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Abstract

The pedestrian mode is an important component of urban networks, and greatly affects the performance of sidewalks and crosswalks, as well as the entire network traffic operations by interacting with other traffic modes (automobile, bicycle, transit). There have been many studies concerning different aspects of pedestrian behavior, such as pedestrian walking speed, delay, gap acceptance, signal compliance, route choice, etc. The Highway Capacity Manual (HCM) first included the pedestrian mode in 1994. The HCM 2010 provides several methodologies for evaluating the pedestrian level of service (LOS) of different urban street facilities. However, it does not comprehensively address pedestrian operations and does not consider some recent important findings such as pedestrian-vehicle interactions at crosswalks, pedestrian signal compliance rate, pedestrian jaywalking behavior, etc. This paper provides an overview of the literature on pedestrian operations in urban networks, identifies the important aspects of pedestrian operation analysis and provides several recommendations for enhancing the analysis of pedestrian facilities in the HCM on the basis of a summary of available U.S. and international literature. The following topics are discussed: pedestrian movement models, pedestrian crossing behavior, pedestrian-vehicle interactions. Pedestrian travel time estimation at the path level is proposed as an integrated approach for pedestrian operation analysis.

Keywords: Pedestrian, Operation, Urban network, HCM

1 Introduction

The pedestrian mode is an important component of urban networks, and greatly affects the performance of the sidewalks and crosswalks, as well as the entire network traffic operations by

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interacting with other traffic modes (automobile, bicycle, transit). A schematic of a pedestrian trip in an urban network is shown in Figure 1. The trip consists of walking portions which do not have interactions with vehicles, and crossing portions which do. Given an origin-destination, pedestrians have multiple route alternatives and may encounter different traffic conditions along their path. Pedestrian trip travel time represents the total time a pedestrian spends from an origin to a destination within a network.

There have been many studies concerning different aspects of pedestrian behaviors, such as pedestrian walking speed, pedestrian delay, gap acceptance, signal compliance, route choice, etc. The Highway Capacity Manual (HCM) included the pedestrian mode in the HCM 1994 (update to the HCM 1985). The most current edition (HCM 2010) provides several methodologies for evaluating the pedestrian level of service (LOS) of different urban street facilities (i.e., signalized/unsignalized intersections, urban segments). The LOS score for the entire urban street facility is determined as a regression function of pedestrian LOS at intersections, at links and the roadway crossing difficulty, which greatly depend on pedestrian delay at each location, pedestrian speed and available space respectively. However, the HCM 2010 does not fully cover the entire pedestrian trip and it is missing some important findings in recent studies, including research on pedestrian-vehicle interactions, jaywalking behavior outside the crosswalks, pedestrian route choice and crossing location selection.

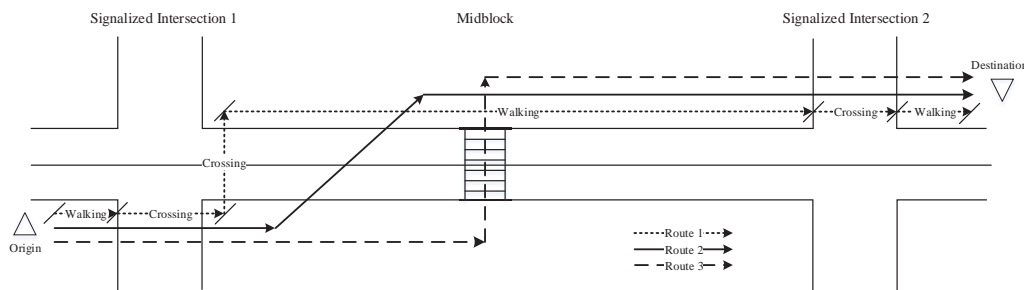


Figure 1 Schematic of a Pedestrian Trip in an Urban Network

Pedestrian behavior in urban networks was described by Hoogendoorn and Bovy (2004) as a hierarchical structure with: strategic level (departure time choice); tactical level (activity scheduling and route choice); and operational level (road crossing and interactions). The tactical decision interacts with the operational level when, for example, pedestrian travel route may change due to available crossing facilities, and pedestrian crossing location may affect the pedestrian overall travel time. This structure explains the relationship among these three levels and emphasizes the necessity for an integrated method for pedestrian operation analysis. However, most existing studies ignore these mutual impacts, and pedestrian travel time is typically analyzed only at the intersection level. Thus, in order to approximate the pedestrian perspective, it is necessary to develop a pedestrian travel time model that considers the entire trip.

The objective of this paper is to provide an overview of research related to pedestrian operations in urban networks, and to provide recommendations for evaluating pedestrian facilities in the HCM on the basis of a summary of available U.S. and international literature. Pedestrian travel time estimation at the path level is proposed as an integrated approach to approximate the pedestrian perspective in pedestrian operation analysis.

The next section provides an overview of previous studies on pedestrian traffic operations, including pedestrian movement, pedestrian crossing behavior, pedestrian-vehicle interactions, and pedestrian travel time. Conclusions are provided at the end of the paper along with recommendations for the HCM.

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