Chapter 7

Modeling the Change of Urban Spatial Structure: Use Interzonal Travel Data to Estimate Urban Growth and Expansion by Hierarchical Cluster Analyses

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ABSTRACT

The Urban spatial structure is affected by spatial interactions among various activity locations, and land uses in the city over the transportation system. Each city has its unique circulation pattern of passengers and freight due to its unique geographic conditions and the distribution of locations of economic activities. In that sense, it is claimed in this chapter per the authors that urban spatial structure can be modeled using interzonal (O/D) travel data. Thus, the chapter presents a case study of modeling spatial structures developed by employing Hierarchical Cluster Analysis (HCA) using travel pattern data for current and future scenarios. As a result, urban growth and expansion were estimated based on the level of interaction (represented by distance or similarity modeled based on trip interchanges) over the transportation system in terms of population and/or employment increases. The interaction was described by a measure of distance or similarity, modeled with respect to trip interchanges.

INTRODUCTION

Elements of the urban transportation system, namely, types, capacity and characteristics of travel modes, infrastructures, and users, and the cost or time of travel, have a unique spatial imprint which shapes the urban form. Each city presents different socioeconomic and geographical characteristics; therefore, the spatial imprint of the transportation system differs correspondingly (Rodrigue et al., 2013). For instance,
while some cities have an urban form shaped by mainly highway modes, and others have different spatial forms compared to the former because various public transport modes, including non-motorized modes and infrastructure developments are taken place in a more balanced transportation system. Urban spatial structure is affected by spatial interactions among different activity locations and land uses over the city’s transport system since each city has its unique circulation pattern of passengers and goods. In that sense, it is claimed in this chapter per the authors that urban spatial structure can be modeled using interzonal (O/D) travel data. OD data are the outputs of the trip distribution step from the travel demand modeling (TDM) process. Thus, by comparing the spatial structures obtained from the models created by employing Hierarchical Cluster Analysis (HCA) for a base year and future scenarios, urban growth and expansion can be estimated in terms of population and/or employment changes, based on the level of interaction, represented by distance or similarity calculated based on trip interchanges, over the transportation network. For example, a network with substantial highways projects and the other having substantial public transportation investments can be compared with respect to the spatial structure impacted by the dominant elements of the transportation system such as highway, public transit modes, and major transport terminals. This chapter presents a case study of the analyses of urban spatial structures of Sakarya Province of Turkey (Figure 1) for base and future scenarios. Base year and future urban structures were modeled and compared to estimate the urban growth and expansion for years 2012 and 2023. Results of the analyses can be used to confirm the growth and the expansion of urban city core as well as other urban and suburban developments and their emergence with their neighboring clusters. Decision makers will be able to develop their capacities to plan ahead in order to meet future needs better from the spatial restructuring in urban agglomerations, when they know the extent and location of the future growth ahead.

BACKGROUND

In urban settings, characteristics of transportation system and infrastructure, and the attractiveness of transport modes shape mobility of travelers and demographic growth. Urban form is the spatial imprint of an urban transportation network. Therefore, “urban (spatial) structure can be defined as the set of relationships arising from urban form and the underlying movements of goods and people” (Rodrigue et al., 2013).

Transportation systems have long been recognized as vital parts of city systems. They affect the quality of live (Vuchic, 1999) and have strong effects on shaping the form of settlements. Urban transport systems can mainly be grouped into public, private, and freight transport systems. In most cases, they can be complementary, but they may usually compete against each other under the lack of a comprehensive planning effort (Rodrigue et al., 2013).

- Public Transportation: The purpose is to provide publicly accessible mobility where it is demanded, especially in urban settings. Its efficiency is based on the cost per passenger or traveled km. Major public transport modes must be operated in a fully or semi-exclusive right-of-way in order to provide high capacity and reliability. It includes modes such as cable (aerial tram, funicular, and so on), rail (tram, light rail, metro, and so on), and rubber tired modes (bus and minibus). Livable