

**Spatiotemporal Analysis of Urban Traffic Accidents:  
A Case Study of Tehran City, Iran**

January 2018

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**Spatiotemporal Analysis of Urban Traffic Accidents:  
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A Dissertation Submitted to  
the Graduate School of Life and Environmental Sciences,  
the University of Tsukuba  
in Partial Fulfillment of the Requirements  
for the Degree of Doctor of Philosophy in Science  
(Doctoral Program in Geoenvironmental Sciences)

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# Abstract

Urban traffic accidents (UTAs) may be seen as discrete events, localized in space and time (Haji Mirza Aghasi, 2017). UTA rates all over the world show great disparities, especially between developed and developing countries. UTAs lead to injury, death, disability and pain, loss of productivity, grief, and social and mental health problems. Although many studies have been undertaken to investigate the severity of traffic accidents, the relationship between risk factors and UTA severity has not yet been adequately identified. One of the reasons for this inadequate identification is the varied complexity of factors that influence UTAs. These factors include (but are not limited to) driver characteristics, such as gender and age, vehicle characteristics, vehicle type, environmental factors, climate conditions, and the geographical characteristics of accident sites. Appropriate study and planning can enhance transport and driving safety and reduce the number and severity of UTAs. Such research is particularly meaningful when spatial and temporal factors are considered together.

Traffic safety crises, death, damage, and the costs resulting from UTAs are some of the most important public health and policing challenges facing Iran and other countries. In Iran, UTA victims are typically people between 15 and 44 years of age; UTAs are the second leading cause of death after heart disease in Tehran (Aftab News Agency, March 19, 2015). UTA statistics in Tehran reveal a serious problem with a significant fatality and injury rate.

This study aims to identify the spatial pattern of UTAs in the city of Tehran, in order to identify causes and consequences, as well as the temporal and spatial variations of UTAs. The relationship between the space and time used for daily activities that generate daily urban trips and UTAs is examined using data for Tehran City between 2010 and 2011. The analysis is based on different databases, both spatial and non-spatial, which include the locations of UTAs and their dates, causes, nature, and other attributes. To identify the causes of these severe incidents and to draw effective conclusions and suggestions for reducing UTAs, this study has

used data to investigate major and minor causes, various factors, and the types of UTAs in Tehran City. The study has considered different aspects of UTAs, including the urban environment, land use, population, human activities, culture, and other issues considered to be the most important pillars of the phenomenon. In order to understand drivers' knowledge, cultural beliefs, behaviors, and attitudes toward traffic regulations, questionnaires were distributed to 1,500 drivers in the study area to gather data; of these, 1,177 were returned. The results demonstrate that the culture and knowledge of drivers have a direct effect on localized UTAs.

One of the main topics explored in this study is urban structure (US), the concentration of educational, commercial, and cultural activities that make up a large number of urban trips and urban dynamics, road usage, and time. The relationships between population, land use, and the dynamic city patterns that constitute urban structure suggest spatial considerations linking UTAs with the urban structure of Tehran City. Time is considered a crucial variable that leads people to different kinds of locations and risks. Land use and population data are combined with UTA data using geographic information system (GIS) techniques to generate relevant inputs for analysis. The methodology uses cluster analysis techniques to analyze the association between UTA numbers and land-use categories per 1,000 residents of Tehran City. Such techniques verify the temporal variation in UTAs, over time periods segmented into different zones.

The results show that suburban zones with industrial land use and more highways are associated with higher numbers of severe accidents, involving fatalities and injuries. In comparison, the central business district (CBD) zone is the safest, as measured by the number and severity of UTAs. Traffic limitation boundaries, wide pedestrian walking areas, and increased police checks make the CBD safer, despite its higher population density and daily activities. The UTA spatial pattern has been observed to change dramatically in different zones

and hours, especially during rush hours. Increased, lower-severity UTAs occur in Tehran during rush hours, when there is traffic congestion on the transportation networks and public transportation.

Land use categories, urban structure, and population density vary across city zones and these variations create different rush hours; thus, different zones have different rush hours. In relation to population movement, urban dynamics, and urban structure, the main roads types in different zones become congested at different times of day, reflecting the activities and dynamics associated with the dominant land use category. Thus, the rush hours in different zones result in different UTA spatial patterns within the city.

In addition, this study explains the relationship between urban structures and UTAs in Tehran. It has been discovered that the locational pattern of various land uses in the urban area reflects socio-economic and ecological factors. Furthermore, the spatial and temporal analyses of relative UTA risks identify dangerous segments in different city zones and land uses, depending on the season, month, day, and time.

**Keywords:** geographic information system (GIS), kernel density estimation (KDE), land use, rush hour, urban structure (US), urban traffic accidents (UTAs).

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# Abbreviations

<b>BRT</b>	Bus Rapid Transit
<b>CBD</b>	Central Business District
<b>FA</b>	Fatal Accident
<b>GIS</b>	Geographical Information System
<b>IA</b>	Injury Accident
<b>IRI</b>	Islamic Republic of Iran
<b>NNH</b>	Nearest Neighbor hierarchical
<b>KDE</b>	Kernel Density Estimation
<b>PDIRI</b>	Police Department of the Islamic Republic of Iran
<b>PIRIMPO</b>	Presidency of Islamic Republic of Iran Management and Planning Organization
<b>RH</b>	Rush hour
<b>TTN</b>	Tehran Transportation Network
<b>TTTO</b>	Tehran Traffic and Transportation Organization
<b>TUS</b>	Tehran Urban Structure
<b>SCI</b>	Statistical Centre of Iran
<b>UTA</b>	Urban Traffic Accident
<b>US</b>	Urban Structure