

Spatiotemporal Analysis of Urban Traffic Accidents:

A Case Study of Tehran City, Iran

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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).

Content

Abstract	i
List of Tables	vii
List of Figures	viii
List of Photos.....	x
Abbreviations	xi
Chapter 1: Introduction	1
1.1. Background and problem statement.....	1
1.2. Research objectives.....	4
1.3. Geographical setting of the study area	4
1.4. Literature review	10
Chapter 2: Materials and Methods	23
2.1. Data collection	23
2.2. Data acquisition.....	24
2.3. Methodology	25
Chapter 3: Spatial Structure and Socio-economic Characteristics of Tehran	29
3.1. Spatial structure of CBD and socio-economic characteristics	29
3.2. Spatial structure and socio-economic characteristics of the urban zone.....	33
3.3. Spatial structure and socio-economic characteristics of the suburban zone	35
Chapter 4: The Spatial and Temporal Distribution of Accidents in Tehran.....	37

4.1. Temporal distribution of UTAs.....	37
4.2. Spatial distribution of UTAs	57
4.3. Hot spots over time	63
4.4. High-risk areas	68
4.4.1. High-risk areas by land use.....	68
4.4.2. High-risk areas by population density.....	78
Chapter 5: UTAs by Zone.....	82
5.1. UTAs in the CBD Zone of Tehran.....	82
5.1.1. CBD by time	85
5.1.2. CBD by road type	90
5.1.3. CBD by accident type	90
5.2. UTAs in the Urban Zone of Tehran	92
5.2.1. Urban zone by time	95
5.2.2. Urban zones by road type.....	100
5.2.3. Urban zones by accident type	101
5.3. UTAs in the Suburban Zone of Tehran.....	101
5.3.1. Suburban zone by time.....	105
5.3.2. Suburban zone by road type.....	110
5.3.3. Suburban zone by accident type.....	111
Chapter 6: Spatiotemporal Analysis of Tehran UTAs.....	112
6.1. Introduction.....	112

6.2. Drivers of culture and knowledge in Tehran UTAs.....	113
6.3. Spatiotemporal pattern of UTAs in Tehran.....	117
6.4. Spatiotemporal analysis of CBD UTAs	135
6.5. Spatiotemporal analysis of urban zone UTAs.....	138
6.6. Spatiotemporal analysis of suburban zone UTAs.....	139
Chapter 7: Conclusions	141
Acknowledgments	148
References.....	149
Appendix.....	159

List of Tables

Table 4-1: Monthly distribution of Tehran's UTAs (2011).....	43
Table 4-2: Daily distribution of Tehran's UTAs (2011).....	45
Table 4-3: Hourly distribution of Tehran's UTA (2011).....	48
Table 4-4: Ranking hot risky zones cluster by land use.....	76
Table 4-5: UTAs by land use over time.....	77
Table 4-6: Ranking hot risky zones cluster by population.....	81
Table 5-1: CBD accidents by road type and accident type.....	84
Table 5-2: Urban zone accidents by road type and accident type.....	94
Table 5-3: Suburban zone accidents by road type and accident type.....	104
Table 6-1: Summary of questionnaire results (2015).....	115
Table 6-2: Statistics of hotspots.....	123
Table 6-3: Number of hot spot by land use category.....	126
Table 6-4: Qualification of UTAs by land use.....	130
Table 6-5: Qualification of UTAs by zones.....	131
Table 6-6: Qualification of UTAs by road type in 3 zones.....	132

List of Figures

Figure 1-1: The location of Tehran province and study area.....	7
Figure 1-2: Tehran districts.....	8
Figure 1-3: Tehran transportation road network (2011).....	9
Figure 2-1: Research flow chart.....	27
Figure 2-2: Tehran zones classified.....	28
Figure 4-1: Hourly variation in UTAs type (2011).....	49
Figure 4-2: Spatial distribution of UTAs over time (0:00 – 6:00).....	50
Figure 4-3: Spatial distribution of UTAs over time (6:00 – 12:00).....	51
Figure 4-4: Spatial distribution of UTAs over time (12:00 – 18:00).....	52
Figure 4-5: Spatial distribution of UTAs over time (18:00 – 0:00).....	53
Figure 4-6: Variation of UTAs by season, month and day by zone.....	56
Figure 4-7: Spatial distribution of damaged UTAs.....	60
Figure 4-8: Spatial distribution of injured UTAs.....	61
Figure 4-9: Spatial distribution of fatal UTAs.....	62
Figure 4-10: Hot spots of accidents (7:00-09:00).....	66
Figure 4-11: Hot spots of accidents (12:00-14:00).....	66
Figure 4-12: Hot spots of accidents (14:00-16:00).....	66
Figure 4-13: Hot spots of accidents (18:00-20:00).....	66
Figure 4-14: Tehran traffic map.....	67
Figure 4-15: Tehran geocoded land use (2011).....	74
Figure 4-16: Tehran accidents by land use plot (7:00 - 9:00).....	75
Figure 4-17: Tehran accidents by land use plot (12:00 - 14:00).....	78
Figure 4-18: Tehran accidents by land use plot (14:00 - 16:00).....	78

Figure 4-19: Tehran accidents by land use plot(18:00 - 20:00).....	78
Figure 4-20: Accidents by 1000 population (7:00-9:00).....	80
Figure 4-21: Accidents by 1000 population (12:00-14:00).....	80
Figure 4-22: Accidents by 1000 population (14:00-16:00).....	80
Figure 4-23: Accidents by 1000 population (18:00-20:00).....	80
Figure 5-1: CBD structure and UTAs.....	83
Figure 5-2: Hourly variation in number of UTAs in CBD.....	88
Figure 5-3: Urban zone structure and UTAs.....	96
Figure 5-4: Hourly variation in number of UTAs in urban zone.....	98
Figure 5-5: Suburban structure and UTAs.....	102
Figure 5-6: Hourly variation of UTAs in suburban zone.....	108
Figure 6-1: Accidents by a) month, b) day and c) hour in Tehran's zone.....	119
Figure 6-2: Hourly variation of UTAs by zone a) CBD, b) urban zone and c) suburban zone.....	120
Figure 6-3: UTAs pattern through US.....	133

List of Photos

Photo 5-1: Accident in CBD zone, Tohid St, Toward Tohid Square, 2:15PM.....	89
Photo 5-2: Accident in CBD zone, Navab Highway, Close to Jomhoori Square, 8:30AM	89
Photo 5-3: Accident in urban zone, Azadi St. 4:00PM.....	99
Photo 5-4: Accident in suburban zone, Babaie highway, 11:40AM.....	109
Photo 5-5: Accident in suburban zone, Jadeh ghadim, 9:25AM.....	109

Abbreviations

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