

Analysing the Principles of Urban Road and Structural Design Effective in Reducing Traffic Accidents and Traffic Amount

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Abstract

The main purpose of this research is to study the principles of urban road and structural design effective in reducing traffic accidents and amount of traffic (case study: old fabric of Zanjan city). This research is a descriptive correlational study. The statistical population of the research, including citizens of Zanjan city, were 202 people 135 of whom were selected as samples according to the Cochran's sample size formula. The 135 questionnaires were distributed and analysed. A questionnaire based on research dimensions and model was used to collect data. To examine the hypotheses and find the answers to the research questions, various tests such as Kolmogorov-Smirnov test (to check the normality of the variables), and Pearson correlation (to investigate the relationships between variables) were used. Analysis of data collected was carried out using SPSS software. The results of the hypotheses test indicate that there is a positive and significant relationship between the principles of urban road and structural design and reduction of traffic accidents and amount (Zanjan case study).

Keywords: Traffic accidents; Zanjan city; Traffic; Design principles

Introduction

The aim of this study is to design the Zanjan central part roads network, in order to reduce traffic flow caused by the lack of proper design of the roads network, and lack of principles of urbanization, that is to resolve the problems of urban traffic in the central part of Zanjan city, which are due to the lack of suitable road network. Innovation of this research is the use of Axwoman plugin in the GIS environment prioritizing roads design in urban fabric. Accordingly, knowledge of the status of urban roads (in this research in Zanjan) is necessary in terms of connection, road width and capacity, compatibility with adjacent applications, access hierarchy, and existing traffic. This would be effective and necessary in correcting the poor roads of Zanjan city, which leads to the creation of traffic nodes in normal status and, naturally, the emergence of a crisis in abnormal status.

In the present study, we analyse and examine the principles of urban road and fabric design effective in reducing traffic accidents and amount of traffic in the old fabric of Zanjan and introduce relevant solutions at the end.

Statement of the problem

Communication networks of a city play the role of vital arteries for it and are considered as one of the main and important determinants of urban development projects. The importance of the communication network in urban design is such that they cannot be distinguished from one another, because all of residents' activities of a city including commercial, cultural, administrative, social activities and so on depend entirely on the communication network of the city. Therefore, any design in the city has to be done simultaneously with the consideration and design of its rational and reasonable communication network. However, it can sometimes be seen that designers, by ignoring the primary principles and rules of the communication network in their design, cause disturbance and rupture in the urban structure and, in addition to unrecoverable economic losses, create many social-traffic problems. The results of the studies show that the massive amount of movements in the cities (which pass through or end to the city center), poor accessibility and inappropriate structure of the city transportation network, the spatial location of land uses, the excessive density of the city center, the lack of coherence in pedestrians and vehicles traffic, and the existence of many traffic nodes all contribute to the increment of cities social-traffic problems. Therefore, in this study by examining the

status, the road network in Zanjan and how the transportation through them is and studying high traffic streets with high traffic at certain times are investigated in two aspects. The first aspect is the pathology of road network type In terms of accessibility such as primary and secondary networks and the amount of traffic in them given the network capacity. The second aspect includes examination of the causes and factors of creating traffic in troubled networks and finally providing a plan and solution to reduce traffic problems caused by traffic nodes emerged by poor roads design. In this research, we study the principles of urban road and fabric design effective in reducing traffic accidents and amount of traffic. In fact, in this research, we seek to answer the question of how well the principles of urban road and fabric design are effective in reducing traffic accidents and amount of traffic in old structure of Zanjan.

Importance and necessity

The issue of transportation and traffic, which today, as a political-social phenomenon, plays a very important and critical role in the socio-economic structure and qualification of a society, forms the basis of the modern urban life and the human movement requirements. Modern, civilized human needs to know where the development of the transportation system goes, and if he/she neglects the application and utilization of the principles of urbanization and traffic, it will inevitably make the present and future generations facing with many dangers.

Goals

Aim

Analysis of the principles of urban road and structural design effective in reducing traffic accidents and amount of traffic in old structure of Zanjan.

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Objectives

1. Analysis of the structure of the central part of Zanjan communication network in terms of urbanization using the road design principles in urban planning.
2. Study of the roads network and traffic condition and volume of vehicles in current situation in the area studied.
3. Identifying the formation of a city structure and its affects by the formation of streets.

Questions

Main question: To what extent there is a relation between the principles of urban road and structural design and reduction of traffic accidents and amount of traffic in old structure of Zanjan?

Sub questions: To what extent there is a relation between the vehicle traffic and the reduction of accidents?

1. To what extent there is a relation between formation of the urban fabric, and traffic and the reduction of accidents?
2. To what extent there is a relation between urban planning, and traffic and the reduction of accidents?

Hypotheses

Main hypothesis: There is a relationship between the principles of the urban road and structural design and reduction of traffic accidents and amount of traffic in old structure of Zanjan.

Sub hypotheses: There is a relation between the vehicle traffic and the reduction of accidents.

1. There is a relation between formation of the urban structure, and traffic and the reduction of accidents.
2. There is a relation between urban planning, and traffic and the reduction of accidents.

Methodology

The present research is an applied research in terms of purpose, and a descriptive-analytical research in terms of the nature and methodology. We collected Part of the theoretical information through library studies, and the use of documents, records and reports. The statistical population of this research, based on its subject and purpose, is the central area of Zanjan city. In order to get knowledge of the mentioned area, the studies conducted by the master plan consultant (including how to use lands and zoning related to the residential, industrial, commercial, administrative and agricultural domains; general installations, equipment, and facilities of renewal areas; upgrading and related priorities; defining the measures and regulations related to all cases; as well as how to use urban lands in different neighbourhoods of the city and the exact location and area of the land for each of them; the precise and detailed conditions of the traffic network and the density of population and buildings in urban units; priorities related to the upgrading and renewal areas; development and resolving urban problems; and the position of all the various urban factors), as well as field observations and acquisitions have been used.

Statistical population

The statistical population in this research is the central part of Zanjan city including 202 people, which using Cochran formula, the sample size reached to 135 people.

Literature and Background

Research background

Lotfi and Bakhtiari presented an article titled "Organizing movement system in the context of urban neighbourhoods through the analysis of the connectivity principle in the new urbanism movement by the use of space syntax method" [1]. This research tries to provide an expandable method for analysing and organizing the cities communication network by applying the connectivity principle to the new urbanism and by the use of space syntax method as well as utilizing GIS. Assessment of the connectivity principle shows that the city communication network has a relatively good connectivity, which, of course, reduces for vehicular case. The comparison of the results of the connectivity analysis based on the explained criteria and the analysis of the city spatial structure by space syntax method on one hand, and field observations, on the other hand, show that in the space syntax method the results will be closer to the reality due to the consideration of the communication network to the whole city's spatial structure. In other words, what is important is to consider the worn out and historic fabric to the whole urban system. In addition, given the traffic problems in the central part of the Kashmar, it can be concluded that the connectivity is just one of the factors affecting the network performance in roadways and walkways, fluid motion, as well as the development and promotion of walking. Note that other factors related to the network also effect on this issue that they can be combined with the quantitative criteria of the connectivity.

Kazemi nia and Parizi, present an article called "Assessing the power of urban roads network and designing the most suitable geometric roads network with a crisis management approach using GIS" [2]. This research was carried out with the aim of assessing the urban roads network against crises in the district 6 of Kerman, with an earthquake approach. Kerman is vulnerable to earthquakes due to its geographical location and old structure. This research, therefore, tries to assess the process of empowering urban roads network for crisis management using spatial information systems. For this purpose, the vulnerability of the roads network was first examined. Parameters that could play a role in the vulnerability and destruction of the roads during the crisis were considered for the assessment of the district 6 of Kerman roads network. These parameters include indices of roads proximity to the vulnerable infrastructures, building characteristics (buildings date, number of floors or building height and type of building usage), and roads indices (slope, length, width, number of intersections, Existence of bridges and so on). Each of these indices were weighted according to the AHP method and, then, modelled in the GIS environment, and finally, using the analytic functions, the vulnerability map of the roads of studied area was prepared. After determining the vulnerability of the roads network, a Geo-referenced database was designed for urban roads to provide faster evacuation and services for injured people at or after the crisis. The roads geometric network of the district 6 of Kerman was finally created. The results indicate that the vulnerability of the roads network of the studied area (except in new areas) is more than moderate and mostly high. The vulnerability of the roads network in area 1 and 6 of the district under study is more evident, thus having priority in planning.

Asadi and Pakzad in their study, "Accessibility Pathology in the Qazvin old structure (Case Study: Akhond neighbourhood)", write: Access networks are one of the most influential factors in creating the structure and main skeleton of cities, which need to be updated and adapted to their time and place conditions in any time interval due to

changing the needs of the residents [3]. If the access networks, as the vital arteries of the city, are organized, urban structure can survive and allow the city to grow and develop further and further. Undoubtedly, one of the most important problems of urban old structures is the inefficiency of the communication network. Low-width, entangled, and non-engineering roads inconsistent with access needs, in addition to making it difficult for residents to come up and access to the fabric, it also make difficult to provide urban services and facilities. Given the undeniable role of communication network in redesigning and organizing urban worn out structures, the presentation and compilation of any plan in this regard requires the application and observance of the principles and rules of the communication network design such as physical and visual permeability, urban roads hierarchy, longitudinal and transverse sections etc. Over all, the current surveys show disadvantages of the studied area and, using the results, provide the necessary solutions and suggestions to resolve the problems of the roads system. These suggestions can be of planning type and, accordingly, the following interventions can be designed. These measures, however, should be under the supervision of the transportation system and traffic engineers and, in general, can be provided with the cooperation of planning managers, urban designers, transport and traffic managers and managers of the organizing plan of the Qazvin old fabric roads network.

Jennifer Dill provided a useful examination of the connectivity measurement methods by measuring the network connectivity for bicycling and walking in Portland, Oregon area [4]. These measures were block length, block size, block density, intersection density, street density and connected nodes ratio, link to node ratio, grid pattern, pedestrian route directness, effective walking area, gamma index and alpha index.

Steiner et al. also introduce units for measuring connectivity and state the analysis tools and standards of these units for optimal connectivity in their study. In the next step, they evaluate the connectivity of two neighbourhood units in the Florida using these measures (one by grid network and the other by curved network having ratios [5]. Given the standards defined in the connectivity article, the grid network is achieved far above the curved network.

In their paper on Street Connectivity Measurement, Berrigan, Pickle and Dill also calculated values of nine variables (link to nodes ratio, interconnection density, street network density, connected node ratio, block density, median block length, average block length, gamma index and alpha index) for each buffer [6].

Testing the hypotheses

After describing variables and the responses obtained from the statistical population in this section, we address examining the hypotheses and the statistical testing used in the research. In other words, in this chapter we analyse the findings so that can statistically examine the validity of the hypotheses.

Testing normality of the data distribution

To investigate the normality of distribution of the data related to the research variables, Kolmogorov Smirnov test was used results of which are presented in the following tables (Table 1).

If the significance level of Smirnov Kolmogorov test is greater than 0205, we can conclude that the distribution of data related to the variables is normal. As shown in the table the significance level of the research variables is greater than 0205, so we can say that the distribution of data related to the variables is normal.

Inferential Statistics

Main hypothesis

Hypothesis H_0 : There is a relationship between the principles of the urban road and fabric design and reduction of traffic accidents and amount of traffic in old fabric of Zanjan.

Hypothesis H_1 : There is no relationship between the principles of the urban road and fabric design and reduction of traffic accidents and amount of traffic in old fabric of Zanjan.

Regarding the main hypothesis of the research, the results of Pearson correlation coefficient are shown in Table 2. According to the table, the correlation coefficient between the principles of the urban road and fabric design and reduction of traffic accidents and amount of traffic at the level of $p < 0.0205$ is equal to 02331 ($r = 0.2331$), which is statistically significant. Therefore, considering $\text{sig} = 0.02012$ in the Pearson test, the hypothesis H_0 is not approved and the hypothesis H_1 is approved, that is there is a significant relationship between the principles of the urban road and fabric design and reduction of traffic accidents and amount of traffic (Table 2).

First hypothesis

Hypothesis H_0 : There is a relation between the vehicle traffic and the reduction of accidents.

Hypothesis H_1 : There is no relation between the vehicle traffic and the reduction of accidents.

Regarding the first hypothesis of the research, the results of Pearson correlation coefficient are shown in Table 3. According to the table, the correlation coefficient between the vehicle traffic and the reduction of accidents at the level of $p < 0.0205$ is equal to 02113 ($r = 0.2113$), which is statistically significant. Therefore, considering $\text{sig} = 0.02031$ in the Pearson test, the hypothesis H_0 is not approved and the hypothesis H_1 is approved, that is there is a relation between the vehicle traffic and the reduction of accidents (Table 3).

Second hypothesis

Hypothesis H_0 : There is a relation between formation of the urban fabric, and traffic and the reduction of accidents.

Hypothesis H_1 : There is no relation between formation of the urban fabric, and traffic and the reduction of accidents.

Regarding the second hypothesis of the research, the results of Pearson correlation coefficient are shown in Table 4. According to the table, the correlation coefficient between the formation of the urban fabric, and traffic and the reduction of accidents at the level of $p < 0.0205$ is equal to 02121 ($r = 0.2121$), which is statistically significant. Therefore, considering $\text{sig} = 0.02003$ in the Pearson test, the hypothesis H_0 is not approved and the hypothesis H_1 is approved, that is there is an inverse relation between the formation of the urban fabric, and traffic and the reduction of accidents (Table 4).

Third hypothesis

Hypothesis H_0 : There is a relation between urban planning, and traffic and the reduction of accidents.

Hypothesis H_1 : There is no relation between urban planning, and traffic and the reduction of accidents.

Regarding the third hypothesis of the research, the results of Pearson correlation coefficient are shown in Table 5. According to the

Variable	Formation	Traffic	Planning
Z	12320	12333	12121
significance level	0224	0261	0253

Table 1: Examining normality of data by Kolmogorov-Smirnov test.

	Design principles	Reduction of accidents
Design principles and Reduction of accidents	Pearson Correlation coefficient	1
	Sig of probability value	02012
	Number	135

Table 2: Correlation co-efficient.

	Vehicle traffic	Reduction of accidents
Traffic and Reduction of accidents	Pearson Correlation coefficient	1
	Sig of probability value	02031
	Number	135

Table 3: Correlation co-efficient.

	Formation of the Urban Fabric	Reduction of accidents
Formation of the urban fabric and Reduction of accidents	Pearson Correlation coefficient	1
	Sig of probability value	02003
	Number	135

Table 4: Correlation co-efficient.

	Urban planning	Reduction of accidents
Urban planning and Reduction of accidents	Pearson Correlation coefficient	1
	Sig of probability value	2001
	Number	135

Table 5: Correlation co-efficient.

table, the correlation coefficient between urban planning, and traffic and the reduction of accidents at the level of $p < 0.0205$ is equal to 02242 ($r = 0.2242$), which is statistically significant. Therefore, considering $\text{sig} = 0.2001$ in the Pearson test, the hypothesis H_0 is not approved and the hypothesis H_1 is approved, that is there is a significant relation between urban planning, and traffic and the reduction of accidents (Table 5) [7,8].

Results of the Discussion

The formation of a city fabric can be directly related to the roads communication network of the city in a two-way relationship as the type of each of these structures is also affected by the formation of streets inside the city. That is why, in this research, the connectivity of the roads network in the central part of Zanjan was investigated. Obviously, what are important from the urban planner's point of view in various structures are motion characteristics and accessibility, roads access network efficiency, impact of the communication network on type of fabric, and other social issues of this kind. Hence, the final goal is to study the principles of organizing roads network in this part of the city in terms of reducing traffic and accidents.

Suggestions

1. We should identify the type of problem and, then, provide appropriate urban planning to solve it.
2. The information obtained should be evaluated, and used in design and formation of roads.
3. Traffic issues have to be evaluated to help reduce accidents.

4. We should take an appropriate action for the design principles by a great deal of research and investigations.

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