TransCad analysis and GIS techniques to evaluate transportation network in Nasiriyah city

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Abstract. Transportation is an essential element for the development of countries economically, socially, and culturally. AL-Nasiriyah is one of the highly congested urban centers within Dhi-Qar province. Network in the city center suffers congestion, particularly during peak hours simply because of the existence of vitality centers (educational, commercial and government). The network is used to assess the flow of the current traffic network patterns through several programs such as the (TransCad, GPS, GIS) so collecting different types of data, such as (Traffic volumes and free flow speed) using a device (MSSS), field surveys is done for the work of large-scale map road network.The results of the evaluation showed that most of the roads in the city have a level of service type (B), as the network showed service-level type (F) at which the vehicle relative to the road capacity (v/c) is greater than one in the city center, such as (Habboubi Street, Nasir bridge, Sumer Street, etc.) as illustrated in analysis map. On the basis of that proposed to add new roads to change path of external - external trips and also add new bridges to get rid of the congestion that appeared in the city center.

1 Introduction

The purpose of transportation is to provide a mechanism for the exchange of goods, information, and to support economic improvements for society, [1]. Transportation provides the means to travel for purposes of employment, exploration, personal fulfillment and is a necessary condition for human activities, such as commerce, recreation, and defense. Travel patterns within the central part of Dhi-Qar are focused on Nasiriyah which provides strong links and good services between Nasiriyah and the other District centers, Al Shatra, Al Rifaai, Suk Shoyukh and Al Jabayish, which are lack good services locally, [2].

Generally road networks comprise of three classes of roads:

- Major arterial: These connect main towns and governorates, they carry mostly long- distance traffic that is either generated in the towns or collected from the rural areas by the secondary and local roads
- Minor arterial: these connect small towns and groups of villages and link these areas into the primary road network.
- Collector roads: these connect the more lightly-populated rural areas into the secondary and primary road network. They also provide access to individual plots such as farms and homes, usually these roads are unpaved or poorly paved.

2 Case study

AL-Nasiriyah is the capital city of Dhi-Qar Province. It is located between latitude (30°40' 00" to 32° 00' 00") north and longitude (45°40' 00" to 47°10' 00") east and is located at zone (38 N) according to UTM (Universal Transverse Mercator) geographic coordinate system. The area of Dhi-Qar is (12900 sq. km) representing 3% of the total area of Iraq. Most of it is very fertile producing various agricultural crops. The governorate is famous for its Marsh area (Haur Al-Hammar). That means the governorate has economic importance in terms of agricultural and tourism potential, the latter including both natural and historical/ archaeological tourism as illustrated in Figure 1, [3, 4].

There are four main roads which link Nasiriyah with the other four Qada centers: (1) Nasiriyah – Ur (recently paved, single carriageway, with no proper shoulders), (2) Nasiriyah Bathaa (moderate condition) parts of these two roads run parallel to the Nasiriyah-Bathaa railway, (3) Nasiriyah Suk Shoyukh (moderate single carriageway with no proper shoulders), (4) Nasiriyah Sayid- Dakhil (dual carriageway, well paved with no traffic signs, part of the road currently damaged due to wars and conflicts).

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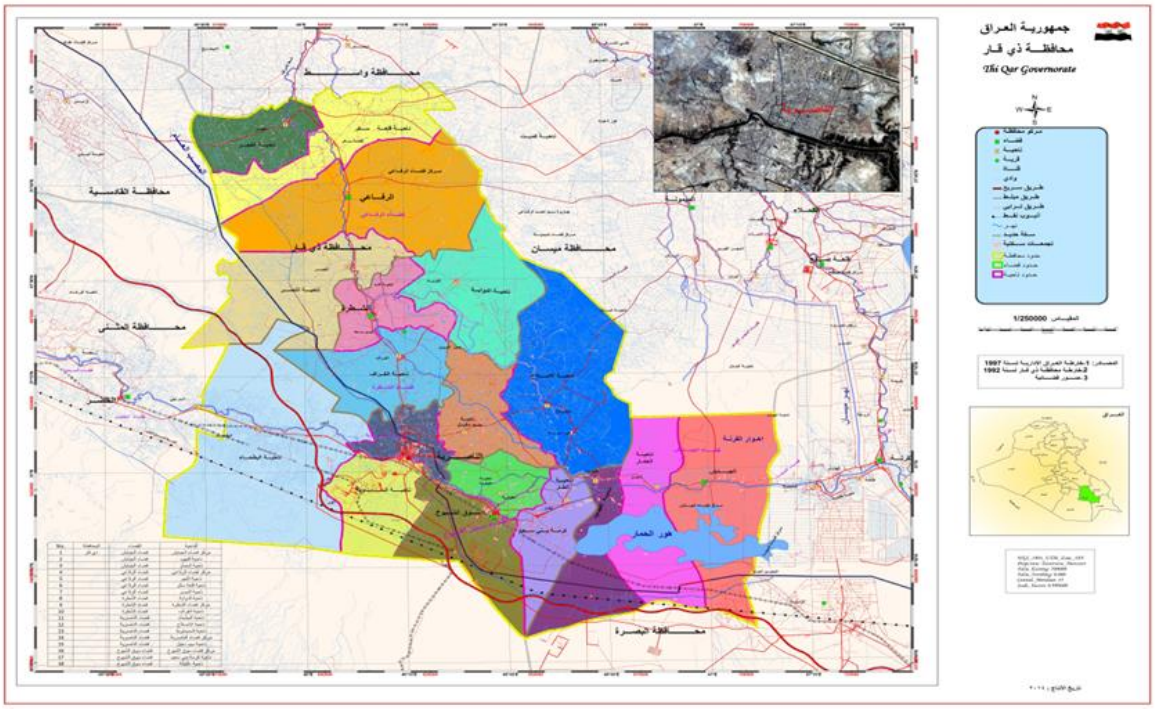

Fig.1. The Map of Thi-Qar Governorate

3 Problem statement

Al-Nasiriyah city as many other Iraqi cities has no comprehensive published studies in transportation planning, or traffic management plans, [5], taking into account the annual growth in population, employment and car ownership that effects on the daily activities, to become represent a burden increases day after day. Transportation engineers usually face the problem of how to reproduce information from field survey. This process is to create predictive statistical models that describe the behavior and relationship of the phenomenon und reconsideration. Practically, it is not easy to develop a model from field data, because the reality that many phenomena are non-linear and/or collinear or it's a difficult to derive a model.

4 Aim of study

Given this context, the aim of this research is to evaluate Al-Nasiriyah city transportation system by applying a transportation planning process and mitigate the challenges mentioned above. The main objectives are:
- Gathering information pertaining to the transportation system in the province to facilitate the tasks of the decision-maker for the development of this network
- Analyzing the existing traffic situation of Al-Nasiriyah City based on a reliable traffic count.
- Modelling and building the road network of Al-Nasiriyah City using a suitable transportation planning software.
- Preparing traffic data base including as follows:
- Vehicle movements survey on both external and internal ambit
- Count and classify vehicles on the internal road network
- Survey peak time for the entrance to the city

5 Traffic survey method

Mobile Speed Safety System (MSSS) was used to determine the size of each traffic congestion survey areas of the stations registered within the city boundaries Figure 2 illustrated this device, [6].

Mobile Speed Safety System (MSSS) is based on Sense's' multi-racking radar, capable of tracking multiple vehicles simultaneously, uses a lobe that oversees several lanes up to 150 meters deep. Vehicles moving within that cone are tracked and their movements analyzed.

Speed is determined through Doppler and checked by distance over time, the advantages and benefits of this device are [7]:
- High-resolution digital images
- Continuous speed verification by applying two independent methods
- Provides information about time, date, location, vehicle speed, speed limit
- Uses Senses' unique multi-tracking radar
- Tracks and measures each vehicle more than 20 times per second
- Triggers at an adjustable speed limit and report line

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Fig. 2. Mobile Speed Safety System (MSSS)

6 AL-Nasiriyah city traffic volumes

The most important points in a position were chosen to control the surveys to the center of the city where these points distributed as shown in the Figure 3. These five stations were observed surveys using MSSS device

The major traffic Volume getting into the Al-Nasiriyah city is through the internal zone station EN2, Figure 3 explains the internal zone stations for the traffic survey around the city center especially concerning the passing traffic leaving the center to the other areas, and Table 1 and Figure 4 show the traffic flow. From all of that, it is found that the city center generating more attraction than with ratio 21%, also the traffic flow leaving the city center is about 61% of the whole traffic flow passing the city center of AL Nasiriyah city.

Fig. 3. Satellite image (Quick bird resolution 50 cm) illustrating Locations of observing points in the city center

Table 1. Traffic Volume through city centre

Observing points	Out of center (veh.)	To center (veh.)	Total (veh.)
En1	6308	6267	12575
En2	24640	1106	35705
En3	5433	3406	8839
En4	7272	5221	12493
En5	4090	4857	8957

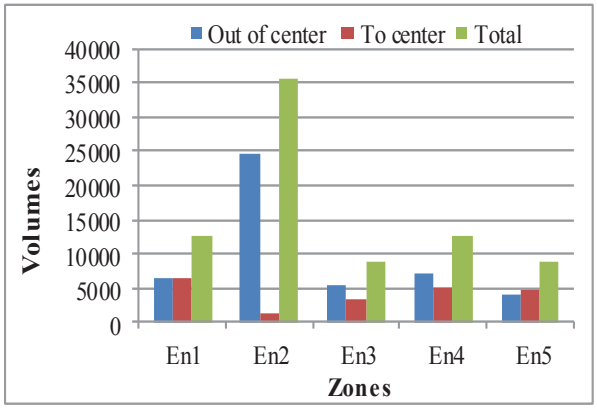

Fig. 4. Distribution of traffic flow towards city center

7 Type of traffic composition internal traffic volume

Most ratios of vehicle type were nearly kindred and steady through the traffic flow passing every station from the internal zone stations around AL Nasiriyah city center , and the major part is for the saloon private cars with 51% of the passing vehicles in the city center, and about the same ratio for the vehicles leaving the center 50%, followed by the taxis 14% of all the vehicles traffic flow, but the mini buses recorded 13% of the vehicles traffic flow getting into the center , and 19% for the vehicles leaving the center , totally its forms around 16% of the whole volume vehicles traffic flow for the city center , this is shown Table 2 and Figure 5.

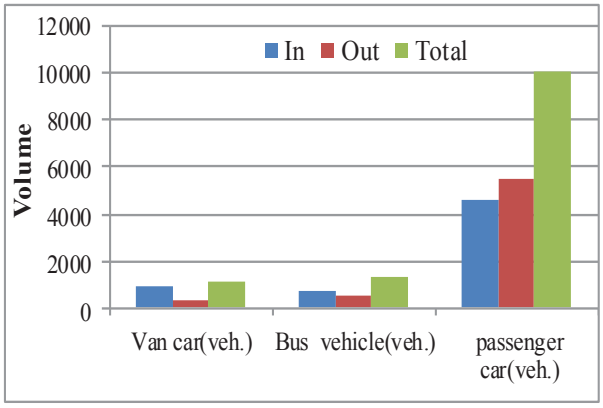

Fig. 5. Distribution of vehicles in traffic volume throw internal cordon station (En1) for Example

8 Data input

8.1 Data Base of Links Shape File

The database of Al-Nasiriyah road network was taken from the Directorate of AL-Nasiriyah Municipality (GIS unit) while the others are obtained by observation or measuring them. Mainly three types of attribute data were collected.

Table 2. Distribue infernal Traffic volume by vehicle type

Entrances		Passenger car (veh.)	Bus vehicle (veh.)	Van car (veh.)
En1	To center	4640	737	890
	Out of	5474	552	282
	Total	10114	1289	1172
En2	To center	8565	1691	810
	Out of	16181	6913	1546
	Total	24746	8604	2356
En3	To center	4075	858	500
	Out of	6711	1153	975
	Total	3306	937	978
En4	To center	4494	1549	1229
	Out of	7800	2486	2207
	Total	2125	1680	1062
En5	To center	2289	1219	582
	Out of	4414	2899	1644
	Total	21272	5340	4215

The First data were descriptions attributes, which give the descriptions like roads (length, width, number of lane, speed limit, and capacity etc.), the Second data was cost attributes, which play the essential role in the analysis of road to found the optimal route location, the cost of length of road in meters and cost of time (drive time) in minutes.

Attributes

Finally, third was the restriction attributes, which also have the main role accompanying cost attributes. This attribute data include restriction values like one-way and no entry road (closed road). Table 3 shows part of these attributes, [8, and 9]. Account access through each time has been through the equation (time = distance / speed) and speed were taken from the municipality to the specific speed of each road has been the application of the equation, in reality, There was no significant difference, [9].

8.2 Data Base of Nodes Shape File

The database of nodes layer contained the number and the geographic coordinate of node (Easting and Northing) this is shown in Table 4. Examples of these were inserted in the attributed table of nodes layer. The necessary attribute of nodes is necessary in network analysis and traffic assignment of road network for the study area

Table 4. Part of Nodes and Intersections Attributes

ID	(E)Coordinate (m)	(N) Coordinate (m)
1	614230.088148	3433700.98101
2	614242.397959	3433791.77074
3	614244.155956	3433695.99353
4	614244.380534	3433697.63914
5	614256.785087	3433788.53176
6	614256.892316	3433789.32004
7	614261.040399	3434889.08932

Table 3. Part of Data Set of Links

ID	Link Id	One Way	Length (m)	Time (min)	Speed (km/hr.)	Link width (m)	Capacity (pcph)	Dir.
1	78	FT	65.788	0.131576	30	12	5484	1
2	77		68.085	0.13617	30	12	5484	1
3	671	FT	121.415	0.24283	30	12	5484	1
4	55	FT	65.788	0.131576	30	12	4113	0
5	621	FT	509.413	0.611296	50	10	5484	1
6	841		3.909.19	2.606126	90	12	5484	0
7	128		3.909.19	2.606126	90	12	5484	0
8	137	FT	82.031	0.164061	30	10	5484	1
9	139		4925.325	3.28355	90	12	4113	1
10	4432	FT	60.461	0.120922	30	9	4113	0

9 Performing a traffic assignment

Executing traffic assignments is simple in TransCAD software ver. 4.5. It is preparing the O-D matrix and network files with all the right data included as discussed in previous sections. TransCAD Stochastic User Equilibrium and System Optimum models are utilized for each assignment with a default number of iterations equal 20 per assignment. After each assignment, the output volumes for each link are exported to a new geographic file, [10].

In this study, city has been divided into four zones based on the administrative division of the Department of Municipal and through these divisions was the traffic count field O-D matrix.

9.1 Performing System Optimum Method

The System Optimum assignment assigns trips to the network so that the total travel time for all trips in a network is minimized. In this assignment method, individual travel times are not minimized (as in the UE and SUE assignments), only the total travel time. Individual users may be able to choose alternate routes to reduce their own travel time but only at the cost of increasing the travel times of other travelers by a greater amount and thus the total system travel time. Ultimately, the System Optimum yields a solution whereby congestion is minimized.

10 Analyses

Trips for each O-D pair are then assigned to the links in the minimum path and the trips are added up for each link. The assigned trip volume is then compared to the capacity of the link to see if it is congested. If a link is congested the travel time is adjusted to result in a longer travel time on that link. Changes in travel time means that the shortest path may change. The whole process is repeated several times (iterated) until there is an equilibrium between travel demand and travel supply. Trips on congested links will be shifted to uncongested links until this equilibrium, condition occurs. Trans CAD automatically joins the results table to the attribute table of the street network file and shows this as a new data view on screen.

10.1 Implementation of System Optimum Method in TransCAD

The results of the stochastic user equilibrium assignment model is presented in the Figure (6) and Table (5-A-B) which present part of the of result table that join to the attribute table of the road network.

The v/c ratio is very importance indicators to the level of service of roads. From Figure (6) it can be noticed that: the v/c ratio is divided into ten classes. The links with green color present most of Al-Nasiriyah road network have (v/c) ratio range between (0.00-0.50), level of service A. The yellow and orange colors represent the v/c range between (0.50-0.70) LOS B that includes links approximately 2% from all links, such as (188-521-616-617-628-655-660-724-730-789-791-812-815. etc.).

The links with orange color represent the range between (0.70-0.80) LOS C are (341-651-544-251-285-321-204-709-714-749-693-868-847-849-841). Then there are 1.5% links in Al-Nasiriyah network which has v/c ratio between the range (0.80-0.90) which represent level of service D and the ID for some links (88-91-93-867-980-982-1114-1123) and there are 14 links which have v/c ratio between the ranges (0.90-0.1) which represent LOS E. The Black color represent the range (v/c > 1) which is shown clearly in the city, especially in the center where it appeared in 93 link such as (57-171-179-488-508-575-853-966-1001-1121).

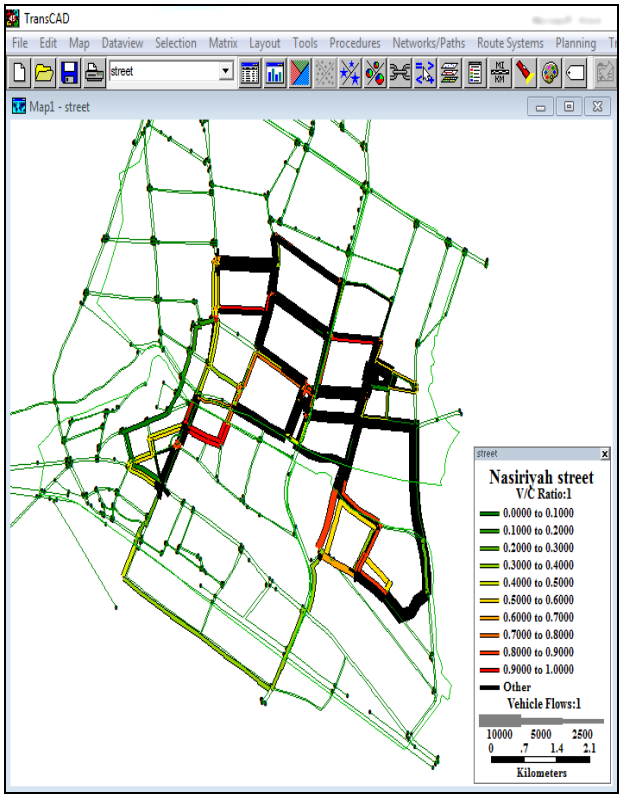

Fig.6. System Optimum Method Assignment Model Result

11 Conclusions

Through the application of System Optimum method for the analysis of the road network and also through traffic surveys that have been applied to the entrances of the city and some of the points in the city center was observed that the concentration of traffic congestion occurs in the city center which is a crowded market and most of the government state departments and this has resulted through the analysis in the program Trans CAD where black color appeared clearly that represents the ratio (v/c> 1.0) in many links almost 100 links specially in city center and which have the type of services of the type F between emerged after the other of the ratios (v/c) then gradually generally in the road network of the of

Nasiriyah city is the type of service level B which represents the ratio (v/c) of (0.40-0.70).

Table (5-a). Part of Data Set of Links Attributes

ID	DIR	One Way	Length m	Time min	Speed Km/h	Link Width	Capacity	Alpha	Beta
33	1	--	939.61	0.96	60	12.00	3984.000	0.15	4
43	1	--	93.54	0.18	30	12.00	3984.000	0.15	4
432	0	FT	281.84	0.33	50	9.00	2813.000	0.15	4
441	1	--	727.69	0.87	50	13.00	4241.000	0.15	4
542	1	--	89.82	0.09	20	9.00	2813.000	0.15	4
698	1	--	898.01	0.89	60	11.50	3255.500	0.15	4
770	0	FT	77.53	0.19	20	9.50	3341.500	0.15	4
814	1	--	564.22	0.67	50	11.5	3341.500	0.15	4

Table (5-b). Part of System Optimum Assignment Model

ID	AB-Flow	BA-Flow	TOT-Flow	AB-Time	BA-Time	Max-Time	AB-VOC	BA-VOC	MAX-VOC	AB-Speed	BA-Speed
33	1722.36	0	1722.36	0.944	0.939	0.944	0.432	0	0.432	35.40	35.58
43	246.05	0	246.05	0.187	0.187	0.187	0.061	0	0.061	30.00	30.00
432	0		0	0.338		0.338	0.000		0.000	21.03	
441	1881.63	1957.89	3839.52	0.142	0.142	0.142	0.443	0.461	0.461	29.85	29.82
542	926.526	1790.42	2716.94	0.059	0.060	0.060	0.329	0.636	0.636	20.02	19.58
698	3756.89	3945.47	7702.36	1.136	1.188	1.188	1.154	1.211	1.211	47.40	45.33
770	0		0	0.142		0.142	0.000		0.000	20.03	
814	182.63	112.473	295.105	0.128	0.128	0.128	0.054	0.033	0.054	20.00	20.00

12 Recommendations

The external- external trips that pass through the network should be changed their path to:
- Rehabilitation of the highway, which passes on the Alholandy Bridge for trips destined for Basra.

- Use the university road for trips destined for the provinces of Al-Muthanna, Karbala and other arterial road as planned as first step and a ring road should be constructed to carry the external trips without pass through the center of the city.

In order to increase the capacity of congested links, on street parking and encroachment should be removed and the carriage way of these links should widened in addition to Traffic Management Measure is required.

New roads should be added to current network and new bridges on the rivers that cross and divide the road network should be constructed as the master plan suggested.

Fig.7. The process of taking photos and survey data during the monitoring process

Fig.8. The MSSS device during the traffic survey

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