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GIS APPLICATION TO EVALUATE TRANSPORTATIONS NETWORK IN NASIRIYAH CITY

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Abstract: Transportation is an essential element for the development of countries economically, socially, and culturally, where the progress in countries is measured through the progress in transportation systems and urban road network .In Iraq, the urban roads network in Nasiriyah city suffer strongly from problems, such as low speed, long travel time, and drop in level of service. Al-Nasiriyah is one of the highly congested urban centers within Dhi-Qar province. Network in the city center suffers congestion, The selected network suffers congestion, particularly during morning and evening peak hours simply because of the existence of vitality centers (educational, commercial and government) that this network uses In the present study was to assess the flow of the current traffic network patterns through several programs such as the Trans Cad), GPS, GIS) has been collecting different types of data, such as (Traffic volumes of intersections and free flow speed) using a device (MSSS), furthermore field surveys 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 the one in the city center, such as (Habboubi Street, Nasir bridge, Sumer Street, etc.) and this 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, reducing the intersections and symptoms as much as possible to reduce congestion, maintenance major road and work to reduce the turns to reduce access time.

Keywords: *GIS, Traffic volume, Purpose of trip, Peak hour, Capacity of road, O-D matrix ,level of service (LOS), Traffic congestion.*

استخدام برنامج Trans cad للتحليل وتقنيات نظم المعلومات الجغرافية لتقييم شبكة النقل في مدينة الناصرية

الخلاصة: النقل هو عنصر أساسي لتنمية الدول اقتصاديا، اجتماعيا، وثقافيا ، حيث يتم قياس التقدم في البلدان من خلال التقدم في أنظمة النقل وشبكة الطرق الحضرية. وفي العراق ، وشبكة الطرق الحضرية في مدينة الناصرية تعاني بشدة من المشاكل ، مثل انخفاض سرعة ، وقت السفر الطويل ، والانخفاض في مستوى الخدمة الناصرية هي واحدة من المراكز الحضرية المزدحمة جدا في محافظة ذي قار. الشبكة في مركز المدينة تعاني الازدحام ، خاصة خلال ساعات الذروة في الصباح والمساء بسبب وجود مراكز حيوية (التعليمية والتجارية والحكومية) التي تستخدم هذه الشبكة ، في هذه الدراسة، تم إجراء تقييم أنماط تدفق حركة المرور الحالية للشبكة عن طريق عدة برامج مثل (Trans Cad ، GPS، GIS) تم جمع أنواع مختلفة من البيانات ، مثل (حجم التقاطعات المرورية وسرعة تدفق الحرة) باستخدام جهاز (MSSS) ، علاوة على ذلك اجريت المسوحات الميدانية لعمل خارطة لشبكة الطرق في المدينة على نطاق واسع.

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أظهرت نتائج عملية التقييم إلى أن اغلب الطرق في المدينة لديها مستوى من خدمة نوع (B) ، كما ان الشبكة اظهرت نوع خدمة من المستوى (F) الذي تكون فيه نسبة المركبات الى سعة الطريق (v/c) اكبر من الواحد في مركز المدينة مثل (شارع الحبوبي ، جسر النصر ، شارع سومر، الخ) وهذا مبين بخارطة التحليل. وعلى اساس ذلك اقترح إضافة طرق جديدة للتخلص من الرحلات الخارجية – الخارجية وأيضا إضافة جسور جديدة للتخلص من الازدحام التي ظهرت في وسط المدينة ، تقليل التقاطعات والعوارض قدر الامكان لتقليل الازدحام ، صيانة الطرق الرئيسية والعمل على تقليل الانعطافات لتقليل زمن الوصول .

1. Introduction

The demand for transport has increased considerably as Dhi-Qar has developed over the past few decades. The transportation system is a road based system, but also has railway lines. 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 not available good services locally [1].

Generally in Iraq and Dhi-Qar, 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

Dhi-Qar governorate is located in the Southern part of Iraq with the Euphrates River flowing through it, The total population of Dhi-Qar was estimated to be 1,716,226 in 2013 The spatial distribution of population, as concluded, indicates that, Nasiriyah District represents the first rank at approximately 36% of the total population, followed by Al Shatra in second and Al Rifaai in third with 22% and 20% respectively. Suk Shoyukh ranks fourth with 15%, and fifth and lowest is Al Jabayish with approximately 4% of the total population[8,9]. The area of Dhi-Qar is 12,900 sq. km representing 3% of the total area of Iraq.

Most of it is very fertile producing various agricultural crops. It could be said, therefore, that the governorate has economic importance in terms of agricultural and tourism potential, the latter including both natural and historical/archaeological tourism [2,3].

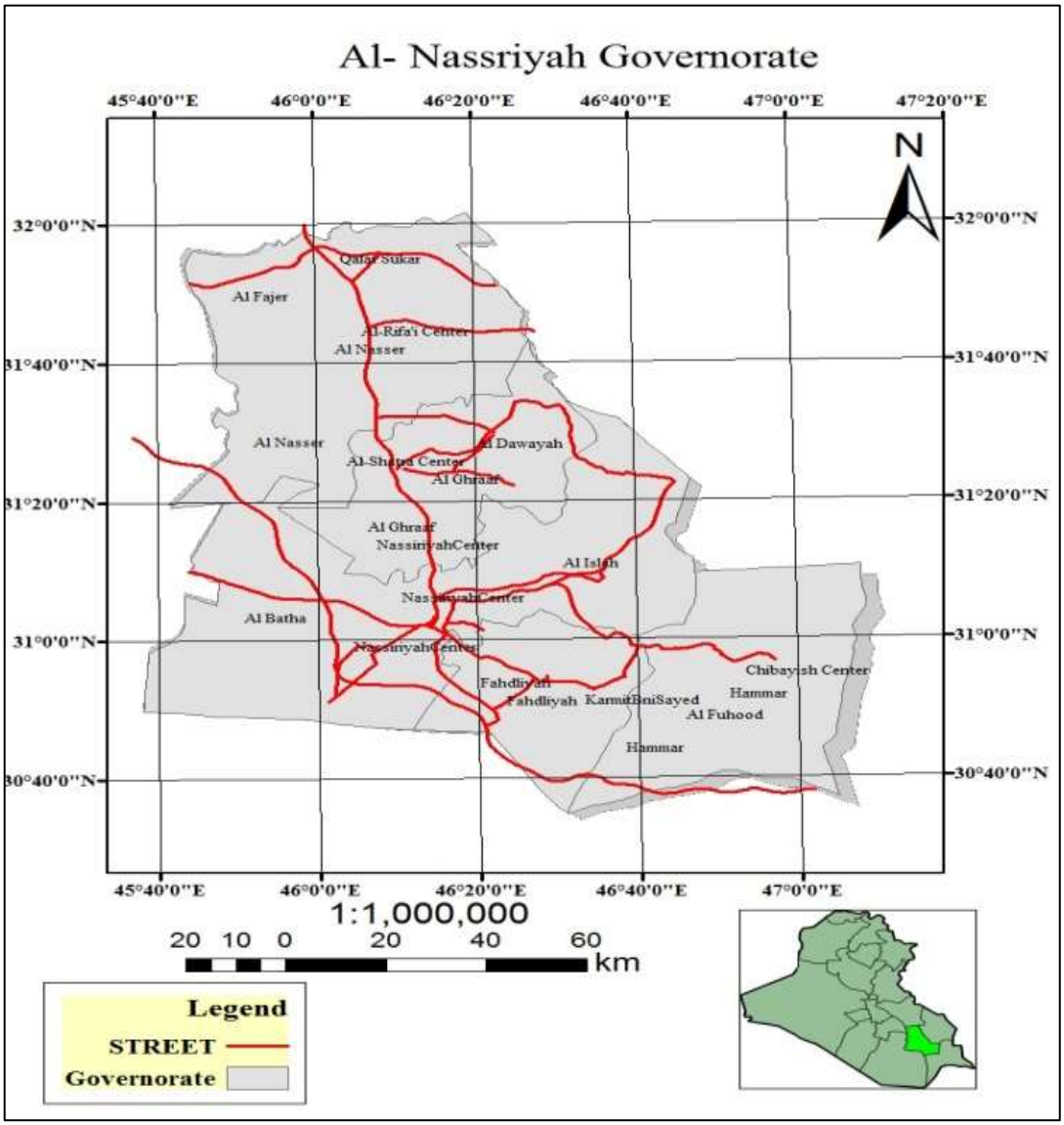

Figure 1. The map of Thi-Qar Governorate

3. Problem statement

Al Nasiriyah city and many other Iraqi cities do not have comprehensive studies of published on transportation planning, or plans for traffic management taking into account the annual growth in population and expected employment increase up to 3.5 million in 2030 and the result is a dramatic increase in demand for transport services which suffer currently from very poor conditions.The recent urban road network badly suffers from problems, such as low speed, increasing congestion and increased travel time, lower the level of service, and increase the level of accident rates, poor road network management as a whole in the absence of studies on the overall level of each city. Where most of the traffic studies are still dealing with individual cases without the existence of a comprehensive strategy to deal with transportation issues. For this reason, the urban road network is used to increase efficiency and that can be achieved through the flow of traffic sound management and this requires a great deal of travel times, travel speed and data delay.

4. Aim of the 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

1.Gathering information pertaining to the transportation system in the province because of the large dispersion to get this system in the current period to facilitate the tasks of the decision-maker for the development of this network

2.Analyzing the existing traffic situation of Al-Nasiriyah City based on a reliable traffic count.

3.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. AL-Nasiriyah city entrance

Al-Nasiriyah city has a six main entrance link it with the traffic came out of the city , represented by the traffic from the hinterland and the traffic from the Dhi-Qar districts and areas as it is the administrative center of the province , besides the traffic came from the province around because it's the node of main way through the south region of Iraq. The first entrance is from north-east or is known as Baghdad entrance EX1 which is the connection axis of the city traffic with the traffic came from the north and the middle of Iraq as provinces of Baghdad Diyala and Wasit. And the second entrance is the north-west EX2 which is the connection axis of the city traffic with the traffic of its region hinterland as Saieed-Dakheel area , while the third and fourth entrances EX3 ,EX4 successively make the same traffic function for the second entrance by connect the city with the traffic come from Ur and Suq Al Shuyoukh.

The fifth entrance (EX5) represent the traffic connection axis of Al Nasiriyah city with Al Basra province, but the last and sixth entrance EX6 link Al Nasiriyah city with AL-Muthannah province,[4] .

6. 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.

6.1. *Mobile Speed Safety System (MSSS)*

Mobile Speed Safety System 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 is[10]:-

- 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

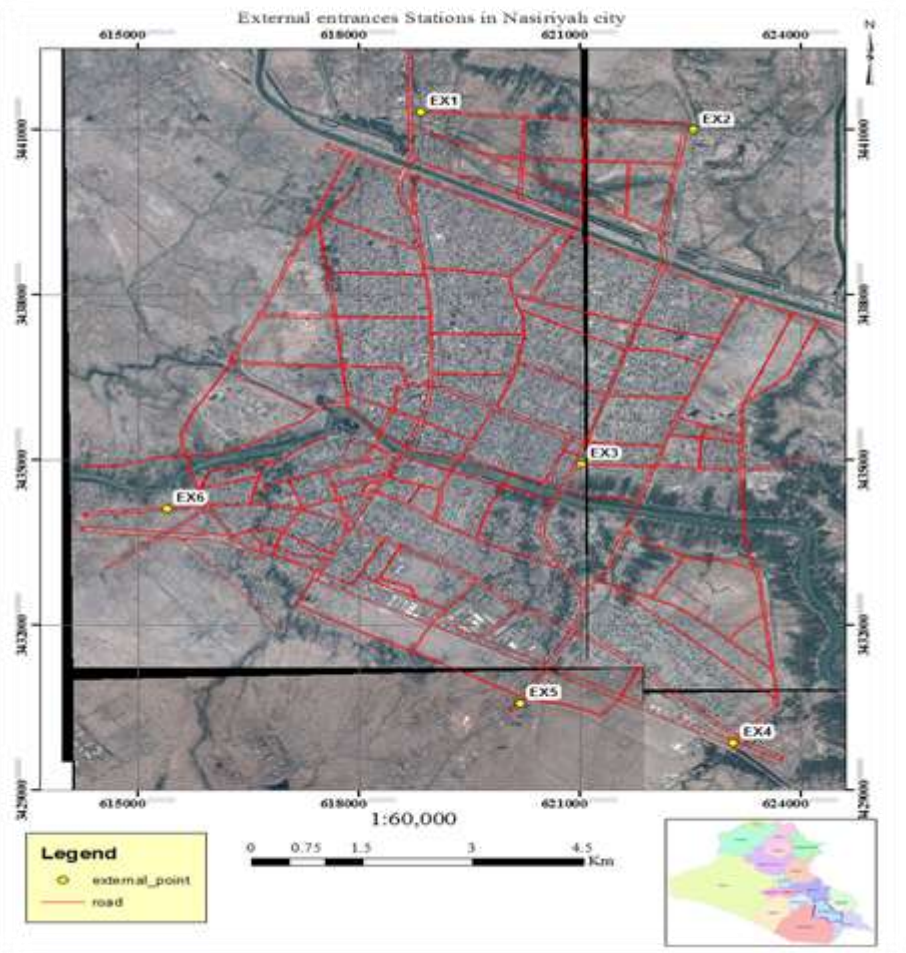

Figure 2. Map Extracted from satellite image (quick bird, resolution 50 cm) explain External entrances Stations in Nasiriyah city

Figure 3. Mobile Speed Safety System (MSSS)

6.2. *Traffic Surveys in City Entrances*

The use of the device (MSSS) to monitor the vehicles at the entrances to the city Surveys conducted from (6 am-6 pm) and three days for each entrance started from (1/2/2016) to (22/2/2016) , were the results of the survey are shown in the following Table (1)

Table 1. Distribute traffic volume by city entrance

Highway entrance Al-Nasiriyah city	Traffic Volume (veh./day)		
	Out to	In to	Total
EX1	7660	18771	26431
EX2	4506	4373	8879
EX3	3413	3860	7273
EX4	9360	9098	18458
EX5	9898	6359	16257
EX6	5686	10160	15846

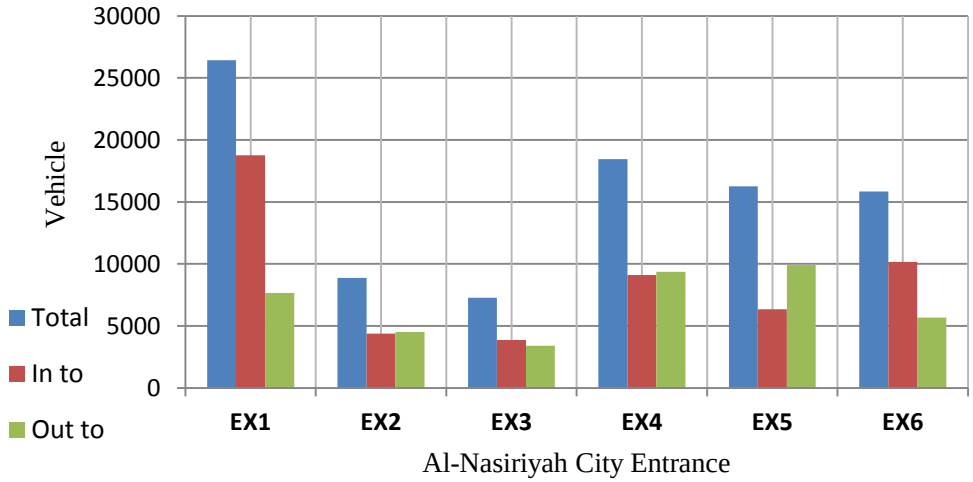

Figure 4. Distribution traffic volume by city entrance

Through (Table 1) and (Figure 1) , show that the more substantial volume of traffic enter the city through Baghdad entrance that represent the main axis movement for the traffic came from Baghdad city towards Al Basra province through Al Basra entrance EX5 that have the more substantial volume of traffic leaving Al Nasiriyah city . From the above mentioned, we can account the outlet traffic volume in the city about 50% from the whole external traffic came from north to the south of the city.

6.3. *The purpose of External Traffic Tripe*

Samples of the questionnaire were Collected from the entrance to the city in order to know the purpose of the trip to determine the most trend areas it, it, The trip purpose for the private work was dominant on the trips distribution type in Al Nasiriyah city

concerning the external traffic flow from and to the city through its main entrances, and it was somewhat balanced, followed by the purpose for governmental work, then for shopping, See Table (2). Also it has been notices repeating of the trip (other) for the with a high ratio for the external traffic towards the city through Baghdad entrance, Saieed-Dakheel entrance, and Sdenawia entrance, due to the existing military base belong to the Ministry of Defense , and because of the general security situation that prevent the travelers from saying the honest information about their trip destination and purpose , as shown in Figure (5) .

Table 2. Part distribution o traffic in city through city entrance according to purpose of trip purpose

Purpose of trip	EX1 %			EX2 %			EX3 %		
	In	Out	Total	In	Out	Total	In	Out	Total
Home	2.3	4.4	6.7	3.4	2.1	5.5	6.7	3.7	10.4
Governmental	5.4	2.0	7.4	4.5	15.4	19.9	8.3	10.7	19
Shopping	2.9	23.4	26.3	13.6	15.4	29.0	4.2	10.5	14.7
Recreation	4.8	0.0	4.8	3.6	7.7	11.3	3.4	0.0	3.4
Private job	34.7	42.4	77.1	12.7	57.7	70.4	40.1	39.2	79.3
Education	16.5	4.5	21	0.9	0.0	0.9	8.7	4.5	13.2
Others	33.9	23.1	57	59.1	3.8	62.9	28.8	31.2	60

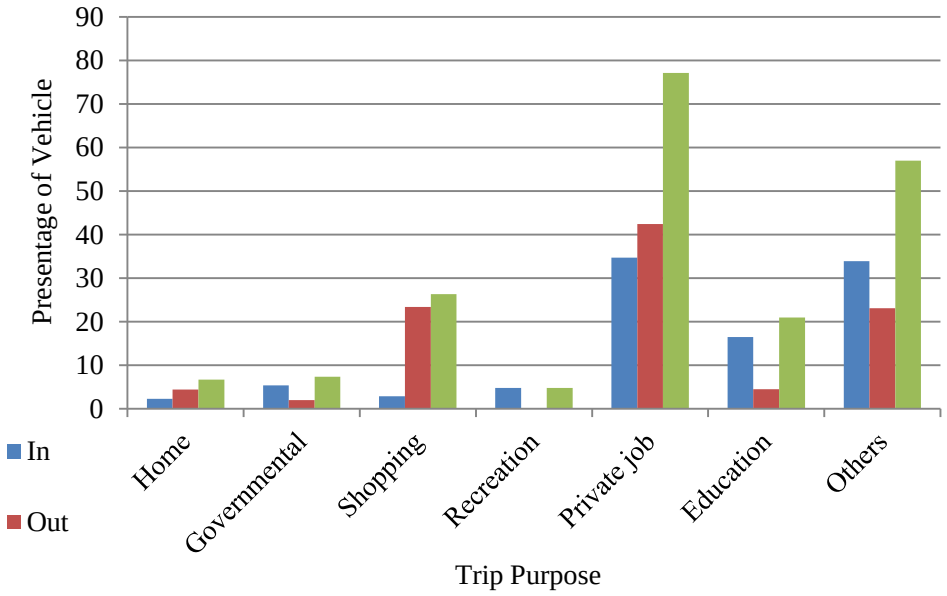

Figure 5. Example for distribution of traffic in city through city entrance due to trip purpose through EX1

6.4. *Traffic load for the external traffic flow of Al-Nasiriyah city*

It has been monitoring the number of vehicles on several days each entrance were recorded observations per hour using the device MSSS , And then were taken average of these observations the date of this observation (1/2\2016) to (3/2/2016),the result are shown in the following Figure (6).

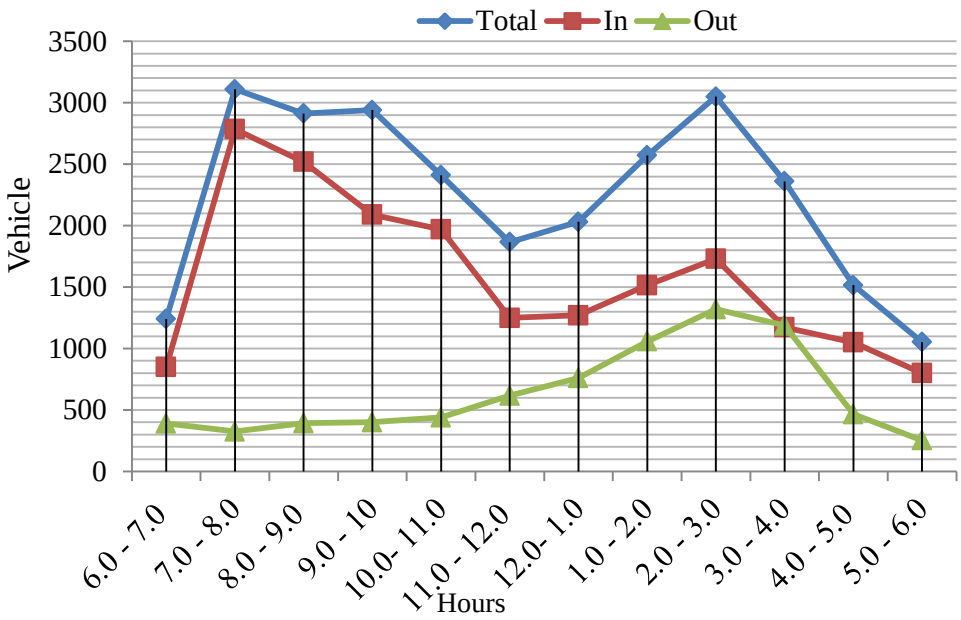

Fig.(6):Peak hour to traffic volume through (EX1) entrance

The peak period for the traffic flowed to AL Nasiriyah city determined through its main entrances (8–9) in the morning , and it has not been noticed any other peak period during the time survey which take twelve hours, and the same peak period determined for all external traffic through city main entrances this shown in Figure (6).

While we found a little differences between traffic peak period for traffic flow through city main entrances , for the two regional entrances EX2, EX4, did not record any variation in peak period through the time survey for the vehicle traffic, but the third regional entrance EX3 determine the time (7:00 – 10:00) in the morning as a peak period for the traffic flow for the vehicle enter the city.

For the entrances that have the traffic came from the around provinces ,determined variations of the peak periods , for Baghdad entrance (7:00-9:00) in the morning as a peak period for the traffic enter the city, and (2:00 - 4:00)afternoon as a peak period for the traffic leaving the city. Al Basra entrance record (8:00 – 9:30) in the morning as a peak period for the traffic leaving the city. And (8:00 – 11:30) in the morning as a peak period for the traffic enter the city for Al Samawa entrance.

7. Data input

7.1. *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. 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. 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.[5,6].

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].

Table 3. Part of Data Set of Links Attributes

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

7.2. *Data Base of Nodes Shape File*

The database of nodes layer contained the number and the geographic coordinate of node (Easting and Northing). Example of these attribute is stated in Table (4), these were inserted in the attributed table of nodes layer. The 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

8. Performing a Traffic Assignment

Executing traffic assignments is simple in Trans CAD 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. Trans CAD 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[6]. In this study, city has been divided into four zones based on the administrative division of the Department of Municipal and through these divisions were the traffic count field O-D matrix

8.1. *User Equilibrium (UE) method*

The first of the three convergent algorithms, the UE assignment assigns trips to a network so that no individual user can reduce their travel times by choosing an Traffic Assignment Models alternate route. It continues to be one of the most commonly used algorithms in the transportation planning industry and transportation research. Its underlying assumption is that travelers choose the route that minimizes their individual travel times and that if they discover a faster route, they will take it – a relatively realistic assumption.

Worth noting that the UE assignment is also an iterative method and that the assignment continues until convergence is achieved or a maximum number of iterations (set by the user) has been performed. The more stringent the convergence criteria, the more iterations required to complete the assignment. The main shortcoming of the UE assignment is that each user is assumed to have perfect information – that they are aware of all possible routes and the congestions conditions of those routes at any given time. It is, thus, unrealistic that real people will ever travel exactly as the User Equilibrium model predicts.[7]

9. Analysis

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.

9.1. *Implementation of User Equilibrium in Trans CAD*

The results of the stochastic user equilibrium assignment model is presented in the Figure (7) and Table (5-a-b) which present part of the of result table that join to the attribute table of the road network.

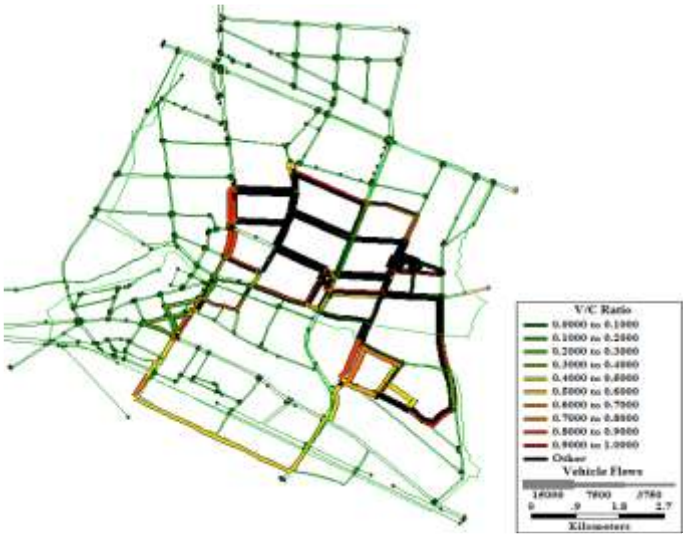

Fig.(7): Stochastic User Equilibrium Assignment Model Result

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
24	1	FT	939.61052757	0.86	60	12	3984	0.15	4
57	1	FT	2994.78399891	2.24	80	12	3973	0.15	4
195	1	FT	507.43083766	0.60	50	12	3984	0.15	4
285	1	FT	1403.35462495	1.05	80	12	4061	0.15	4
369	0	–	116.79917349	0.05	20	9	2813	0.15	4
828	1	FT	1310.69115296	0.98	80	11.5	3255	0.15	4
857	0	–	599.47856534	0.71	50	9.5	3341	0.15	4
1125	0	–	118.81350686	0.23	30	9	2813	0.15	4

Table (5-b). Part of Stochastic User Equilibrium Assignment Model Result

ID	ab-flow	ba-flow	tot-flow	ab-time	ba-time	max-time	ab-voc	ba-voc	max-voc	ab-speed	ba-speed
24	2031.825	0	2031.8	0.948	0.939	0.948	0.510	0.00	0.510	0.764	0.771
57	6332.726	3931.112	10263.8	4.316	2.562	4.316	1.589	0.986	1.589	10.503	17.690
195	749.887	5679.969	6429.8	0.609	1.004	1.004	0.188	1.425	1.425	31.070	18.847
285	2790.688	0	2790.6	1.092	1.052	1.092	0.700	0.00	0.700	43.165	44.797
369	0	0	0	0.851	0.851	0.851	0.00	0.00	0.00	43.506	43.506
828	46	5430.993	10073.4	1.621	1.957	1.957	1.426	1.668	1.668	26.267	21.761
857	0	0	0	0.719	0.719	0.719	0.00	0.00	0.00	31.075	31.075
1125	3832.386	3197.971	7030.3	1.459	1.285	1.459	1.177	0.982	1.177	38.200	43.377

The v/c ratio its very importance indicators to the level of service of roads .From level service it can be notice 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 (0.00-0.40), level of service A.

The yellow and orange colors represent the v/c range between (0.40-0.70) LOS B that is included 69 link such as (82 – 39 – 42 – 47 – 81- 125 – 1145 – 108 – 650), The links with red color present the range between (0.70-0.80) LOS C are 22 link for example (140 – 174 – 188- 321 – 892) in (Rubaie Street, Hospital Street ,etc.), then the ratio range between (0.8-0.9) found 21 link LOS D, and the ratio range between (0.9-0.99) LOS D that is include links (425-493-589-707-761-973-1002-1017-1018) Finally in Al-Nasiriyah road network have (v/c) ratio range (over 1) approximately (100) link specially in city center (Sumer Street , Al- Haboby center, Alnasr bridge , etc.)

10. Conclusions

Through the application of User Equilibrium (UE) 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).

11. Recommendations

1-The external- external trips that pass through the network should be changed their path to:-

A- Rehabilitation of the highway, which passes on the Alholandy bridge for trips destined for Basra,

B- 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.

2- 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.

3-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.

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