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# TRAFFIC PERFORMANCE EVALUATION AND ANALYSIS OF Al-FALLAH INTERSECTION IN BAGHDAD CITY UTILIZING SYNCHRO.10 SOFTWARE

Dr. Abdul-Razzak Tarish Ziboon[1], Dr. Zaynab Ibrahim Qasim[2], Maysam Ali Yousif [3*]

1) Prof., Building and Construction Engineering Department, University of Technology, Baghdad / Iraq.
2) Assistant Prof., Building and Construction Engineering Department, University of Technology, Baghdad Iraq.
3) Engineer, Building and Construction Engineering Department, University of Technology, Baghdad Iraq.

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**Abstract:** Transportation is an essential element for the development of countries economically, socially, and culturally. The progress in countries is measured through the progress in transportation systems and urban road network. Al-Fallah intersection which lies in northeastern of Baghdad city considered one of the highly congested urban centers, suffers congestion, particularly during morning and evening peak hours. The objective of this study is to analyses the delay time, degree of saturation, level of service in Al-Fallah intersection in Baghdad city using Synchro.10 software in addition to evaluate and analyze the intersection for choosing the best suggestion. The technique of video recording has been used for collection the traffic volume data for all approaches from 7a.m to 4 p.m. for three days: Monday, Tuesday, and Wednesday. The operation analysis of isolated signalized intersection provides valuable and important information about the performance of transportation system in the city.The through movements of Al-Fallah Street illustrate the movement from center of Al-Sadir city to Al-Rusafa and reverse, they represent the heaviest traffic volumes in Al-Fallah intersection. The Results of analysis specified that the Al-Fallah intersection works under level of service F with an average control delay of (322.1) seconds per vehicle and degree of saturation (2.56) v/c during the peak hours.

***Keywords**: Synchro 10, delay, peak hour, level of service.*

## تقييم اداء المرور وتحليل تقاطع الفلاح في مدينة بغداد باستخدام برنامج Synchro 10

**الخلاصة:** يعتبر النقل عنصر أساسي لتنمية الدول اقتصاديًا واجتماعيًا وثقافيًا .يتم قياس التقدم في البلدان من خلال التقدم في أنظمة النقل وشبكة الطرق الحضرية .يعتبر تقاطع الفلاح الذي يقع في الشمال الشرقي من مدينة بغداد واحداً من المراكز الحضرية المزدحمة للغاية ، يعاني من الازدحام ، وخاصة خلال ساعات الذروة الصباحية والمسائية .الهدف من هذه الدراسة هو تحليل وقت التأخير ودرجة التشبع ومستوى الخدمة في تقاطع الفلاح في بغداد باستخدام برنامج Synchro.10 لتقييم وتحليل التقاطع واختيار أفضل اقتراح. استخدمت تقنية تسجيل الفيديو لجمع بيانات حجم حركة المرور لجميع المناهج من الساعة 7 صباحًا إلى الساعة 4 مساءً لمدة ثلاثة أيام (الاثنين والثلاثاء والأربعاء). يوفر تحليل التشغيل للتقاطع معلومات قيّمة ومهمة حول أداء نظام النقل في المدينة.. يوضح اتجاه الحركة في شارع الفلاح من وسط مدينة الصدر إلى الرصافة وعكسها ، أثقل أحجام مرورية في تقاطع الفلاح. و أوضحت نتائج التحليل أن تقاطع الفلاح يعمل تحت مستوى الخدمة F بمعدل تاخير ( 317.1 ) ثانية / مركبة ودرجة تشبع v/c(2.11) خلال ساعات الذروة.

*Corresponding Author alabdullahmaysam@gmail.com

## 1. Introduction

The purpose of transportation is to provide a mechanism for the exchange of goods, information, users and to support economic improvements for society. 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 [1]. The congestions have several causes, such as an increase of traffic, which is the inevitability results for increases of population, number of vehicles and equipment. The poor condition of the infrastructure uses the individual transport rather than mass transport. Lastly the existence of services and government centers especially those that deal directly with the public, leads to the state of congestion, [2]. Determining the level of service (LOS) for urban street and intersections is very important, as the first step of analysis procedure, affects the planning, design, and operational phase of transportation projects as well as the allocation of limited financial resources among competing transportation projects, [3].

Many traffic improvement studies are made in different locations in Baghdad city and other countries. One of these studies had evaluated the traffic performance of Al-Ameer signalized intersection in Samawa city, which fits with the prevailing conditions and geometric properties of the intersection. The technique of video recording has used for collecting the traffic volume data for all approaches. These data are abstracted from video films. SYNCHRO 8 software was used to evaluate and analyze the intersection and choose the best suggestion. The evaluation process result showed that the intersection is operated with level of service (LOS F). By suggestion of several strategies which vary from signal optimization to geometric improvements. The best solution has been found by suggestion an overpass at the east-west direction, and the level of service has improved from (LOS F) to (LOS C). [4]

## 2. Case Study

Al-Fallah Intersection is located in Al-Sadir city in the north-east of Baghdad city that is presented in Fig.1. It connects two main roads in Al-Sadir city (Al-Fallah Street and Al-Quds Street). Al-Fallah street Extends from Mosaab Bin Omair to Al-Umal street, it is represented the north-south direction, whereas the east-west direction is represented by the road which extends from Al-Baldiyat to Altalbiya region. Al-Fallah intersection is four legs intersection, the layout of intersection illustrate in Figure.1. The traffic is controlled for all movements to eliminates vehicle-vehicle crossing conflicts. Also, it's consisting in all the approaches of three lanes for thought and left movement and exclusive lane for right turning to accommodate by the intersection. The important reason for selecting this location is the abnormal congestion according to the increase in population and the rapid shift in land use have led to an abnormal increase in trips Generated. The required data are shown in Table .1

Table.1 Roads Structures

| No. | Street Name | Surface | Structure State | Lanes No. | Median width (m) | Width lane (m) |
|---|---|---|---|---|---|---|
| 1 | Al-Fallah Street | Asphalt | good | 3 | 1 | 3 |
| 2 | Al-Quds Street | Asphalt | good | 3 | 7 | 3.3 |

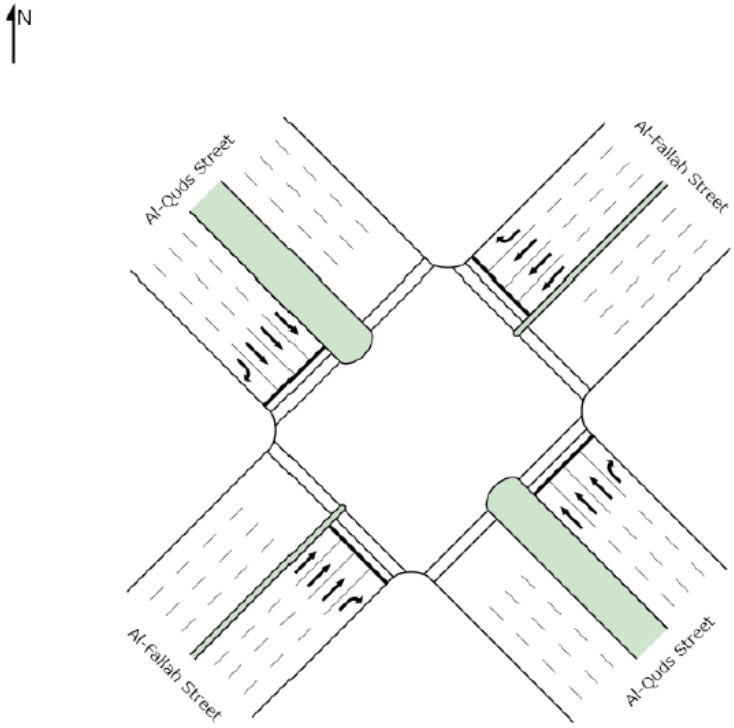


Figure .1 sketch for Al-Fallah Intersection

## 3. Problem Statement

Al-Fallah Intersection is considered as one of the major intersection in Al-Sadir city, it serves more than 15 million vehicles per year. Al-Fallah intersection is signalized intersection, the excessive traffic volume during the peaks hour leads to abnormal congestion. Furthermore, this increased volume leads to reduce speeds due to the entering and heavy traffic and increased travel times.

Beside the psychological effects for the road users and the adverse environmental effects, the long delay values resulting from the oversaturation of the intersection have great economic damage associated with the raised user cost and the vehicle operating cost (fuel consumption and depreciation) and the long delay values resulting from the

oversaturation of the intersection have great economic damage associated with the raised user cost and the vehicle operating cost (fuel consumption and depreciation.

## 4. Research Objective

Al-Sadir city as many other Iraqi cities has no comprehensive published studies in transportation planning, or traffic management plans 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 describe the behavior and relationship of the phenomenon and reconsideration.

The main objectives of this research work are:

1. Analyzing the existing traffic situation of Al-Fallah intersection based on a reliable traffic count.
2. Evaluating the traffic performance at Al-Fallah intersection by the assessment the existing level of service utilizing SYNCHRO 10 Software.
3. Looking for proposals to improve the service level of the intersection.

## 5. Data Collection

To achieve the objective of this study, the necessary traffic volume survey was conducted by video recording for each approach at the intersections in order to determine the traffic volume for all the movement in Al-Fallah intersection, traffic counts had been performed three times during the days of Monday, Tuesday and Wednesday (25,26,27/1/2018) in order to take into consideration the difference in the traffic volume during the weekdays. A period of the count extends from 7am to 4 pm by video recording so as to define the peak hour which represents the single hour of the day that has the highest hourly volume. Each hour divided into quarters in order to identify the traffic pattern and peak hour traffic ranked under the fundamentalist form approved by the State Corporation for Roads and Bridges. In this study, the highest peak hour volume within the days is selected for each movement in the intersection to simulate the worst situation in the capacity analysis of the current intersection. The vehicles speed is measured using SPEED GUN, as shown in Fig. 2. Table.2 and Figure 3 show the traffic volumes for all the movements in Al-Fallah intersection during the counting period from 7 am to 4 pm. peaked in 7-8 a.m.

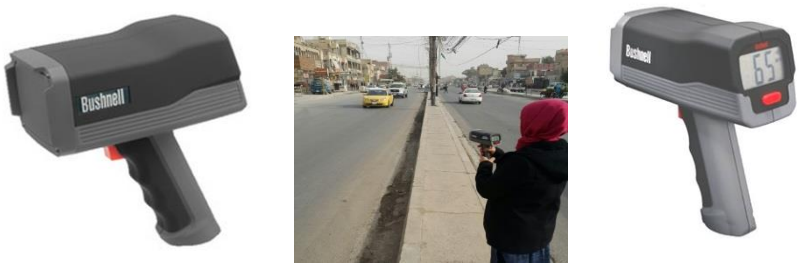


Figure 2: The speed gun using in measuring the vehicles speed

Table.2 Traffic Volume for the Approaches of AL-Fallah Intersection

| Direction | | North Bound | | | West Bound | | | South Bound | | | East Bound | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Movement | L | Th. | R | L | Th. | R | L | Th. | R | L | Th. | R |
| Traffic Volume (Veh/h) | 7- 8 am | 398 | 1768 | 342 | 254 | 822 | 316 | 462 | 990 | 394 | 246 | 962 | 394 |
| | 8 - 9 | 480 | 1705 | 215 | 430 | 1660 | 420 | 306 | 574 | 215 | 142 | 191 | 63 |
| | 9 -10 | 476 | 1330 | 206 | 421 | 1481 | 335 | 301 | 351 | 193 | 116 | 203 | 52 |
| | 10 -11 | 432 | 1560 | 146 | 390 | 1246 | 287 | 295 | 325 | 189 | 123 | 185 | 41 |
| | 11 -12 | 476 | 1412 | 118 | 382 | 1329 | 340 | 286 | 436 | 176 | 141 | 192 | 68 |
| | 12 -1 | 465 | 1456 | 206 | 296 | 1431 | 395 | 300 | 530 | 189 | 135 | 221 | 95 |
| | 1 - 2 | 438 | 1655 | 252 | 285 | 1598 | 329 | 305 | 856 | 296 | 156 | 235 | 86 |
| | 2 -3 | 415 | 1692 | 241 | 309 | 1629 | 306 | 322 | 534 | 214 | 158 | 271 | 93 |
| | 3–4 pm | 391 | 1319 | 120 | 318 | 1480 | 291 | 261 | 441 | 165 | 160 | 280 | 102 |

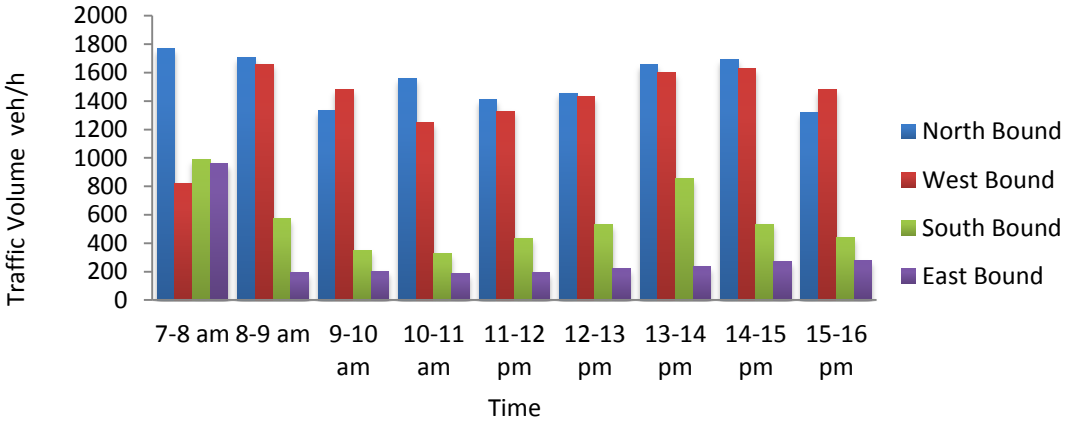


Figure .3 Traffic Volumes for the Approaches of AL-Fallah Intersection

## 6. Synchro 10

The SYNCHRO 10 Software and the Highway Capacity Manual are used for the purpose of this traffic study to perform all the operational analyses of the existing (current geometry) of Al-Fallah intersection. The primary result of operational analysis is the assignment of levels of service to traffic facilities under various traffic flow conditions. The methodology which is followed by the SYNCHRO 10 Software to analyze the performance of the intersection In the signalized intersection, the traffic signals are used to control the traffic movements and the right of way is assigned successively for the intersecting movements in order to eliminate the traffic conflicts. The methodology which is followed by the synchro 10 for the operational analysis of the signalized intersection is illustrated through the scheme shown in Figure 4 for traffic signal ope,,g ration for signalized intersections.

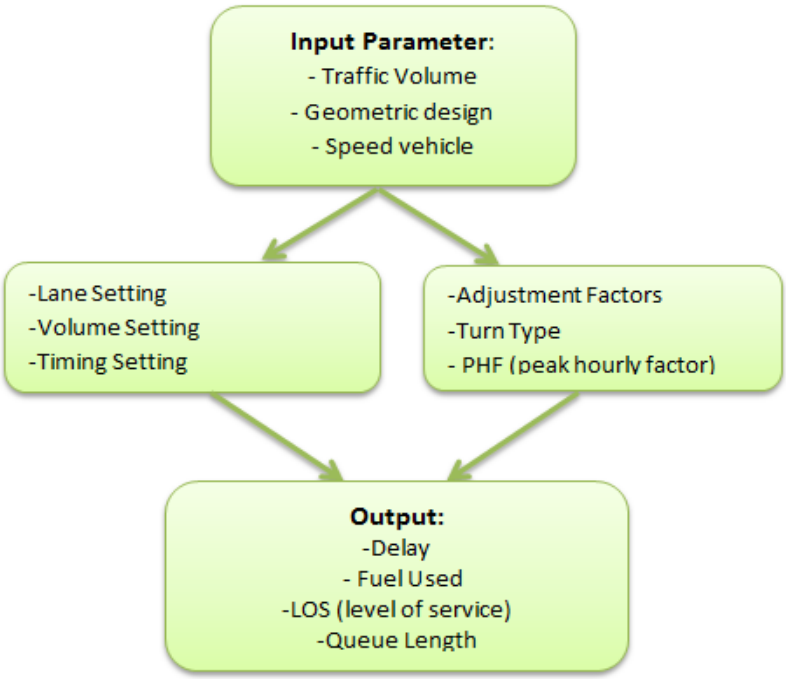


Figure 4: Methodology for the Signalized Intersection Operational Analysis by Synchro.10

## 7. Analysis Results for the Current Conditions

Results of the analysis are performed on existing traffic volumes and the existing geometric configurations of AL- Fallah intersection. Levels of Service (LOS) Criteriamreco mended by highway capacity manual are shown in Table 3, [5]**.** The results shown in Table 4 below indicate that the AL-Fallah intersection operates under level of service (F) with an average control delay of (322.1) seconds per vehicle during the peak hours studied. Also the through movements from AL-Fallah Street and the reverse movement operate with capacity constraints (LOS F) under existing traffic-volume conditions during the peak hours. The Sample of input data is shown in Figure.5. Then, Improvements are recommended at this direction to improve the overall intersection operation.

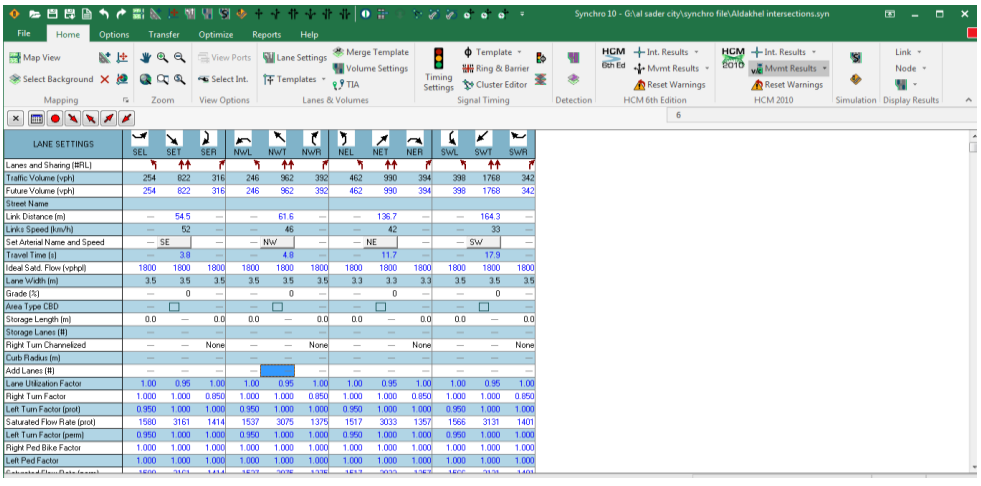

Figure .5 Samples of SYNCHRO.10 Inputs

Table 3. Level of Service (LOS) Criteria (HCM, 2000)

| Level of Service | Delay , (sec/veh) |
|---|---|
| A | ≤10 |
| B | > 10-20 |
| C | > 20-35 |
| D | > 35-55 |
| E | > 55-80 |
| F | > 80 |

Table 4. The Operational analysis results for the existing condition of AL-Fallah intersection

| Direction | Critical Movement | Degree of Saturation (v/c) | Average Delay (Sec/Veh.) | Level of Service |
|---|---|---|---|---|
| East Bound | Through | 1.69 | 233.3 | F |
| West Bound | Through | 1.87 | 279.1 | F |
| North Bound | Through | 1.55 | 229.9 | F |
| South Bound | Through | 2.56 | 428.5 | F |
| The Whole intersection | | 2.56 | 322.1 | F |

## 8. Future Traffic Volume

Geometric design of new highway facilities or improvements to existing highways should not usually be based on existing traffic volumes alone, but should take into consideration future traffic volume predictable to use the facility. Economically to justify any improvements to the existing condition, a highway should be designed to serve the traffic volume that is likely to happen within the design life of the facility**,** [6]. Many highway agencies believe the maximum design period is in the range of 15 to 24 years. Therefore, a period of 20 years is widely used as a basis for design. Traffic cannot usually be forecast accurately beyond this period on a specific facility because of probable changes in the general regional economy, population, and land development around the facility, which cannot be predicted with any degree of assurance.

With this preface, the selected design life for the AL-Fallah Bridge is 20 years with an annual growth factor of 3 percent which reflects the socioeconomic nature of the Baghdad city. The necessary calculation for the projection of the current traffic volumes to represent the traffic in the design year of 2038 is shown below, [7].

$$future\ traffic\ volume(2038) = \ Current\ volume(2018) \times projection\ factor\ (TPF) \quad (1)$$

$$TPF = (1 + r)^n \quad (2)$$

**Where:**

TPF: Traffic Projection Factor

r: Annual Rate of Traffic Growth, %

n: Design Life, years

For AL-Fallah bridge: $TPF = (1 + 0.03)^{20} = 1.8$

The future (2038) traffic volumes for all the movements in the Al-Fallah Intersection are shown below:

The future traffic volume in AL-Fallah St. (N) = 3182 veh/hr.
The future traffic volume in AL-Fallah St. (S) = 1782 veh/hr.
Sum= 4964 veh/hr.

The total traffic volume in the intersection = 6902 veh/hr.
The release rate = (4964/7902) x 100
= 72 %

Though, the overpass will relief the traffic volume from the intersection with a rate of 72 % which consider more than half the volume served by the intersection, this will provide both space and time to be used for the remaining movements in the intersection and also by eliminating the traffic volume there will be a remarkable reduction in the conflicts points.

## 9. The Suggested Improvements

After considering the future traffic volumes for the different movements in Al-Fallah intersection and the availability of free land within the intersection area which can be used in the overpass construction reduce the traffic through movement in AL-Fallah Street, the proposed geometric design for the AL-Fallah Bridge represents the unique solution to improve the performance of the intersection after considering the restrictions mentioned above [8]**.** In order to evaluate the performance of the overpass after considering the proposed geometric design, signal phasing plan and the design year (2038) traffic volume, operational analysis is performed using the highway capacity SYNCHRO 10 Software and the summary of results is shown in Table .5 below. The results indicate that the interchange will operate under level of service B in the design year with an average delay value 20 times less than that exist now before intersection geometry modification.

The use of bridge to serve the through movements in AL-Fallah Street direction will lead to release the traffic volume in the AL-Fallah intersection with a rate shown in the calculation below (based on the design year):

Table 5. The Operational analysis results for the AL-Fallah overpass in the design year (2038)

| Direction | Movement | Phase | Green Time, Sec | Average Delay, sec/Veh | Level of Service |
|---|---|---|---|---|---|
| East Bound | Right-T<br>Through<br>Left-T | **1** | **25** | **51.4** | **D** |
| West Bound | Right-T<br>Through<br>Left-T | **2** | **25** | **43.3** | **D** |
| North Bound | Right-T<br>Through<br>Left-T | **3** | **30** | **30.1** | **C** |
| South Bound | Right-T<br>Through<br>Left-T | **4** | **30** | **32** | **C** |
| The Whole Intersection | | | | **41.3** | **D** |
| Cycle time=110 Sec<br>Amber Time=3.5 Sec./Phase<br>All Red=2 Sec./Phase | | | | | |

## 10. Conclusions

Based on the conducted traffic survey, the available free land and the operational analysis results for the AL-Fallah Intersection in addition to the existence of future project plan to use bridge via an overpass through the major direction in the intersection, the following are the main recommendations:

1. The local case study of Al-Fallah intersection suffer from highly congestion on four approach which lead to level of service to be at minimum requirements (level F).
2. The adoption of the proposed geometric design in this research. The design concept is the construction of an overpass for Al-Fallah Street. The operational analysis conducted for performance evaluation shows that the intersection currently (2018) operate at LOS F with average delay (322.1 sec/veh). After the adoption of the proposed geometric design, it will operate at LOS D with average delay (41.3 sec/veh) in the design year (2038).

## 11. Recommendations

1. Based on the results of the present work, the concerned authorities have to improve the signal timing of the signalized intersections by setting required time per approach based on its demand, in order to improve the level of service of the network
2. Bridges are one of the effective ways to eliminate the congestion. Therefore, it is suggested that to construct a bridge on the north-south direction of analyzed direction, as the level of service is very poor on this direction

## 12. References


1. Hoel and Sadek, (2011): "*Transportation Infrastructure Engineering*", SI Edition, Publisher, Global Engineering Program Christopher M. Shortt.
2. Qasim Zaynab I., Abdul-Razzak Ziboon, and Khaldoon Falih (2018), "*TransCad analysis and GIS techniques to evaluate transportation network in Nasiriyah city*" MATEC Web of Conferences 162:03029, January 2018, DOI: 10.1051/matecconf/201816203029.
3. Mohapatra, S.S., Bhuyan, P.K. (2012) "*Self-Organizing Map (SOM) of Artificial Neural Network (ANN) for defining Level of Service criteria of urban streets*" International Journal of Traffic and Transport Engineering (IJTTE).
4. Joni., .Hasan H., and Mafaz M. Hikmatt, (2017) "*Assessment at Al-Ameer signalized intersection in Samawa city"* January 2018 MATEC Web of Conferences 162:01039 .
5. Highway Capacity Manual (HCM, 2000), "*Transportation Research Board, Washington D.C:mChapter16 ."*
6. Mafaz Mazin H.Aldahhan, (2016) "*Traffic Flow Improvements for Samawa Downtown Transportation Network* ".
7. Tomas Sliupas, (2006), *"Annual Average Daily Traffic Forecasting using Different Techniques"* (TRANSPORT – 2006), Vol XXI, No 1, 38–43 .
8. AASHTO,(2004) American Association of State Highway and Transportation Officials.