



# OPTIMUM DEVELOPMENT OF TRANSPORTATION NETWORK USING ACCESS MANAGEMENT APPROACH IN BAGHDAD CITY (UTAIFEYAH DISTRICT AS CASE STUDY)

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## ABSTRACT

The quality of the geometric design of the road network shall be enhanced when a new access management is applied to get the most optimized route that may be chosen by the road user. Herein Utaifeyah district in Baghdad City is selected, transportation network map is generated for the area, points of problems or incidents like traffic congestion points are located and taken into consideration. The work includes data collection of the traffic volumes within the network from the study area, and then applying optimization study for the alternatives that uses microscopic traffic simulation.

The results shows that when the access management scenarios were proposed, and the corridor analysis of the related transportation network was applied, the quality of transportation style of the Utaifeya district shall be improved, the access ratio to the district has increased to 216%, and the emissions of the harmful matters from vehicles have been decreased by 30%.

## KEYWORDS:

Streets Geometric Design, Access Management, microscopic traffic simulation

التطوير الأمثل لشبكة المواصلات باستخدام نظام إدارة الدخول في مدينة بغداد  
(دراسة حالة منطقة العطفية)

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## الخلاصة

يمكن تحسين نوعية التصميم الهندسي لشبكة الطرق عندما يتم تطبيق إدارة الدخول للحصول على أمثل مسار يمكن أن يختاره مستخدم الطريق. في هذا البحث تم اختيار منطقة العطفية في مدينة بغداد، تم رسم خارطة شبكة المواصلات للمنطقة، تم تحديد النقاط التي تحدث فيها مشاكل أو عوارض مثل مناطق الاختناق المروري و تم الاهتمام بها. العمل تضمن النقاط التالية جمع البيانات للحجوم المرورية الموجودة في شبكة مواصلات منطقة الدراسة، ثم القيام بدراسة مثلى للبدائل من خلال استعمال محاكاة المرور المجهرية.

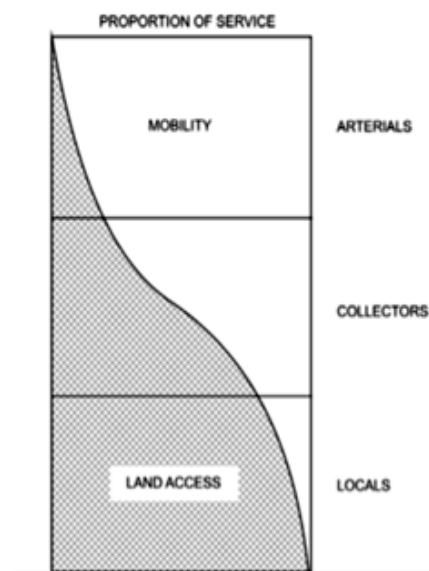
بينت النتائج انه عندما يتم اقتراح سيناريوهات إدارة الدخول، و استخدام تحليل الممر لشبكة النقل، فان مستوى المعيشة في منطقة العطفية قد تطور، حيث زادت نسبة الدخول بمقدار 216%، و قلت الانبعاثات المؤذية من المركبات بنسبة 30%.

## 1. INTRODUCTION

Access management may be considered as a process of enhancing the performance and the safety of the transportation network and the related area, with respect to the geometric design of the streets by:

- Improving Traffic accessibility and movability.
- Reducing environmentally harmful conditions.
- Reducing accidents.
- Encouraging economic activities.

Fig. 1 shows the relation between mobility (as y-axis) and the accessibility (as y-axis) according to the functional classification of the highways.



**Fig. 1. Highway Functional Classification [AASHTO, 2011]**

According to the mentioned above, the access management may include the road geometric design (number of lanes, median type, right/left lanes, horizontal/vertical curves, right of the way), traffic control facilities, type and the location of the connection between the related land and the transportation network in a safe and efficiently operated way. Also the access management technique should pass through many technical constraints, such as limitations in available land, fixed land use, budget shortages, and conflicts with the residents.

The transportation network in the Utaifeyah District and the proposed alternatives were analyzed by using microsimulation transportation software.

## 2. REVIEW OF LITERATURE

The access management plans have studied majorly by the TRB (Transportation Research Board).

NCHRP Report 348 defines the concepts of the access management as a guideline to include the legal bases, controlling access, traffic impacts, access permits, access categories, spacing standards, design concepts, and criteria. The main objective of the report is to fulfil the

requirements of upcoming trends of the geometric designs and the environment [NCHRP Report 348, 1992].

NCHRP Report 420 classified access management techniques and present methods for estimating the safety and operational effects of the different techniques. This report focused on the access management techniques that could be measured. The report considered the unquantified effects as poor practice [NCHRP Report 420, 1999].

NCHRP Report 548 studied the access management in continuation with transportation planning process; including their benefits, economic evaluation, safety, and mobility. The report categorizes the access management according to the type of the plan as stat, city, and locals. The report also manifests the desired results of the access management plans [NCHRP Report 548, 2005].

NCHRP Report 659 studied the previous literatures on the AASHTO Policy on the Geometric Design of Streets and Highways and the Access Management Manual and made complementarians. This report introduces a guide that reflects the design of the driveways as whole integrated with whole transportation network and as separated case [NCHRP Report 659, 2010].

Watters et al studied the evaluation of access management technique in South Africa, since 1996 when a first document in the access management was published, revisions are published continuously. They recommended many concepts like converting from reactive to proactive in the planning process. They also focus on the concept that streets is for the people as well as motorized vehicles. They also recommend that the use of rapid transit in the arterials [Watters et al, 2011].

Psariano et al used the microscopic traffic simulation as a platform for the analysis to make a decision in the process of access management strategies. They chose a suburban arterial with commercial and industrial areas, recommendations are made for the use process of access management strategies [Psariano et al, 2014].

### 3. OBJECTIVES

The objective of this paper is to validate the performance of the proposed access management alternatives in the Utaifeyah District by using microsimulation transportation technique.

### 4. METHODOLOGY

The methodology of applying the microscopic simulation into access management plans in this paper consists from 5 steps:

The first step is setting goals and objectives, as an access management approach, the accessibility and the both movability need to be enhanced. That means the capacity of the transportation network is preserved, elimination of congestions, user friendly transportation network for the drivers, pedestrian and the residents and employee, making less harmful environmental effects on the transportation network especially gas emissions and noises.

The second step is data collection; all traffic volumes in the transportation network are collected during the days of the week, the peak hour period was found between 6:00 to 7:00 pm at the shopping period, the traffic composition was mainly private car due to the nature of the district which most of it is residential area with some shopping places, the geometry of the streets is gathered, one of the main sources of the network geometry is google map, the urban plan of the area is given by the municipality of Baghdad which includes the land use plan of the district. The trends of the pedestrian and residents are studied and found out there are lacks in the recreational areas, parking areas, and slow improvement of the commercial activities. The

district has no fatal or injury accidents, there are just small accidents which rarely happened and cause small vehicle damages, that was because of the special nature of the district which is mainly residential with some agriculture and vacant lands.



**Fig. 2. The Methodology of the Work**

The third step is setting alternatives as an access management tools to gain the objectives of the study. These alternatives are concluded from the trends of the residents, shoppers, commuters in the district. These proposed alternatives shall make good improvements to the district.

The fourth step is to validate the proposed alternatives; this could be done by making simulation of the proposed access management development. A transportation network was set that includes all the streets in the district, then the Paramics software was used which is a microscopic simulation software, then points of conflicts and congestions are located during the simulation technique, reports that include the resulting volumes, delays in the streets, emissions in the transportation network. Some parameters in the software are changed according the local conditions. This step is repeated with each alternative. A comparison was made between the results of the original case and the alternatives to validate the proposed alternatives.

The fifth and final step is setting the recommendations that shall develop the Utaifeyah District. Fig. 2 shows the methodology of the work.







Fig. 4. The Major Inner Street in Utaifeyah District



Fig. 5. Streets in Utaifeyah District

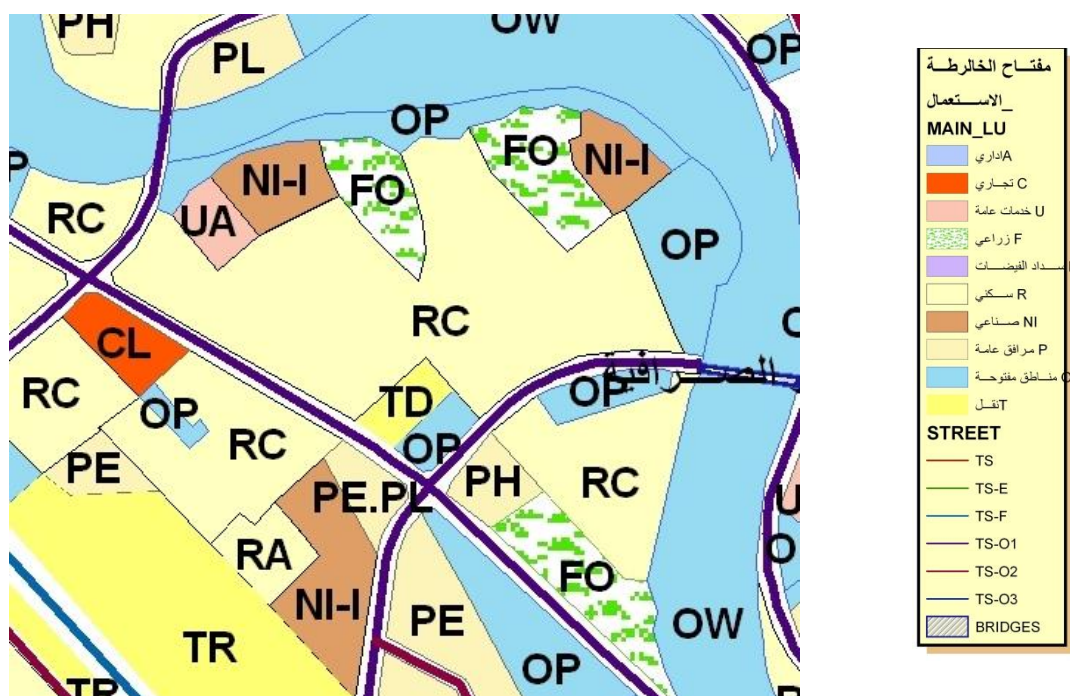
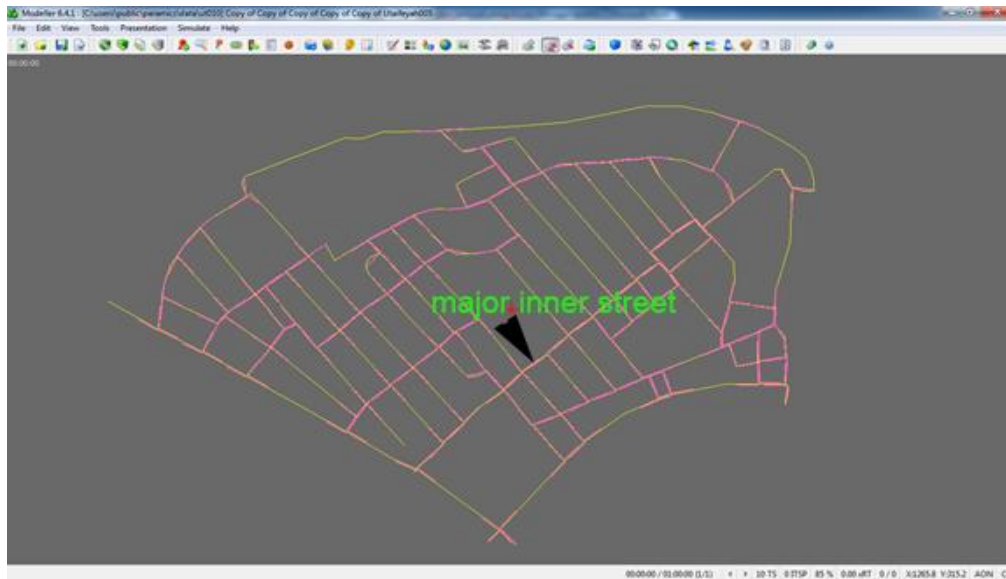


Fig. 6. Urban Plan of Utaifeyah District





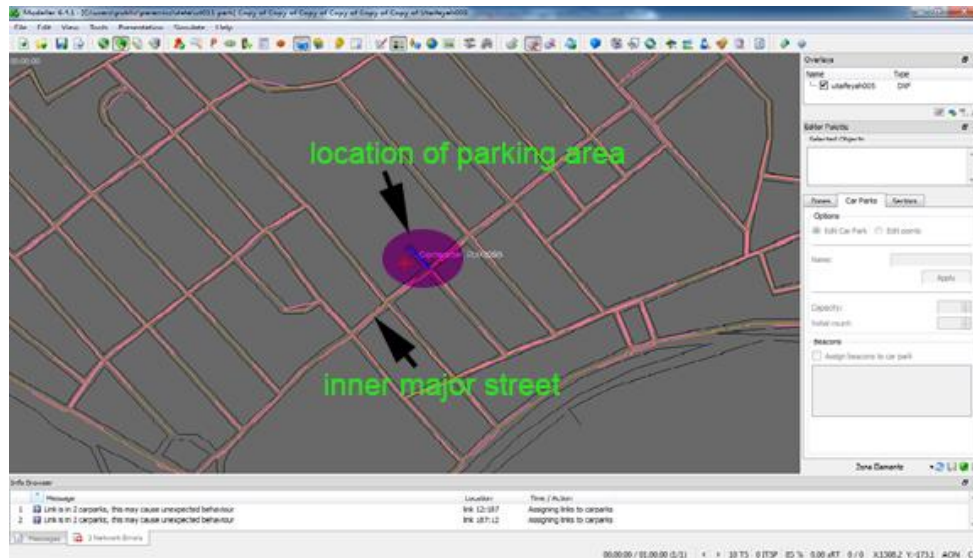
**Fig. 7. The transportation network of Utaifeyah District.**

There is a need in the area to establish a safe environment for pedestrian, one of effective solutions is by planting green trees to protect the pedestrian from the heat of the sun in the most days of the year, beside that the green trees is compatible with the general appearance of the area which famous for its widely distributed high rise palm trees all over the area.

To gain the integrity between the function of the current transportation network in the area and the traffic operations needed to enhance the mobility and the accessibility in the area, only the development is in the drive ways only because most of the area is considered residential and the minor roads inside the area is sufficient to maintain the traffic operations needed.

The land use plan needs some modification in the inside major street, and the urban plan have to increase the commercial activities in the inside major street, which may be become as result after the improving the access management in the area. When the transportation network in the area works more efficiently the investors will enter the area and a high rank development may happen.

Two scenarios have been proposed to improve the transportation network in the Utaifeyah District the first is establish a parking area in the inside major street, as shown in [Fig. 8](#), the second is to rehabilitee the riverside street, as shown in [Fig. 9](#).



**Fig. 8. Scenario 1; establish a parking area in the inside major street**



**Fig. 9. Scenario 2; rehabilltee the riverside street**

## 6. USE OF MICROSCOPIC SIMULATION

Herein the microscopic simulation or microsimulation technique was used, the microsimulation is dynamic stochastic model that deals with the individual vehicle in the transportation network separately, this technique had been used in many commercial softwares like Paramics and Vissim.

The simulation operation may include desecrating the time period into several time segments called time steps, every event in the transportation network shall be entered according to the time step. The time step may be a measure of accuracy, when the number of time steps is increased the accuracy will be increased also. The microsimulation software makes decision of release vehicles and the direction of movement and type of the maneuver taken by the vehicle at each time step.

The Paramics microsimulation software includes the following steps:

1. Geometry of the transportation network: traffic zones, road types, number of lanes, type of the intersections, traffic signals location, parking areas, and transit routes.



2. Data collection according to the demand of the traffic which may depend on land use, activities, population. Traffic zones have been distributed all over the district.
3. Calibrating the parameters according to the local types of vehicle, headways, and distributions of traffic during the day.
4. Making starting simulations or runs to the specified alternatives.
5. Output reports managing.

## **7. DEVELOPING THE AREA**

Two scenarios were proposed herein to develop the Utaifeyah District

### **7.1. Scenario 1**

This scenario may be done by establishing a car park near the inside major street. This major street includes many commercial and services activities, these activities need car parking areas to enhance customer attractions.

By using [Table 1](#) the area needs to 200 vehicle parking spaces, when this number of car parking spaces is available then the impedance due to the movement of the parked drivers in sides of the inner major street may be eliminated. Thus the full use of the available capacity is oriented for mobility.

### **7.2. Scenario 2**

The Utaifeyah area lies on the riverside and contains agricultural areas, and has many tall palm trees. The riverside street has many potential benefits one of these benefits is relief of the traffic flow on the inner major street which may provide another access in or out of the district.

There are vacant lands near this bypass riverside street and near the river and the agriculture areas. Green roads specially to be used by pedestrians and bicycle riders may be established in these vacant lands. These roads are to be pedestrian friendly; this could be done by planting high trees on the walk side to protect the pedestrian from the sun effect which is harmful in the most days of the year, and also by separating the pedestrian from the motor vehicle streets to make a good environment for the pedestrian. This Scenario may develop also the recreational side of the district.

The establishing the bypass riverside street may reduce the emission of the harmful matters from the vehicles in the inner major street and in the all residential areas in the district, when the residents may alter their route by using the bypass riverside street instead of the inner major street.

**Table 1. Parking Lot Space Requirements [Iowa State University, 2012]**

<b>Land Use</b>	<b>Spaces/Unit</b>
<b>Residential</b>	
<b>Single-Family</b>	2.0/residential unit
<b>Multifamily</b>	
<b>Two-family dwelling</b>	1.0/Dwelling Unit
<b>Row dwellings</b>	1.0/Dwelling Unit
<b>Multiple dwellings</b>	1.5/Dwelling Unit
<b>Hospital</b>	0.2/Bed plus 0.5/Employee plus 0.5/Doctor
<b>Auditorium/Theater/Stadium</b>	0.2/Seat
<b>Restaurant/</b>	1.0/14 GFA
<b>Industrial</b>	
<b>Manufacturing Plants</b>	0.5/Employee on maximum work shift plus 1/38 sq m office space
<b>Mini-warehouse</b>	0.1/Storage spaces plus 1/caretaker plus 5 for customers
<b>Retail Stores, Shops, Super Markets</b>	
<b>0 - 380 SM</b>	1/28 GFA
<b>381 - 1560 SM</b>	1/20 GFA plus specified use requirements other than retail
<b>over 1560 SM</b>	1/20 GFA
<b>Office</b>	4/100 GFA
<b>Elementary &amp; Intermediate School</b>	0.5/Employee plus 10 spaces for visitors
<b>High School</b>	0.5/Employee plus 0.1/student

GFA, sq. m. of gross floor area  
SM, sq.m.

## 8. RESULTS

In this section, comparisons are made between the traffic volumes of the transportation network of the original case and when scenarios 1 and 2 are added. The output results are summarized and presented in tables mainly for the major street, because the streets in the network may be classified as locals and they lie in the residential areas. The changes of the traffic volume in the inner major street when the proposed alternatives are applied are considered.

### 8.1. Scenario 1

Although the volume is increased in the inner major street and the access traffic into or out from that street is increased but this Scenario shall improve the commercial life of the district.

### 8.2. Scenario 2

When a bypass riverside street is added the traffic flow in the inner major street is relieved, as many drivers divert their route into the bypass street.

### 8.3. Scenario 1+2

By merging Scenarios 1 and 2 the traffic volumes is reduced and also the commercial life in the district shall be developed and all the harmful effects from the emissions shall be reduced. The summary of the results are presented in [Table 2](#) which shows the volume changes in the inner major street and [Table 3](#) that shows the comparison of the carbon emission between do nothing and the proposed Scenarios.

**Table 2. The Volume Changes in the Inner Major Street**

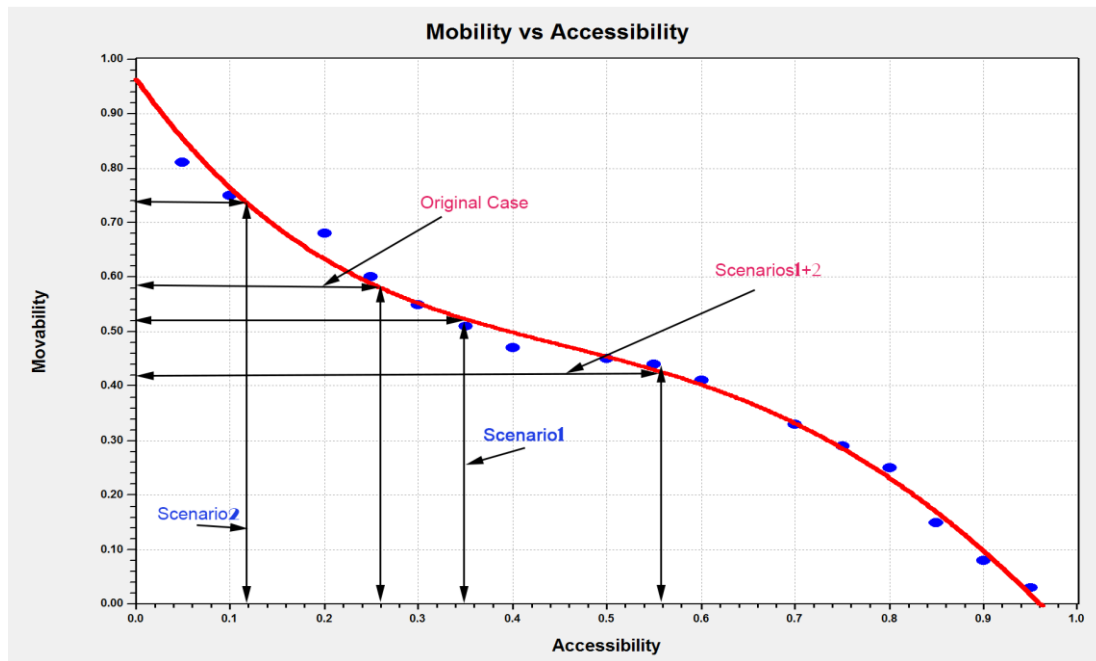
<b>The Scenario</b>	<b>Traffic Volume (pcu/hr)</b>	<b>Access Ratio</b>
<b>Original Situation</b>	1445	0.257
<b>1</b>	1630	0.347
<b>2</b>	823	0.174
<b>1+2</b>	1060	0.556

Fig. 10 shows the changes in the function of the inner major street, according to AASHTO Policy on the Geometric Design of Streets and Highways the street, Fig. 1 shows previously, the inner major street may be considered as collector in its original situation.

**Table 3. Comparison of the Emissions of Vehicles in the Inner Major Street**

<b>The Scenario</b>	<b>Traffic Volume (pcu/hr)</b>	<b>CO<sub>2</sub> Kg/hr</b>	<b>CO Kg/hr</b>	<b>NO<sub>x</sub> Kg/hr</b>	<b>HC Kg/hr</b>
<b>Original Situation</b>	1445	718.3041	57.9384	1.78811	1.192421
<b>1</b>	1630	737.3429	59.47407	1.835504	1.224026
<b>2</b>	823	384.5636	31.0189	0.957313	0.638395
<b>1+2</b>	1060	506.3721	40.84397	1.260537	0.840603

When Scenario 1 is applied the accessibility function slightly changed, and the street shall remain in the collector zone, but when Scenario 2 is applied the accessibility function is highly reduced the street function approach the arterial specification, this is a good indication for the future development when the land use of the area in the inner major street may be changed to a dens commercial area, so the access traffic in this street could be diverted to other streets in the transportation network. When Scenarios 1+2 are applied the street approaches the local characteristics mainly because the decreasing in the traffic volume and the availability of the car parking area increases the accessibility in the area, so Scenarios 1+2 will sustain the current land use plan and have some potential capability in reserving the traffic capacity in the future.



**Fig. 10. The Changes in the Functions of the Inner Major Street.**

## 9. CONCLUSIONS

The following points may be concluded from the work of this paper:

1. When the access management scenarios were proposed to develop the study area, and with the application of the corridor analysis of the related transportation network, a considerable improvement in the quality of transportation style of the Utaifeya district shall be happened, the access ratio to the district has increased to 216%, and the emissions of the harmful matters from vehicles have been decreased by 30%.
2. The local streets capacities shall be preserved, the traffic volumes are reduced in the inner major street because drivers may divert their route to the bypass street.
3. The applying of microscopic simulation technique may be a helpful tool to evaluate the alternatives proposed by access management plan.
4. All the proposed alternatives require small budget to be implemented.
5. The analyze scheme could be applied to other areas with some calibration.

## 10. REFERENCES

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