

## PLANNING TO CONTROL TRAFFIC CONGESTION IN DUHOK UNIVERSITY CAMPUS

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### ABSTRACT

This research is an examining overview of traffic congestions in Duhok city, particularly in university of Duhok as case study area. The study deals with different modes of congestion control standards and systems, calculations utilized within normal programming usage. This research additionally depicts exactly of the more basic proposals formed based on the data and statistics that has been measured by researchers, through taking time (economic) and social factors in consideration. The statistics involved measurement of private cars in university particularly at the gates at morning time. Different measurements and gathered data was analyzed, then the research focused on finding out appropriate alternative plan to control congestion of traffic in University Campus. Those issues, consider managing, congestion should evaluate the tests over public transportation arranging and improvement, to expand social, environmental and economic benefits to all. After identifications and studying various applied experiences regionally and internationally, the research, studied the linkage of private and public modes of transport in University of Duhok, and ended with some recommendations, to encourage and enhance the public travel and non-motorized transportation.

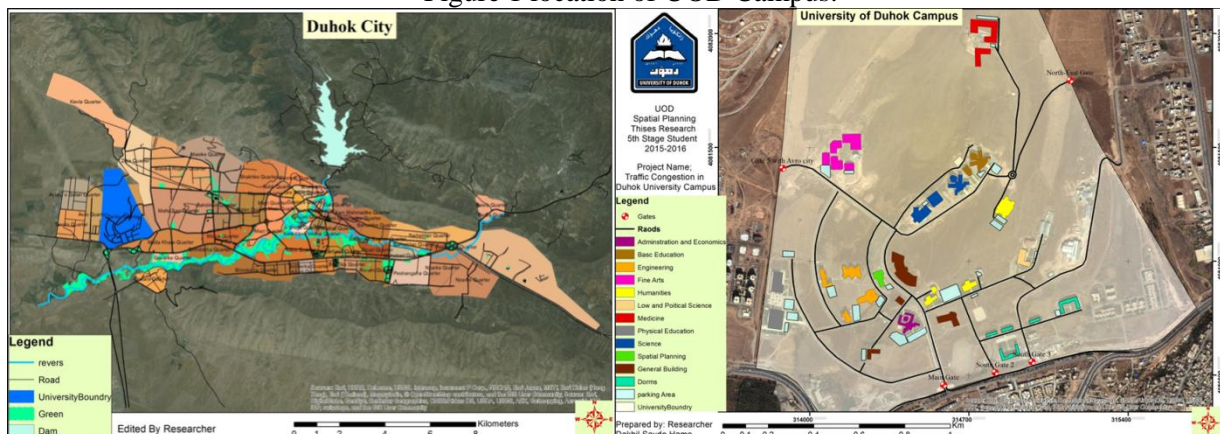
**KEY WORDS:** Traffic congestion, push and pull approach, public transport

### 1. INTRODUCTION

UOD is the biggest public university located in west of Duhok city near to international highway between Iraq. The inefficient transportation planning and the increased using of car based mode within university of Duhok, campus are leading to higher congestion levels affecting the social, economic and visual environment. It is apparent that there is

a lack of other transportation modes such as public transportation, bicycle and walking. There is also lack of parking areas within campus which causes difficulties for the students and the teaching staff in being punctual for reaching their work destinations. Although there is an increasing number of private cars using in Duhok University campus; however, no clear planning approaches are taken towards other transportation modes.

Figure 1 location of UOD Campus.



**Fig. (1):** Location of UOD Campus in Duhok city **Source:** Researcher/ Duhok Directorate

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**1.1 Research problem**

The car based mode has been as main facility for transportation by staff of teaching and many students, leads to increase the loads over streets within University specially from 8:15-9:15Am, so leads to produce congestions, additional to the time consuming, those congestion has a negative impact on the astatic view of the University. There is traffic congestion in Duhok University Campus, especially during peak hours (between 08:15- 09:15 in the morning and 14:00- 15:00 in the afternoon).This leads to long lines of vehicles, and a waste of time for the university population.

**1.2 Significance and Objective**

The significance of this research lies in the efforts of studying the traffic congestion in Duhok university campus, and how to deal with increased car based mode especially during peak hours, and the objective is to set some planning trends to encourage students and teaching staff to use more sustainable transportation modes.

**2. MATERIAL AND METHODS**

**2.1 Transportation in University campuses;**

Transport system in campus is considered a challenge to Universities. The growing problem of traffic congestion, parking deficit, lack of public transport and pedestrian safety are some of the long list of challenges facing universities today (Coulson, 2011). Universities campuses suffer from different congestion issues. Transport is affected by mobility of staff, lecturers, students and guests to various parts of universities, plus movement from outside to inside university. (Kaplan & Clapper, 2007).

Increases in universities activities and members including students and staff will require additional vehicles. This will overload the current capacities of campuses which might lead to traffic congestion within university campus. (Toor & Halvlick.2004).

Supporting public transport systems is a method applied in many universities worldwide as it is affordable to all. This will help lessening traffic loads on the surrounding community around universities urban areas. (TCRP, 2001). Master Plans encourage sustainability through different varieties of transport systems and depending on planning and transportation techniques for controlling and managing congestion. (Zalkow & Renkens, 2010).

**2.2 Definition of Key Terms;**

**2.2.1 Congestion**

Congestion results from the overload of traffic on available infrastructure and gets worse when the capacity cannot keep up with the demand. (Downs. 2004)

**2.2.2 Traffic Congestion;**

Traffic congestion is a phenomenon of increasing traffic disruption on the component of the transportation system, note in terms of delays and queuing, which is generated by interactions between units flow in the stream of traffic or at the intersection of streams of traffic. This phenomenon is most pronounced when the level of demand on the movement of approaching or exceeding the current capacity of the element and the best indicator of the occurrence of congestion is having queues (Taylor et al, 2000).

**2.2.3 Types of Congestion**

**Table (1):** the Summary of types of congestion.

types of congestion	Definition
Recurrent congestion	Happens toward standard times at a week. It could be foreseen eventually of perusing street by clients that typically utilize the course throughout individual times. Cases from repetitive blockage through morning or nighttime crest hour congestion, or blockage because of general occasions for example, a road showcase ahead of specific day every week.

Non-recurrent congestion	Happens in non-regular times at a week. It is unforeseen and erratic by the driver and is regularly because of events, for example, vehicle breakdowns, accidents.
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Pre-congestion (Borderline congestion)	Happens in free-flow states breakdown. This might happen possibly at time period. The point when clogging happens alternately upstream or downstream
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Source: adapted from Brownfield, 2003

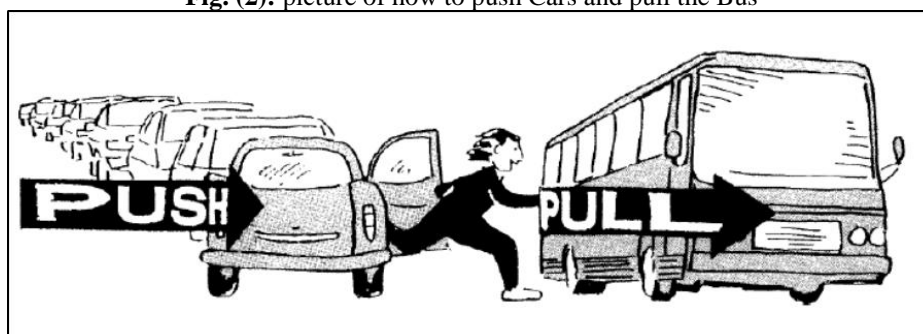
### 2.2.4 Transportation Demand Management (TDM), also called Travel Demand Management;

TMD focuses on maximizing the efficiency of the urban transport system in order to discourage unnecessary use of private vehicles and promoting more effective, healthy and environment-friendly modes of transport, in general it has been a public transport and non-motorized transport (Online TDM Encyclopedia,2016)

### 2.2.5 Measures with push-and pull-effects

Redistribution mode of transport distribution to provide cycle lanes, sidewalk wider, planting strips, and bus leans, redistribution time-cycles at the traffic lights in favor of public transport modes of non-motorized, public awareness concepts, the participation of citizens and marketing enforcement and punish (Müller,Schmidt.1992)..See fig. 2

Fig. (2): picture of how to push Cars and pull the Bus



Source; (Müller, Schmidt.1992)

### 2.2.6 Parking on street;

Parking on street reduces supply of roads. The circulation of drivers looking for a parking space is a major contribution to urban traffic congestion (Planning Urban Car Park, n.d). Parking problems are measured in terms of an inadequate user options, inconvenient parking pricing methods, inefficient use of existing parking capacity, excessive automobile use, economic, environmental and aesthetic impacts of parking facilities (Victoria Transport Policy Institute, 2010).

### 2.2.7 Time Selection;

Selecting trip time is based on daily necessary activities, so that in traffic realm there are main consideration about peak hour, which carry out high traffic volumes during day in road network in urban areas (Roger, 1970).

### 2.3. Public Transport Benefits;

Public transport system provides passengers with a comfortable travel, safety and security to all, also reduces congestion and waste time, as well as requires less capacity of land use, economically is cheaper than private modes, environmentally reduces pollution, and also is more esthetic for University campus.

- Public Transport promotes individual chances.
- Get on state funded transport provides alternatives for people transport to go work, visit friends, school.
- Public transport gives right will arrival for work to millions.
- Public transport provides individual movement and freedom for citizen from every gait of life.
- Public Transportation saves Money.
- Public transport gives economic chances and drives society development and revitalization.
- Public transport minimizes Carbon Footprint.

- Public transport minimizes petrol consuming.
- Public transport save fuel and minimize crowding (American Public Transportation Association. 2016).

**2.4. International and regional experiences of transport in University Campuses:**

**2.4.1. California University**

The University of California accepted thirty-eight students for the first time in 1869 with only ten faculties. In current situation, there are 238,000 students and about 190,000 staff and faculties in California’s University and 1.7 million alumni all over the world.

There is only fixed parking supplies in California University. The need for car parking spaces varies daily, therefore prices for parking will increase and decrease to maintain the needed vacancy rate. When price is too low it will lead to congestion results. When price is too high, there will be more spaces available and less economic validity. Prices can vary sufficiently to avoid chronic overcrowding or underuse.

The parking lots prices in the campus vary for those who pay by the hour according to (1) time of day, (2) day of the week, (3) location of campus and (4) time of year.

The fixed prices are usually announced to the public to have idea of available spaces in each lots and structure. Usually, the prices are less in the proper locations and at the rash hours. Free Parking are usually available on holidays to encourage staff and students to go to the University Campus in order to make use of the open library or sports areas, and other available activities. (California State Controller. 2004)

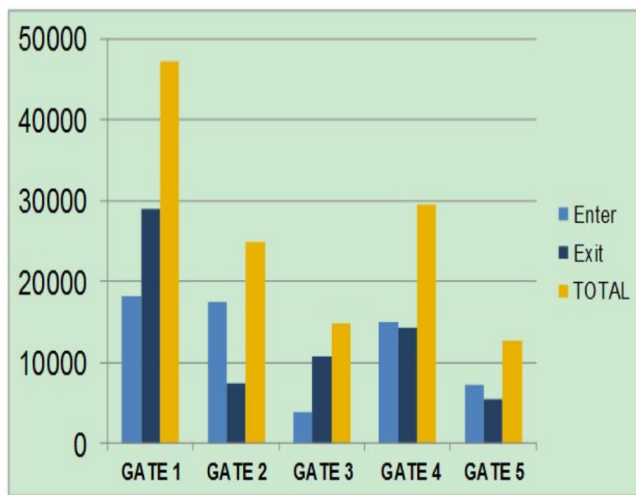
**2.4.2 Saudi Arabia, King Saud University**

The King Saud University Campus hosts 34000 students which leads to pressure on available car-park facilities within campus.

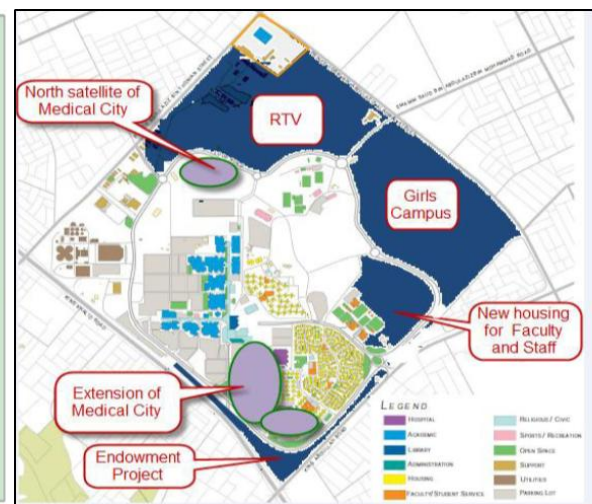
The most congestion points are near to the entrance and in the center of campus because of lack parking spaces and huge load of vehicles on the road of access points at the center of the university campus.

Sustainable transport policies for University campus, the plan is to provide buses to the students within campus and build new houses for students this will lead to reduce traffic congestion and demand for parking space within the University campus (Masaad, 2014)

See figures3,4.



**Fig. (3):** Daily traffic volumes on



**Fig. (4):**Map of King Saud University Campus King Saud University main gates (2008)

**Source:** Deputy for Projects, KSU Master Plan Update, 2009



There are current approaches used for decreasing congestion in University but they are not enough such as;

- 1-Students accommodation in the UOD campus
- 2-Alternately different timing for work hours start in colleges during the daily and weekly however there is congestion in University campus, some colleges start at 8:00am and the other colleges start at 9:00 am.

\*During current economic situation temporarily the staff is divided in two shifts (Sunday, Monday, and Tuesday) and other (Tuesday, Wednesday, Thursday).

**4.2.Observation of current situation;**

The researchers was standing at the university main gates, collecting the relevant data (private cars, busses, etc...) over the time period 7:45 am till 10:00 am of Sunday morning for the incoming

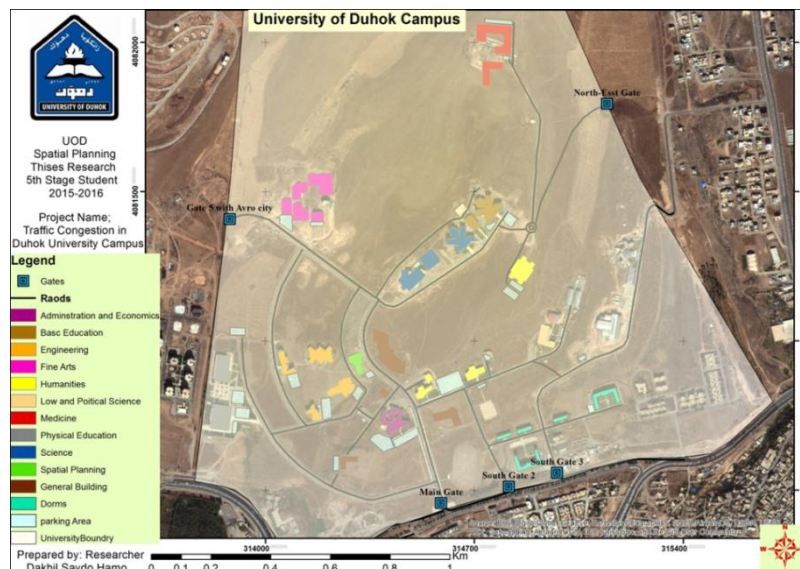
traffic. And the Exit/departure time from 1:00 pm till 3:00 pm

Data collection, conducted at the three functional gates of the university, covered the period from the begging of September till the end of November 2016.

At the begging of the academic year, traffic congestion is prominent at the main campus gate. See Figure (7) and Figure (8).

To alleviate the congestion problem, a short term solution was put in practice in the form of a new U-turn close to the main gate. Also closing a U-turn opposite the college of Administration and Economics.

The situation of gate and passing transport the University has five gates, the functioning gate are three as shown in key plan of Gates in figure (7)



**Fig. (7):** Key plan map of the Gates in UOD campus.

**Source:** Researchers

- 1-At the Morning three gates are open
- 2-After 9:00 Am south Gate 2 will de close completely the other remain

In the summer there is a few number of vehicle in University because of just employees comes and some students who fail in their subjects

The researchers observed the gate of University from 1th September till 22th November and the table’s bellows approve that. See figures8 and 9.



**Fig. (8) & (9):** Congestion of cars in the front of student center of UOD campus afternoon  
**Source:** Researchers

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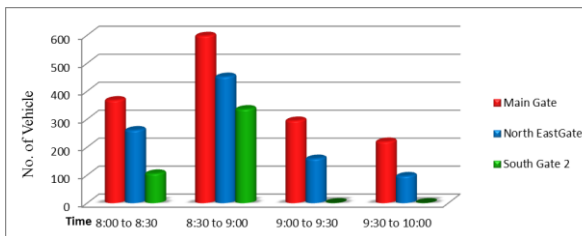
**3.Measurement the number of vehicles;**

The Researchers measured Number of vehicles (Cars, Taxis, Buses, Mini buses) that enters to the University campus in the morning from 7:45 Am - 10:00 Am in 6th, November, 2016. In three gates, in different times of peak hours congestion.

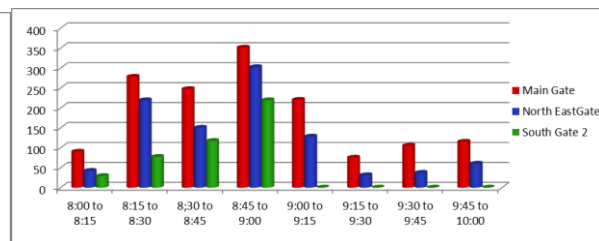
**5.ANALYSIS AND RESULTS**

In this study, the focus was on the measurement, and analysis of many factors that lead to address the problem of the existing traffic congestion in the University of Duhok including network intersections, and streets.

Figure (10A) shows number of vehicle that entre to the UOD campus during 2 hours in three Gates and divided into four intervals every 30 minutes starting 7:45am.



**Fig (10A):** Source: Researchers



**Fig. (10B):** Source: Researchers

-Figure (10B) shows number of vehicle that entre to the UOD campus during 2 hours in three Gates and divided in to 8 intervals every 15 minutes.

-From analyzing data the peak hour of entering to UOD campus is from 8:15 to 9:15 Am, as shown in above figure.

Figure (11) shows number of vehicle that exit from the UOD campus during 2 hours in main Gates.

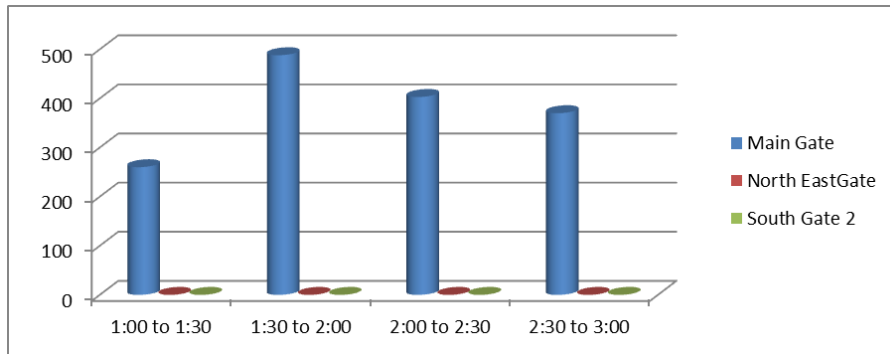


Fig.(11): Source: Researchers

-From analyzing data the peak hour of exiting traffic in UOD campus is from 1:30 to 2:30 pm.

Figure (12) shows percentage of different types of vehicles that entere to the UOD campus during 2 hours in three Gates. Mostly private cars and Taxis are used to arrive to UOD as destination.

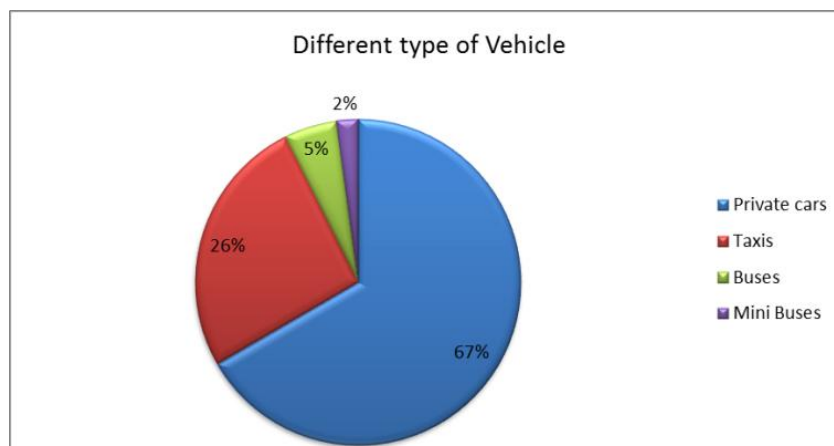


Fig. (12): Source: Researchers

**Measuring congestion index in the four segments;**

The researchers chose four segments in University of Duhok, street network depending on the level of congestion by observation it during several months, as shows in figure (5), segment 1 is located outside of campus at the main entrance starting from south Gate 2 to the main Gate. Segment 2 starting from U-turn near the main Gate to the intersection in front of administration

and Economic College. Segment 3 starts from intersection of south Gate 2 to the intersection in front of administration and economic college, and segment 4 starts from circle near to the English translation college to the college of Basic Education. The researchers got data by using GPS and GIS, calculating congestion index for each segment by equation of congestion index as shown in fig.13 below:



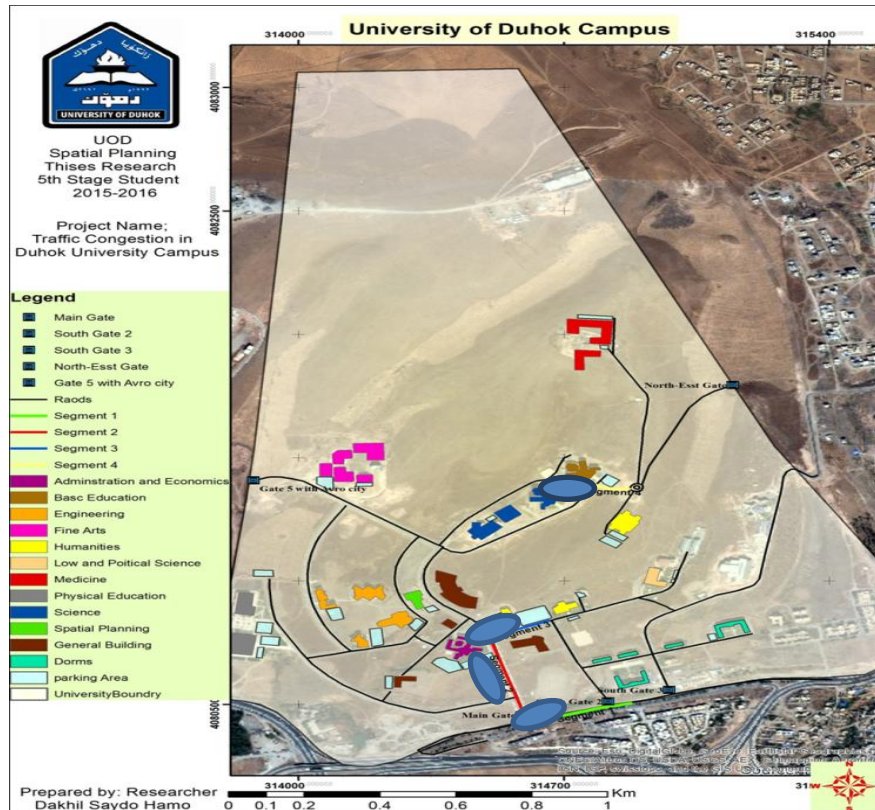


Fig. (13): Locations of 4 Segments of congestion in UoD Campus

Source: Researcher

Congestion index has been calculated  $C.I = (c - c_o) / (c_o)$

C.I = Congestion Index

c = Actual Travel Time

c<sub>o</sub> = Free Flow Travel Time

Congestion index near zero will indicate very low level of congestion, while an index greater than 2 will indicate high-congested condition.

Actual travel time can be calculated for each segment by GPS and GIS speed data, speed limits were adopted for calculating the free flow travel time. (Lomax et al, 1997).

#### Congestion index in segment 1

c = Actual Travel Time = 94 seconds, c<sub>o</sub> = Free Flow Travel Time = 25 seconds

Congestion index =  $(94 - 25) / 25$ , Congestion index = 2.8

As congestion index in segment 1 are greater than 2 that indicate the high level of congestion condition in this segment.

#### Congestion index in segment 2

c = Actual Travel Time = 140 seconds, c<sub>o</sub> = Free Flow Travel Time = 31 seconds

Congestion index =  $(140 - 31) / 31$ , Congestion index = 3.5

As congestion index in segment 2 are greater than 2 that indicate the high level of congestion condition.

#### Congestion index in segment 3

c = Actual Travel Time = 112 seconds, c<sub>o</sub> = Free Flow Travel Time = 26 seconds

Congestion index =  $(112 - 26) / 26$ , Congestion index = 3.3

As congestion index in segment 3 are greater than 2 that indicate the high level of congestion condition.

#### Congestion index in segment 4

c = Actual Travel Time = 58 seconds, c<sub>o</sub> = Free Flow Travel Time = 18 seconds

Congestion index =  $(58 - 18) / 18$ , Congestion index = 2.2

As congestion index in segment 4 is greater than 2 that indicate the high level of congestion condition



Fig. (14): Photos by Researchers

**Average passengers per car;**

The researchers took Sample for measuring average passenger per vehicle in the main Gates of UOD, the researchers chose this sample because it is the main gate where the congestion is high and the researchers decided to choose the morning and noon, in peak hour.

**Average Passenger per car that enter to the UOD campus;**

The researchers observed and measured 929 vehicles from (8:40 Am - 10:00 Am) transported 2188 persons, from simple calculation each vehicle transfer 2.35 person per vehicle

$$\text{Average passenger per car} = (\text{total No. passengers}) / (\text{total No. cars})$$

$$\text{Average passenger per car} = 2188 / 929, \text{ Average Passenger per car} = 2.35 \text{ passenger/car}$$

**Table (2):** shows numbers of passengers per vehicle that entre to the UOD campus in the main Gate. Time 8:40-10:00

Person per car	No. cars	No. person
1 person	302	302
2 person	313	626
3 person	116	348
4 person	78	312
5 person	120	600
<b>Total</b>	<b>929</b>	<b>2188</b>

Each car transfer 2.35 passengers with size 8.6 m<sup>2</sup>, from that we get the average area of passenger / car and equal 3.66 m<sup>2</sup>, for entering into the UOD campus.

**Average Passenger per car that exit from the UOD campus;**

The researchers observe from measure 447 vehicles during 30 minutes (2:00 pm - 2:30 pm) that transported 980 passengers, average Passenger per car = 2.2 passenger/car.

Each car transport 2.2 passengers with size 8.6 m<sup>2</sup>, from that we get the average area of passenger / car and equal 3.9 m<sup>2</sup> this for exiting from UOD campus in the main Gate.

**Measurement of the area of vehicle;**

The researchers get the area of car by taking samples of 15 cars in the parking of Spatial planning, and equal to 8.6 m<sup>2</sup>.

**Average passenger per Bus;**

24 passenger / Bus, The size of Bus is 15 m<sup>2</sup>, Each Bus transfer 24 passengers with size 15 m<sup>2</sup>,

From that we get the average area of passenger / Bus and equal 0.63 m<sup>2</sup>.

**Average passenger per Mini Bus;**

14 passenger / Mini Bus, The size of Mini Bus is 9 m<sup>2</sup>, Each bus transfer 14 passengers with size 9 m<sup>2</sup>, from that we get the average area of passenger / Mini Bus and equal 0.64 m<sup>2</sup>.

Measuring the space required for transport and parking of different modes of transportation. (Shifting from car based mode to mass transport mode).

Amount of space required to transport the same number of passenger by car, mini bus and bus or bicycle, according to (2.3) passenger / car.

For transporting 1000 passengers by car it needs 435 cars to transport them,

$$\text{No. of cars needed} = 1000 / 2.3 = 435 \text{ cars}$$

And Amount of space required to transport 1000 passengers are 5437 m<sup>2</sup>, from this equation

Space required = No. of cars multiply by area of car

$$\text{Space required by cars} = 435 * 12.5 \text{ m}^2$$

$$\text{Space required by cars} = 3741 \text{ m}^2.$$

For transporting 1000 passengers by Bus it needs 42 Buses,

$$\text{No. of Buses need} = 1000 / 24 = 42 \text{ Buses}$$

and Amount of space required to transport 1000 passengers are 1008 m<sup>2</sup>

Space required = No. of Buses multiply by area of Bus

Space required for Buses =  $42 * 24 \text{ m}^2$

Space required for Buses =  $1008 \text{ m}^2$  Source: (Planning Department, December, 2016).

For transporting 1000 passengers by Mini Bus it needs 72 Mini Buses, and Amount of space required to transport 1000 passengers are  $1044 \text{ m}^2$  on the road

Space required by Mini Buses = No. of mini Buses multiply by area of mini Bus

Space required for mini Buses =  $72 * 14.4 \text{ m}^2$

Space required for mini Buses =  $1044 \text{ m}^2$  Source (Planning Department, December, 2016).

## 6. CONCLUSIONS

**1. The researchers found in UOD Campus, most of students, staff and employees are using private cars and Taxis.** This leads to increased congestion as well as needs more parking areas for cars, and more cost in comparison with public transport, also visual, air, and noise pollution. Moreover, shortage of public transport such as (bus and mini-bus) is not leads to using of privet cars by students and other employees. However, lack of parking lots for all types of vehicles in the whole campus, especially for students cars encourages people to park their cars on the street causing congestion and time delay for both staffs and students.

**2. The biggest transportation challenges facing the UOD campus are.**

-Traffic congestion, especially in the morning and afternoon at main gates

-Shortage of Parking Spaces

-The road network is not planned and designed properly

-Lack of public transportation.

-Huge traffic flow.

- Congestion at certain areas and time in campus such as; college's entrances.

-Poor sidewalk infrastructure or no suitable walking pathways

-No biking

**3. To improve the traffic congestion in the main Gate and inside the University campus.**

-Promoting public transport and should be improved and encouraged.

-Availability of parking area

-More accessible and safe walkways.

-Different start times for faculties

- To discourage Auto car based mode (push), and at the same time improve (pull) other transportation modes such as public transport mode, walking and biking

-A ring road to be designed for cars to enter and exit to the campus from gates

-Putting Charges on every car entering the university campus (visitors and staff)

**4. The research proved the hypothesis,** through the measurements that proved the effect of congestion on time delay and cost. Also promoting public transport for more sustainable urban transportation.

## 7. RECOMMENDATIONS

**1. Promoting public transport within the city of Duhok as a long term plan and within the UOD campus as a short term plan**

**A-Promoting public transport, a free shuttle Bus from 8:00 Am to 6:00 Pm every 15 minutes,** the Bus shuttle will serve three Gates as follows:

-Buses Routs with Buffer zone 250 m

### **a- Rout 1**

Start from the main Gate through central Library then College of humanities Department of History, Geography and Kurdish then College of Low and Political sciences then Department of English and Translation then College of Basic Education then College of Science department of Computer science, Physics and Mathematics then Deanship of college of Science then department of Biology and Chemistry then Student center then end point at the main Gate, also covering college of Medicine and college of Pharmacy as well as North south Gate.

### **b-Rout 2**

Start from main Gate through Student center and college of Spatial Planning and Apply Science then Institute of Fine Arts then college of Engineering Department of Civil engineering, Water Resources and college of Physical Education then department of Architectural then Electrical and Computer then Registration Directorate then Zanko Bank then college of Administration and Economic then the end point at the main Gate.

**B-For lecturers they can still use their cars to access to their destinations,** on the condition of providing parking spaces. In the long term plan, they also can change to Buses

**2. Pricing car parking,** this will be supported pricing for employees, lecturers, and students

3. For the visitors the suggestion is not allowing their cars inside Campus. As 1400 cars enter UOD campus during 30 minutes, from 8:30 Am to 9:00 Am, will still be a difficulty for finding enough parking spaces to all these cars, the suggestion is to build few multi-storey car parking near

University gates with paid cost, for students and visitors as show in figure (6-2).

4. Encourage to use biking within UOD campus.

5. Build addition Dorms inside UOD campus to reduce using of car based mode.

6. More accessible and safe walkways to encourage students for walking. See figure 15.

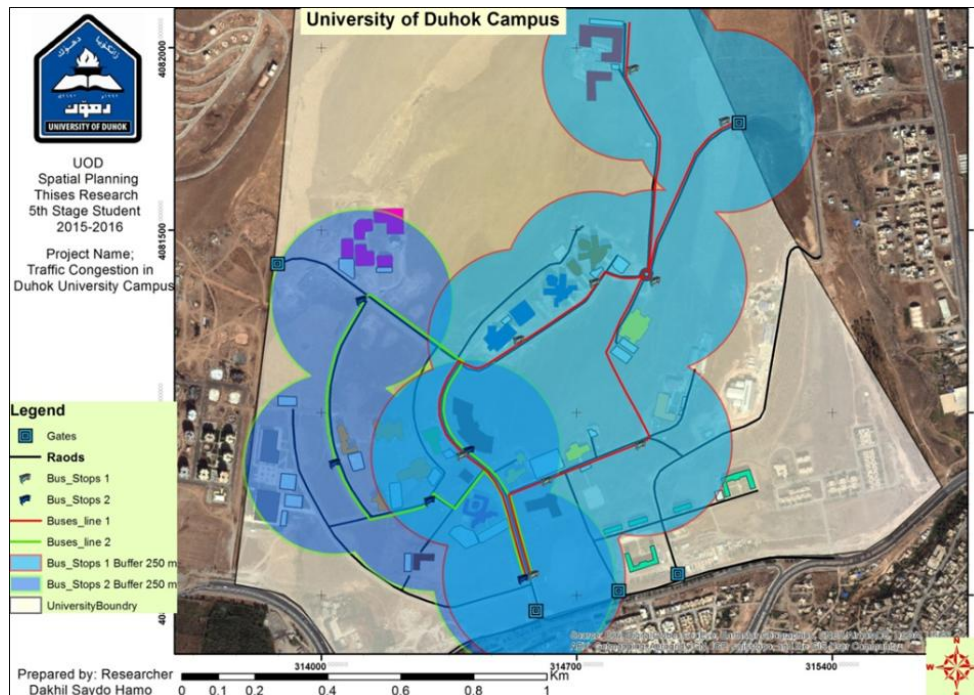


Fig. (15): shows map of Buses line and Bus stop with the buffer 250 M that suggested by researchers.

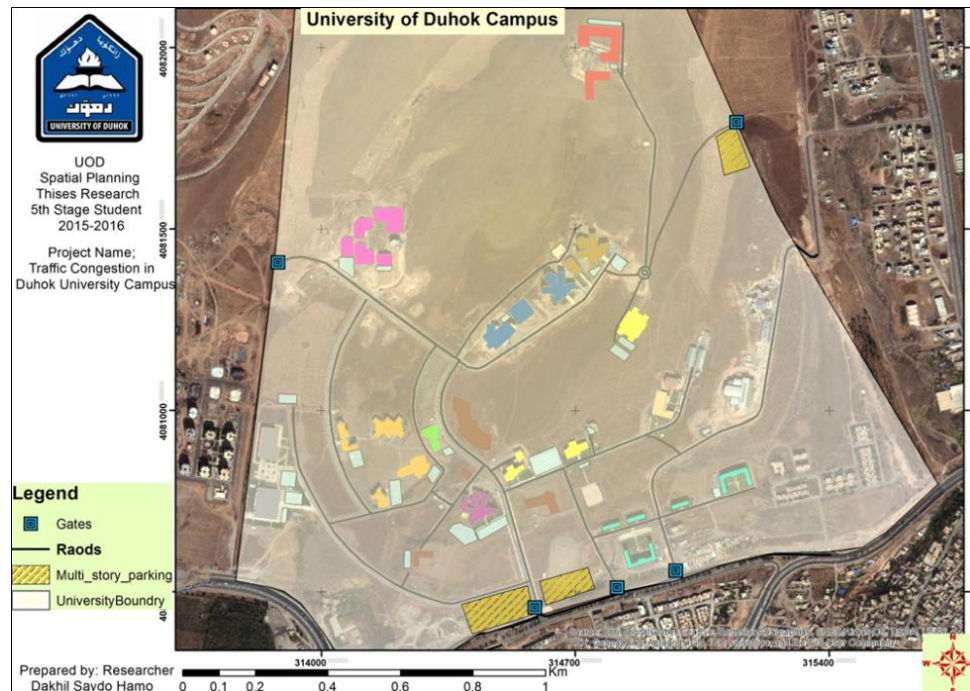
Source: Researchers

### The Route 1 has 6 Buses stops

first Bus stop they cover then College of humanities Department of History, Geography and Kurdish, and central library second Bus stop the cover college of Low and Political sciences the third Bus stop the cover other departments of humanities the fourth Bus stop cover College of Basic Education and College of Science department of Computer science, Physics and Mathematics the fifth Bus stop cover Deanship of college of Science and department of Biology and Chemistry the sixth Bus stop cover Student center, and then ending at the start point in the main gate.

### The Route 2 has 4 Buses stops

first Bus stop they cover college of Spatial Planning and Apply Science and Student center second Bus stop the cover Institute of Fine Arts third Bus stop the cover college of Engineering Department of Civil engineering, Water Resources and department of Architectural, and college of Physical Education fourth Bus stop college of Engineering Department of Electrical and Computer, Registration Directorate, Zanko Bank and college of Administration and Economic, and then ending at the start point in the main gate. See figure 16.



**Fig. (16):** shows map of Multi-story car Park that suggested by researchers.

**Source:** Researchers

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