

## Simulation study for Changing some roundabouts in Karbala government into signalized roundabouts

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Keywords	Abstract
<p><i>A Simulation Study, Signalized Roundabout, PTV Vissim, Level of Service</i></p>	<p><i>This research aims to analyze and evaluate some of the main roundabouts in Karbala Governorate after they were converted to signalized roundabouts by the simulation program PTV VISSIM. These roundabouts suffer from large traffic, which leads to a significant decrease in their level of service (LOS), especially at peak times, when it is observed that the traffic police intervene to direct the traffic and reduce congestion. Therefore, one of the proposals was to use the light signal to control the roundabout at peak times.</i></p> <p><i>The results were positive in the first roundabout, as the level of service (LOS) decreased from F to D, and the LOS of the other roundabout also decreased, though to a lesser extent, from F to E due to heavy traffic volumes at peak times and design errors in the roundabout.</i></p>
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### 1. Introduction

Iraq's population growth has impacted transportation networks, particularly in Karbala, leading to congestion at roundabouts and delays in traffic flow. Roundabouts are sometimes treated as intersections with traffic signals, and traffic police are needed to manage high volumes during peak times. This highlights the need to study roundabout performance and determine when to convert them into signalized roundabouts for effective traffic management.

### 2. Problem research

Karbala roundabouts often experience significant traffic congestion, particularly during peak hours, requiring traffic police intervention to manage and alleviate the congestion. This indicates that the roundabouts are not functioning optimally in terms of facilitating smooth traffic flow without stopping, especially during peak times.

### 3. Aim and Objectives of the research

- Compare functional performance of roundabouts and signalized roundabouts.
- Determine traffic volume threshold for converting roundabout intersection to signalized roundabout.

### 4. Traffic volumes in Iraq

The population increase in Karbala has led to a significant rise in the number of vehicles on the roads. This has caused congestion, which has become increasingly evident in recent years. The Ministry of Planning has published statistics on the number of registered private sector cars and all types of plates at the Directorate of Traffic between 2016 and 2020.

### 5. Simulation Concept

Simulation is an essential tool for studying traffic and transportation problems by designing a model close to reality. It helps to analyze issues such as congestion, delay, level of service, and traffic network performance. Traffic simulation programs are necessary for evaluating traffic in all its details.

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**6. Roundabout**

Roundabouts are generally defined as a circular intersection in which the velocities are finite and cannot be exceeded. Likewise, the vehicle does not stop moving, but its speed decreases significantly, according to the determinants designated for this type of intersection. The vehicles revolve around a median island, and they head as they rotate toward the special exits at the intersection (Ahac and Dragčević 2021)

**7. Signalized Roundabout**

Combined roundabouts with traffic lights are not common due to the public's reluctance to accept this hybrid system. Most research on roundabouts and traffic lights focuses on them as separate entities. However, a study by Lakouari, Oubram et al. (2018) found that the combination of traffic signals with roundabouts can work effectively for medium traffic volumes. They recommend using the combined system in places with medium to high traffic volumes to address roundabout issues before converting them into traffic signals.

**8. Study Area**

All roundabouts are located in the urban CKD area. These roundabouts contain a high traffic density compared to the other roundabouts, and many violations of priority laws have been noted to eliminate congestion and shorten the travel time as much as possible.

**9. Characteristics of Selected Roundabout**

The design characteristics of roundabouts greatly impact their performance, and it is important to consider these details when creating simulation models in programs such as Vissim. Key factors include all directions of the roundabout being at the same level as sea level, the absence of heavy truck traffic within the roundabouts, no pedestrian crossings on any roundabouts, and no nearby car parks.

**10. layout Roundabout**

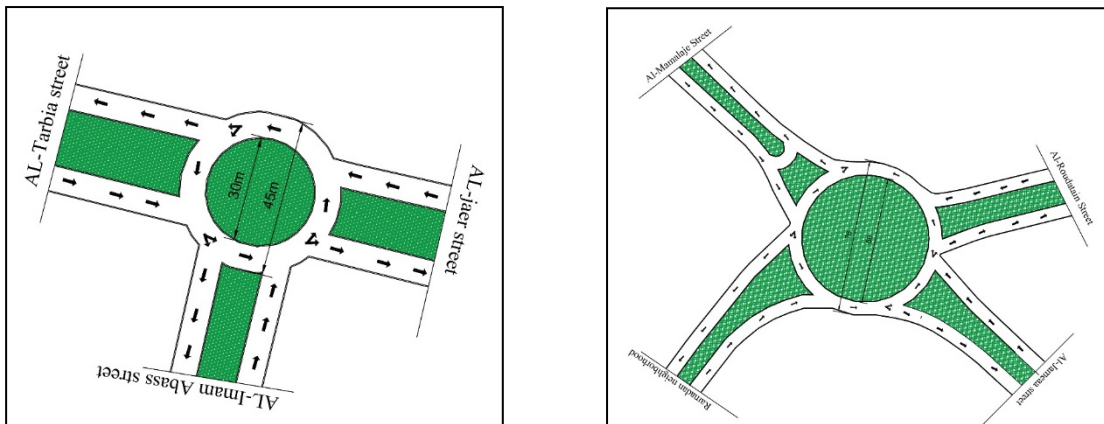


Figure Hata! Belgede belirtilen stilde metne rastlanmadı. 1 Said AL-Assar and AL-Mohafada

**11. Data collection**

The process of collecting data on traffic volumes is one of the important parts of the process of simulating reality.

•forward direction •right turn •left turn •U-turn Traffic volumes are calculated in a way that cameras are installed at the beginning of all streets leading to the roundabout, where five cameras were installed to cover the roundabout completely. Traffic volumes were calculated at peak hour volume 07:30 to 8:30 am, 12:30 to 13:30 am, and 19:30 to 20:30 for a period of four days (three working days distributed over the days of the week and one day off) During the period from Saturday, October 1, 2022, to Friday, October 7, 2022

**12.Cycle Length design**

The cycle length was calculated based on the Webster equation that provides the optimal cycle length with the least lost time and least delay it Basic equation in many transportation design books and the Result was The optimum cycle length for Said Al-Assar Roundabout is 100 seconds and The optimum cycle length for Al-Mohafada Roundabout is 50 second.

**13.Validation Results**

The delay values in the Said Al-Assar Roundabout were calculated and compared with the values obtained from PTV Vissim, and according to the regression (R2), the result was as shown below (Figure 1) shows the degree of convergence in the results between reality and the program, with a value of approximately 87.5%.

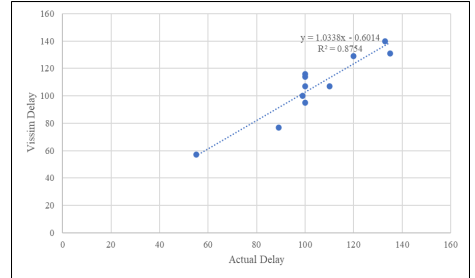


Figure 2 Validation model with regression ( $r^2$ )

**14.Comparison of Roundabout and signalized Roundabout**

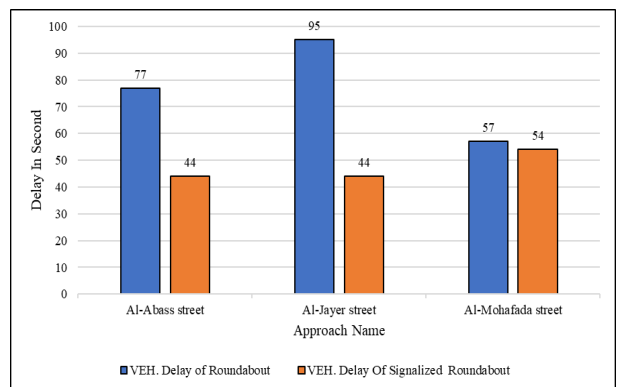
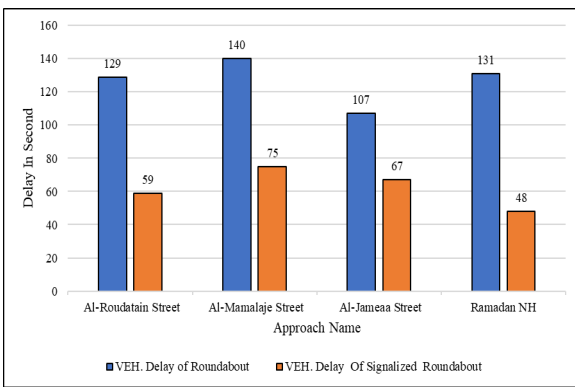


Figure 3 comparison chart between the delay in Said Al-Assar Roundabout and signalized Roundabout and between the delay in Al-Mohafada Roundabout and signalized Roundabout

The delay times for all approaches of Said Al-Assar and Al-Mohafada Roundabout and Said Al-Assar and Al-Mohafada signalized Roundabout were analyzed in Figure(3). The results showed a significant reduction in delay times after the roundabout was upgraded. Approaches such as Al-Roudatain Street, Al-Mamalaje Street, Al-Jameea Street, Ramadan NH, Al-Abass Street, Al-Jayer Street, and Al-Mohafada Street experienced a substantial decrease in delay times ranging from 5% to 63%. Overall, the roundabout upgrade had a positive impact on traffic flow and reduced delays on all approaches.

**15.The general behavior of delay values with an increase in traffic volumes**

this part, the relationship between the delay and the traffic volumes entering the roundabout had been discussed, The values were calculated by providing the PTV Vissim with incremental values of traffic volumes and recording the delay values so that the (Figure 4), shows the increase in delay with the increase in traffic volumes, as shown below separately

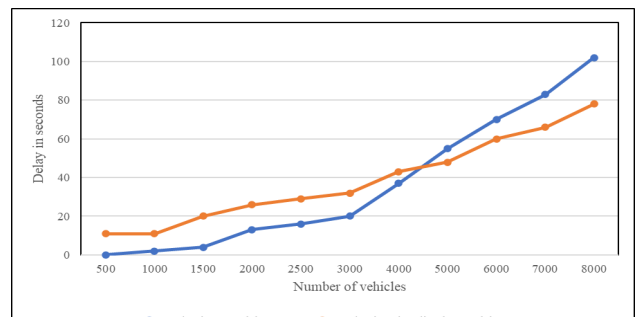
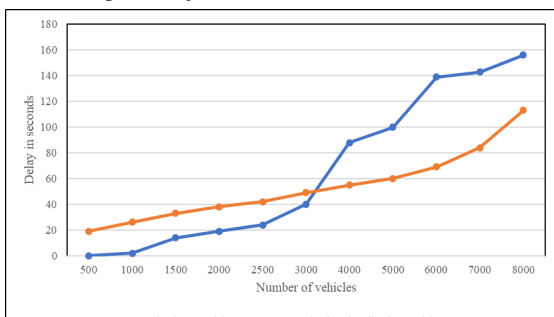


Figure 4 General behavior of delay with increase traffic volumes for Said Al-Assar and AL-Mohafada Roundabout

the roundabout's curve intersects with the Signalized Roundabout curve at the traffic volume in (3300 v/h and a delay value of 55 seconds) and (4500 v/h and a delays value of 48 seconds), which is the value at which it is preferable to put a light signal on the roundabout to control it in case of not wanting to convert it into a Signalized intersection

### 16. Conclusions

- 1-Optimal signal times for Said Al-Assar and Al-Mohafada signalized intersections are 100s and 50s, respectively.
- 2-The model built in PTV Vissim program matches reality by 87%.
- 3-The level of service in all roundabouts is F with delays exceeding HCM requirements.
- 4-Converting roundabouts to signalized roundabouts reduces delays and shifts service levels to E for Said Al-Assar and D for Al-Mohafada.
- 5-At traffic volumes of 3300 and 4500 v/h, converting roundabouts to signalized roundabouts is preferable to regular roundabouts.
- 6-This case is useful for temporary traffic control or if conversion to traffic light is not desired.

### 17. Recommendation

Based on the study's findings, it is recommended to install traffic lights on roundabouts to reduce delay times and use them partially during peak hours. It is also important to develop clear plans to solve the issue of traffic congestion in the long term, such as transferring government and service departments from the city center.

### 18. Conflict of Interest:

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this paper.

### 19. Contribution of Authors:

[Author 1's Ali Fadhlallah Hussein]: Conceived and designed the study, collected and analyzed the data, and wrote the manuscript.

[Author 2's PhD. Hussein Ali Ewadh]: research supervisor.

[Author 3's PhD. Raid R.A. Almuhanha]: Assisted with data collection Contributed to the study design, data interpretation, and revised the manuscript for important intellectual content and research supervisor.

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