

## Processing Traffic Jam in Al-Sadrain Intersection in the Holy City of Najaf

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**Abstract.** Modern metropolitan cities worldwide suffer from heavy congestion due to high daily commutes for various purposes. Intersections are the most congested component of the network and represent the sites of accidents. At the same time, the intersection (Al-Sadrain) in Al- Najaf Al-Ashraf city is regarded as one of the major important intersections. Typically, this intersection increases the volume of traffic during rush hours, which raises traffic congestion. Therefore, the problem with this article is that unclear how the distribution of the surrounding areas affects traffic accidents and junction congestion. Our hypothesis to solve the problem is that an important relationship must be clear between the intersection and its surrounding areas. In this study, analysis the current service of intersection as field survey adopting the analytical approach using simulation by HCS2010 and VISSIM software, based on GIS that showed: the eastern approach (coming from Al- Kufa) was (F) (3.18.97), the result of the western approach (coming from Najaf) (F) (3.45.49), and the result of the northern approach (coming from the College of Administration and Economics) (D) (1.38). 83) and the result of the southern approach (coming from Al- Rawan Street) (E) (1.14.13). When the times of delay to the level of service intersection, as adopted by the capacity of roads on the program (HCS 2010), amounted to more than (800) seconds/vehicle at peak times. So, the classification of service at this intersection is in level (E). Through the traffic intersection analysis, recommendations and proposals must be taken before any decisions regarding land use , which has effects on the city.

**Keywords:** Traffic intersections; peak hour; congestion; HCS 2010; VISSIM; GIS.

### 1. INTRODUCTION

Transport planning has a fundamental role in achieving the future vision of the transport system. Therefore, that should include a comprehensive study of possible strategies and an evaluation between the transport planning bodies [1-4]. Intersects are a critical part of the road network due to the concentration of different traffic volumes that increase the possibility of accidents [5]. Those negatively affect the overall performance of the road network by increasing delay times and reducing service levels [6]. The annual traffic growth rate during the last ten years is about 11.5%, which is higher, corresponding to the population rate of 3.14%. Al-Obaedi [7] reported that Al-Najaf City suffers from a lack of road hierarchy. That means the population density is distributed in an irregular manner, and thus, movement and access are difficult in the city as well as heavy traffic [10]. Despite the problem caused by intersections on the network and what bridges and tunnels represent as an ideal solution, it can succeed as a short-term site plan or an engineering solution for a specific intersection, but that requires very high costs and purely planning procedures in determining their efficiency and signing them in a suitable place [11]. In this situation, using a simulation program (VISSIM) is based on GIS in traffic analytics. As well as, (Highway Capacity Software (HCS) 2010 Streets module was used to analyze the network street), HCS 2010 program for the requirements of service analysis [10]. For all that, and more, this article discusses and analyzes the important intersection (Al-Sadrain intersection) to solve the problem of crowding in this important part of this region.

Lies in the lack of clarity on the relationship between congestion at the intersection and the nature of the surrounding areas, and the congestion causes delays. Traffic accidents and the increase in the number of vehicles in Najaf lead to traffic jams. Thus, the intersection does not accommodate this increase in vehicles and traffic. The research aims to highlight the phenomenon of congestion in the study area (Al-Sadrain intersection) in the city of Najaf, the relationship of this congestion to the nature of the area surrounding the intersection, and that the intersection in its current condition does not provide the required service in a meaningful way at present, but if the current situation of the intersection and the surrounding area is studied in a planning study. And engineering that can result in solutions that make the work of the intersection effective and efficient in its results in reducing traffic congestion.

## 2. RESEARCH METHODOLOGY

The research adopted the descriptive approach and simple logical analysis through the data that could be obtained from studies and research specialized in urban transport and from some relevant authorities, as well as by relying on field surveys carried out by researchers. The research adopted the descriptive and analytical approach through the data of the field survey and car survey, as well as the relevant departments. Studies and research specialized in the field of urban transport and analysis using VISSIM programs, HCO2010, and analysis of the result to get the recommendation and conclusion.

American Roads and Transportation Association (AASHTO) officials define a traffic intersection as the area where two or more roads meet or intersect [10]. It is the point at which vehicles are likely to conflict, pedestrians and cyclists are exposed to danger [11], and traffic intersections are dealt with schematically within a comprehensive plan and with the participation or access to the opinions of residents that reflect the opinion of society [12]. An intersection is an area shared by two or more roads that may be joined or crossed. A system of signalized intersections is critical in the smooth operation of both arterial and urban street facilities. [13] Unsignalized intersections exist widely in urban traffic systems. Traditional procedures such as the HCM were proved to be inadequate to capture the system impacts of queues and oversaturated conditions [14].

So, it is necessary to conduct assessments of intersections in cities because of their impact on the capacity of the road system on scientific bases that enable the accurate identification of defect points, thus taking possible measures to improve the performance of these intersections as much as possible [15]. The city's traffic intersection is divided into intersections with one level (ground intersections) and intersections with two or more levels in terms of the spatial separation of opposing movements. Therefore, a list of standards must be followed while planning traffic intersections.

## 3. THE LEVEL OF SERVICE AND STUDY AREA

There are six criteria for expressing the level of service; the best is the service level (A) to (F) is the worst. Service level represents standard units as a qualitative measure of the impact, including operating speed, travel time, traffic disturbances, driving safety, and road suitability [16]. That depends on the average delay time for vehicles and is calculated for each group of traffic lanes (traffic lanes). For each side, then for the intersection as a whole, the service level is related to the value and amount of time The delay directly. According to the time spent stopped at the crossing, there are six degrees of service level measurement [17]. Moreover, these values differ across junctions with traffic signals and those without them since traffic lights are essential for controlling how cars travel, which lowers delays and hence improves service quality. Therefore, by appointing specific service levels for road systems under their functional categorization, most specialized organizations participating in the creation reached road and transportation system standards [11].

The site is about 3.858 km away from Al- Najaf city center. This location is considered the axis of the link between two important cities in Iraq as Al- Najaf and Al-Kufa city. The site is an essential node because it is in a commercial and administrative area due to the location of the commercial Al-Rawan Street, considered one of the city's most important tourist and entertainment attractions. Where the Department of Regional Development, Municipality, and Urban Planning is located, Figure 1.



Figure 1: The streets overlooking the intersection using (GIS10.8).

According to a survey of that region, the majority of Al- Najaf's intersections are of the first type, and with their gradation between the main, intersection, and local (according to the classification of streets and roads that make up the intersection), the level of service in it ranges between two degrees (C, D), with a delay time of 20-55 seconds

as the highest and lowest delay time. From all of the above, this article aims to develop a general and comprehensive plan for transportation in the city of Najaf and to update what was already in place, as well as in the event of a basic design update to organize and define the nature of land uses now and, in the future, and limit or reduce crowding.

**4. FIELD STUDY**

To fulfill the requirements of this study, the necessary surveys were conducted to collect the following traffic information:

**4.1 Traffic Volume**

To calculate traffic volumes at Al Sadrain Intersection, surveys were conducted over five days (3/1/2023 to 8/1/2023), and these days were chosen to show. The discrepancy in traffic volumes between (Saturday and Tuesday) and official working days (Sunday, Wednesday, and Thursday) because the study area is located in government departments, and by twelve hours from 6:00 in the morning until 6:00 in the evening to determine the rush hour (The hour in which the highest volume passes), which represents the design hour, which is relied upon in analytical calculations in road planning. For this study, the highest readings of traffic volumes were adopted for the analysis or design to be on the right side.

- Classification of vehicles into four main sections according to the Iraqi Code for Roads and Bridges (SORB). Figure 2.
- Taking traffic surveys for every quarter of an hour of daylight hours for traffic volumes at the intersection during the counting hours (daytime), Figure 2.

The manual of the study area was conducted on six sites; the study area guidance was put into practice. In this kind of survey, vehicles are typically counted over the course of twelve consecutive hours, divided into two working hours from 7:30 in the morning until 1:30 in the afternoon and from noon until 7:30 in the evening, and divided vehicle into five types: small cars, minibusses, buses, and trucks, Figures 3 to 5.

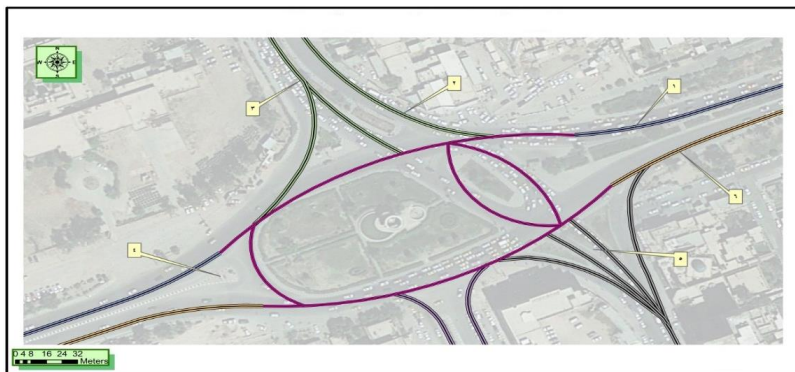


Figure 2: Shows the field survey stations inside the intersection, GIS10.8 program.

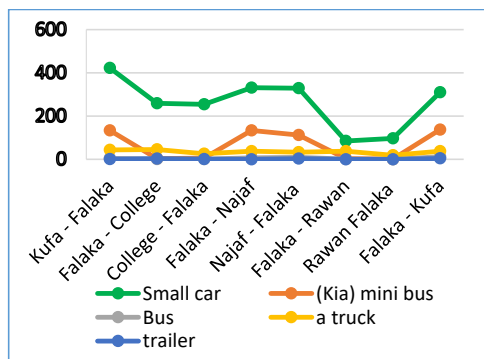


Figure 3: Traffic volume in morning rush hours.

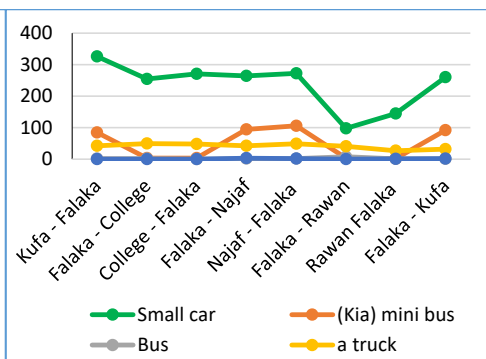


Figure 4: Traffic volume in daytime rush hours.

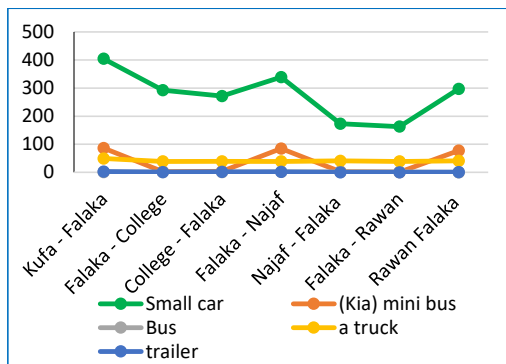


Figure 5: Traffic volume in the evening rush hours.

#### 4.2 Roadside Interviews

Personal interviews were conducted to count the sources and destinations of trips within the intersection. These interviews were conducted in (8) locations, as shown in Figure 6.

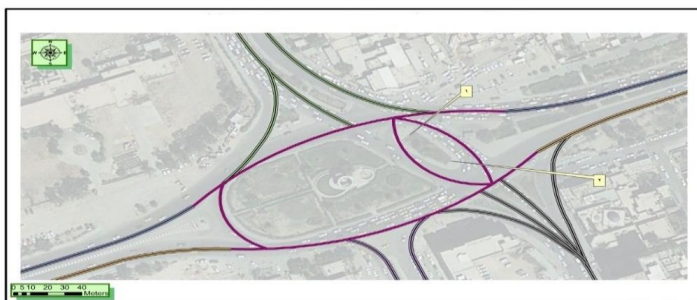


Figure 6: Detour movement survey stations, GIS10.8 program.

#### 4.3 Limit Turning Movements at Intersections

Movements were counted in intersections in two locations for continuous periods every 15 minutes. As follows: Three peak periods (in two hours for each period) during a typical workday: at first the morning period (7:30 to 9:30), then the midday period (1:00 to 3:00), finally the evening period (4:30 to 6: 30). Note (These three periods were suggested based on the recommendations of the traffic men in the intersection area), see Figure 6.

#### 4.4 Trip Times Surveys

Surveys of journey times with the Traffic Analysis were conducted three times in each direction for each truck during the peak hours of the week (morning peak 7:30-9:30, midday 1:00-3:00. 4:30–6:30 in the evening). Trip time measurement studies are conducted in the trolleybus approach. In this method, both delay times and queue lengths are recorded at the intersection.

#### 4.5 Inventory of the Road Network

Six manual traffic census locations were used to make an inventory of the road system. The number of lanes and stopping points were all mentioned in this description.

### 5. ANALYSIS

The analysis of the intersection in two simulation ways:

#### 5.1 Service Level Analysis Using HCS2010 Software

The analysis in the (HCS 2010) program was that the intersection as a whole was (E) with a delay exceeding 70.36 seconds and that the movement is very restricted. The result of the eastern approach (F) was (12.31.81), the result of the western approach (F) equal (31.25.83), and the result of the northern approach (D) equal

(54.34.42). Then the southern approach (E) result equals (75.43.62), as shown in Figure 7.

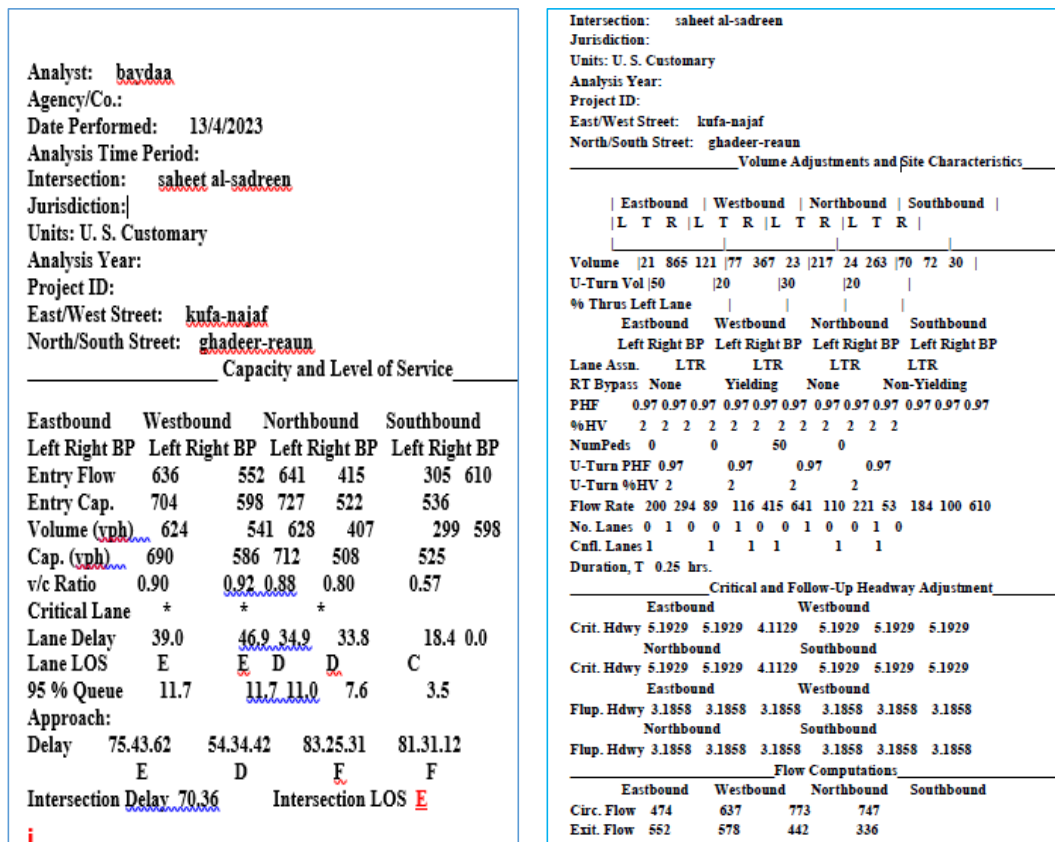


Figure 7: The process of program calculations (HCS2010) and extraction of results.

### 5.2 Using (VISSIM) program to analyze Vehicle Tracking

By dividing the intersection into four areas (A/B/C/D), as shown in Figures 8 to 11.

- Analysis A: Area (A) contains several lanes that run correctly without certain obstacles, except for one lane, the right turn lane. Where the area that the driver needs overlaps with the sidewalk, thus overtaking occurs on the other lane. Area (A) contains several lanes that run correctly without certain obstacles, except for one lane, the right turn lane. Where the area that the driver needs overlaps with the sidewalk, thus overtaking occurs on the other lane. The color of the lanes is green; see Figure 12.
- Analysis B: Area (B) is a complex area with many overlaps between the lanes, as all lanes overlap with each other, and this area can be considered an intersection by itself, so we recommend closing the middle lane of the carrot intersection, see Figure 13.
- Analysis C: The area (C) is complex and overlaps tracks, so all the tracks overlap, which makes the track turn at the turn, which leads to a large overlap between the tracks, see Figure 14.
- Analysis D: In area (D), there are two types of overlaps, which are overlaps with severe curvature overlapping with the middle carrot, but the left track is free of problems when closing the middle carrot and closing the northern track, see Figure 14.



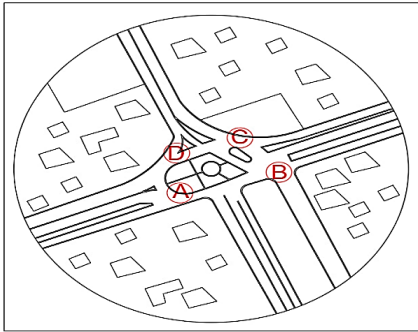


Figure 8: Division of the intersection into four zones (A/B/C/D).

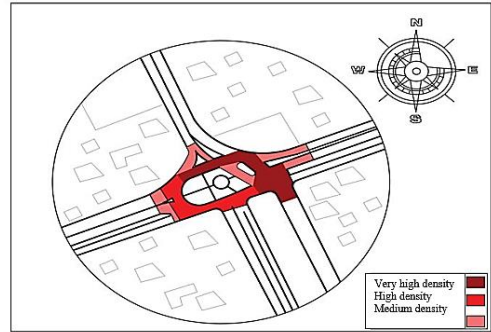


Figure 9: Classification of traffic density at the two breasts intersection.

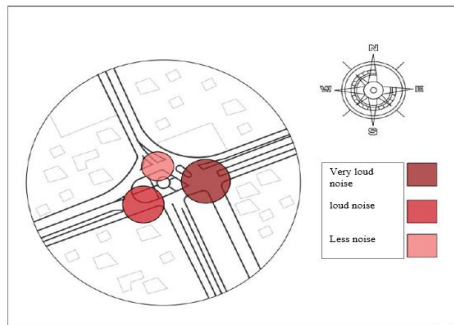


Figure 10: Noise level due to traffic jams at Al Sadrain intersection.

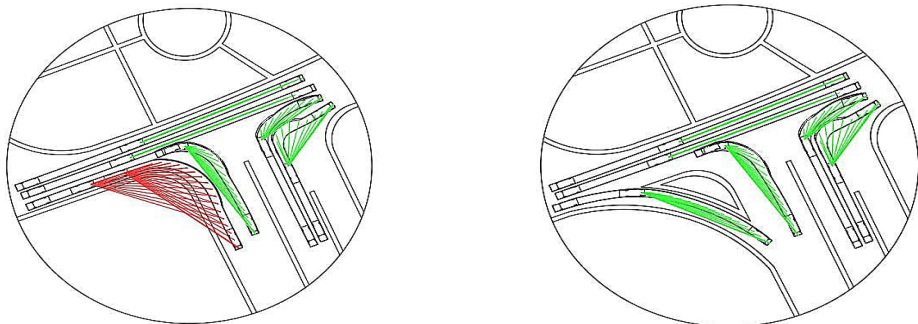


Figure 11: Analysis traffic interferences in section (A), by vehicle tracking and VISSIM program.

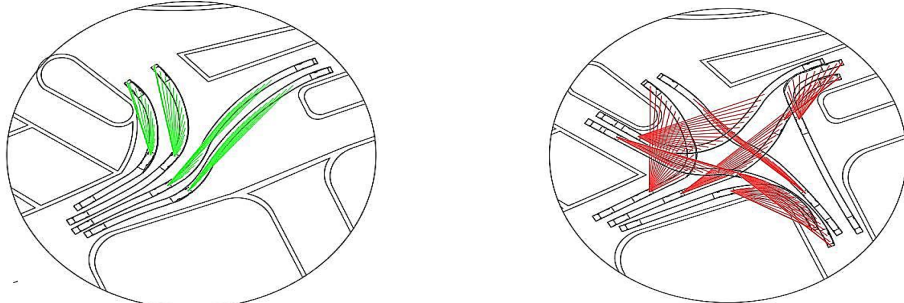


Figure 12: Analysis of traffic interferences in section (B), by vehicle tracking and VISSIM program.

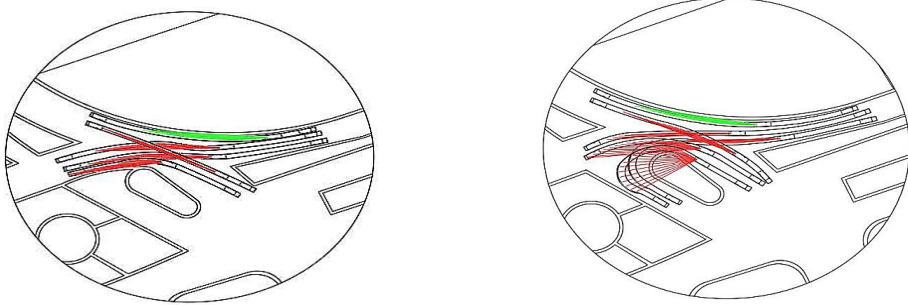


Figure 13: Analysis of traffic interferences in section (C), by vehicle tracking and VISSIM program.

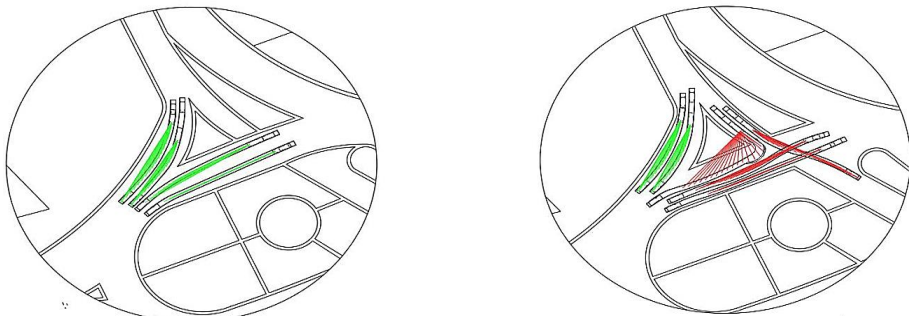


Figure 14: Analysis of traffic interferences in section (D), by vehicle tracking and VISSIM program.

## 6. CONCLUSIONS

- The results of the analysis of the intersection in the program (HCS2010) showed that the intersection is inefficient, especially at peak times of working days,
- equal to 800 seconds/vehicle, and (E) level is the level of service for all survey days during peak hours.
- The main movement at the intersection for all survey days is the movement between the east and west approaches.
- The result of the eastern approach was (F), the result of the western approach (F), the result of the northern approach (D), and the result of the southern approach (E).

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