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Research Article

Improving the Level of Service of a Portion of 60-M Ring-Road in Erbil City

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ABSTRACT

This study aims to implement the factors that can improve the level of service of 60-M Ring-Road in Erbil, Kurdistan Region of Iraq. These factors are minimizing the traffic volume, providing a higher quality pavement, widening the road carriageway, and constructing bridges. The main objective of this paper is to increase the LOS of a specific road known as 60-m ring road from New City Mall to PAR hospital in Erbil city. For this purpose, the data on speed and traffic flow are collected using video camera to collect data to be reasonably analyzed with respect to the speed of the vehicles and set the LOS for the proposed road. The result shows that average speed in this study is 19 km/h, and this confirms that the LOS in this particular road segment is at F category. In addition, the calculated peak hour factor is 0.97 which is more than a typical value in urban area. Finally, the study revealed that the traffic volume on this specified road is too high.

Keywords: Bridge ramp, congestion, highway capacity manual, level of service, peak hour factor, space mean speed, urban

INTRODUCTION

Over the past decade, the number of private cars has been significantly increased at Erbil city, where the number tends to be more than a vehicle per family. This is due to the absence of the required public transport in the city such as buses, light rapid traffic system (LRTS), railway networks, and underground routes.

Based on the last statistics in 2011, Erbil city as a capital of Kurdistan region, Iraq, is considered to be one of the major cities in the region, with population about 1.6 million people. Human settlement at Erbil can be traced back to possibly 5000 BC, and it is one of the oldest continuously inhabited areas in the entire world. At the heart of the city, there is the ancient Citadel. Apart from its strategic geographical position, commercial development, and tourism of attraction resorts, traffic congestion is one of the challenges that has been affected the movement of vehicles in the city.[1]

Urban areas can be varied as greatly as the variety of activities performed there: The means of production and the types of goods, trades, transportation, and delivery services. The third definition states that urban areas are those locations where there is a chance for a diversified living environment and various lifestyles.[2]

In recent years, traffic congestions have significantly increased in Erbil city. There are several reasons which directly and indirectly influence the traffic distribution inside Erbil city. The presence of public transport tends to encourage road users to reduce utilizing private cars which does not exist as required in Erbil city. The main ring road known as 60 m street around the center of Erbil is the most strategic road which has the advantage of its wide carriageway, in which the wide is 18 m per each side, divided into five lanes. Geometrically, roads with this geometry should provide a reasonably high level of service (LOS). In reality, due to the existence of several branch roads from the outer and inner of the ring road, the LOS has been noticeably decreased.

LOS in Urban Area

The term LOS is used to qualitatively define the operating conditions of a roadway depending on several factors such as speed, travel time, maneuverability, delay, and safety. The LOS of a facility is designated with a letter, A to F, with A representing the best operating conditions and F the worst as shown in Table 1.[3]

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The LOS is simply one of the pillars of geometric design which is a measurement of any particular road to assess the case of traffic movement depending on the average traffic speed. The LOS is not smoothly passable defined for heterogeneous traffic flow with different operational features.[4]

The LOS is considered to be a measure of traffic condition on any particular road which has been clarified in the HCM, 2000. Depending on the operation characteristics of the vehicles, the LOS can be differentiated relying on the traffic speed and distribution of the vehicle represented as traffic volume.

Ideally, the worst LOS tends to be equal volume to capacity for the traffic condition. In other word, when the volume of capacity ratio is close to one, it indicates poor traffic condition. As a result, the obstacles on the pathway of both sides can significantly drops the traffic speed despite of the multi-lane road.[5]

The factors listed below may influence the evaluation of the LOS:[6]

- Factors affecting the speed such as traffic restriction.
- Operating speed and travel time.
- Quality of traffic condition represented as driving comfort and convenience.
- Freedom of maneuver with the similar speed required for operation.

Objective

The fundamental aim of this paper is to improve the LOS for a specified road in which proper solutions are proposed to be constructed in the locations where the vehicle movement becomes reasonably more efficient. This can be achieved using data collection in monitoring system designed for the determination of the vehicle speeds and traffic volume. Furthermore, the traffic condition is aimed to be converted from the worst condition to a reasonably better. This may be achieved by proposing proper solutions for that particular road after evaluating the problem.

Study Area

The real problem associated with the study area is the branch roads existing on the 60-m ring road. They have a great impact to create traffic jam due to vehicles passing the branch roads to the left turns as shown in Figure 1. This possibly generates vehicle conflict minimizing the design speed of the road which is 60 km/h.

After inspection stage of 60-m wide ring road of Erbil city, the study area was found to be a particular road to conduct the study satisfactorily. The proposed area is located between Eskan intersection and Koya intersection on the 60-m wide ring road. This portion appeared as the busiest part exposed to traffic congestion. This is due to the branch roads located on the path of the selected road, where the branch roads create traffic conflict as a result of traffic movement passing the branches to the left turns on the medians as shown in Figure 1.

METHODOLOGY

The following procedure will be undertaken in the field.

To set an efficient plan, a map of the proposed area was sketched properly, in a way that the points of two cameras were fixed with the distance of 150 m between them. The ideal position of the cameras has been chosen based on the entering vehicles from the branches to the left turns which exist from the medians of the road. Figure 1 shows the opposite side of the 60-m wide ring road, that collect data from two branch roads.

Consequently, the monitoring process was designed to record the license number of any passing car through the two cameras at two different times. This time is considered to be a travel time to determine the speed of the vehicles based on the actual distance between the two cameras.[7] To guarantee recording the time more precisely, the direction of both cameras was set on the same vision angle.

Space mean speed (v_s) is the average speed of all the vehicles along a given road segment at a typical instant in time (Ortuzar and Willumsen, 2011). After the monitoring process, the analysis of the collected data and processing were started as shown in Table 2. The determination of the speed for any vehicle is calculated utilizing the following formula:

$$\text{Speed (v)} = \frac{\text{Actual distance (d)}}{\text{Travel time (t)}} \quad (1)$$

Where;

Speed (v): The real speed passing through the portion of

Table 1: Level of service in urban street classes (highway capacity manual, 2000)

Urban street class	I	II	III	IV
Range of speeds	70–90 km/h	55–70 km/h	50–55 km/h	40–55 km/h
Typical speed	80 km/h	65 km/h	55 km/h	45 km/h
LOS	**Average travel speed (km/h)**			
A	>72	>59	>50	>41
B	>56−72	>46−59	>39−50	>32−41
C	>40−56	>33−46	>28−39	>23−32
D	>32−40	>26−33	>22−28	>18−23
E	>26−32	>21−26	>17−22	>14−18
F	≤26	≤21	≤17	≤14

LOS: Level of service

the studied road (km/h)

Actual Distance (d): The distance between two fixed cameras in km

Travel time (t): The time spent by any particular vehicle on the study road can be found by subtracting t_1 and t_0

t_0: The initial recorded time from the first camera in seconds

t_1: Last recorded time spent by a vehicle in seconds.

To locate a sufficient approach, two cameras were used per day of monitoring during peak hours (8:30 AM and 5:30 PM). The operation of monitoring was done triple for each side of the road. The recording process was designed for peak hours. The average speed of 3 days based on the collected traffic condition was calculated as the final result to be a realistic representation of condition and this is shown in Table 2.

RESULTS AND DISCUSSION

The observations undertaken on the study area generate diverse interpretations regarding the traffic condition. The calculated traffic speed required for the determination of LOS confirms that the traffic condition varies from E to F. According to Table 3, the average travel speed for the vehicles in a specific time is 19 km/h which locates at the F category representing the worst LOS. This confirms that the influence of the branch roads is considerably high.

$$Ú = \frac{\sum fi * ui}{\sum fi} \tag{2}$$

$$\sum fi*ui=1376$$

$$\sum fi = 72$$

$$Ú=\frac{1376}{72}=19\,\text{km/hr}$$

$$S = \sqrt{\frac{\sum fi*(ui-ú)^2}{N-1}} \tag{3}$$

$$\sum fi*(ui-ú)^2 = 664$$

$$(N-1) = \sum fi - 1 = 71$$

$$S2 = \frac{664}{71} = 9.35 \rightarrow S = \pm 3.05 \text{ km / hr}$$

$$PHF = \frac{\text{Total volume for 1 h}}{4*\text{Maximum volume of 15 min}} \tag{4}$$

$$PHF = \frac{2045}{4*525} = 0.97$$

Ú is the arithmetic mean speed.

S is the standard deviation.

PHF is the peak hour factor typically between 0.8 and 0.95.

Tables 3 and 4 illustrate a part of data collection and statistical analysis. The results show that the arithmetic mean speed of the vehicles is 19 km/h and the standard deviation of the data is approximately ±3.05 km/h. This gives a decent indicator of the differences in distribution of the speed vehicles which is not so high in the range of 16–22 km/h. The typical value of the peak hour factor (PHF) is between 0.8 and 0.95 indicating a lower PHF characteristic. In this study the (PHF) is higher than the typical value (0.97). This proves the worst LOS on this road segment.

Figure 2 demonstrates the frequency of observed vehicles for the vehicles traveling this particular road section in which the speed of 17 km/h has the highest frequency, and this is statistically called as a modal speed.

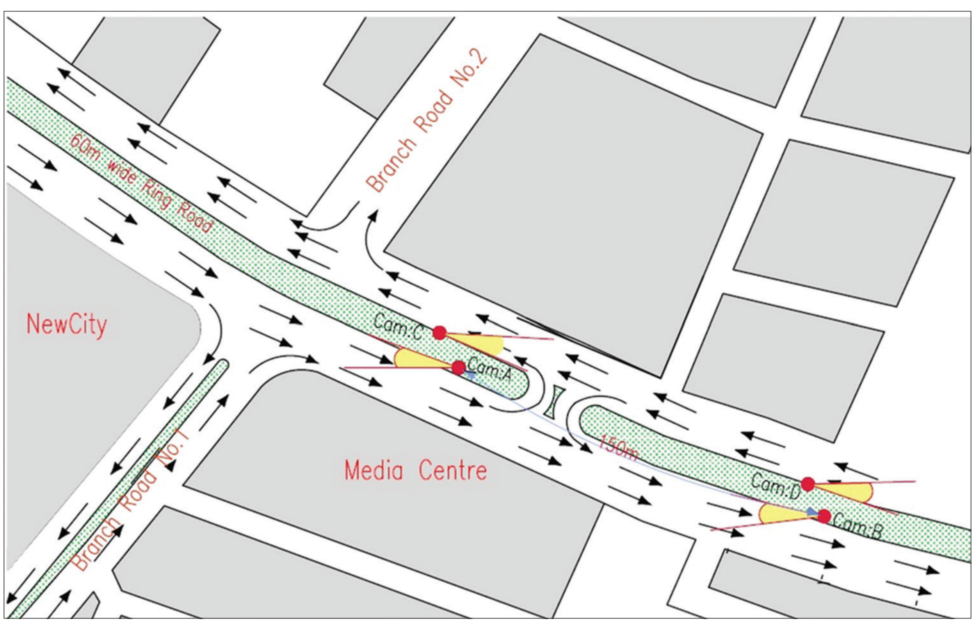

Figure 1: The location of the fixed cameras in the study site

The median speed is obtained from the cumulative frequency distribution curve [Figure 3] approximately as 16 km/h, the 50th percentile speed, and 20 km/h, the 85th percentile speed.

Solution from Geometric Design Points of View

Since the most problematic points to highlight are the branch roads which are causing traffic conflict, it is fair to state that the 60-m wide ring road has the advantage of its wideness from geometrical viewpoints. This can be of great importance to design an efficient network system of transport to reorganize the movement of traffic. Ideally, to fix the traffic conflict at this particular area, it is fair to say that designing bridge ramps would be a helpful option for improving the LOS, specifically for the vehicles traveling from the branch roads to the left turns on the 60-m ring road.

The essential considerations that should be taken into account for designing bridge ramps are as follows:[8]

- Design speed
- Number of lanes and its width
- Grades
- Curve geometry
- Effect of alignment skew
- Crossroad median consideration.

Table 2: Typical illustration of data processing and calculation

Sample/Vehicle No.	t_0 (s)	t_1 (s)	Actual travel time (h)	Distance (km)	Speed (km/h)
1			$t_1 - t_o$		$\text{Speed (v)} = \dfrac{\text{Actual distance (d)}}{\text{Travel time (t)}}$
2					
3					
:					
N-1					
N					
Average space mean speed (v_s) (km/h)					

Table 3: Sample of data collection and calculation

Car No.	t_0 (s)	t_1 (s)	T actual (h)	Distance (km)	Speed (km/h)
1	2	28	0.0072	0.15	21
2	6	42	0.0100	0.15	15
3	20	48	0.0070	0.15	19
4	14	50	0.0100	0.15	15
5	24	54	0.0083	0.15	18
6	30	97	0.01861	0.15	8
:				0.15	
6200				0.15	
Average travel speed (km/h)					19

Table 4: Sample of vehicle speed data and statistical analysis

Speed class km/h	Class median, ui	Class frequency (number of observations in class), fi	fi*ui	Percentage of observations in class	Cumulative percentage of all observations	f (ui-ú) ²
11−14.9	0	0	0	0	0	0
15−18.9	17	47	799	65	65	4
19−22.9	21	19	399	26	91	4
23−26.9	25	3	75	4	95	36
27−30.9	29	1	29	1	97	100
31−34.9	33	0	0	0	97	196
35−38.9	37	2	74	3	100	324
Totals ∑=		72	1376			664

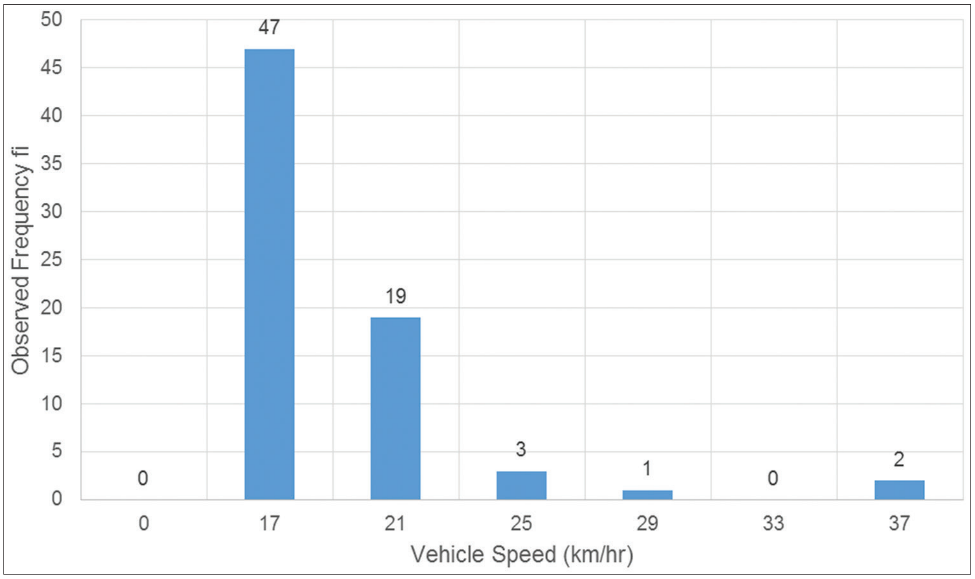

Figure 2: Histogram of observed speed vehicles during peak hour

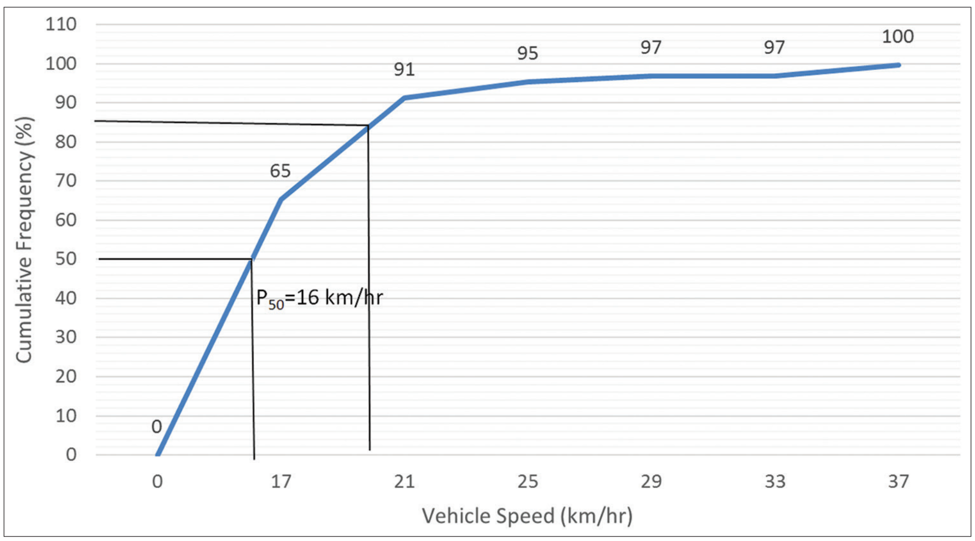

Figure 3: Cumulative distribution

In line with the above-mentioned interpretations, it is highly recommended that the proposed ramp should apply the three fixed terms such as safety, economy, and comfort in the design process. However, the restrictions which exist on the studied area may cause some difficulty in design speed, number of lanes, and radius of the curve which may lead to slightly uncomforted traffic condition for the road users. Since there are a limited number of solutions such as changing the position of the U-turns or perhaps adding them as well as changing into intersections, therefore the only logical solution is remained to construct bridge ramps to hold the traffic flow which makes the real problem of this study.

CONCLUSIONS

It is obvious that the LOS has been significantly influencing toward its worst condition on the study area due to the numerous vehicles moving straight foreword conflicting with the vehicles coming from the branch roads. Despite the real traffic condition, it has been found that the absence of public transport has negatively affected in minimizing the LOS as well as the traffic awareness of the road users.

The results showed that the average travel speed of vehicles was noticeably less than the design speed of the road (19 km/h), while the design speed specified to be 60 km/h. This drop of speed is considered to be a great difference.

Since the geometrical advantages of the study area are reasonably appropriate for extra changes more than the restrictions, it is highly recommended that the design and construction of bridge ramps may lead to solve the traffic congestion on that particular road.

Recommendations

The most striking point to emerge is that a tremendous number of private cars are used by the road users due to the inefficient public transport. On a larger scale, the existence of a sustainable transport system can be of a favorable support including different pillars of sustainability which are efficiency, economically, and socially. From sustainability perspective, increasing awareness is considered to be vital to encourage people using efficient public transport, for example, establishing a variety of lanes for buses, motorists, cyclists, and tramways (LRTS).

Based on evaluating the gathered data taken from monitoring process at the study area, it was found that the LOS may be significantly improved toward a reasonably better. This could be achieved by designing proper infrastructures which geometrically are of great support. It is highly recommended that construction of bridge ramps may increase the space mean speed (v_s) of vehicles traveling on the road segment, avoiding conflicts between vehicles moving from branch roads to the left turns against straight forward moving vehicles located on 60-m wide ring road.

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