Estimating Statistical Model for Driver U-Turn Gap Acceptance Behavior

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Abstract: Gap acceptance is the most important parameter in determining the capacity of U-turn opening. U-turn safety and efficiency are affected by the behavior of drivers on gap acceptance. The driver required a sufficient gap length to cross the U-turn section. This study is a trial to find a statistical model for driver gap acceptance behavior. A video recording has been used to collect traffic volumes and characteristics for microscopic information such as the number, types of vehicles, opposing through traffic, turning movement, time headway acceptable gap, queue length, and the number of lanes in each direction. The studied area was located within an urban area characterized by a large number of commercial shops and governmental offices. The highway segment was located at the extended of Al-Ghadeer sector toward Al-Escan highway. That link between the Jameea and Al-salam sectors on one side and Al-Escan and Al- qadesiya sectors on the other side with Najaf-Kufa highway in Najaf city. This segment was a 4-lane divided highway containing on-street parking in each direction and five mid-block U-turns with acceleration lane distribution along the median. Four U-turn facilities were selected as a case study. The traffic volumes for each direction were calculated manually every 15 minutes. Traffic volume and traffic composition were determined manually. A simple software program called EVENT written in C-language provides a system for data counting and enables digital counting for available gaps. The queue length is determined for every 30 seconds and then determine the average queue length for every 15 minutes. Results show gap length gives a higher influence on U-turn gap acceptance decision than wait time; and U-turn driver age, vehicle type of both U-turning and opposing through traffic, and queue time did not influence gap acceptance decision at a 95% confidence interval; U-turn gap acceptance decision connected in equation with gap length, and wait time under the percentage correctness of about 50%. Average travel speeds are an essential factor in driver gap acceptance decisions. It may be the absence factor that made the model more corrective. Future research could also focus on the control and management of such a medium opening to ensure traffic flow and safety. Some of the proposed improvement plans can be studied in detail to assess efficiency and effectiveness.

Keywords: U-Turn, gap acceptance, Median opening, statistical analysis.

1 Introduction

The highway network in any developed country presents a part of the transportation system in addition to malty modes that have progressed over many years. A highway system contains many factors such as vehicles, pavement, parking facilities, and controller applications; all these parameters work according to recognized measures and following timetables in any transportation mode like air, land, or water. Highway users, control operators, and the operating environment are normally interconnected with each other. Hole transportation systems also, reflected in place need decisions multitude made by carriers, shippers, government policy, travelers' mode, and as a result all these element artificial nonusers regarding the investment of using transportation facility, (Garber & Hoel, 2009). Traffic congestion is mainly due to the intensive use of automobiles, whose ownership has spread massively in Latin America in recent decades. Private cars have advantages in terms of facilitating personal mobility, and they give a sensation of security and even of heightened status, especially in developing countries. They are not an efficient means of passenger transport, however, since on average at rush hours each occupant of a private car causes about 11 times as much congestion as a passenger on a bus (Alberto Bull,2004). U-turn facilities are used as open areas for two-way traffic flow on the road, often set at the entrance of an intersection or the middle of the road section. U-turn behaviors of vehicles have a significant impact the traffic performance. In theory, the through vehicles should get priority over the U-turn vehicles all the time. However, the conflicts between U-turn vehicles and incoming through vehicles are common especially when the U-turn vehicles are in a long queue, each the endurance waiting limit of drivers, or the incoming vehicles are reluctant to yield (Wu, et.al., 2020). According to that, movements at mid-block U-turn openings are highly complex and hazardous. Ordinarily, the opposing traffic stream speed is moderately higher than the turning vehicles, which (i.e., turning vehicles) have to wait for a suitable accepted gap before turning with a lower speed. Limited studies found that providing methodology of estimating capacity models and predicted a time delay for movements at un signalized intersections, or at least provided specific procedures of capacity estimation and delay of turning movement at median U-turn openings. Therefore, researchers are focusing on this point (i.e., capacity and delay estimation) at mid-block U-turn median openings (Hussein, N., 2008). Recently, the U-turn movement used as a strategy at intersections by depending on it (in addition to a right turn) instead of a direct left turn. Lowering travel time and delicate is the main advantage of using this strategy, especially, at high to moderate major street traffic volume. On the other hand, mid-block U-turn capacity should be much higher than direct left turns movement capacity, and eliminate conflicts of right turns plus U-turns as compared with direct left turns. These models support traffic engineers in suggesting solutions and recommending suitable alternatives without spending very expensive resources required to implement alternative strategies in the real field. traffic Simulation models essentially can improve the level of service in the planning and design level of the urban road networks. In a few studies dealing with the alternative of U-turn movement section enhancement. In many countries in the world, speed humps are widely dependent as a procedure for controlling traffic flow and as a result, the turning process will be easier and decrease the number of accidents. The speed hump effect on (ATS) had been studied by the turning vehicles, results of these studies showed that using of speed hump can reduce the (ATS). U-turn section suggestion as a new design shows an increase in U-turn opening capacity, improvement in the level of saturation, decrease in queue length, and time delay. Researchers concluded that using the roundabout as the new model and fly over U-turn as the secmodeldels, (Zainab A. and Jalal T, 2021). This research focuses on dealing with traffic congestion related to U-shaped turning areas using traffic micro-simulation software because they are the areas in which traffic congestion occurs within cities. The current work aims to explore a statistical model depending on real field data collected from malty U-turn openings to represent traffic movements characteristics at these sites

1 Site Selection

To select highway sections for the investigation of U-turn traffic characteristics, a short investigative trip through the study area was performed to identify suitable highway segments containing some mid-block U-turn facilities with the same operational conditions different in some characteristics. In addition to that, the selected mid-block U-turn facilities have to provide a suitable location for setting the camera required for video recording (that's because here in Iraq, the highways don't control by camera systems or any intelligent technology). To collect sufficient and representative data, it was necessary to observe a segment traffic volume and flow that was statistically meaningful, to represent a range of traffic flow and section geometrics design, (AL-Kubaisi, 2007).

There are many sites of the U-turn sections that have been selected in Najaf city. These sites are appearing in the same geometric layout. The extracted parameters were collected every five minutes from videotape previously recorded and played; these parameters include: through volumes, merging (turning) volumes, opposing traffic volumes, average queue length, percent of heavy vehicles in each direction, gap acceptance for every five minutes, and No. of the lanes for each site.

The study area was located within an urban area characterized by a large number of commercial shops and governmental offices. The highway segment was located at the extended of Al-Ghadeer sector toward Al-Escan highway, which linked between the Jameea and Al-Salam sectors on one side and Al-Escan and Al-Qadesiya sector on the other side with Najaf-Kufa highway in Najaf city as shown in Fig.1. This segment was a 4-lane divided highway containing on-street parking in each direction and five mid-block U-turns with acceleration lane distribution along the median. four U-turn facilities were selected, denoted U1, U2, U3and U4, as shown below in Fig.2. The selected first U-turn (U1) was in front of the Najaf General Traffic Directorate on the Al-Escan highway. This U-turn is providing a two-way turning ability with a storage lane in each direction. The width of U1 is (15m). The second U-turn (U2) is the first U-turn on Al-Ghadeer highway toward Al-Salam intersection, in front of the side door of Al-Hakeem hospital. This U-turn also was a two-way turning ability without a median and have a storage lane in each direction. The width of U2 is (11.90m). While the third U-turn (U3) is the second U-turn on Al-Ghadeer highway toward Al-Salam intersection, in front of some commercial shops with the same geometric design as U2. The width of U3 is (12.80 m). Finally, the details of the fourth selected U-turn (U4) which is the third U-turn on Al- Ghadeer highway toward Al- Salam intersection, in front of some commercial shops with the same geometric design as U2 &U3. The width of U4 is (14.30m).

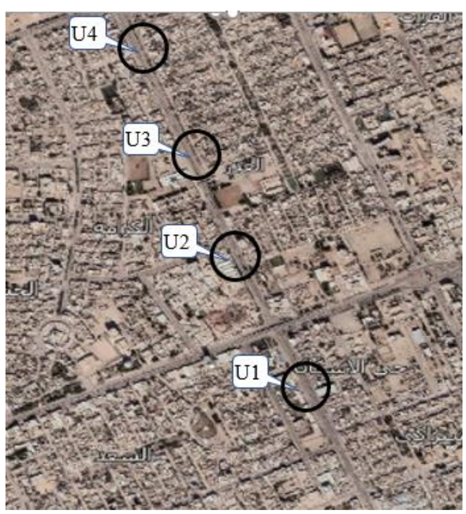


Figure 1 Snapshot for site selection of studying area

3. Data Collection Methods Used in This Study

To select a suitable data collection method, many criteria must be considered. These include the accuracy of the data, ability to review, costs of data collection as it should be kept as low as possible, data collection method should not affect traffic and the driver attention, it should be avoided the locations or periods of poor visibility, e.g., nighttime, foggy weather, the characteristics of traffic should be different from free flow to traffic congestion and obtain official security permission for setting up tools for data collection. In this study, video records have been used to collect traffic volumes because they are the means available method that can calculate much microscopic information such as the number, types of vehicles, opposing traffic, turning movement, through traffic, time headway acceptable gap, queue length and number of lanes on the road. Table 1 represents a summary of the data collected in this study.

The process of data analysis is very complex and required high accuracy to obtain good results. Many software can use to analyze and display the data. VLC players and GOM players are used to display the video recording. The method of analyzing data for video recording is not easy and required a long period to obtain accurate results based on the type of data needed. The traffic volumes for each direction were calculated manually every 15 minutes. As well as, the traffic composition for each direction for every 15 minutes was also calculated. The camera position was carefully chosen so that all variables of interest could be visibly observed. After that, the saved recorded movie files were played and evaluated in a computer laboratory. Traffic volume and traffic composition were determined manually. A simple software program called EVENT written in C-language (Al-Neami, A. H. 2000), provides a system for data counting and enables digital counting for available gaps. According to (HCM, 2010), the queue length is defined as "a line of vehicles waiting to take an opportunity to move within same flow rate from the front of the queue at through traffic average speed". In this research, the queue length is determined for each one minute then the average queue length for every 15 minutes is taken for analysis.

Figure 2 Snapshot for site selection of the four U-turns (U1, U2, U3, U4)

4. Data Collection Results

4.1. Traffic volumes

Table 2 shows the average traffic volumes for every15 minutes interval for sites U1, U2, U3, and U4 respectively. The analysis period was varied based on the availability of high traffic volumes and queues at these sites. The flow is determined for each counting period. The traffic volumes are counted for the whole location including through, opposing, and turning volumes, in addition to the maximum and average queue length for every five minutes.

4. 2. Traffic Composition

The traffic composition is computed per direction for each site selection. In general, the traffic composition contains passenger cars, trucks, and buses. The FHW class the traffic into three vehicle types vehicle classes with definitions as shown in figure 3.

Group1: Passenger carriers include motorcycles (class1), passenger cars (class2), Pickups, panels, and vans (class3) including 2-axle, or 4-tire single units, can have 1- or 2-axle trailers, and buses (class4) include 2- or 3-axle, full length.

Group2: commercial carriers include single-unit trucks, 2-axle or 3-axle or 4 or more axles, 6-tire, (dual rear tires) (class5-7), Single-trailer trucks, 3- or 4- or 5- or 6- or more axles (class8-0), multi-trailer trucks, 5 or less or 6 or 7 or more axles (class 11-13).

Table 3 shows the traffic composition for each direction. According to this table, the percentage of passenger cars is more than the others types for all sites.

Table 1: Summary of data collection in this study.

Site NO.	Location	Date	Duration
U1	Nearby Najaf Traffic Directorate	15/10/2021	2 hr.
U2	first one in Al- Ghadeer highway	26/10/2021	2 hr.

U3	Second one in Al- Ghadeer highway	17/11/2021	3 hr.
U4	Third one in Al- Ghadeer highway	28/11/2021	2 hr.

Table 2: Summary of data collection for the four sites selected

Time sec.	**Opposing vol.**	**Through vol.**	**Turning vol.**	**Max. queue length**	**Avg. queue length**
			Site U.1		
15	137	231	132	6	3
30	193	272	195	7	4
45	179	221	131	8	4
60	154	224	100	7	4
			Site U.2		
15	113	156	**107**	6	3
30	123	160	109	5	3
45	151	202	142	8	4
60	73	88	80	8	4
			Site U.3		
15	82	126	53	3	2
30	88	185	73	4	2
45	124	186	86	10	5
60	192	147	161	9	5
			Site U.4		
15	82	139	42	4	2
30	125	170	33	6	3
45	79	205	32	5	3
60	119	247	35	4	2

Gap acceptance is the most important parameter to determine the capacity of U-turn opening. Safety and performance are affected by the behavior of drivers to accept gaps. At unsignalized intersections such as the U-turn section, the driver is required to sufficient gap to cross the U-turn section. Many factors affect the decision to accept such as traffic flows, the geometric of the road, and the environmental and human factors (Nagalla, et.al., 2017). In this study, the gap acceptance was measured as the difference in time between starting a vehicle it's maneuvering towards the opposite direction and reaching the lag vehicle from the opposite direction to be parallel to the turning point. Figure 4 shows the gap and lag measures.

According to previous studies (Yousif & Al-Obaedi, 2011), if the length of the available gap is more than (5 sec), such gap will be accepted by the majority of drivers, and therefore gaps larger than 5 seconds should be eliminated from the data. The average gap acceptance is calculated for each site in two cases (before and after the filtering process (i.e., excluding gaps greater than 5 seconds). Tables 4 and 5 show the average, standard division, maximum, and minimum gap acceptances for each site before filter and after the filter. Figure 4 shows the histogram for gap acceptance for each site after the filtering. The percent of gap acceptance frequency for gap length range from 2-4 seconds with a period length of 0.5 seconds. All sets take approximately the same ranges of gap acceptance frequency. But only one set U1 show a 2.1% of gap acceptance more than 3.5 and less than 4 second. On the other hand, gap length ranges from 2.5-to 3 second taking the higher frequency.

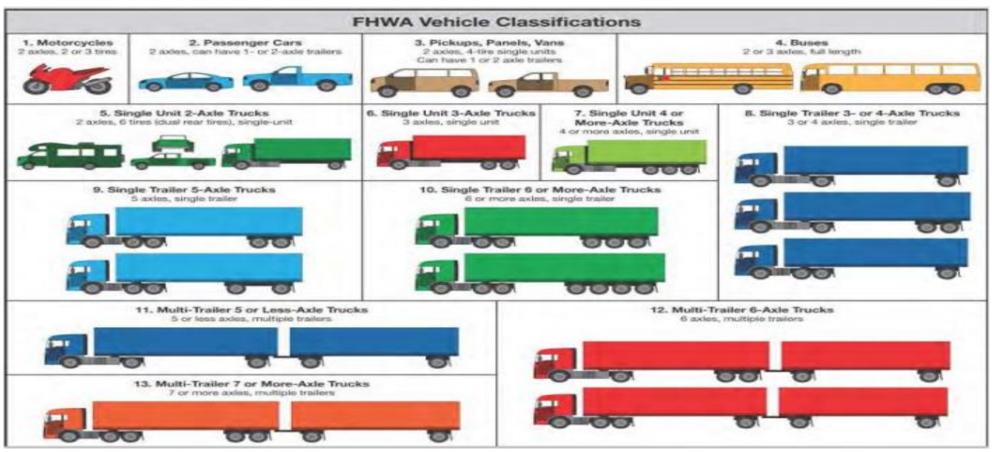


figure 3: FHWA Vehicle Classifications.

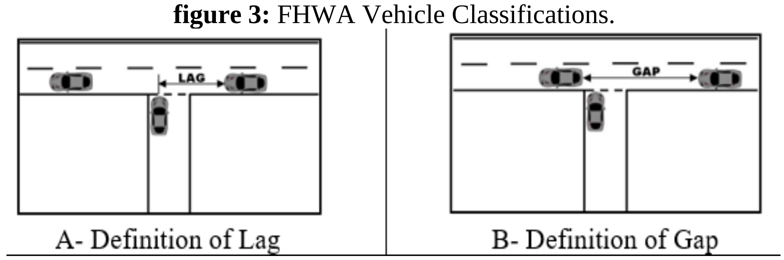


Figure 4: Show the Gap and Lag Measures **(Manish, and Mokaddes, 2016)**

5. Gap Acceptance Probability

The gap acceptance behavior is a complex properly problem, but the more possible solution to it will be either -yes- or -no-. The traditional model used to analyze and correctio is binary logistic regression analysis which explains the occurrence of such an event. The probability of the event occurrence represents the main output of this model. furthermore, the statistical significance level of each variable can be obtained by logistic regression. The probability of mid-block U-turn gap acceptance based on the explanatory variables x_1, x_2, …, x_n can be modeled a (accept) $= \frac{e^z}{1+e^z} = \frac{1}{1+e^{-z}}$ ... (1)

$$z = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n \quad \ldots (2)$$

where β_0, β_1, β_2, …, β_n represent parameters estimated from the logistic regression analysis.

Table 3: Traffic compositions for all sites.

Site U.1			
Direction	**% P.C**	**% Truck**	**% Bus**
Opposite volumes	96%	2.3%	1.7%
Through volumes	97.3%	1.4%	1.3%
Turning volumes	98%	1.2%	0.8%
Site U.2			
Opposite volumes	100%	0%	0%
Through volumes	100%	0%	0%
Turning volumes	100%	0%	0%
Site U.3			
Opposite volumes	97.5%	0%	2.5%
Through volumes	97.2%	1.2%	1.6%
Turning volumes	98.6%	0%	1.4%
Site U.4			
Opposite volumes	97.9%	1%%	1.1%
Through volumes	97.5%	0.8%	1.7%
Turning volumes	99%	0%	1%

Table 4: The average, standard division, max., min. gap acceptances for each site before the filter.

Sit. No.	No. of cases	Maximum gap (sec)	Minimum gap (sec)	Average gap acceptance (sec)	Standard Deviation (sec)
U1	190	7.91	2.03	4.38	0.437

U2	150	7.62	2.03	3.61	0.502
U3	249	6.93	2.05	4.63	0.434
U4	199	5.69	2.00	4.38	0.439

The analysis methodology begins by collecting all variables and testing the significance of each variable. Forward and backward stepwise analyses, based on likelihood ratio, were also directed to confirm the level of impact of variables. The level of significance was set at 0.05 for the variable entry and 0.10 for the variable removal in the stepwise analysis. The forward stepwise analysis results were used to evaluate the effect of significant variables. The cutting value for the decision of accepting the gap was set at the probability of 0.5.

All variables are supposed to have an effect on the gap acceptance decision measured and realized for the fourth site previously selected in the current research. Several variables collected are six variables involved in this research:

1. Age group, drivers using the U-turn opening classify into two groups 1- young, and 2-old. (Approximately extracted)
2. Vehicle type, vehicles using the U-turn opening classify into three passenger car types divided into 1- vehicles types of sedans, sport utility vehicles, and vans, 2- taxis, and 3- pick-ups.
3. queue time, when a U-turning vehicle makes the first move to join the queue until it completely reaches the front of the queue, define as the time length duration.
4. wait time counting for vehicles stopping at the first line as a position of the queue.
5. gap length, the headway time on opposing through traffic referring to gap length in seconds. According to Highway Capacity Manual 2010, the parameters of gap acceptance take the word “gap” replaces with “headway” in case of estimating the potential capacity (HCM, 2010).
6. opposing vehicle type, vehicles using the U-turn opening classify into three passenger car types divided into 1- vehicle types of sedans, sport utility vehicles, and vans, 2- taxis, and 3- pick-ups. Truck types were omitted from this research due to their low percentage and the land use was CBD area.

The variables (1) - (4) related to mid-block U-turn traffic flow while the remaining related to the opposing traffic flow. In addition, the combination of u-turning vehicle type (3) and opposing vehicle type (5) were also of interest. It is supposed that both U-turning and opposing vehicles have the comparable capability to identify the gap and average speed.

Table 5: The average, standard division, max., min. gap acceptances for each site after the filter.

Sit. No.	No. of cases	Maximum gap (sec)	Minimum gap (sec)	Average gap acceptance (sec)	Standard Deviation (sec)
U1	143	3.91	2.03	2.68	0.387
U2	120	3.17	2.03	2.61	0.313
U3	144	3.29	2.05	2.76	0.34
U4	167	3.26	2.00	2.64	0.309

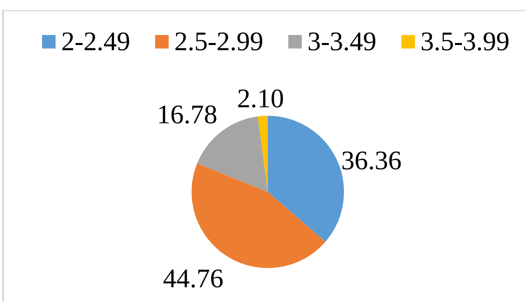
6. Field Data Processing

From all periods recorded data was collected and combined for general analysis to contract the overall average U-turning driver behavior for the four selected sites. In the laboratory, video recorded was studied more than one time to ensure that the data collected was suitable information, (i.e., useful data are: vehicle type, queue time, wait time, gap length). Meanwhile, driver age data was founded on the perception of the observer. So, roughly two groups of age were depending to eliminate human perception error. The following situations provide data that could not be used in the analysis process:

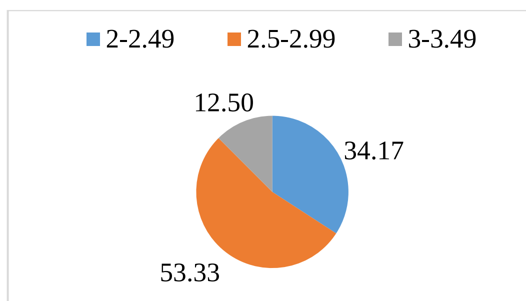
- when opposing traffic was congested;
- when the opposing vehicle stopped or approaching stope for U-turning vehicle; and
- when U-turn opening was controlled by police or any moving controls.

The data collected after reviewing reached 307 U-turning vehicles totally that extracted from the video record. It is well known that each driver wants to U-turning gat only one gap accepted while he/she faced one or more rejected gaps. The gap length was known as the most significant variable in the gap acceptance process. Certainly, any driver tends to reject insufficient small gaps and accept suitable large enough gaps. This driver behavior had been selectively analyzed to describe the reasons that stand behind the rejection of a large gap or accept a small gap. Therefore, 614 cases were collected (307 vehicles, 2 gaps each).

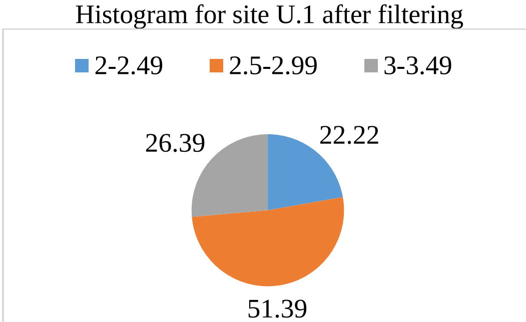
All data equal to or less than 2 seconds were screened out because that gap length never is sufficient for a U-turning vehicle to complete a turning maneuver. Furthermore, all gap lengths equal to or more than 5 seconds were also omitted from the data-dependent analysis that returns to the ability of all u-turning vehicles to maneuver within such a large gap. After filtering data, all analysis processes included a total of 574 of the U-turn gap acceptance decisions.



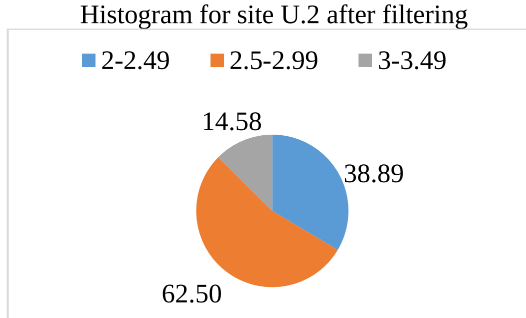
Histogram for site U.1 after filtering



Histogram for site U.2 after filtering



Histogram for site U3 after filtering



Histogram for site U4 after filtering

Figure 5: Histogram for the four selected sites after filtering

6.1 Correlation Analysis

Table 6 shows Pearson correlation coefficient resulting from the correlation analysis. Analysis results specified a probable relationship between U-turn gap acceptance, gap length, and waiting time.

Logistic regression analysis was performed using entering all considered variables. Table 7 illustrates the p-value of each variable. It is well known that when the p-value is less than the preset significance level, the null hypothesis is rejected. All obtained results prove that the studied variable is statistically significant. The variable with a higher p-value has less effect on the U-turn gap acceptance decision.

Table 6 Pearson correlation coefficient between all variables.

Variables	Age	U-turn Vehicle Type	Queue Time	Wait Time	Gap Size	Opposing Vehicle Type
Gap acceptance	-0.003	-0.002	-0.025	<u>0.41</u>	<u>0.79</u>	-0.037
Age		0.048	0.039	-0.064	0.06	-0.064
U-turn Vehicle Type			-0.059	-0.036	0.021	0.024
Queue Time				-0.047	-0.016	0.018
Wait Time					<u>0.269</u>	0.053
Gap Size						0.003

The effect of variables on gap acceptance decision in the descending order is listed as follows: gap length > wait time > age > U-turning vehicle type > queue time > opposing vehicle type. Individually, just two variables were statistically significant, at the significance level of 0.05, these are gap length and wait time.

For more explanation of each factor's effect on gap acceptance decision from data collection of the 4- selected sites, figure 6 shows the gap acceptance relationships with driver's age, vehicle type, queue time, waiting time, gap length, and opposing vehicle type respectively. Firstly, depending on two age groups young and old drivers only. So, the results obtained give a very low correlation with the gap acceptance decision as R^2= 0.005. on the other side, from data on three types of vehicles using the U-turn facility. Figure 6-B shows the same low correlation shown in figure 4-A with R^2 = 0.004. Researcher opinion depends on the fact that car operation characteristics widely depend on the psychological properties and mood of the driver.

Figure 6-C shows queue time which is previously defined as the time duration spent by theU-turning vehicle from start to joining the queue until it reaches the front of the queue. Queue time depends on turning vehicle speed and vehicle operating characteristics. Due to some obstacles field collection data for velocity didn't completed. So, the correlation of queue time with gap acceptance decision isalso at a low level with R^2 =0.0004. Waiting time represents an essential factor in driver decision results obtained gave a low correction with R^2 =0.01 as shown in figure 6-D. The same trend is shown in figure 6-E for the gap length effect on gap acceptance. Opposing vehicle type is also supposed to have an effect on gap acceptance decision, figure 6-F shows data collected on Opposing vehicle type effect on gap acceptance decision.

Table 7 Significant test of all variables.

Variable	Wald's χ^2	d_f	p-value

Age	131.34	1	0.358
U-turn Vehicle Type	74.528	1	0.489
Queue Time	54.639	1	0.553
Wait Time	7.333	1	0.000
Gap Size	548.825	1	0.001
Opposing Vehicle Type	0.001	1	0.912

6.2. Effect Of Significant Variables

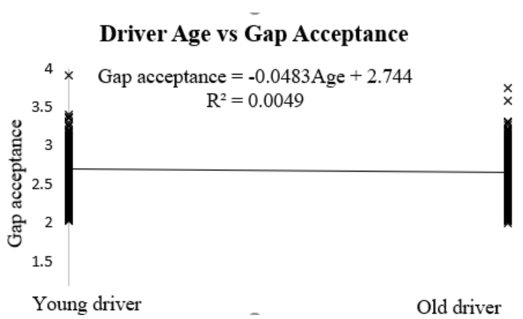
According to each significant variable p-value of each one of them was entered in the forward stepwise logistic regression analysis process. Table 8 illustrates the results of the stepwise analysis, together with the variables at each step and parameters estimation. The following sub-section described the effect of each variable, entering at each step.

The connection of gap length with a probability of accepting the gap was taken the following relationship with R^2= 0.27:

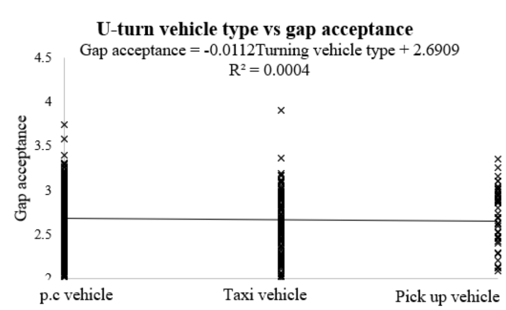
$$z = 2.316 - 0.082 \text{ (gap length)} \qquad \text{….3}$$

The wait time gives the impression to have no correlation with gap length. To forecast the U-turn gap acceptance decision at a 95% confidence interval, only two factors were involved in the model preparation. The established U-turn gap acceptance decision model was shown as follows in equation 4-4 with R^2 =0.489:

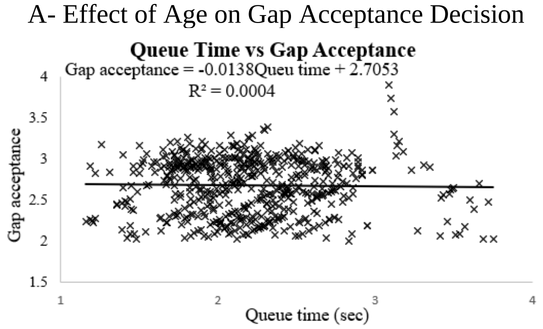
$$z = 4.564 - 0.396 \text{ (gap length)} + 0.008 \text{ (wait time)} \qquad \text{…. 4}$$



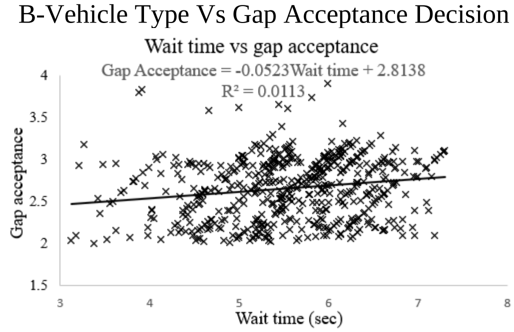
A- Effect of Age on Gap Acceptance Decision



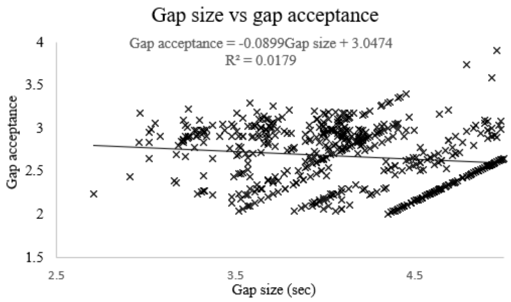
B-Vehicle Type Vs Gap Acceptance Decision



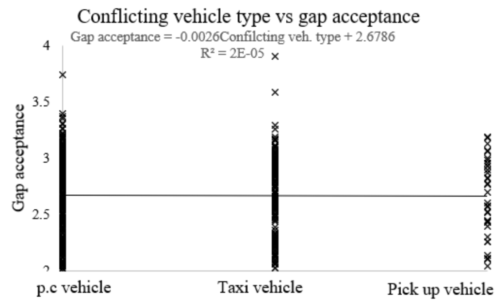
C-Queue Time Vs Gap Acceptance Decision



D-Wait Time Vs Gap Acceptance Decision



E- Effect of Gap Size on Gap Acceptance Decision



F-Opposing Vehicle Type Vs Gap Acceptance Decision

Figure 6: Effect of the Selected Factor on Gap Acceptance Decision

The mean accepted gap tends to decrease as the queue time or waiting time increases (Kyte, et.al, 1991). From the results of current research, queue time has no statistically significant on U-turn gap acceptance. U-turning vehicles, when staying in the queue, could see the opposing through traffic stream and appreciate the traffic flow condition. Consequently, U-turning drivers would not prefer to take delays in the queue to decide if or not the available gap accepted. However, it also is subject to the nature of the driver inhabitants in the area. Unlike the past research (Ebisawa, R., et.al 2001), where a study exhibited that the opposing speed and waiting time also inclined the U-turn gap acceptance decision. Thus, the waiting time was not particularly due to its discrepancy. In accumulation, variances of site characteristics might change the analysis results. Some variables affecting U-turn gap acceptance and reasons for driver aggressive behaviors were different and difficult to evaluate. But, opposing speed was the same factor affecting both behaviors. The aggressive behavior is mainly the outcome of the attitudinal character of the driver, not dependent on the driver's wait time (Kaysi and Abbany, 2007). Most aggressive drivers (90%) conducted the forcing maneuver after waiting not more than 10 seconds. Thus, the longer waiting time would contribute to the unsafe movement, implying that the driver himself is not an aggressive driver but could induce aggressive behavior. On the contrary, the real aggressive driver would conduct the forcing maneuver at the beginning of his waiting, without considering the wait time.

Table 8: Forward stepwise regression analysis result.

	variable	B	S. E	Wald's χ^2	df	p-value
Step 1	**constant**	2.316	0.124	18.667	1	000
	Gap size	0.082	0.03	2.758	1	0.005
Step 2	**constant**	4.564	2.316	1.971	2	0.066
	Gap size	-0.396	0.357	-1.108	2	0.028
	Wait time	+0.008	0.241	+0.035	2	0.097

Note: df=degree of freedom, S.E.=Standard Error, B=Estimated Parameter

7. Conclusion and Recommendations

The conclusions could be listed as follows:

- gap length and wait time show significantly affected on U-turn gap acceptance decision at a 95% confidence interval;
- gap length gives a higher influence on U-turn gap acceptance decision than wait time;
- U-turn driver age, vehicle type of both U-turning and opposing through traffic, and queue time did not influence on gap acceptance decision at a 95% confidence interval;

- U-turn gap acceptance decision resulted in equation connected gap length, and wait time under the percentage correctness of about 50 %.

The variables influencing on U-turn gap acceptance decision at the midblock median opening were investigated in the current research. The following points can be advised for future studies:

- Studying the effect of travel speed of turning vehicles and opposing traffic flow effect on U-turn gap acceptance decision.
- The relationships between opposing through traffic characteristics (e.g., volume, headway, etc.) and gap length and/or speed can be examined.
- Focusing on the control and management at such median opening to ensure the traffic flow and safety.

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