Simulation of U-turn traffic based on VISSIM and PARAMICS micro simulation

Zainab A T AL-kareawi1 and Jalal T S Al-Obaedi2
1 MSc student, Roads and Transport Dept., College of Engineering, University of Al-Qadisiyah, Iraq.
2 Asst.Prof. Roads and Transport Dept., College of Engineering, University of Al-Qadisiyah, Iraq.

Abstract. Traffic simulation models are one of the most important tools that are widely used to analyse and manage transport systems. These tools are used to model complex traffic sites and evaluate various traffic alternatives and testing their effect prior to application in real sites. Median U-turn is an example of such complicated sites. There are many microsimulation tools such as VISSIM, ALIMSUN and PARAMICS. The goal of this study is to develop the simulation model of median U-turns and compares between VISSIM and PARAMICS models. The data were collect from two selected site at Al-Diwaniyah city, Iraq. The data used in verification of the developed model represent the through traffic volumes and turning traffic volumes at both directions as well as the average queue length created at the U-turn site. The calibration and validation process of the developed models show that both VISSIM and PARAMICS models can provides reasonable approximation for real traffic at the selected site. Further research is needed to examine these tools based on additional sites and to apply such tools to examine different scenarios to enhance traffic conditions at U-turn sites.

Keywords: Traffic simulation, U-turn, Vissim, Paramics, U-tur

1. Introduction
Traffic simulation models are one of the most important tools that are widely used to analyse and manage transport systems. These tools are used to model the complexity of transport and evaluate various traffic alternatives in order to determine the optimal solution for any traffic technology. The traffic simulation used the offline work to examine the technologies before being applied on real sites. The classification of traffic simulation models including microscopic modelling, macroscopic modelling and mesoscopic modelling. The microscopic type is the most used one to model the complicated traffic/ geometric conditions [1-3].
There are many types of microsimulation software including PARAMICE, VISSIM, and AIMSUN [4]. Microscopic traffic simulation models take into account the interactions between individual vehicles and other vehicles in the road network. Simulation models are built using sub-models including car following model, lane changing model, and gap acceptance [5].
Car following models define a driver-recognized mode that would follow the lead vehicle at low speed without the ability to change lanes [2]. Lane changing models describe the driver’s behaviour in changing the lane within a specified time [6]. Gap acceptance models used to calculate the number of vehicles passing through the conflict point, and the gap is defined as the change in time between the rear of the leading vehicle and the front of the following vehicle [7].
Median U-Turning is a complicated section defined as an open space in the median that allows vehicles to pass from the going lane to the return. Therefore, median U-turn are examples of the areas that generate traffic for the two paths of the road and hence the providing a solution to this problem represents a solution for two problems [8].

1895 (2021) 012030 doi:10.1088/1742-6596/1895/1/012030
There are many type of U-turn including non-traversable median this type including physical barriers such as concrete barriers, raised concrete curb and island, and grass or swale median. That prohibit movement of traffic across the median [9]. Full opening allows turns in both directions while a directional opening allows only one direction turning [10, 11].

The turning movement in the median U-turn is one of the complex and more dangerous movements compared to the turning movements at other intersections. This related to the speed difference between turning and mainline traffic. Such speed difference will reduce the traffic safety [12] which is the main concern of the of traffic agencies [13].

There are many studies to development the simulation models of U-turn section such as Al-Obaedi [8] by applying VISSIM microsimulation with the use of average spent time for merging and merging volumes for calibration and validation process and the result shows good agreement for all the selected sites. However, the calibration process in later research did not consider all traffic the comparison with the whole traffic volumes in the two direction and ignored the effect of the U-trun traffic coming from the opposing direction. Al-Jameel [14] development a simulation model of U-turn using S-PARAMICS. The parameters used in calibration and validation process including opposing volumes and turning volumes only, and the result shows close behaviour with observed data. However, very limited research that used Paramics in modelling U-turn sites.

This work will examine the validity of applying both Vissim and Paramics to replicate real traffic movements at U-turn sites by considering the limitations through making the calibration and validation process based on the whole traffic volumes in the system as well as the queue length generated prior to the U-turn site.

2. Methodology

According to flowchart show in figure (1), the research methodology includes site selection, data collection and analyses, models building, calibration and validation process, and compares result between VISSIM and PARAMICS microsimulation.

Two sites are selected at Al-Diwaniyah city, Iraq. The site no.1 has a speed hump in the opposing direction and site no.2 does not has such a speed hump. The video recording is used to collect data. The parameters determine including the merging, opposing, through volumes and queue length, and lane choice of each direction. Figure (2) and Figure (3) give snapshot of these sites.

VISSIM and PARAMICS models are used in this study because they are considered the most trusted programs over the world. The parameters that are used to compare between the simulated and actual result are the through, opposing volumes, merging volumes in two directions, and the average queue length at every five minute intervals. The calibration and validation iterations are applied until the simulation results satisfying the real data.
3. Data collection

There are many methods for collect data including Pneumatic road tubes, Piezoelectric sensors, Magnetic sensors, Induction loop detectors, Microwave radar, Infrared detectors, Laser radar, Ultrasound detection devices, and Video recordings [15]. According to the parameters required in the microsimulation, video recordings is the most appropriate type for this work to extract some related parameters as discussed below.

The extracted traffic volumes include for through, merging (turning) and opposing traffic are collected from the video recorded for each five minutes as well as, the average queue length is calculated for each five minutes. Figure (4) illustrates the layout of U-turn sites and the labels of traffic volumes above. In the figure, “merge 1” refers to the U-turn direction with higher volumes than the another direction “merge 2”. In addition, the term “through volumes” refers to the through traffic volumes in the direction of “merge 1” while “opposing volume” refers to the traffic volumes opposing to traffic volumes at merge 1. Table (1) and Table (2) show the analyses of data collection for each site. It should be noted here and as shown in Figure, 3, site 2 that there is an entering traffic from nearing branch which causing weaving traffic. The data collection has covered that.

The traffic lane distribution for each direction have also determined as shown in Table (3). Video recordings showed that the merging vehicles prefer the middle and outer lane to increase the turning radii. Table (5) show the percentage of heavy vehicles in each direction for each site. According to highway capacity manual (HCM-2010 [16]) the queue length is defining as "a line of vehicles, bicycles, or persons waiting to be served by the system in which the flow rate from the front of the queue determines the average speed within the queue ". The queue length is determining for each 20 second and then determine the average queue length for each five minute.
Figure 4. The layout of U-turn sites and the labels of traffic volumes above

Table 1. Analyses of data collection for site no.1

| No. | Opposing vol. | Through vol. | Merge1 vol. | Merge2 vol. | Max. queue length | avg. queue length |
|-----|---------------|--------------|-------------|-------------|-------------------|-------------------|
| 5   | 56            | 78           | 39          | 8           | 3                 | 2                 |
| 10  | 60            | 75           | 36          | 8           | 4                 | 3                 |
| 15  | 99            | 88           | 40          | 12          | 4                 | 3                 |
| 20  | 57            | 84           | 53          | 13          | 4                 | 2                 |
| 25  | 64            | 65           | 34          | 11          | 5                 | 2                 |
| 30  | 116           | 90           | 42          | 17          | 5                 | 3                 |
| 35  | 101           | 81           | 31          | 18          | 2                 | 2                 |
| 40  | 84            | 71           | 46          | 12          | 3                 | 3                 |
| 45  | 102           | 76           | 42          | 15          | 5                 | 5                 |
| 50  | 96            | 84           | 47          | 9           | 6                 | 4                 |
| 55  | 102           | 66           | 39          | 10          | 5                 | 4                 |
| 60  | 108           | 66           | 40          | 11          | 5                 | 4                 |

Table 2. Analyses of data collection for site no.2

| No. | Opposing vol. | Through vol. | Merge1 vol. | Merge2 vol. | Max. queue length | Avg. queue length |
|-----|---------------|--------------|-------------|-------------|-------------------|-------------------|
| 5   | 72            | 90           | 54          | 2           | 4                 | 3                 |
| 10  | 68            | 65           | 46          | 0           | 4                 | 4                 |
| 15  | 53            | 95           | 35          | 0           | 0                 | 0                 |
| 20  | 62            | 79           | 59          | 0           | 3                 | 3                 |
| 25  | 60            | 55           | 61          | 0           | 4                 | 4                 |
| 30  | 50            | 57           | 40          | 3           | 4                 | 3                 |
| 35  | 59            | 66           | 49          | 3           | 4                 | 3                 |
| 40  | 55            | 58           | 49          | 1           | 4                 | 3                 |
| 45  | 60            | 75           | 51          | 2           | 6                 | 5                 |
| 50  | 64            | 53           | 45          | 2           | 6                 | 3                 |
| 55  | 49            | 89           | 55          | 0           | 3                 | 3                 |
| 60  | 66            | 89           | 48          | 1           | 6                 | 3                 |
| 65  | 45            | 93           | 44          | 1           | 4                 | 4                 |
| 70  | 57            | 84           | 59          | 1           | 5                 | 4                 |
| 75  | 64            | 83           | 36          | 2           | 3                 | 3                 |
| 80  | 65            | 60           | 59          | 3           | 6                 | 4                 |
| 85  | 69            | 76           | 50          | 1           | 4                 | 4                 |
| 90  | 56            | 83           | 62          | 3           | 6                 | 5                 |
| 95  | 66            | 79           | 51          | 2           | 5                 | 5                 |
| 100 | 54            | 82           | 39          | 0           | 0                 | 0                 |
| 105 | 66            | 87           | 49          | 1           | 5                 | 4                 |
| 110 | 58            | 76           | 43          | 0           | 3                 | 3                 |
| 115 | 66            | 73           | 53          | 1           | 5                 | 4                 |
| 120 | 78            | 107          | 53          | 1           | 5                 | 5                 |
### Table 3. Lane distribution for each direction for two sites.

| Lane No. | Opposite volumes | Through volumes | Turning volumes |
|----------|------------------|-----------------|-----------------|
|          | Site 1 | Site 2 | Site 1 | Site 2 | Site 1 | Site 2 |
| Lane 1   | 45.8%  | 27.69% | 81.6% | 32.9% | 79.14% | 86.37% |
| Lane 2   | 54.2%  | 72.31% | 18.4% | 56.6% | 20.86% | 13.63% |
| Lane 3   | 0%     | 0%    | 0%    | 10.5% | 0%     | 0%    |

### Table 4. Traffic composition for each direction for two sites.

| Direction          | % P.C  | % Truck | % Bus |
|--------------------|--------|---------|-------|
|                    | Site 1 | Site 2 | Site 1 | Site 2 | Site 1 | Site 2 |
| Opposite volumes   | 97.75% | 95.81% | 2.25%  | 4.19%  | 0%     | 0%     |
| Through volumes    | 97.40% | 96.31% | 2.48%  | 3.69%  | 0.12%  | 0%     |
| Turning volumes    | 97.7%  | 94.7%  | 1.91%  | 5.3%   | 0.39%  | 0%     |

#### 4. SIMULATION MODELS

This section includes the development of simulated models and the calibration and validation process using VISSIM 5.1 software and PARAMICS 6.4.1 software. In VISSIM, the allowed simulation time is 10 minute for the student licence where the first 5 minute is used as a warm up time, and the second 5 minute is used to compares the result obtain in simulation models with the real data.

In PARAMICS models, the running time is not limited and therefore the whole running simulation time is selected based on the available data (1 hr for site 1 and 2hr for site 2) plus extra 15 minutes used as a warm up time.

#### 4.1. Models development

Traffic networks have been built similar to those in real sited for both sites using both VISSIM and Paramics. The VISSIM models were built by adding link (to draw the road) and connector (to draw the u-turn), use “yield priority” to make the turning vehicle wait until enough gap is available. The hump speed is select by adding, “reduce speed area”. The traffic volume for each direction is entered to the networks by using the” vehicle input tool” The priorities of movements were applied by introducing “conflict area” which give the priority of opposing traffic. Figure (5) show the snapshot for modelling build in VISSIM.

The PARAMICS model is built by adding nodes, link, and zones (to draw the network). The “movement tab” was used to make the turning vehicle wait until enough gap is available and the “control speed” is applied to force the simulated speeds to be like in a real hump speed. The traffic volumes for each direction is added by using “travel demand editor”. Figure (6) show snapshot for modelling build in PARAMICS.

#### 4.2- Calibration and validation process

Calibration is the process of selecting parameters for the program by trying to match a sample of field data with the program output, and validation is the process of checking the parameters selected from the calibration stage with another data model to obtain the results of a comparison between the model and the field data [17].

This phase is considered as a time consuming as it is based on the principle of trial and error so that the parameters are recalculated each time. If the parameters that selected in calibration process do not satisfy the validation process, this parameter should be change unite satisfy the data in both the calibration and validation process.
For site No.1, the data used consists of twelve intervals and the data used in site No.2 consist of twenty-four intervals. One of these intervals were used in calibration process and the rest intervals used in validation process. The parameters used in the calibration and validation process are through, merging volumes in each direction, and the average queue length for each five minute.

In VISSIM models, the running time is 10 minute. The first 5 minute is representing the warm up time, and the second 5 minute is used to compares the result obtain in simulation models with the real data. The queue length section is adding in the network to determine the average queue and compare the result with the real data.

In PARAMICS models, the running time used in this study is 1:15 hour for site No.1 and 2:15 for site No.2. The first 15 minute is a warm up time, and the rest time is used to compare between simulation model and real data. The result obtained after the calibration and validation process in VISSIM and PARAMICS models show in Table (5), (6), (7), and Table (8). These results show from the simulation results are in good agreement with the real data for the two sites.

Figure 5. Snapshot for modelling build in VISSIM

Figure 6. Snapshot for modelling build in PARAMICS
Table 5. The result of simulation and actual result in VISSM for site no. 1

| No. | Actual opposing vol. | Simulated opposing vol. | Actual through vol. | Simulated through vol. | Actual merge1 vol. | Simulated merge1 vol. | Actual queue length | Simulated queue length | Actual merge2 vol. | Simulated merge2 vol. |
|-----|----------------------|-------------------------|---------------------|------------------------|------------------|-----------------------|---------------------|-----------------------|------------------|----------------------|
| 5   | 56                   | 47                      | 78                  | 83                     | 39               | 36                    | 2                   | 2                     | 8                | 8                    |
| 10  | 60                   | 49                      | 75                  | 79                     | 36               | 34                    | 3                   | 2                     | 8                | 9                    |
| 15  | 99                   | 101                     | 88                  | 73                     | 40               | 30                    | 3                   | 4                     | 12               | 16                   |
| 20  | 57                   | 49                      | 84                  | 89                     | 53               | 53                    | 2                   | 1                     | 13               | 12                   |
| 25  | 64                   | 56                      | 65                  | 57                     | 34               | 32                    | 2                   | 1                     | 11               | 12                   |
| 30  | 116                  | 124                     | 90                  | 65                     | 42               | 23                    | 3                   | 3                     | 17               | 19                   |
| 35  | 101                  | 105                     | 81                  | 77                     | 31               | 22                    | 2                   | 2                     | 18               | 22                   |
| 40  | 84                   | 86                      | 71                  | 70                     | 46               | 41                    | 3                   | 2                     | 12               | 14                   |
| 45  | 102                  | 103                     | 76                  | 74                     | 42               | 34                    | 5                   | 6                     | 15               | 18                   |
| 50  | 96                   | 104                     | 84                  | 84                     | 47               | 39                    | 4                   | 3                     | 9                | 6                    |
| 55  | 102                  | 106                     | 66                  | 62                     | 39               | 34                    | 4                   | 3                     | 10               | 12                   |
| 60  | 108                  | 116                     | 66                  | 62                     | 40               | 35                    | 4                   | 4                     | 11               | 13                   |

Table 6. The result of the simulation and actual in VISSIM for site No.2

| No. | Actual opposing vol. | Simulated opposing vol. | Actual through vol. | Simulated through vol. | Actual merge1 vol. | Simulated merge1 vol. | Actual queue length | Simulated queue length | Actual merge2 vol. | Simulated merge2 vol. |
|-----|----------------------|-------------------------|---------------------|------------------------|------------------|-----------------------|---------------------|-----------------------|------------------|----------------------|
| 5   | 72                   | 72                      | 90                  | 96                     | 54               | 51                    | 3                   | 3                     | 2                | 0                    |
| 10  | 68                   | 68                      | 65                  | 66                     | 46               | 47                    | 4                   | 4                     | 0                | 0                    |
| 15  | 53                   | 60                      | 95                  | 96                     | 35               | 32                    | 1                   | 0                     | 0                | 0                    |
| 20  | 62                   | 59                      | 79                  | 93                     | 59               | 58                    | 3                   | 4                     | 0                | 0                    |
| 25  | 60                   | 62                      | 55                  | 59                     | 61               | 64                    | 4                   | 4                     | 0                | 0                    |
| 30  | 50                   | 58                      | 77                  | 82                     | 40               | 41                    | 3                   | 3                     | 2                | 2                    |
| 35  | 59                   | 57                      | 66                  | 66                     | 49               | 48                    | 4                   | 4                     | 3                | 3                    |
| 40  | 55                   | 55                      | 58                  | 59                     | 49               | 48                    | 3                   | 3                     | 1                | 0                    |
| 45  | 60                   | 59                      | 75                  | 81                     | 51               | 50                    | 5                   | 4                     | 2                | 1                    |
| 50  | 64                   | 66                      | 53                  | 52                     | 45               | 46                    | 3                   | 2                     | 2                | 1                    |
| 55  | 49                   | 58                      | 89                  | 101                    | 55               | 57                    | 3                   | 3                     | 0                | 0                    |
| 60  | 66                   | 69                      | 89                  | 106                    | 48               | 43                    | 3                   | 3                     | 1                | 0                    |
| 65  | 45                   | 54                      | 93                  | 108                    | 44               | 42                    | 4                   | 4                     | 1                | 0                    |
| 70  | 57                   | 58                      | 84                  | 95                     | 59               | 58                    | 4                   | 4                     | 1                | 0                    |
| 75  | 64                   | 66                      | 83                  | 92                     | 36               | 34                    | 3                   | 3                     | 2                | 1                    |
| 80  | 65                   | 66                      | 60                  | 61                     | 59               | 61                    | 4                   | 4                     | 3                | 2                    |
| 85  | 69                   | 69                      | 76                  | 82                     | 50               | 51                    | 4                   | 4                     | 1                | 0                    |
| 90  | 56                   | 57                      | 83                  | 94                     | 62               | 56                    | 5                   | 6                     | 3                | 2                    |
| 95  | 66                   | 68                      | 79                  | 86                     | 51               | 51                    | 5                   | 4                     | 2                | 1                    |
| 100 | 54                   | 60                      | 82                  | 89                     | 39               | 38                    | 0                   | 0                     | 0                | 0                    |
| 105 | 66                   | 68                      | 87                  | 101                    | 49               | 45                    | 4                   | 3                     | 1                | 0                    |
| 110 | 58                   | 58                      | 76                  | 83                     | 43               | 44                    | 3                   | 3                     | 0                | 0                    |
| 115 | 66                   | 68                      | 73                  | 83                     | 53               | 51                    | 4                   | 2                     | 1                | 0                    |
| 120 | 78                   | 74                      | 107                 | 123                    | 53               | 49                    | 5                   | 6                     | 1                | 0                    |
### Table 7. The result of the simulation and actual in PARAMICS for site No.1

| No. | Actual opposing vol. | Simulated opposing vol. | Actual through vol. | Simulated through vol. | Actual merge1 vol. | Simulated merge1 vol. | Actual queue length | Simulated queue length | Actual merge2 vol. | Simulated merge2 vol. |
|-----|----------------------|-------------------------|---------------------|------------------------|--------------------|-----------------------|---------------------|----------------------|------------------|------------------------|
| 5   | 56                   | 48                      | 78                  | 59                     | 39                 | 39                    | 2                   | 1                    | 8                | 10                     |
| 10  | 60                   | 66                      | 75                  | 83                     | 36                 | 40                    | 3                   | 0                    | 8                | 10                     |
| 15  | 99                   | 93                      | 88                  | 90                     | 40                 | 42                    | 3                   | 3                    | 12               | 11                     |
| 20  | 57                   | 67                      | 84                  | 87                     | 53                 | 48                    | 2                   | 4                    | 13               | 16                     |
| 25  | 64                   | 72                      | 65                  | 77                     | 34                 | 43                    | 3                   | 3                    | 11               | 13                     |
| 30  | 116                  | 117                     | 90                  | 96                     | 42                 | 38                    | 3                   | 3                    | 17               | 12                     |
| 35  | 101                  | 114                     | 81                  | 103                    | 31                 | 42                    | 2                   | 3                    | 18               | 12                     |
| 40  | 84                   | 92                      | 71                  | 85                     | 46                 | 43                    | 3                   | 3                    | 12               | 13                     |
| 45  | 102                  | 111                     | 76                  | 87                     | 42                 | 40                    | 5                   | 5                    | 15               | 16                     |
| 50  | 96                   | 99                      | 84                  | 88                     | 47                 | 43                    | 4                   | 3                    | 9                | 14                     |
| 55  | 102                  | 109                     | 66                  | 83                     | 39                 | 42                    | 4                   | 4                    | 10               | 9                      |
| 60  | 108                  | 117                     | 66                  | 76                     | 40                 | 41                    | 4                   | 4                    | 11               | 15                     |

### Table 8. The result of simulation and actual result in PARAMICS for site No.2

| No. | Actual opposing vol. | Simulated opposing vol. | Actual through vol. | Simulated through vol. | Actual merge1 vol. | Simulated merge1 vol. | Actual queue length | Simulated queue length | Actual merge2 vol. | Simulated merge2 vol. |
|-----|----------------------|-------------------------|---------------------|------------------------|--------------------|-----------------------|---------------------|----------------------|------------------|------------------------|
| 5   | 72                   | 57                      | 90                  | 77                     | 54                 | 45                    | 3                   | 3                    | 2                | 2                      |
| 10  | 68                   | 71                      | 65                  | 74                     | 46                 | 46                    | 4                   | 3                    | 0                | 1                      |
| 15  | 53                   | 55                      | 95                  | 94                     | 35                 | 35                    | 0                   | 0                    | 0                | 0                      |
| 20  | 62                   | 53                      | 79                  | 70                     | 59                 | 46                    | 3                   | 6                    | 0                | 0                      |
| 25  | 60                   | 58                      | 55                  | 60                     | 61                 | 56                    | 4                   | 5                    | 0                | 0                      |
| 30  | 50                   | 53                      | 77                  | 83                     | 40                 | 46                    | 3                   | 3                    | 2                | 2                      |
| 35  | 59                   | 54                      | 66                  | 70                     | 49                 | 48                    | 4                   | 3                    | 3                | 3                      |
| 40  | 55                   | 57                      | 58                  | 56                     | 49                 | 50                    | 3                   | 6                    | 1                | 1                      |
| 45  | 60                   | 53                      | 75                  | 72                     | 51                 | 48                    | 5                   | 4                    | 2                | 1                      |
| 50  | 64                   | 71                      | 53                  | 59                     | 45                 | 45                    | 3                   | 3                    | 2                | 2                      |
| 55  | 49                   | 52                      | 89                  | 80                     | 55                 | 50                    | 3                   | 5                    | 0                | 0                      |
| 60  | 66                   | 65                      | 89                  | 89                     | 48                 | 48                    | 3                   | 3                    | 1                | 1                      |
| 65  | 45                   | 48                      | 93                  | 98                     | 44                 | 44                    | 4                   | 0                    | 1                | 1                      |
| 70  | 57                   | 50                      | 84                  | 87                     | 59                 | 47                    | 4                   | 8                    | 1                | 1                      |
| 75  | 64                   | 62                      | 83                  | 81                     | 36                 | 51                    | 3                   | 2                    | 2                | 3                      |
| 80  | 65                   | 65                      | 60                  | 56                     | 59                 | 52                    | 4                   | 6                    | 3                | 2                      |
| 85  | 69                   | 62                      | 76                  | 66                     | 50                 | 48                    | 4                   | 4                    | 1                | 1                      |
| 90  | 56                   | 63                      | 83                  | 84                     | 62                 | 49                    | 5                   | 4                    | 3                | 3                      |
| 95  | 66                   | 52                      | 79                  | 77                     | 51                 | 52                    | 5                   | 6                    | 2                | 2                      |
| 100 | 54                   | 55                      | 82                  | 88                     | 39                 | 51                    | 0                   | 1                    | 0                | 1                      |
| 105 | 66                   | 67                      | 87                  | 93                     | 49                 | 50                    | 4                   | 5                    | 1                | 1                      |
| 110 | 58                   | 67                      | 76                  | 73                     | 43                 | 50                    | 3                   | 5                    | 0                | 1                      |
| 115 | 66                   | 63                      | 73                  | 72                     | 53                 | 49                    | 4                   | 4                    | 1                | 1                      |
| 120 | 78                   | 72                      | 107                 | 97                     | 53                 | 48                    | 5                   | 3                    | 1                | 1                      |
4.3. Statistical test
Statistic tests are required for the calibration and validation process to compare the simulation and real data. The GEH formula stands for Geoffrey E. Havers, who developed in the 1970s (see Equation 1 below) [18].

\[
GEH = \left( \frac{(S-O)^2}{0.5(S+O)} \right)^{1/2} \quad \text{Eq. (1)}
\]

Where
\( S \) = simulation data.
\( O \) = Observed data.
This equation uses for compare between real and simulation volumes when
• \( GEH < 5 \): indicates good fitness
• \( 5 < GEH < 10 \): more examinations may be required.
• \( GEH > 10 \): Poor fitness

The GEH is determined for traffic volumes in each direction for each five minutes. Table (9) gives the statistical test for VISSIM and PARAMICS model for each site. The result obtains for statistical test show the maximum GEH within the acceptable limits [18,19].

Based on the statistical test, it can be concluded here that the simulation models using PARAMICS and VISSSIM for the two sites provide reasonable agreement with the data and therefor, the developed models can be used for further applications in testing different scenarios.

Table 9. GEH statistical test for the two sites in VISSIM and PARAMICS.

| GEH         | Opposing vol. | Through vol. | Merg1 vol. | Merge2 vol. |
|-------------|---------------|--------------|------------|-------------|
|             | Max | Avg. | Max | Avg. | Max | Avg. | Max | Avg. | Max | Avg. |
| Paramics site No. 1 | 1.109 | 0.74 | 2.29 | 1.2 | 1.82 | 0.62 | 1.54 | 0.80 |
| Paramics site No.2 | 1.18 | 0.63 | 1.42 | 0.57 | 1.79 | 0.72 | 1.4 | 0.29 |
| Vissim site No.1 | 1.49 | 0.70 | 2.83 | 0.74 | 3.3 | 1.07 | 1.10 | 0.58 |
| Vissim site No. 2 | 1.27 | 0.36 | 1.72 | 0.80 | 0.78 | 0.29 | 1.41 | 0.76 |

5. Conclusions
This paper used two microsimulation tools VISSIM and PARAMICS models to emulate traffic movements at selected U-turn sites at Al-Diwaniyah city, Iraq. Real traffic data has been obtained from the selected site using video recording to estimate the required parameters including merging and opposing traffic volumes, through volumes, average queue length and desired turning lanes. The developed simulation models were calibrated and validated using the real data taken from the site by considering merging, opposing, through volumes and avg. queue length as parameters for comparison. Good agreement has been obtained and that suggest the ability of VISSIM and PARIMCS model to replicate real traffic movements at such complicated sites.

The statistical test after the calibration and validation process for the two models give reasonable agreement with the real data and therefor, the developed models can be used for further applications in testing different scenarios.

6. References
1- J T S Al-Obaedi (2011). Development of traffic micro-simulation model for merges with ramp metering. PhD thesis, University of Salford Manchester, UK.
2- Nor Azlan N N, Md Rohani M (2018). Overview of Application of Traffic Simulation Model. MATEC Web of Conferences, 150, 03006
3- Mohammed B M, Lee V L, Ahmad F M Sadullah (2019). Use of microscopic traffic simulation software to determine heavy-vehicle influence on queue lengths at toll plazas, Arabian journal for science and engineering.
4- Park B, Yun I, and Choi K (2004). Evaluation of microscopic simulation tools for coordinated signal system deployment. KSCE Journal of Civil Engineering, 8(2), 239–248.
5- Olstam J J and Tapani A (2004). Comparison of car-following models. Swedish National Road and Transport Research Institute, SE-581 95 Linköping Sweden.
6- P.G. Gipps. A model for the structure of lane changing decisions. Transportation Research Part B: Methodological, 20(5), pp. 403-414 (1986)
7- Kay N, Ahuja S, Cheng T N, Vuren T V and MacDonald M (2006). Estimation and simulation gap acceptance behaviour at congested roundabouts, Association for European Transport and contributors.
8- Al-Obaedi J T S (2019). Simulating the Effect of Speed Humps on the U-Turn Traffic, International Journal of Engineering, Vol. 32, No. 12, 1773-1780.
9- Liu P, Lu J J, Hu F, and Sokolow G (2008). Capacity of U-Turn Movement at Median Openings on Multilane Highways. Journal of Transportation Engineering, 134(4), 147–154.
10- Helen Katz (2006). Median handbook.
11- National Cooperative Highway Research Program (NCHRP) Research Report 900: Guide for the Analysis of Multimodal Corridor Access Management describes operational and safety relationships between access management.
12- Shihan H J and Mohammed H K (2009). Traffic System Studies at Median U-Turn in Baghdad City Employing U-SIM Model. Journal of Engineering and Development, Vol. 13, No. 1, ISSN 1813-7822.
13- Hameed A M (2012). Study of traffic safety evaluation and improvements at unsignalized intersections. Al-Qadisiya Journal For Engineering Sciences, Vol. 5, No. 2, 150-165.
14- AL-Jameel H A E (2014). Contribution to the U-turn design at median opening in Iraq: Al-Najaf city as a case study, Kufa Journal of Engineering (K.J.E).
15- Alberto P M (2015). Traffic data collection, MSc. Construction Management and Engineering.
16- Highway Capacity Manual (2010). Transportation Research Board. Washington, D.C.
17- Ehler A, Schneck A, and Chanchareon N (2017). Junction parameter calibration for mesoscopic simulation in Vissim. Transportation Research Procedia, 21, 216–226.
18- Muhanad K K (2018). Simulated Traffic Flow at Merging Sections. MCS thesis, Mustansiriyah University, Iraq.
19- Oketch, T and Carrick M (2005). Calibration and validation of a micro-simulation model in network analysis, in Proceedings of the 84th TRB Annual Meeting, Washington, DC.