The impact of technology on decision-making in road and traffic engineering (Synchro traffic simulation software)

Abdelrazag Faraj Emhemed[1] Isa Ali Almukhtar[2] Allam Musbah Al Allam[3]

1,3 Engineering & Technology Research Information Center, Baniwalid, Libya
2 Department of civil engineering, collage of Technical Science, Baniwalid, Libya
resqe2010@gmail.com

Abstract

The profitable aspect of any design is the most important factor in deciding whether to apply it or maintain it or not. Thus, taking an advantage of the scientific and specialized development in the field of road engineering to avoid enforcing solutions without vindicating their effectiveness, where the opinions performing from discussion sessions and guesswork or manual styles Classic is deficient and occasionally leads to increased traffic and problems. Simulation was used to solve traffic problems for the first time in the fifties of the last century, with the aim of testing the effectiveness of the proposed solutions for roads before putting them into practice and use. In this paper The Synchro simulation software was reviewed and its features was explained, the effectiveness of simulation in road engineering and the methods of its use was mentioned, and use the simulation process option to an intersection within the city of Baniwalid, The results were reviewed and traffic capacity has totally improved. "Save efforts, time and money" would be the link between the program and sustainable development.

Keywords: Road Engineering**,** Traffic Engineering**,** Simulation Software, Traffic Simulation**.**

1. Introduction

The economic aspect of any project is the most important factor in deciding whether to implement it or maintain it or not. Therefore, taking the advantage of the scientific and technical development has become the key to the solution to avoid implementing solutions without verifying their effectiveness, where the decisions resulting from discussion sessions and guesswork or manual methods Classicism is incomplete and sometimes leads to increase congestion and problems. The technology is one of the most important basic elements that control decision-making in technical engineering, industrial engineering, military engineering, and other fields. The decision-making process in road engineering in general and traffic engineering in particular has been effected by technology because the use of technology and scientific development and simulation techniques contribute greatly to making the right decision, which in turn provides the standard specifications for any project, which is saving money and quality.

Simulation is the imitation of a real reality or a physical or biological process where simulation represents the characteristics of the behavior of an abstract or physical system in a computer system that represents the same behavior and is an attempt to reproduce a process under similar conditions [1].

The Synchro program simulates roads and traffic intersections to determine their efficiency and the effectiveness of the solutions before implementing them.

2. Research problem and objectives:

The rapid increase in the number of vehicles causes severe traffic jams at most intersections, which makes the capacity of these intersections not commensurate with this increase due to several reasons, as the engineering design, the shape of the intersection and the design of the traffic lights. This research aims to develop solutions and implement them in a simulation system before implementing them on the ground to save time, effort, money and show up how could this software help making the right decision.

3. Synchro:

Synchro is a complete software package for modeling, optimizing, management and simulating traffic system. This software suite includes:

- Synchro: a microscopic analysis and optimization program.
- Sim traffic: a powerful, easy-to-use traffic simulation software.
- 3D Viewer: a three-dimensional view of sim traffic simulations.
- Sim traffic CI: an application that interact with a controller interface (CI) device [2].

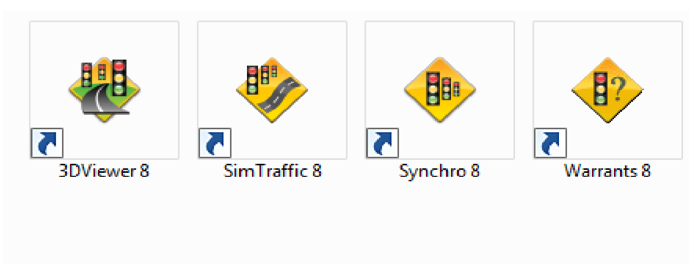

Figure1. Synchro software elements

The evaluation process for traffic performance depends on calculating level of service (LOS) based on calculating the delay times for each group of lanes, and then the whole of intersection. Figure (2) shows the Highway Capacity manual (HCM2000) methodology in evaluating intersections on which the program depends.

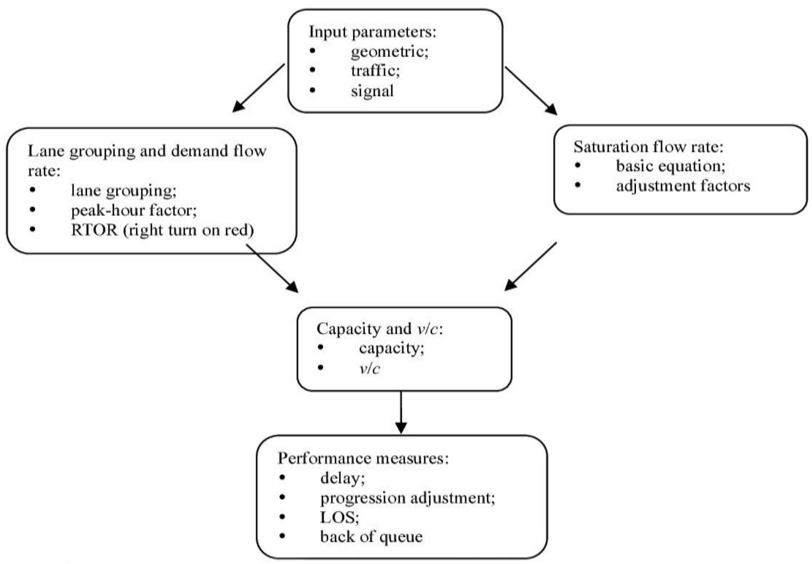

Figure2. Conference information poster [4]

3.1 Input parameters:

3.1.1 Geometric parameters:

- Number of lanes.
- Lane width.
- Grade.
- Area type.
- Storage length.
- Link distance.
- Link speed.
- Travel lanes.

LANE SETTINGS	EBT	EBR	WBL	WBT	NBL	NBR
Lanes and Sharing (#RL)	↑↱		↰	↑	↰	↱
Traffic Volume (vph)	500	100	300	1000	300	250
Street Name	Main Street		Main Street		1st St.	
Link Distance (ft)	469	—	—	320	486	—
Link Speed (mph)	30	—	—	30	30	—
Set Arterial Name and Speed	EB	—	—	WB	NB	—
Travel Time (s)	10.7	—	—	7.3	11.0	—
Ideal Satd. Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12
Grade (%)	0	—	—	0	0	—

Figure3. Geometric parametric input.

3.1.2 Traffic parameters:

- Ideal Saturated Flow.
- Traffic Volume (vph).
- Conflicting Pedestrian.
- Peak Hour Factor.
- Adjusted Flow.
- Heavy Vehicle.
- Bus Blockage.
- Adjacent Parking Lane.
- Parking Maneuvers.

The total traffic volumes obtained by direct census in the field or by photographing and counting the previously photographed traffic volumes. and the proportion of trucks, buses and pedestrians is determined separately.

VOLUME SETTINGS	EBT	EBR	WBL	WBT	NBL	NBR
Lanes and Sharing (#RL)						
Traffic Volume (vph)	500	100	300	1000	300	250
Conflicting Peds. (#/hr)	—	0	0	—	0	0
Conflicting Bicycles (#/hr)	—	0	—	—	—	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Growth Factor	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2	2	2	2	2	2
Bus Blockages (#/hr)	0	0	0	0	0	0
Adj. Parking Lane?	☐	☐	☐	☐	☐	☐
Parking Maneuvers (#/hr)	—	—	—	—	—	—
Traffic from mid-block (%)	0	—	—	0	0	—
Link OD Volumes	—	—	—	WB	—	—
Adjusted Flow (vph)	500	100	300	1000	300	250
Traffic in shared lane (%)	—	—	—	—	—	—
Lane Group Flow (vph)	600	0	300	1000	300	250

Figure4. Traffic parametric input.

3.1.3 Signal parameters:

- Phase Templates.
- Controller Type.
- Cycle length.
- Traffic volume.
- Turn Type.
- Total split.
- Yellow Time.
- All-red Time.
- Pedestrian Phase.

4. The relationship between decision-making and the traffic simulation process

A traffic intersection within the city of Baniwalid is selected to implement the simulation process and to propose traffic and engineering solutions.

4.1 Airport intersection:

4.1.2 Description:

A shallow, three-way intersection, linking the main direction north south of the entrance to Baniwalid city and the Mizdah road, It is a single road from one lane in each direction. The western link goes towards the airport road. The intersection is not signalized. The main reason behind being one of the dangerous intersections in the city of Baniwalid is the high rate of accidents.

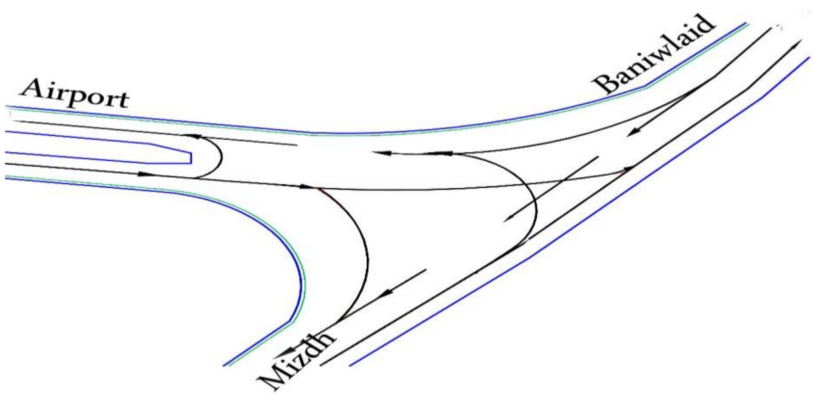

Figure5. Intersection directions.

4.1.3 Intersection geometrical elements:

Table 1**:** *Intersection geometrical elements*

link	lanes	middle	Lane width
A	4	1.5	4
B	2	0	3.6
C	2	0	3.6

4.1.4 Traffic data input:

Table 2**:** *Traffic data input.*

Geometric Input	Link A	Link B	Link C
Traffic Volume	190	390	311
Conflict Pedestrians	50	70	43
Peak Hour Factor	0.90	0.90	0.90
Adjusted flow	206	412	338
Heavy Vehicles	1%	2%	2%
Ideal Saturated Flow	1900	1900	1900
Bus Blockage	0%	0%	0%
Parking Lane	/	/	/
Parking Maneuvers	/	/	/

4.1.5 Geometric data input:

Table 3: *geometrical data input*

Geometric Input	Link A	Link B	Link C
No of lanes	1	1	1
Lane width	4	3.6	3.6
Grade	0	0	0
Storage length	0	0	0
Link distance	94.8m	90.8m	84.6m
Link speed	48	48	48
Travel lanes	2	2	2

4.1.6 Sign data input:

This intersection is un-signalized.

4.1.7 Intersection simulation:

The figure (6) shows the simulation operating of the intersection on Synchro software.

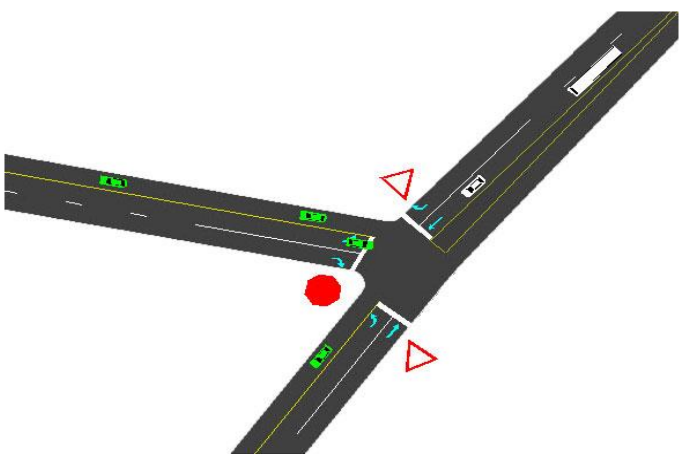

Figure6. Simulation.

After the simulation process, which lasts for 15 minutes, we can get the program report, which appears in Figure (7) and the intersection appears to be in a good traffic condition where the service level is (A) and the traffic capacity was (32.8%), while the delay time on the intersection is (11.3) second.

HCM Unsignalized Intersection Capacity Analysis
4: 10/30/2017

Movement	EBL	EBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Yield	Yield	
Volume (vph)	120	70	55	315	210	101
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	133	78	61	350	233	112

Direction, Lane #	EB 1	EB 2	NE 1	NE 2	SW 1	SW 2
Volume Total (vph)	133	78	61	350	233	112
Volume Left (vph)	133	0	61	0	0	0
Volume Right (vph)	0	78	0	0	0	112
Hadj (s)	0.52	-0.67	0.53	0.03	0.03	-0.67
Departure Headway (s)	6.9	5.7	6.1	5.6	5.7	5.0
Degree Utilization, x	0.25	0.12	0.10	0.55	0.37	0.16
Capacity (veh/h)	489	582	565	624	608	686
Control Delay (s)	11.0	8.3	8.6	14.0	10.8	7.7
Approach Delay (s)	10.0		13.2		9.8	
Approach LOS	A		B		A	

Intersection Summary			
Delay	11.3		
HCM Level of Service	B		
Intersection Capacity Utilization	32.8%	ICU Level of Service	A
Analysis Period (min)	15		

Figure7. The Synchro report.

4.1.8 Roundabout:

The intersection, as evidenced by the simulation process, is in an excellent traffic condition, where the service level (A) is at its best. The alternative that will be studied (Roundabout) is to reduce traffic accidents at this intersection and to try to stop pedestrians running-over, where pedestrians are walking perpendicular to the movement of vehicles continuously due to the presence of the popular market on one of the sides of the intersection.

Traffic lights and signs are useless as some drivers deliberately ignore them. In other way, the traffic lights are an obstacle to the traffic flow because it is operate with a Stop-Go Operation system. Therefore, the alternative and the most appropriate option would be the rotation island, as it will not affect the traffic significantly. The advantage that is forcing all vehicles to reduce speed to turn without impeding the movement and stopping it. It will also reduce the points of conflict at the intersection, as shown in Figures (8) Where the first figure shows the conflict points in the intersection in the current situation, while the second shows the points of intersection when the roundabout, where the conflict points decreased from 10 to 8.

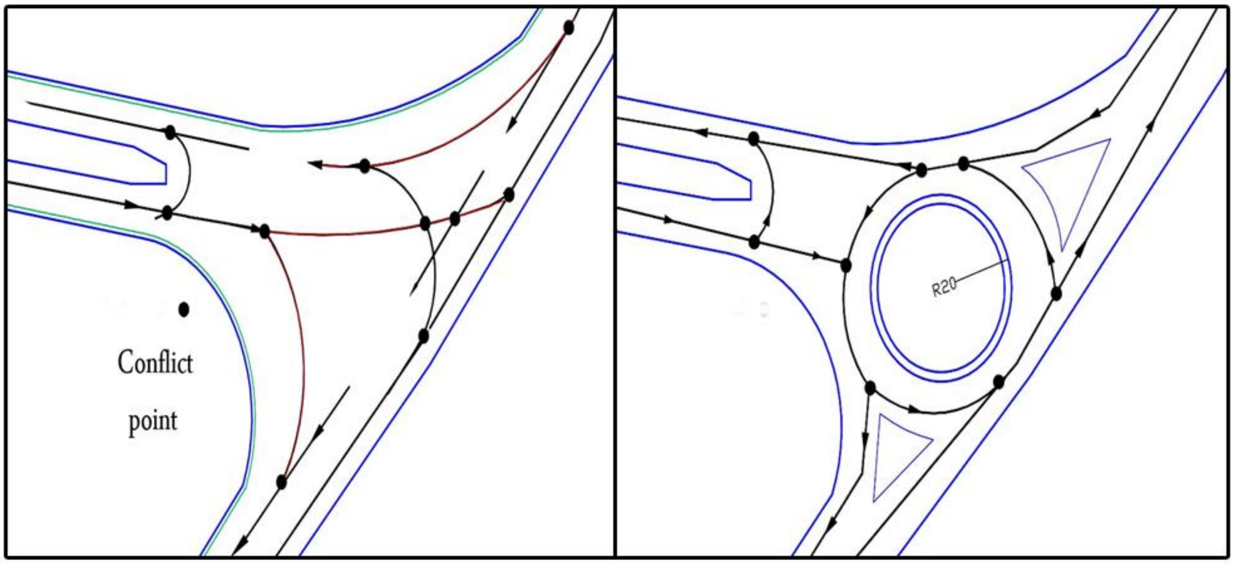

Figure8. The Conflict points.

The Figure (9) shows the data of the roundabout that proposed by the program and the Figure (10) shows the results of the intersection simulation after adding the spin island.

NODE SETTINGS	
Node #	4
Zone:	
X East (m):	534.0
Y North (m):	322.0
Z Elevation (m):	0.0
Description	
Control Type	Roundabout
Max v/c Ratio:	0.33
Intersection Delay (s):	—
Intersection LOS:	—
ICU:	0.33
ICU LOS:	A
Inside Radius (m):	8.4
Outside Radius (m):	20.0
Roundabout Lanes (#):	1
Circle Speed (km/h):	30
Inside Color:	
Transparent Circle:	

Figure9. The roundabout that proposed by the software.

HCM 2010 Roundabout
4: 10/30/2017

Intersection	
Intersection Delay (sec/veh)	6.3
Intersection LOS	A

Approach	EB	NE	SW
Entry Lanes	2	2	2
Conflicting Circle Lanes	1	1	1
Adjusted Approach Flow (vph)	211	411	345
Demand Flow Rate (pc/h)	214	419	352
Vehicles Circulating (pc/h)	238	134	62
Vehicles Exiting (pc/h)	176	318	491
Follow-Up Headway (s)	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	70	0	50
Ped Capacity Adjustment	0.935	1.000	0.946
Approach Delay (sec/veh)	5.8	7.1	5.6
Approach LOS	A	A	A

Lane	Left	Right	Left	Right	Left	Right
Designated moves	L	TR	L	TR	LT	R
Assumed Moves	L	TR	L	TR	LT	R
Right Turn Channelized						
Lane Utilization	0.626	0.374	0.148	0.852	0.676	0.324
Critical Headway (s)	5.193	5.193	5.193	5.193	5.193	5.193
Entry Flow Rate (pc/h)	134	80	62	357	238	114
Capacity, Entry Lane (pc/h)	891	891	988	988	1062	1062
Entry HV Adjustment Factor	0.993	0.975	0.984	0.980	0.980	0.982
Flow Rate, Entry (vph)	133	78	61	350	233	112
Capacity, Entry (vph)	827	812	972	969	985	987
Volume to Capacity Ratio	0.161	0.096	0.063	0.361	0.237	0.114
Control Delay (sec/veh)	6.0	5.4	4.3	7.6	6.0	4.7
Level of Service	A	A	A	A	A	A
95th-Percentile Queue (veh)	1	0	0	2	1	0

Figure10. The Final report.

The roundabout is the best option for this intersection, as the delay times decreased to be (6.3) instead of (11.3), and although the service level for the intersection is still (A) as it was, but in detail the service level for all directions has improved to become (A).

Results and Discussion

1. The airport intersection was simulated by Synchro software (Baniwalid city).
2. The level of service is A.
3. The level of service on link C was B and it was A for the rest links.
4. Roundabout was applied as solution to decrease accidents,
5. Traffic capacity improved at the intersection after adding the roundabout island.
6. The number of conflict points decreased after applying the roundabout island.
7. The delay time decreased after applying the roundabout island.

8. The flow of traffic within the intersection was maintained, conflict points were reduced, and traffic accidents were reduced after the application of the roundabout island.

Conclusions:

The process of simulating traffic in roads and intersections is one of the most important technological developments in recent years, and it directly affects decision-making in the operation of roads and traffic intersections and the application of successful solutions to reduce accidents and traffic jams. This program allows the application of many solutions, including islands, changing the geometry, measurements of roads and intersections, adding or canceling traffic signals, and adjusting the time of their phases. All of these options give decision-makers the ability to implement solutions and choose the least expensive and most successful solutions.

References:

[1] ASHWORTH, R. Simulation of Traffic Delays at T-Junction Various Alternative
Forms of Layout, Simulation, September 1975, 145-148.

[2] Synchro studio 9 user guide

[3] Abelrazag F. atyiah. Evaluation of some serious intersections in Baniwalid by Computer
Applications, Unpublished master thesis, The Libyan academy. 2018.

[4] Web site pictures: https://www.semanticscholar.org/paper/Examination-of-Signalized-Intersections-According-Akmaz-%C3%87elik/f19ef36ddcc72a5d1a344d843f63b015eca06975