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APPLICATION OF QUEUEING THEORY TO SIGNALS SYSTEM AT TWO BUSY CROSS SECTIONS OF CITY HYDERABAD: A SIMULATION APPROACH

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Abstract

This paper attempts to analysis a traffic system and adjustment of signal timings at Thandi Sarak, Hyderabad and then it suggest a signal timing at another cross section of road (next to it) situated at National Highway and Wadhoo Wah road intersection near Rani Bagh. A program in GPSS is developed in order to simulate a queuing system depicting signal timings during rush hours. Each simulation run is essentially an experiment on the system. The advantage of simulation is that these experiments can be completely controlled and completely observed. Effective signal timings are suggested to reduce queue length (traffic congestion).

Keywords: application of queuing signals system reduce queue length

1. Introduction

Simulation is a very powerful method for solving traffic flow problems because of its wide applicability and because it provides a laboratory to study systems without the costs of building or modifying the real system.

The objective of this paper is to analysis an existing traffic signal system and suggests the traffic light system at another cross section of the road to effectively control/manage the traffic flow there. To achieve this goal, two simulation programs are written in General Purpose Simulation System (GPSS) and obtained results from these programs are mainly discussed. Queuing theory one of the diversified field of applicable mathematics that is widely used in many areas including Operation Research, telecommunications, production systems, computer science and Road Management/Engineering.

In 2005 an American study revealed that there might be seven root causes of congestion on roads, poor signal timing is one of them.

Various authors studied traffic analysis both analytical as well as with simulation approach such as Brigham (1995), Bhatt and Raos (1972), Hoover and Perry (1989), Lo and Chow (2004), this paper is organized as follow

Description is given in sections 2. Sections 3 describe some aspects of GPSS as a simulation language. Simulation program of two cross sections (Round about) of the Road in GPSS are given in section 4 and 5. Results are discussed in section 6.

2. Description

(**Fig. 1**) shows the first round about, where as (**Fig. 2**) is the representation of second round about, where currently there is no signals system available. Due to the absence of signals drivers have to face little difficulty, when they cross this round about. (**Table-1** and **Table-2**) shows the statistical data for both models respectively. (**Fig. 3**) shows the whole model connecting both rounds about and suggests the signals position at second round about. Second round about is situated at National Highway between Wahdat Colony round about and Qasim Chouk round about. At this round about there is no traffic light system. Due to this drivers have to face lot of trouble, when they cross this intersection. There is lot of risk of accidents due to the absence of traffic signals. (**Table-1**) shows the statistical data of vehicles arriving at this intersection from various points within one minute. If a traffic light system is established, the risk of accidents can be reduced and as well as the time of journey can be reduced for those who are crossing this intersection.

Below is given the statistical data collected through observations. **(Table-1 and Table-2)** shows data for above both models respectively. Simulation programs use that data to generate results.

Table-1. Shows the statistical data on first round about

Date/day	Time	Wahdat Col to Gul Center (Street-1)	Qasimabad to Wahdat Colony/Kotri	Qasimabad to Latifabad	Latifabad to Qasimabad	G.O.R to Qasimabad	Observer
03-01-2008 Thursday	6:15 to 6:50	60 to 80 veh in 18 sec.	15 To 20 Veh in 10 sec.	30 To 35 Veh in 12 sec.	30 to 40 Veh in 12 sec.	8 To 12 in 8 Sec.	Mahboob Ali
09-01-08 Wednesday	6:45 to 7:20	40 to 50	10 to 15	20 To 30	15 to 25	5 to 10	Jamshed
	8:30 to 9:10	30 to 45	10 to 15	20 to 30	15 to 25	5 to 10	S. Munawar Ali Shah
16-01-08 Wednesday	6:30 to 7:00	50 to 70	12 to 18	25 to 30	30 to 40	10 to 15	Amjad Ali Noonari

Table-2. Shows the statistical data on second round about

Date/day	Time	Shahbaz Bld to Naseem Nagar	Naseem Nagar to Shahbaz Bld	Qasimabad/Wahdat Col to Qasim chok	Qasim Chok to wahdat colony/qasimabad	Observer
05-01-2008 Saturday	5:40 PM	30 to 40 veh cros tm: 1 min	25 to 30 veh cros tm: 1 min	40 to 50 veh cros tm: 1 min	40 to 50 veh cros tm: 1 min	Maqsood Ali Jalbani
07-01-2008 Monday	7:15 to 8:15	35 to 45 veh cros tm:1 min	30 veh cros tm: 1 min	40 to 45 veh cros tm: 1 min	35 to 45 veh cros tm: 1 min	Ayaz Ali
Arrival rate		0.5 to 1.5 sec/vehicle	1 to 3 sec/vehicle	0.5 to 1.5 sec/vehicle	0.5 to 1.5 sec/vehicle	
Proposed Signal duration		12 sec	12 sec	15 sec	15 sec	

Fig. 1. This figure represents the traffic flow environment at the round about situated between Shahbaz Building and Rani Bagh in Hyderabad city.

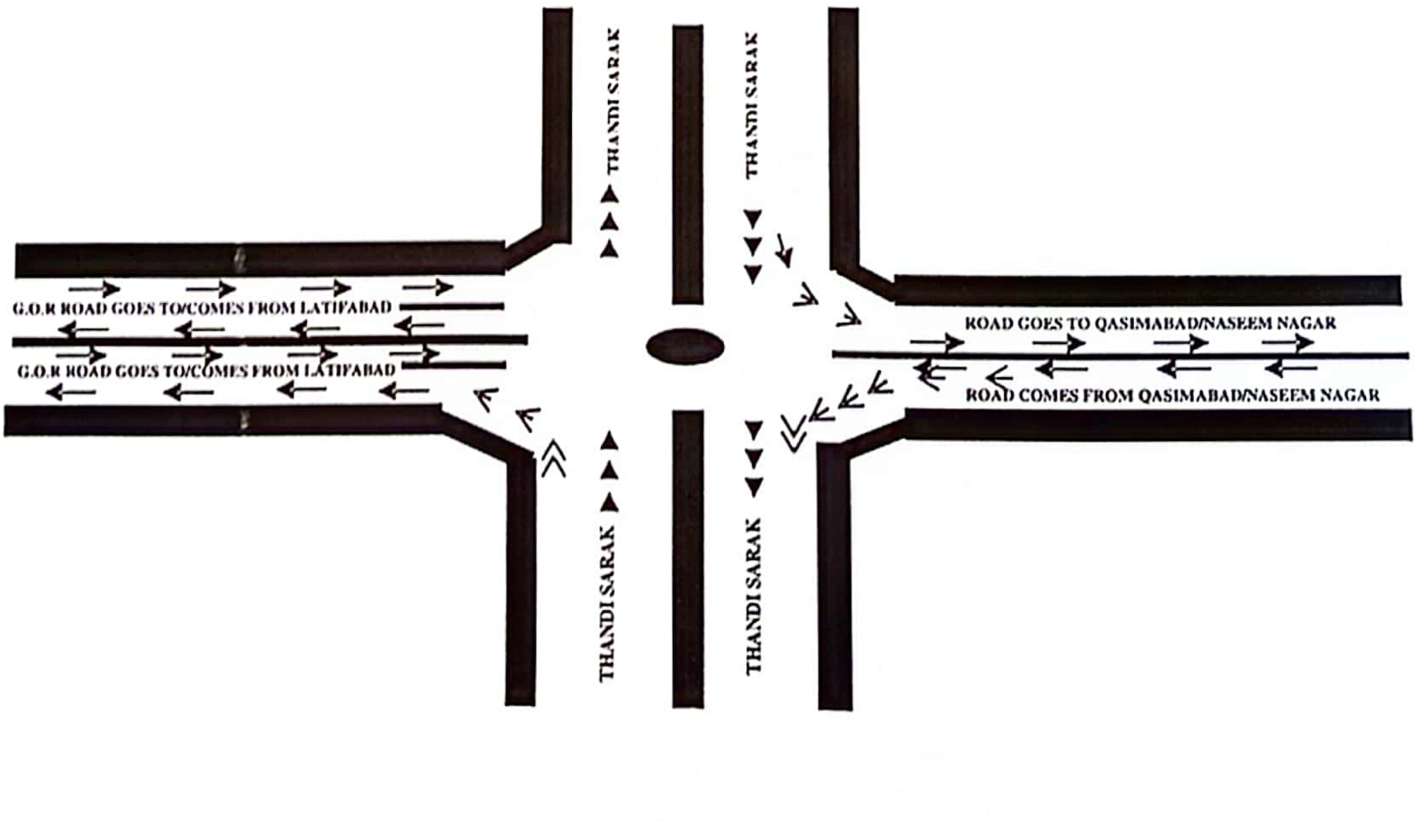


Fig. 2. This figure represents the traffic flow environment at the round about situated at National Highway – between Shahbaz Building round about and Naseem Nagar round about.

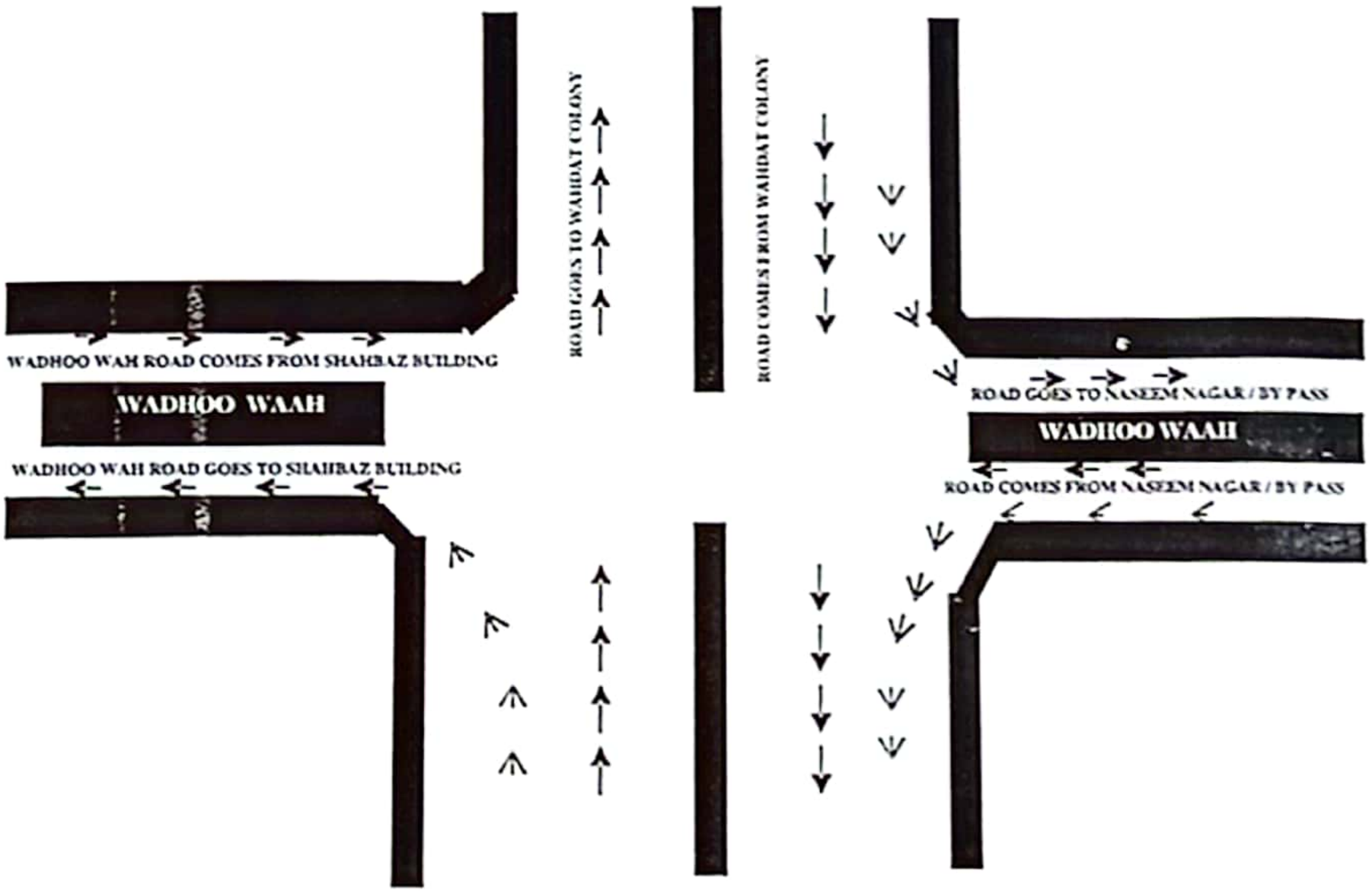
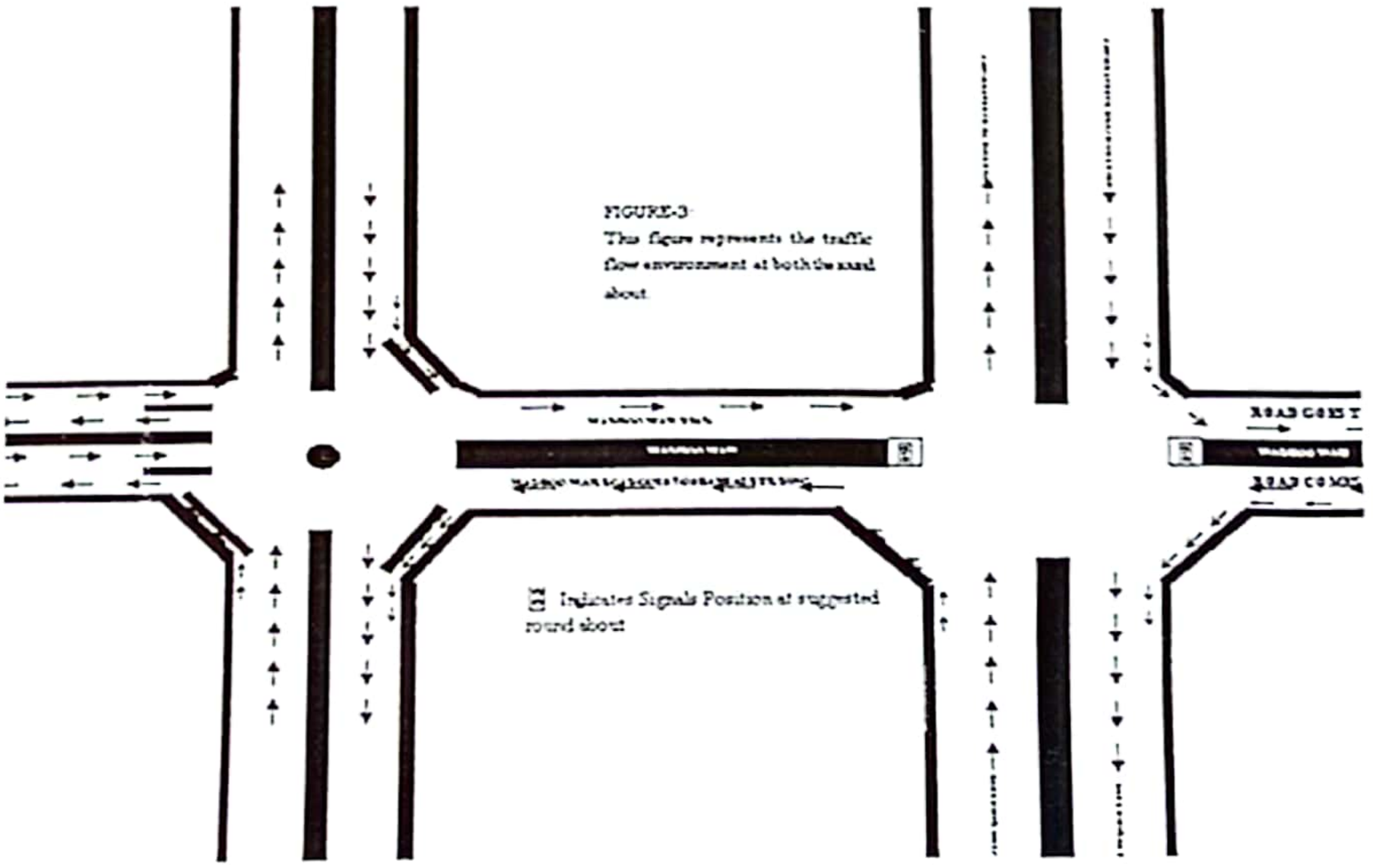


Fig. 3. This figure represents the traffic flow environment at both the round about.



3. General Purpose Simulation System (GPSS):

The GPSS[6] is chosen as the simulation language, because of its availability and ease of handling simulation problems similar to one under investigation.

GPSS has much of the underlying logic of system simulation built-in. some of the basic features of GPSS are as follows:

1. The ability to sample from all well known distributions.
2. The ability to define and sample from empirical distributions.
3. A built-in simulated clock.
4. Automatic generation of queueing logic and statistics at points defined in the system.

GPSS programs for both models are written according to the statistical data obtained during several observations. Below is given the code and description of first GPSS programs that is written for figure-1 model above.

4. Computer programme

(for fig. 1)

```
simulate
***** Light Segment ******
      generate ...1
***Signal lights for street-1.
begn1  seize  grenS1
         advance          18
       release grenS1
       seize  grenR1
         advance          12
       release grenR1
***Signal lights for street-2.
       seize  grenS2
         advance          12
       release grenS2
       seize  grenR2
         advance          10
       release grenR2
***Green light for street-3 for both straight and
right turn.
       seize  grnSR3
         advance          8
       release grnSR3
goto begn1
*****************************************
************ Street 1 segment **************
*****************************************
*** Vehicles to go straight from street1 ***
       generate 2,1
       arrive  strt1S
       if grenS1=nu,waitS1
*time consumed by vehicle to cross the
intersection (signal area)
       advance 2,1
       goto joinS1
waitS1  waitif grenS1=nu
*time consumed by vehicle to cross the
intersection,
if it waited for green signal
       advance 4,2
joinS1  depart  strt1S
          terminate

***vehicles to turn right from street1***
*vehicle arrive every 10 to 20 sec to turn right
       generate 1
       arrive  Strt1R
       if grenR1=nu,waitR1
*time consumed by vehicle to turn right from
intersection
       advance 3,1
       goto joinR1
waitR1  waitif grenR1=nu
*time consumed by vehicle to turn right from
intersection, if it waited for green signal
       advance 4,2
joinR1  depart  Strt1R
          terminate
*****************************************
************ Street 2 segment **************
*****************************************
***vehicles to go straight from street2***
*vehicle arrive every 5 to 9 sec to cross straight
       generate 1
       arrive  strt2S
       if grenS2=nu,waitS2
*time consumed by vehicle to cross the
intersection (signal area)
       advance 2,1
       goto joinS2
waitS2  waitif grenS2=nu
*time consumed by vehicle to cross the
intersection, if it waited for green signal
       advance 4,2
joinS2  depart  strt2S
          terminate
***vehicles to turn right from street1***
*vehicle arrive every 15 to 25 sec to turn right
       generate 2,1
       arrive  Strt2R
       if grenR2=nu,waitR2
*time consumed by vehicle to turn right form
intersection
       advance 2,1
```

```
      goto joinR2
waitR2  waitif grenR2=nu
*time consumed by vehicle to turn right from
intersection,if it waited for green signal
      advance 4,2
joinR2  depart  Strt2R
        terminate
**************************************
********** Street 3 segment **************
**************************************
***vehicles to go straight from street2***
*vehicle arrive every 10 to 20 sec to cross straight
or turn right
      generate 2,1
      arrive  str3SR
      if grnSR3=nu,watSR3
*time consumed by vehicle to cross the
intersection (signal area)
      advance 4,2
      goto jonSR3
watSR3  waitif grnSR3=nu
*time consumed by vehicle to cross the
intersection, if it waited for green signal
      advance 5,2
jonSR3  depart  str3SR
        terminate
***** stop segment *****
*simulation continues for 4 hours
      generate 14400
      terminate 1
      start 1
      end
```

Below is given the code and description of second GPSS programs that is written for figure-2 model as mentioned above.

5. Computer Programme

(for fig.2)

```
      simulate
********* Light Segment *********
      generate        ,,,1
***Green Signal for Wahdat Colony to Qasim
Chouk/Shahbaz Building
begn1  seize  grenS1
        advance         16
     release grenS1
***Green Signal for Qasim Chouk to Wahdat
Colony/Naseem Nagar
     seize  grenS2
        advance         16
     release grenS2
***Green Signal for Shahbaz Building to Naseem
Nagar/Qasim Chouk
     seize  grenS3
        advance         12
     release grenS3
***Green Signal for Naseem Nagar to Shahbaz
Building/Wahdat Colony
     seize  grenS4
        advance         12
     release grenS4
goto begn1
**************************************
********** Street 1 segment ************
**************************************
*** Vehicles to go straight/Right turn from
Wahdat Colony To Qasim Chouk***
        generate 1,0.5
     arrive  stret1
     if grenS1=nu,waitS1
*time consumed by vehicle to cross the
intersection (signal area)
     advance 0.5
     goto joinS1
waitS1  waitif grenS1=nu
*time consumed by vehicle to cross the
intersection, if it waited for green signal
     advance 1,0.5
joinS1  depart  stret1
        terminate
**************************************
********** Street 2 segment **********
**************************************
*** Vehicles to go straight/Right turn from Qasim
Chouk to Wahdat Colony***
        generate 1,0.5
     arrive  stret2
     if grenS2=nu,waitS2
*time consumed by vehicle to cross the
intersection (signal area)
     advance 0.5
     goto joinS2
waitS2  waitif grenS2=nu
*time consumed by vehicle to cross the
intersection, if it waited for green signal
     advance 1,0.5
joinS2 depart stret2
        terminate
**************************************
********** Street 3 segment *******
**************************************
*** Vehicles to go straight/Right turn from
Shahbaz Building to Naseem Nagar ***
        generate 1,0.5
     arrive  stret3
     if grenS3=nu,waitS3
```

```
*time consumed by vehicle to cross the
intersection (signal area)
      advance 0.5
      goto joinS3
waitS3  waitif grenS3=nu
*time consumed by vehicle to cross the
intersection, if it waited for green signal
      advance 1,0.5
joinS3  depart  stret3
        terminate
****************************************
********* Street 4 segment **************
****************************************
*** Vehicles to go straight/Right turn from
Shahbaz Building to Naseem Nagar ***
        generate 2,1
      arrive  stret4
      if grenS4=nu,waitS4
*time consumed by vehicle to cross the
intersection (signal area)
      advance 0.5
      goto joinS4
waitS4  waitif grenS4=nu
*time consumed by vehicle to cross the
intersection, if it waited for green signal
      advance 1,0.5
joinS4  depart  stret4
        terminate
***** stop segment *****
*simulation continues for 4 hours
      generate 144(X)
      terminate 1
      start 1
      end
```

6. Results and Discussion

Proposed time for this signal is given in the view of observations. First it should remain green for 16 seconds for vehicles to pass straight and right turn from Wahdat Colony to Qasim Chouk/Shahbaz Building round about, and then it remains green for 16 seconds for vehicles to pass straight/right turn from Qasim Chouk to Wahdat Colony/Naseem Nagar round about. After that it remain green for 12 seconds to allow vehicles to cross straight and right turn from Shahbaz Building to Naseem Nagar/Qasim Chouk round about, then it remain green for 12 seconds to allow vehicles straight and right turn from Naseem Nagar to Shahbaz Building/Wahdat Colony round about. Note that these timings are suggested specially for rush hours in the evening. First cross section of the road is situated at Thandi Sarak between Wahdat Colony round about and Gul Center round about. First it remain green for 18 seconds for vehicles to pass straight to/from Wahdat Colony and Gul Center, then it remain green for 12 seconds to allow right turn for both sides. After that it remain green for 12 seconds to allow vehicles to cross straight between Latifabad and Qasimabad Road, then it remain green for 10 seconds to allow right turn for vehicles at same sides. Finaly it remain green for 8 seconds to allow G.O.R side vehicles to go straight or right turn. Remember this information of green light is taken for rush hours (evening hours), the signal duration changes some seconds several times in a day for each side.

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