MODELLING AND SIMULATION

FUEL STATION QUEUING SYSTEM

SUBMITTED BY –

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Problem Definition

The heavy rush at fuel pumps demotivate the people to move out of the system without refueling the vehicle. There is regular heavy traffic block outside the fuel filling station in every area on the nearby roads. The whole road is occupied by vehicles waiting for filling fuel. They queue up in 2-3 rows which take away a major portion of the road.

Delays in the availability of fuels may cause drastic outcomes for customers as well as for surroundings. Long waiting times is the most important problem in customer's satisfaction. To manage these situations we will use queuing models which can provide reasonably accurate evaluations of our system's performance.

Aim & Objective

This project should be aimed at realistically depicting the system of queues in Fuel station and also at designing a project for the fast and efficient way of refueling the vehicles at a fuel station.

This should be designed such that it reduces the amount of traffic jam on the station which will immensely save the time and money of the customer.

Methodology

- *All customers have two choices to select from:* *Fuel types petrol for two wheelers and (petrol/diesel) four wheelers:* We are going to divide the customers/vehicles in 4 queues (i.e. two for each two-wheeler and four-wheeler) and we are also providing them to choose payment method i.e. via card or cash.
- *No customer leaves the system after entering the queue.*
- *There is no jockeying in the system:* Basically jockeying is a queue behavior where no (customer/vehicle) move from one queue to another queue if they think they have chosen a slow line. As queue had separated earlier on the basis of type of vehicle, hence there should be no jockeying in the system.
- *We are also assuming* *that if customer enters the system he/she should have to refuel his/her vehicle fuel tank before leaving the system.*
- We have created a C++ program for multi server queuing system.

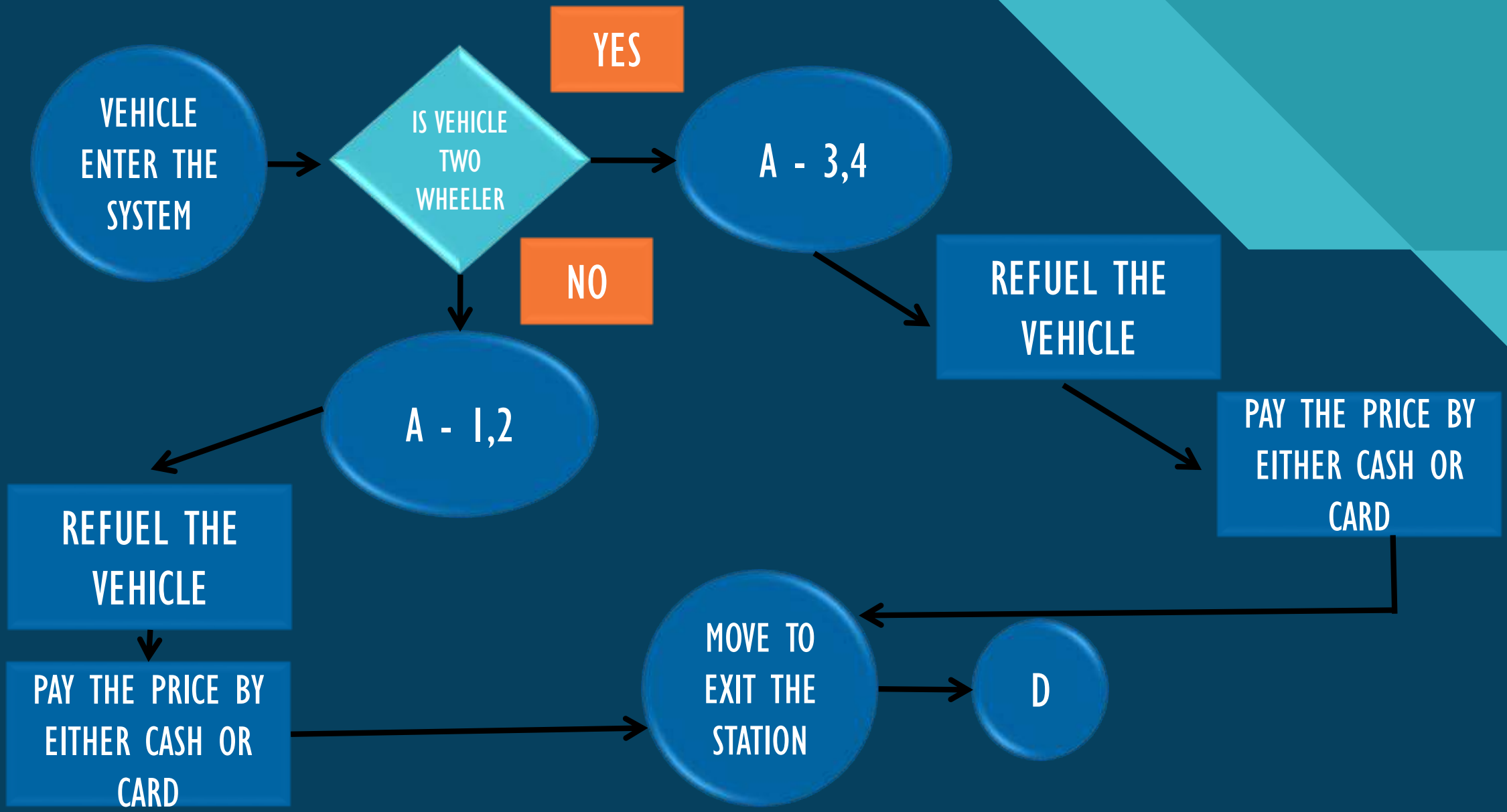
Case Study

- The case study is about simulating the behavior of a petrol station named Indian Oil located in the Nangloi-Najafgarh Road Delhi,110043.
- This petrol station consists of two main platforms;

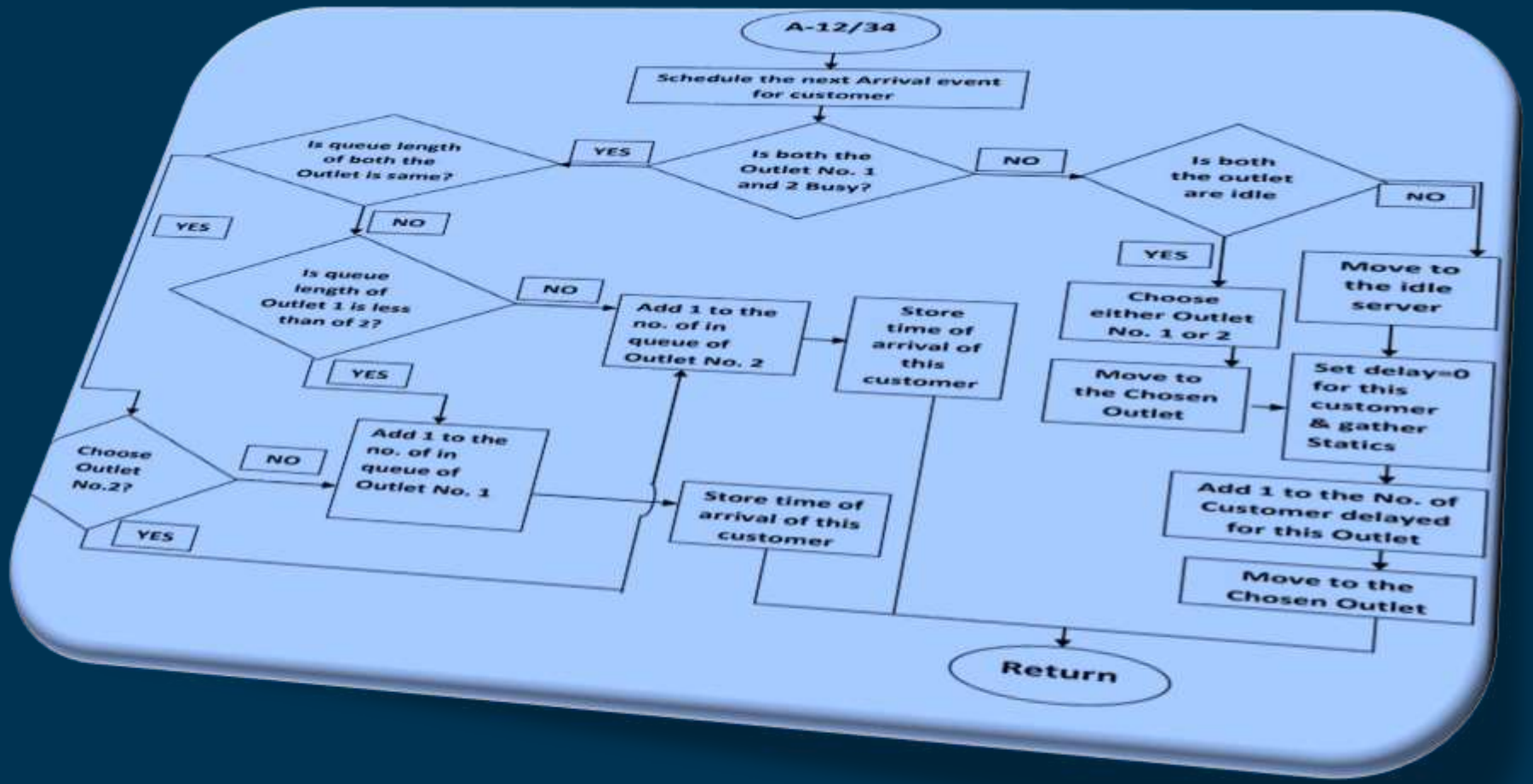
  one of them contains two petrol pump – generally for two wheelers,

  another one contains one petrol outlet and diesel outlet-generally for four-wheelers.
- Process map is made for this reason to illustrate the exact relations and sequences of different sections and activities while customers enter and exit the model.
- The second step to construct the simulation model would be collecting data for each activity's duration that occurs in the model. Therefore, based on the flow charts, related data should be recorded and gathered.

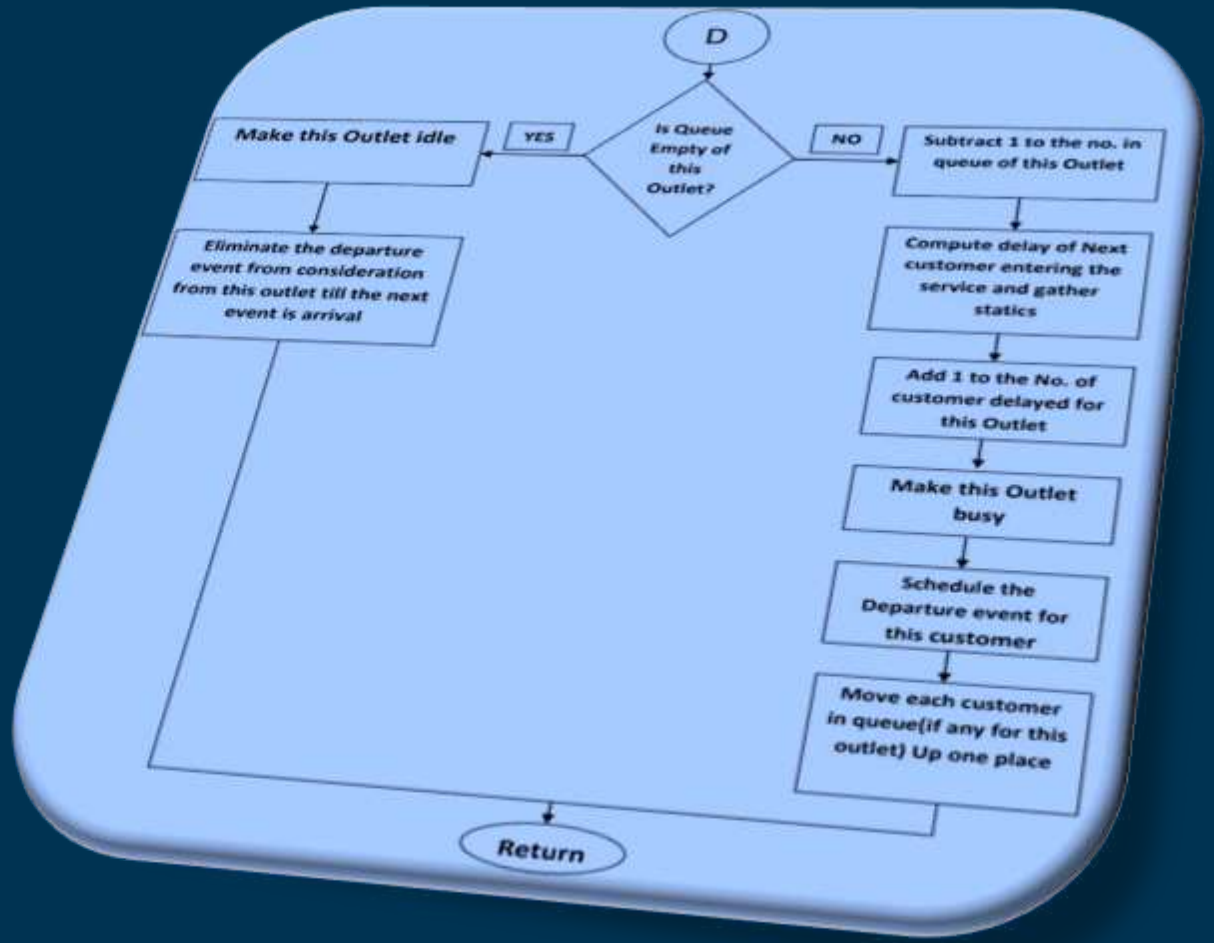
Process Map


VEHICLE ENTER THE SYSTEM
IS VEHICLE TWO WHEELER
YES
NO
A - 3,4
A - 1,2
REFUEL THE VEHICLE
PAY THE PRICE BY EITHER CASH OR CARD
REFUEL THE VEHICLE
PAY THE PRICE BY EITHER CASH OR CARD
MOVE TO EXIT THE STATION
D

Flow chart for Arrival Routine



Flow chart for Departure Routine



Output of C++ Code

Four Wheelers

```
            *** Multi server queuing system ***

            * Four Wheelers *

Please provide the given details:

Mean inter-arrival time= 3

Mean service time= 4.6

Number of customers= 30

Simulation clock time= 72.5875
Total delay= 44.5342
Average delay in queue= 1.48447
Waiting time of customers in Queue 1= 22.6605
Waiting time of customers in Queue 2= 21.8737
Server 1 (Petrol) utilization= 0.808656
Server 2 (Diesel) utilization= 0.637294

Total fuel consumption (Diesel & Petrol)= 429

Press any key to continue!!
```

Two Wheelers

```
            *** Multi server queuing system ***

            * Two Wheelers *

Please provide the given details:

Mean inter-arrival time= 1.6

Mean service time= 3

Number of customers= 30

Simulation clock time= 42.977
Total delay= 42.3459
Average delay in queue= 1.41153
Waiting time of customers in Queue 1= 18.8857
Waiting time of customers in Queue 2= 23.4603
Server 1 (Petrol) utilization= 0.742177
Server 2 (Petrol) utilization= 0.576301

Total fuel consumption (Petrol)= 134

Press any key to continue!!
```

Model Statistics after 3 runs

- Four wheeler simulation table of 30 customers after 1 hour of simulation time.

N	Mi	Ms	Td	S1	S2
1st	3.0	4.6	29.18	64.62	47.02
2nd	4.0	4.6	21.97	62.77	45.63
3rd	3.0	4.0	12.96	83.23	38.98

- Two wheeler simulation table of 30 customers after 1 hour of simulation time.

N	Mi	Ms	Td	S1	S2
1st	1.6	3.0	47.90	89.20	63.05
2nd	1.6	2.4	17.28	74.27	37.24
3rd	2.0	3.0	28.84	67.89	45.76

N represents Number of runs
Mi represents Mean inter-arrival time in minutes
Ms represents Mean service time in minutes
Td represents Total delay in minutes
S1 represents Server 1 utilization in percentage
S2 represents Server 2 utilization in percentage

Model Validation

Validation is a process aims to ensure that the simulation model perform as reality.
In order to validate the model, the total fuel consumption generated from the model was compared with the actual data obtained from the real situation five times.

N represents Number of runs

Fuel cons. represents Fuel (Petrol & Diesel) consumption per hour in liters

Total fuel cons. represents Total fuel consumption per hour in real situation

% in var. represents Percentage in variation

Mean = 449

Average variation = 2.538 < 5 %

- **Model validation results for four wheelers**

N	Fuel cons.	Total Fuel cons.	% in var.
1st	442	457	3.282
2nd	452	457	1.094
3rd	466	457	1.969
4th	449	457	1.750
5th	436	457	4.595

The average variation percentage is less than 5%, which means the model is valid for four wheelers.

Similarly

N represents Number of runs

Fuel cons. represents Fuel (Petrol) consumption per hour in liters

Total fuel cons. represents Total fuel consumption per hour in real situation

% in var. represents Percentage in variation

Mean = 159.69

Average variation = 3.275 < 5 %

- **Model validation results for two wheelers**

N	Fuel cons.	Total Fuel cons.	% in var.
1st	155.38	160	2.880
2nd	167.56	160	4.725
3rd	157.33	160	1.668
4th	153.41	160	4.118
5th	164.78	160	2.987

The average variation percentage is less than 5%, which means the model is valid for two wheelers.

Result

- In our project, two different types of reports are categorized in order to give a better view about what can be derived from these kinds of reports and how useful and helpful they can be for managers to make important decisions.
- Firstly, inter arrival times for the main system entries are discussed : Here is where managers can benefit from the results of a simulation model; optimize their staffing and their working hours, redesign their tasks and jobs, facilitate their petrol station with more advanced devices and many other instances that all would result in better service quality with lower costs and waste.
- Secondly, percentage variations of fuel consumption are discussed : A number of variables have been defined in order to give better visualization scenery on what is happening inside the model while it is running.

In this project which is mainly focused on modeling the behavior of a petrol station, managers could widely benefit from the simulation modeling advantages, considering beneficial reporting system that simulators provide focusing on every desirable element with any detail level.

Thank You