Minimization of Traffic Jam by Using Queuing Theory

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Abstract : Traffic congestion is a phenomenon of increased disruption of the traffic movement. In india with increasing vehicles on the road , traffic jam is quickly increasing. Much has been written about the queuing theory technique and powerful application. This paper is an attempt to analyze the contribution and application of queuing theory in the field of traffic congestion. For this Gole Ka Mandir Gwalior is chosen. The paper summarizes a range of queuing theory result in the following area :waiting time, utilization analysis and system design.

Keywords: *: queuing theory ,system design , traffic jam, utilization analysis , waiting time.*

I. INTRODUCTION

Operation research is a scientific approach to analyzing problems and making strong decisions. In operational research queuing theory, a mathematical technique is used to minimize the waiting time of a particular queuing system. Whenever the problem of jam arises in the course of traffic management the queuing theory and its application always comes into picture. Traffic jam is a situation on the road network that occurs as its use increases and is characterized by slower speeds of longer travel times and increased vehicular queuing. Congestion can also occur because of non - recurring highway incidents such as road works, which can reduce road capacity below normal levels. Thus jam roads can be seen as an example of a common tragedy. When the vechicles are completely stopped for a period of time, this phenomenon is known as traffic jam.

II. FEW NEGATIVE IMPACT OF THE TRAFFIC JAM

III. Wasted fuel expanding air contamination and carbon dioxide discharge attributable to expanded lingering, acceleration and braking.

IV. Due to blocked traffic, crisis vehicles may postpone in coming to their goal where they are earnestly required.

V. Spill over impact from congested primary courses to optional streets and side road as elective courses are endeavored which influence state convenience and land costs.

VI. Delays, which may result in late arrival for employment, meetings and education, resulting in lost business, disciplinary action or other personal losses.

III. Steps Preventing Traffic jam

It consists of the amalgamation of a number of procedures listed below:

- Traffic Flow Measurement
- Traffic Jam Analysis
- Prevention Technique
- Final Evalution
- Result

Representation the Gole ka Mandir Golambar intersection Traffic Flow Model Using Queuing Theory (Single server as a Traffic police).

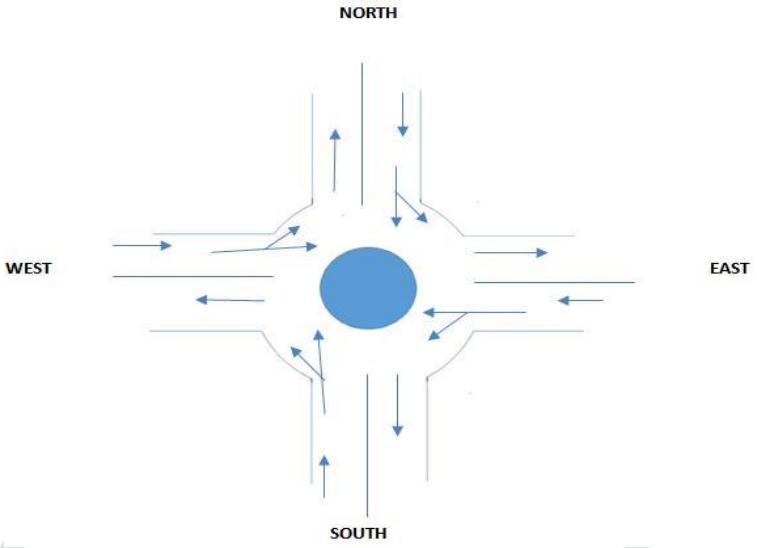

Fig 1: typical representation of the Golambar intersection

IV. Description of the model (M/M/1)

This research is based on the M/M/1, used queueing system. This queueing system assumes Poisson arrival process with rate λ and the service time for customers are negative exponentially distributed with parameter μ. In this system it is assumed that all customers are independent i.e. their decisions to use the system are independent of other users.

V. Assumption of The Model

This research is based on the following assumptions

- Customer are arrive according to the poisson process and the service time follows negative exponential distribution.
- The number of customers in the system is very large.
- The impact of a single customer for performance of the system is very small, that is a single customer consumes a very small percentage of the system resources.
- All customer are independent.
- Total number of car drivers or motorists on the highway is very large.
- A single car uses a very small percentage of the highway resources.

VI. Mean Performance Parameter for the Model

Traffic Intensity

The average number of customers being served is the ratio of arrival and service rate

$$\text{i.e. } \rho = \lambda / \mu$$

For a stable system the service rate μ should always exceed the arrival rate λ and thus ρ should always be less than one. Therefore, it is also known as utilization factor of the server.

Average Number of Customer in the System

The average number of customer in the system is equal to the average number of customer in the queue together with those being serviced.

$$Ls = \lambda / \mu - \lambda$$

Average Number of Customer in Queue

It can be viewed as average queue length that is, the average number of customers who are waiting in the queue. It is defined as

$$Lq = \lambda 2/ \mu (\mu - \lambda)$$

Average Time Spent in the System

The average time spent in the system is equal to the total time that a customer spends in a system i.e. waiting time plus the service time. It is

$$Ws = 1 / (\mu - \lambda)$$

Average Waiting Time in Queue

The average waiting time in queue is the average time a customer waits in queue forgetting service. It is expressed as

$$Wq = \lambda / \mu (\mu - \lambda)$$

TABLE 1:Tabulated representation of the view of the traffic situation at the gole ka mandir intersection

Location	Timing	Arrival		Service		Arrival Rate	Service Rate	Traffic Intensity
		Vehicle	Min	Vehicle	Min			
Railway station to gole ka mandir Intersection	Morning	25	1.19	32	1.01	21	32	0.6631
	Afternoon	22	2.55	17	1.07	9	16	0.5430
	Evening	31	1.16	29	1.03	27	28	0.9492
Cant area to gole ka mandir intersection	Morning	26	2.32	17	1.44	11	12	0.9493
	Afternoon	21	1.33	24	1.01	16	24	0.6645
	Evening	19	1.31	21	1.0	15	21	0.6907
Maripur to gole ka mandir intersection	Morning	17	2.02	15	1.04	8	14	0.5835
	Afternoon	29	1.59	28	1.06	18	26	0.6905
	Evening	51	8.09	42	1.45	6	29	0.2176
Bhind road to gole ka mandir intersection	Morning	28	1.25	35	1.02	22	34	0.6528
	After noon	29	2.3	49	1.19	13	41	0.3062
	Evening	55	4.55	65	2.25	12	29	0.4184

Table 2: Mean Performance Parameter for the Model at Gola Ka Mandir

Location	Timing	Arrival rate	Service rate	Traffic Intensity	Mean no of vehicles waiting	Mean no. of vehicles waiting	Mean Time spent in the system	Mean Time spent in the system

					in the system	in the system		
		λ	μ	P	LS	Lq	WS	Wq
Railway station Golambar Intersection	Morning	21	32	0.6631	2	1	0.0937	0.0621
	Afternoon	9	16	0.5430	1	1	0.1377	0.0748
	Evening	27	28	0.9492	19	18	0.6987	0.6632
Cant area to gole ka mandir	Morning	11	12	0.9493	19	18	1.6704	1.5857
	Afternoon	16	24	0.6645	2	1	0.1254	0.0833
	Evening	15	21	0.6907	2	2	0.1539	0.1063
Maripur to gole ka mandir	Morning	8	14	0.5835	1	1	0.1665	0.0971
	Afternoon	18	26	0.6905	2	2	0.1223	0.0845
	Evening	6	29	0.2176	0	0	0.0441	0.0096
Bhind road to gole ka mandir	Morning	22	34	0.6528	2	1	0.0839	0.0548
	Afternoon	13	41	0.3062	0	0	0.0350	0.0107
	Evening	12	29	0.4184	1	0	0.0596	0.0249

VII. Brief Explanation of the Sampled Data at Different Channels Leading to Gole ka Mandir

Intersection at Different Time:

Information is gathered of vehicles at the gole ka mandir intersection for 10 days in pinnacle long stretches of Morning, Afternoon and Evening i.e. 9:00 - 11:00, 1:30 – 3:00 and 5:00 – 6:30 separately. At that point the average of the arrival and service rate is computed for 10 days and this can be found in the Table-I. At last parameters of the movement stream based queueing model speak to the real circumstance of activity stream at gole ke mandir crossing point. Clarification of the watched activity stream at various channels prompting the gole ka mandir crossing point at various time is given underneath in the Description of Table I and Table II separately.

Description of Table-I

While following the information of this table,it is observed that traffic in channels leading to gole ka mandir intersection from Bhind and army area during peak hour of Evening and Morning respectively the traffic intensity is approaching I.Thus, queueing theory presents the above mentioned traffic situation as a imperfect traffic system.

Depiction of Table-II

This table represent the traffic flow model of queueing theory in mathematical terms. Promote we will examine the traffic flow situation at different channel in different time.

Morning session

Railway station to gole ka mandir

According to collected data arrival rate and service rate were 21 and 32 and hence traffic intensity become 0.6631 which revealed a stable traffic situation but not a good traffic.

Cant area to gole ka mandir

According to the collected data arrival rate and service rate 11 and 12 respectively. Thus the traffic intensity becomes 0.9493 which is 1. Therefore critical condition of traffic flow.

Iitm to gole ka mandir

According to the sampled data the arrival rate and service rate were 8 and 14 and traffic intensity calculated was 0.5835 which revealed a smooth and stable traffic flow.

Bhind road to gole ka mandir

According to the data collected arrival and service rate were 22 and 34 respectively and traffic intensity was calculated 0.6528 which represent stable traffic flow situation.

Afternoon session:

Railway station to gole ka mandir

According to the collectd data arrival and service rate were 9 and 16 and traffic intensity becomes 0.5430 which represented a better traffic flow situation.

Cant area to gole ka mandir

According to the collected data arrival rate and service rate were 15 and 24 and the traffic intensity was 0.6645 which represented a stable traffic flow situation but not a smooth and a good traffic flow.

Iitm to gole ka mandir

According to the collected data the arrival rate and service rate were 18 and 26 and traffic intensity 0.6905 which revealed a stable but not a smooth traffic flow.

Bhind road to gole ka mandir

According to the sample data the arrival rate and service rate were 13 and 41 and traffic intensity calculated was 0.3062 which revealed a fanatnstic traffic flow condition.

Evening session

Railway station to gole ka mandir

According to the collectd data arrival and service rate were 27 and 28 and traffic intensity becomes 0.9492 which represented worst condition of traffic as compare to all other channel and in all the three session.

Cant area to gole ka mandir

According to the collected data arrival rate and service rate were 15 and 21 and the traffic intensity was 0.6907which represented a stable traffic flow situation but not a smooth and a good traffic flow.

rairu to gole ka mandir

According to the collected data the arrival rate and service rate were 6 and 29and traffic intensity 0.2176 which revealed a marvelous traffic flow.

Bhind road to gole ka mandir

According to the sample data the arrival rate and service rate were 12 and 29 and traffic intensity calculated was 0.4184 which revealed a fanatnstic traffic flow condition.

VIII. Results

Acye analysis of the data collected at gole ka mandir intersection reveales proximity to a under perfect system. It is seen that in the morning drivers of commercial transports take advantage of the situation they park and off or on load passangers at unauthorized places very closed to the intersection impeding the flow of the traffic when server resumed work.

It is observed that after installation of equipment for measuring the pollution level in the air, the pollution level has already been crossed the danger level. It is also a matter of concerned for the designers of the pollution free smart city Gwalior. The prevailing “jam” phenomenon in this city is also responsible in raising the pollution level. Thus the present study will be a helping tool for the architects of the pollution free proposed smart city Gwalior.

IX. Conclusion

The queueing theory is an effective mathematical technique for solving various acute problems of any organization or system. As queueing theory focuses on representation of traffic situation by using mathematical terms and formulas, its application cover a wide range of present situation including the traffic congestion. City planning and urban design practices can have a huge impact

on levels of future traffic congestion. The present work is based upon the actual survey of traffic flow at various times and at different location of GOLE KA MANDIR intersection of Gwalior City. The application of the queueing theory is exploited to minimize the traffic congestion leading to a well-known situation "Traffic Jam" at a particular time. The study will be a helping tool for the designers of the forthcoming "Smart City" Gwalior which is a dream project of the people of Gwalior with a hope of "Jam free traffic". We find that the following steps can be taken to avoid the congestion.

- It can be reduced by either increasing road capacity or by reducing traffic.
- We can provide separate lanes for specific user groups
- .Variable message signs can be installed along the roadway to advice road users.
- Increasing width of the channel of congested route or building up of highways.
- Widening the channel of Bairiya and Gobarshahi route by removing the roadside hawkers.
- Introducing public transport such as busses and office cabs
- . There must be parking restriction for the motor vehicles by the roadside (i.e. at unauthorized place), so that congestion can be reduced.

X. References

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