SHIV SHAKTI
International Journal in Multidisciplinary and Academic Research (SSIJMAR)
Vol. 9, No. 3, July 2021 (ISSN 2278 – 5973)

Management of Lalpur (Rudarpur) Toll plaza in Uttrakhand using queuing model M/M/1

Dr. Rudraman
Department Applied Science
Gurukul kangri Vishwavidyalya Haridwar Uttrakhand
Email-rudramansingh10@gmail.com

Abstract

In the present paper study of any stream of traffic system is the analysis of delay. Delay is very important concept because every person has low time for travelling. The Ideal travelling time depends on the situation. Ideal travelling time depend on the traffic system. It is also depend on the performance of toll plaza. The analysis of delay focuses when demand is more than its capacity. This type of delay is called queuing delay. It is solved by queuing theory. This theory solves the problem of waiting time of traveler through toll plaza.

Keywords

Queuing theory, Travelling, Customers, Waiting time, Highways, Toll plaza ,waiting time etc.

Introduction

Toll plaza is a center of taking road tax by travelling vehicles. Lalpur Toll plaza placed near Rudarpur at a distance of 5 kilometer. It is known as Devria toll plaza also which is the biggest toll plaza in Uttrakhand because about thousands vehicles cross Lalpur toll plaza per day. Toll plaza takes road tax for different vehicles. People who passing with your vehicles face many problems of waiting time, sometimes every vehicle wait for long time. Because of waiting time Peoples gathered in toll plaza and they disturb tollplaza staff. Some time people object this situation of queuing time and they are puzzled for this situation. Lalpur toll plaza is mostly busy and travelling vehicles suffer for waiting time because vehicles are running from three highways Rampur to Haldwani , Haldwani to Rudarpur , Kashipur to rudarpur . Efficient sizing of lalpur toll plaza becomes critical in minimization space requirements and capital expanse of collecting user fees.

Queuing Theory (Waiting Line) is the chapter of Operation Research is a precise method to evaluate problems and making decision for waiting time. Queuing theory Models is

Mathematical techniques to minimize the waiting time of a Toll Plaza. Lalpur Toll Plaza is collected user fees from travelling vehicles for compromise the cost of Construction, maintenance of highways in Rudarpur (Udham singh nagar) District . Most of the highways Projects are given on PPP (Public Private Partnership) mode. Toll tax is collected for a reasonable Period of time after which the facility is surrendered to public. The Government of India is try to decrease the problem of waiting time by using FAST TAG in Vehicles. There is two benefits one is waiting time decrease and other is Government can see the fees collection records and controlled of toll plaza in India. By this paper we can solved waiting time using queuing model. It is well known that all these waiting line problems critically restrict the further development of roads and give the best facilities of arrival vehicles. Some things creates waiting as such computer hanging , no electricity , lass toll booths , lazy toll staff . The Lalpur toll plaza have all facilities as such about something seven booths for in and seven booths for out , electricity is twenty four hours , toll staff is expert for work. Some research scholars research in the field of traffic and study of toll plaza. Mala and S. P. Verma [(1)] Minimization of traffic congestion using queuing theory . Clarkson Uka Ohikeza[(2)] Analysis of queue at a Nigerian toll plaza . B. J. Kim[(3)] Conceptualization of traffic flow for designing toll plaza configuration a case study using simulation with Estimated traffic. Schin Antil [(4)] Application of queuing theory on toll plaza to solve the traffic problem. Cheng Wang[(5)] A study of toll plaza Design Based on M/M/c Model of queuing theory. A. N. V. Ravindra and S. Siva. Gowri Prasad[(6)] A review on performance of toll plaza by using queuing theory. H. T. Abdelwahab[(7)] Traffic Micro-simulation model for Design and operational analysis 0f barrier toll stations. U. Mahalingm , P.I.Manju and A. Crowd [(8)] Sourcing of framework for toll plazas. . I. Crown , S. Ganatra , N. Rozeblyum[(9)] A single car interaction model of traffic for a highway toll plaza. G. Liao[(10)] Analysis of expressway tollgate capacity. S.P.Singh and Rudraman discussed management of lalpur toll plaza using queuing model M/M/1.

Method of Queuing Model-

Some time ago lalpur toll plaza used the method manual toll collection for user fees. But at this time it is fully computerized toll plaza and the average number of customers being served is the ratio of arrival and service rate. Let we take service rate = μ

Let arrival rate = λ

Then Utilization factor = $\rho = \frac{\lambda}{\mu}$

But average number of customer is equal to number of customer in waiting line = $L_s = \frac{\rho}{1-\rho} = \frac{\lambda}{\mu-\lambda}$

Average number of customer in queue (L_q) = $L_s - \rho$

Customer time spend in waiting line (queue) = W_s = $\frac{Ls}{\lambda}$ = $\frac{1}{\mu-\lambda}$

Waiting time in queue (W_q) = $\frac{Lq}{\lambda}$ = $\frac{Ls - \rho}{\lambda}$

Observations - We observed only two counter which are mostly busy in morning time and evening time .

For counter No -1

S. N.	Time in Minutes	No. of customer in Queue	Arrival rate	Average of arrival rate
1	Start from 0 Min.	8	00	
2	After 10 Min.	10	0.8	
3	After 20 Min.	13	1.1	0.90
4	After 30 Min.	15	1.2	
5	After 40 Min.	20	1.4	

For counter -2

S. N.	Time in Minutes	No of customers in Queue	Arrival time	Average arrival time
1	Start from zero	7	00	
2	After 10 Min.	10	0.8	
3	After 20 Min.	12	1.0	0.86
4	After 20 Min.	14	1.2	
5	After 30 Min.	17	1.3	

Calculations --

If each customer spend five minutes to pay the user charges then by counter one and two

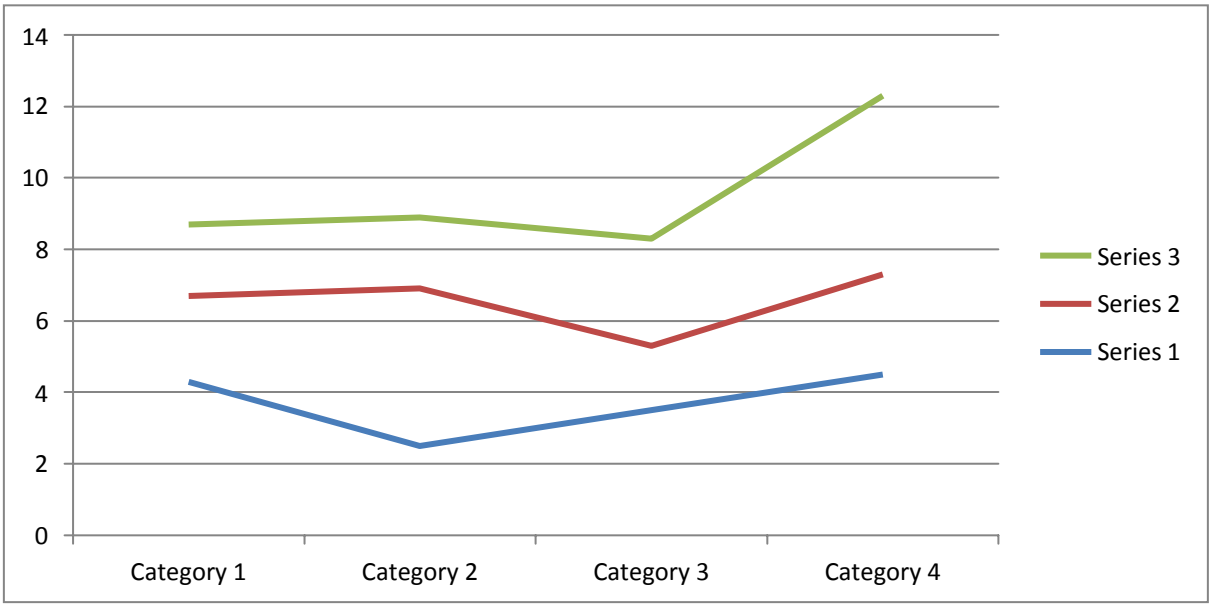
$\lambda = \frac{0.86+0.90}{2}$ = 0.88 and L = λ T = 0.88x5 = 4.40

$\mu = \frac{\lambda(1+L)}{L} = \frac{0.88(5.4)}{4.4}$ = 1.08 c p m (In round one CPM)

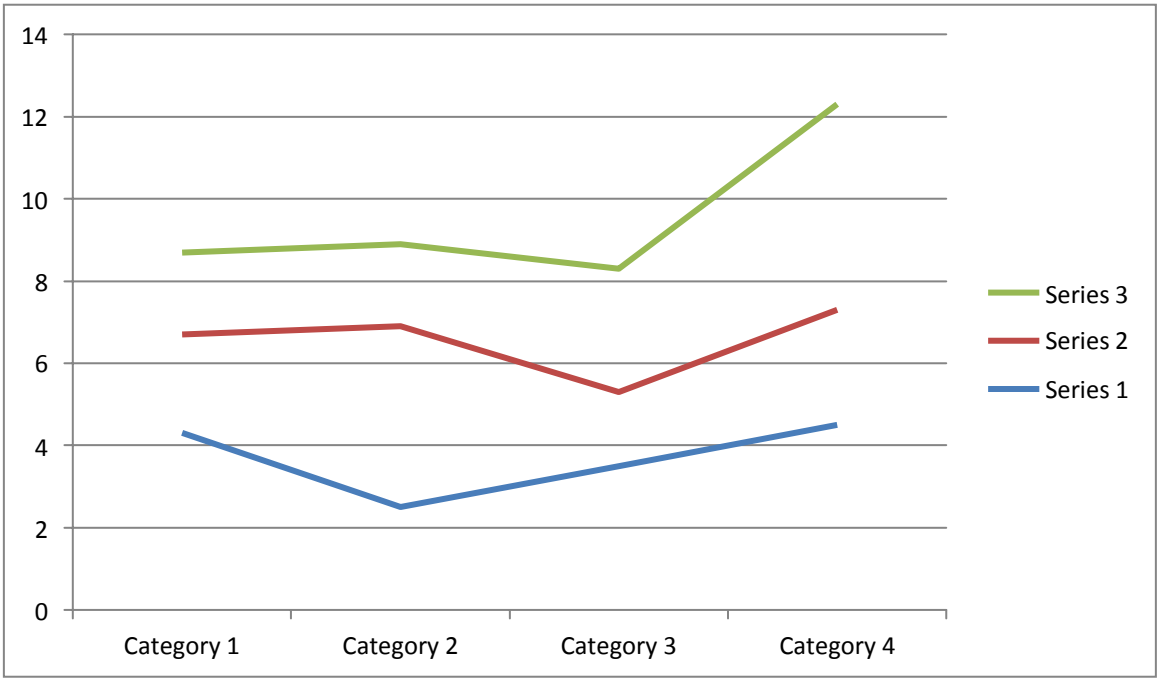
$\rho = \frac{\lambda}{\mu} = \frac{0.88}{1.08}$ = 0.81

If customer spend three minutes to pay user charge

λ = 0.88 and L = 0.88x 3 =2.64 $\mu = \frac{0.88\ (3.64\ )}{2.64}$ = 1.21 and $\rho = \frac{0.88}{1.21}$ = 0.72



Graph for counter -1



Graph for counter -2

Conclusion –

We see that the above calculation for counter number one and counter number two it has been observed that the utilization factor decrease when the time spend by customer is decrease so that the time increase then Utilization factor is increase. We can say that Utilization factor is depend on time spend by customers such that arrival rate also depend on time spend by customers.

Suggestions –

(1) Lalpur toll plaza have separate counter of Government travelers who do not pay the user charge to the toll plaza.
(2) Lalpur toll plaza have separate counter for big loaded truck which have fourteen to thirty tiers.
(3) Lalpur toll plaza have separate more than one counter for vehicles which have FASTAGE.

References

[1] Cheng Wang (2017),`A Study of Toll Plaza design based on M/M/1 queue theory', 7th International conference on Education, Management, Computer and Society, pp:755-759.

[2] Sachin Antil(2017),`Application of Queuing Theory on Journal for Scientific Research & Development, Vol.5, No.7, pp:165-167.And

[3] Shuguo Yang, Xiaoyan (2014), 'Application of the queuing Theory in the traffic Flow of intersection' International Journal of Mathematical and Computational Sciences, Vol.8, No.6, pp: 986-989

[4] Sangavi G V et al. (2017), 'Queuing theory of toll plaza-A-Case study', International Journal of Engineering Research and Technology, Vol.6, No.6, pp: 541554

[5] Yinghong LI and Qiyuan PENG (2007),'Queuing model of railway section carrying capacity', International Conference on Transportation Engineering, pp: 1070-1075.

[6] Lu Liu et al. (2015), 'study of the effect of Queuing at Curbside Bus-stop on Road link Capacity', International Conference of Transportation Professionals, pp: 1451-1459

[7] Jianguo LI and Cong LI (2011),"Simulation and Analysis of time-consumption of Emergency Supplies Loading Services based on Queue Theory" , 3rd International Conference on Transportation Information and Safety, pp: 135-142.

[8] Atul Aradhye and Shrikant Kallurkar (2014), “Application of Queuing Theory to Reduce Waiting Period of Pilgrim”, International Journal of Innovative Research in Science Engineering and Technology, vol.18, no.1 pp: 16775-16781

[9] B.J. Kim (2011), ‘Conceptualization of traffic Flow for designing toll plaza configuration: a case study using simulation with Estimated traffic volume’, International Journal of industrial Engineering, vol.18, no.1, pp: 51-57

[10] Nico Vandaele et al. (2000), ‘A queuing-based traffic flow model’, Journal of Transportation Research and Environment, vol.5, no.2, pp:121-135.

[11] Satish agnihotri (2016), ‘Application of Queuing Theory in Traffic Management System’, Anveshana international journal of Research in Regional studies, law, social sciences, journalism and management practices, vol.1,no.9, pp: 68-77

[12] Dheeraj Duhan, Nishant arya et al. (2014), ‘Application of queuing Theory to address Traffic problems at highway Toll plaza’, Journal of Applied Mechanism and Materials, vol.529, no.594, pp:2583-2587.

[13]Clarkson Uka chikezie (2011), ‘Analysis of Queuing at a Nigerian Toll plaza’, World journal of Engineering and pure and Applied Science, vol.1,no.3, pp: 51-59

[14] Yi-Jian Liu et al . (2017), ‘Optimization of Design Scheme for Toll plaza based on M/M/C Queuing Theory and Cellular Automata Simulation Algorithm’, Journal of Modern and Applied Science, vol.11, no.7, pp:1-12

[15] Mala and S.P. Varma (2016), ‘Minimization of traffic congestion by using Queuing Theory’, IOSR Journal of Mathematics, vol.11, no.1, pp: 116-122.

[16] YAN Qiu and ZHU Wengtong (2013), “application of queuing theory in highway toll station design”, international journal of information and communication technologies in education, pp: 607-612.

[17] WU Zhizhou and ZHANG Jianqiao (2011), “optimal design of container terminal’s gate system based on m/g/k queuing model” international journal of information and communication technologies in education, pp: 2671-2676

[18] JIAO Peng-Peng, WANG Hong-lin (2015), ‘Bus Scheduling Optimization Based on Queuing Theory’, journal of highway and transportation Research and Development, Vol.9,No.2, PP: 23-29