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Application of Queuing Theory to Reduce Waiting Period of Pilgrim

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ABSTRACT: Waiting period is a global problem that almost everyone has to face, which causes a great waste of time for everyone. It is well known that all these waiting line problems critically restrict the further development. Queuing theory is a mathematical approach to the study of waiting period in queues. Pilgrims wait for a long period to have 'Darshan' of Lord Vitthal. This paper presents the results of application of queuing theory that evaluates the effectiveness of implementation multi-server queuing model instead of single server model for 'Darshan' at Pandharpur, a large periodical pilgrimage center. Simulation shows that by implementation of multi-server queuing model number of pilgrims served get manifold. The waiting period reduces tremendously by using this proposed system.

KEYWORDS: Queuing theory, Waiting period, Simulation.

I. INTRODUCTION

Waiting period is a global problem that almost everyone has to face, which causes a great waste of time for everyone. It is well known that all these waiting line problems critically restrict the further development. Therefore, there is clearly a vital need for effective measures and policies to fight all these issues caused by the unsustainable waiting. The main problem of this study is to optimize the waiting period of pilgrims and their time in the system. Our aim is to make sure that the Shri Vitthal Rukmini Mandir Samity could handle pilgrims flow without any problems. The objective is to find out the number and different types of queues in terms of single or multiple server models. The number of queues has to be determined in order to minimize pilgrim's waiting period.

This problem is similar to the single-server and multi-server production problem. Here pilgrim will be treated as job and deity as a machine, who will serve. An operation on job and taking darshan by pilgrim will be treated as service in respective cases. Edie had done work in toll design, who considers traffic delays at tollbooths of homogenous booths and homogenous vehicles. [2]Different types of queues make the problems considerably harder to analyse. Erlander and Belenky had used few industrial engineering tools to study, design and optimization of transportation problems.[8,9] Typically Hall used queuing theory methods in analyzing toll booth problems.[9] In order to verify the proposed model and algorithm, Lin Cheng and Fei Han used the Nguyen-Dupuis network for the numerical example, and the results showed that the model were effective and efficient.[1] Fernandes & Bampi, Lucjan & Jozef reported that simulation-based approach can be applied to various areas related to transportation systems and its feasibilities have been reported by Abbas-Turki, Grunder & Elmoudni, Krajzewicz, Hertkorn & Wagner, Gale, Oliveron & Silvan. [3, 4, 5, 6, 7] At pandharpur, every pilgrim will choose how to take darshan depending on their nature and capability and the queue length outside the temple. They can take darshan by touching the feet of lord Vitthal or they can take darshan just by seeing the Lord Vitthal from long distance. Lastly many pilgrims those cannot take darshan by either of these, take darshan of temple. Since a wide variety of queuing configurations under different conditions has to be analyzed, demands a flexible method.

II. MATERIALS AND METHODS

This was a cross sectional study carried out at the Shri Vitthal Rukmini temple at Pandharpur. Questionnaires were prepared to pilgrims who came for darshan during the pilgrimage period. The data collection was mostly through interviews, as most of the pilgrims could not read the questionaries. The questionnaire sought the pilgrims information like, age and gender, time spent before reaching Pandharpur and in the queue to take darshan. The perceptions of

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pilgrim about the queuing and pilgrims' behaviour in the queue were sought. Few pilgrims also offered suggestions on how to shorten the waiting period in the queue.

The infrastructure of Shri Vitthal Rukmini Temple was studied. The queuing method and discipline within the queue, as well as the behaviour of the queuing population was observed. Data was obtained in the pilgrimage period for 3 months as well as expert advice. Data obtained from the study and expert advice was analysed using matlab software.

III. ASSUMPTIONS

We have categorized pilgrims at Pandharpur into four types: young men, young women, old men and old women. There are no separate queues for either of these. We also consider that the pilgrims are following M/M/1/∞/FCFS queuing system for darshan i.e.
(1) The arrivals to the temple are taking place according to Poisson Process.
(2) The service times are distributed exponentially.
(3) Only one server (i.e. Lord Vitthal) is present.
(4) The pilgrims are served on First Come First Serve basis.
(5) There is no limit of the pilgrims.

IV. PROBLEM FORMATION

Out of many pilgrimage centres, in India, we selected Pandharpur in Maharashtra. We collected the data of pilgrims, who take either mukh darshan or direct darshan by touching the feet of Lord Vitthal. In this paper, we focused on the pilgrims, who are in the queue of mukh Darshan.

For the darshan by touching the feet of Lord Vitthal, there we cannot increase the number of servers, as there is only one main Deity i.e. Lord Vitthal. But mukh darshan is taken from long distance. So number of pilgrims can see the deity at the same instant. It means number of pilgrims can take the darshan at same time. This mukh darshan can be treated as multi server model. If we can apply the multi server queue model for much darshan, waiting period of pilgrim can be reduced.

V. OPTIMIZATION OF WAITING PERIOD OF PILGRIM

The pilgrims for mukh darshan are categorized like old men (A), young men (B), old women (C) and young women (D). The data collected is of one day in the pilgrimage period. After that, we find the simulation of all the data using a simple program using Matlab.

1. Present System

Presently all pilgrims are forming only one queue. This queue may contain young & old men as well as women. The advantage of this system is that it provides more operational elasticity and increases the efficiency of the queues. This system is like a single server queue. However, the disadvantage is that the wide range of service times in the queue causes variability. As variability in the service times is one of the major causes for long queues, this inconvenience can decrease the efficiency. A more detailed quantitative study taking into account the actual numbers is therefore required.

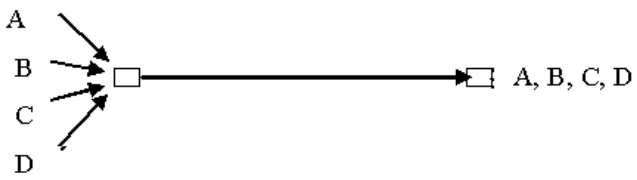

Fig.1 Present System 1: One line

2. Proposed Systems

Separate the queue according to the categories of pilgrims will be the first option. The drawback of a separate queue system is that certain system can be underutilized while others may be overloaded. It can decrease the efficiency in operation. The behaviour of separate lane queuing system can be studied by analytical queuing systems. This option

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cannot be adopted for direct darshan as here only one server is present and similarly it cannot be applied for the mukh darshan as it will be very tedious job to handle number of queues within the temple.

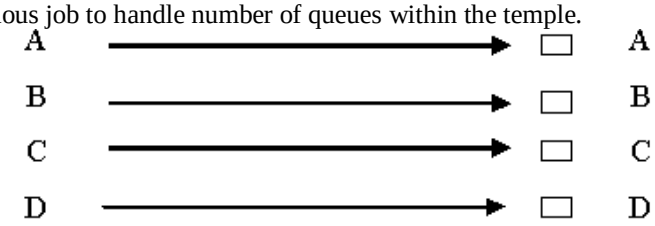

Fig. 2 Proposed System 1: Separate Line

Another option all types of pilgrims would be allowed in one queue. The queues will be separated exactly at the start of service, means darshan. Each queue may contain young & old men as well as women. The advantage of this case is that it provides more operational elasticity and increases the efficiency and utilization of the queues. However, the same disadvantage is the wide range of service times.

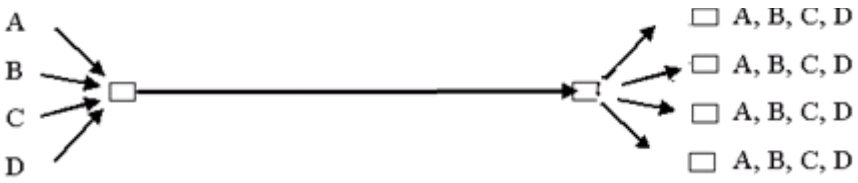

Fig. 3 Proposed System 2: One Line with separation

In fact, by combining the insights of all above, a third option might even be more attractive by using specialized queues to keep the variability per queue to a minimum and by also allowing 'overflow' when one or more locations are underutilized for the moment.

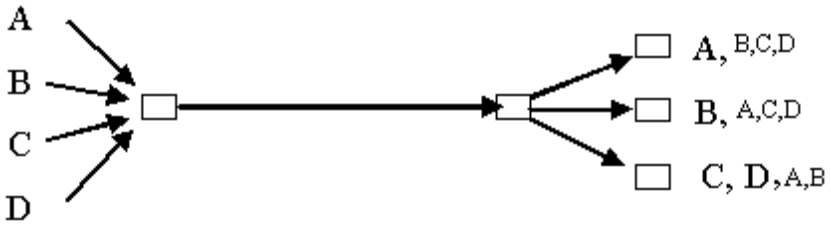

Fig. 4 Proposed System 3: Specialization and Overflow

Accordingly, the aim is to find a combination of separate and mixed systems at each darshan to reduce the variance in service times at the same time, balanced queue lengths at each location. Furthermore, pilgrims should not be confused and clear directions are required.

Analytical queuing methods, unfortunately, are not sufficiently capable to predict queuing systems with specialization and in combination with "overflow". At this point, to evaluate and optimize the waiting period, simulation becomes a necessary tool.

VI. DETERMINING THE NUMBER OF SERVERS

This study is carried out at Shri Vitthal Rukmini Temple at Pandharpur. Due to the restrictions of place, the proposed system 2 cannot be implemented. Comparison will be made between the present system and the simulation of the proposed third system.

1. Description of the system

To provide valid input data is a vital part of the simulation study for the simulation model, such as forecasting number of pilgrims visiting per hour and respective service times. The data used in the simulation model are based on a case

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study. Input data and the performance of the queuing system are directly related so it is important that the assumptions and input data are correct.

2. Pilgrim configuration

Pilgrims coming to Pandharpur can be categorized into main two types i.e. gents and ladies and it further subdivided into young and old. We have to give equal preference for the darshan to all these categories. It is also to find out darshan time for all these categories.

3. Arrival Pattern

Pandharpur is a pilgrimage center. Daily average 25 thousand pilgrims take darshan. While at weekends or on holidays, this number goes to around 50 thousands. There are four Periodical pilgrimages at pandharpur, where the numbers of pilgrims visiting are more than 5 lacks. The pilgrim forecasts are based on working days, weekends, and pilgrimage period. In periodical period the number of pilgrims visited is in lacks. In the remaining period, for nonworking days, the number of pilgrims is more than the visitors in the working days. In this study, the arrival data is gathered by a case study for a day in the pilgrimage period.

4. Service times

In this study, darshan is treated as service. The pilgrim will move in front of Deity and takes darshan. There is no service provided by Deity, but the performance of pilgrim in front of deity is treated as service. So it depends on each pilgrim.

5. Waiting times

Clearly, waiting time is the most important indicator. Not only the average waiting time, but more importantly the distribution of waiting time is of interest. In particular, few percentages of pilgrims prefer to wait for a certain long period of time. But on the other hand many pilgrims did not join the queue, if the predicted waiting time is more. The average waiting time for darshan is 30 minutes, which is acceptable. However, analysis of the waiting times for darshan in pilgrimage period shows that many pilgrims have to wait longer than 3 hours, which is unacceptable. The average waiting time does not show the long waiting times, but that is compensated by shorter waiting time.

6. Queue lengths

As another pointer of operational significance, queue lengths have to be monitored. Queue lengths depend on service times, waiting times, number of servers, and arrival patterns of pilgrims. The queue heading towards the mukh darshan should be capable enough to accommodate long queue. This is where the difference between pilgrim categories becomes important. In the simulation model, incoming pilgrim would select the server on first come first serve basis. The decision whether to join the queue or not is mainly depend upon the waiting period and waiting period is mostly predicted by the length of queue.

VII. RESULT AND DISCUSSION

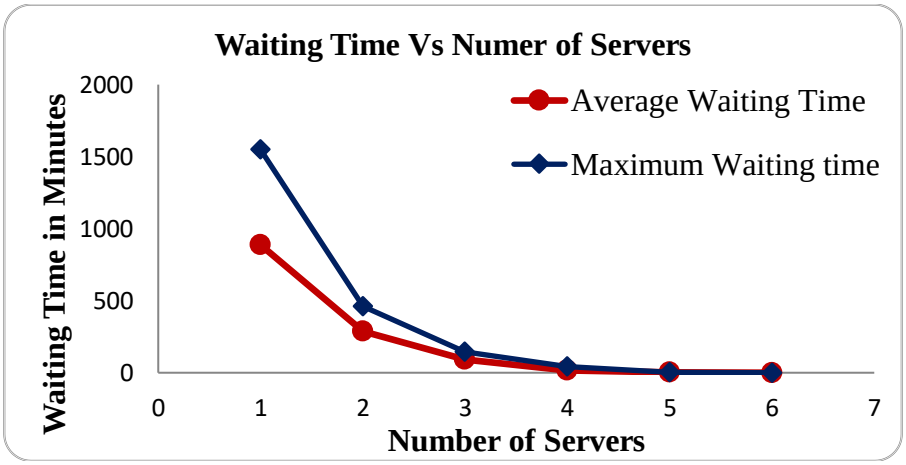

Fig. 5 Simulation Result of Waiting Time Vs Number of Servers

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A simulation of queuing approach is the combination of the conceptual framework from queuing theory with the modelling of difficult real life situations by simulation. Queuing theory can limit the number of variables to be examined, while simulation technique compares and evaluates the different variables. From the fig. 5 it is clear that the maximum waiting period of the pilgrims with the forecasted arrival is 1549 minutes and the average waiting period is 887 minutes. It also indicates that as the number of server increases, the waiting period decreases. Here we have considered the number of servers up to 6 only as the number increased more than 6, there is no remarkable decrease in the waiting period.

Table 1

Pilgrim Type	Arrivals (number/100)	Service Time (Sec)
A (Old Men)	50	2.5
B (Young Men)	10	3
C (Old Female)	30	5.5
D (Young Female)	10	2.5

The data was collected in the three pilgrimage period. The pilgrims were segregated as per their gender and age as men & women as well as young & old. A review of the three proposed options, discussed before, four types of Pilgrims, labelled A, B, C and D, as in Table 1, illustrates the combined approach. Based on the queuing theory, the third and fourth options have to be compared with the present system. However, due to the mixed services under option 3 and even more the overflow under option 4, simulation is necessary to evaluate the performance.

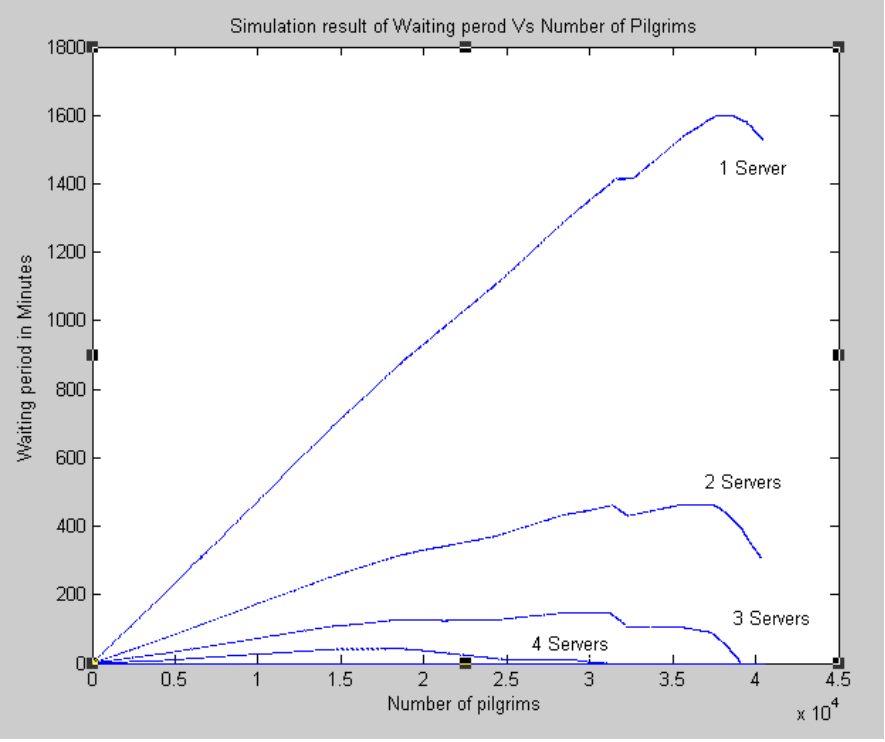

Fig. 6 Simulation of Individual Waiting Time of each Pilgrims Vs Number of Servers by Metlab

The results from simulation, as presented in fig 5, reveal the importance of this combined approach. From this figure, it is clear that when there is only one server (present system); the maximum number of pilgrims who can take darshan is maximum 18,000. The predicted number of pilgrims is around 44,000 in the pilgrimage period. The simulation shows that considering the predicted data, the average waiting period is 887 minutes and maximum waiting period is 1549 minutes, which is impossible. It shows that it was impossible to serve the number of pilgrims as on the day of case study. It is necessary to increase the number of servers. From fig 5, it is clear that, the optimum number of servers should be four. The simulation shows for 4 servers, average waiting period is 16 minutes and maximum waiting period

is 41 minutes. As number of servers is increased more than four, there is no considerable decrease in the waiting period of the pilgrims. But due to constraints, it is proposed to have the place so that at least three pilgrims should be able to take darshan simultaneously. This system will be just like multi-server system.

This case study illustrates the importance of the combined approach of queuing theory and simulation. Without queuing theory, the proposed third option as well as many more optional overflow variables would not have been considered. Without simulation, the systems could not have been evaluated properly.

VIII. CONCLUSION

In this paper, we optimize the length of queue as well as waiting period of the pilgrims at Shri Vitthal Rukmini Mandir, Pandharpur. After changing the queuing model from single server to multi-server model, it is found, from the simulation, that waiting period is reduced tremendously. At the same time, it is also found that number of pilgrims that can be served also increased by manifolds.

REFERENCES

[1] Lin Cheng and Fei Han, "Optimal Road Toll Design from the Perspective of Sustainable Development", Discrete Dynamics in Nature and Society, Vol.2014, pp.1-7, 2014.
[2] Edie, A. C. "Traffic delays at toll booths", Journal of Operations Research Society of America, vol. 2, pp.107-138., 1954.
[3] Fernandes, R.J. and S. Bampi. . "A software environment to integrate urban traffic simulation tasks", Proceedings of the 10th European Simulation Symposium, Nottingham, United Kingdom, pp.371-377, 1998.
[4] Lucjan, G. and O. Jozef. "Modeling of public transport commuters flow at urban interchange centers", Proceedings of the 11th European Simulation Symposium, Erlangen, Germany, pp.217-219, 1999.
[5] Abbas-Turki, A., O. Grunder and A. Elmoudni "Simulation and optimization of the public transportation connection system", In Proceedings of the 13th European Simulation Symposium, Marseille, France, pp.435-439, 2001.
[6] Krajzewicz, D., G. Hertkorn and P. Wagner. "An example of microscopic car models validation using the open source traffic simulation SUMO", Proceedings of the 14th European Simulation Symposium, Dresden, Germany, pp.318-322, 2002.
[7] Gale, C. and M.J.Oliveron and G.Silvan, "Simulation tool for managing a non-automated distribution warehouse", 14th European Simulation Symposium, Dresden, Germany, pp.266-270, 2002.
[8] Belenky, A.S. "Operations Research in Transportation Systems - Ideas and Schemes of Optimization Methods", Kluwer Academic Publisher, 1988.
[9] Erlander, S. "Optimal Spatial Interaction and the Gravity Model", Springer - Verlag, 1991.
[10] Hall, R. "Queueing Methods for Service and Manufacturing", Prentice-Hall, New Jersey, 1991.