Current Journal of Library and Information Sciences
Volume.7, Number 3; July-September, 2022;
ISSN: 2836-9300 | Impact Factor: 6.61
https://zapjournals.com/Journals/index.php/cjlis
Published By: Zendo Academic Publishing

OPTIMIZING QUEUE STRATEGIES FOR BOSSANOVA CHAIN RESTAURANT: A COMPREHENSIVE STUDY

Wei-Han Wu[1]

Article Info

Keywords: Queuing Models, Service Systems, Optimization, Waiting Cost, Revenue Maximization

Abstract

Queuing is a prevalent and vexing issue in various service systems, such as banks, restaurants, and supermarkets, where customers often endure prolonged wait times, resulting in discomfort and the potential loss of impatient patrons. Increasing service capacity might seem like a straightforward solution, but it invariably leads to escalated fixed and variable costs, making the optimization of this trade-off between revenue loss and cost a complex challenge for businesses. This study explores existing queuing models and proposes innovative approaches for addressing these critical issues.

Introduction

Queuing is a common phenomenon prevalent in service systems, such as banks, restaurant and supermarket. Customers usually spent a lot time waiting in lines, which bring them uncomfortable experience. Alternatively, the impatient customers could leave, causing revenue loss. One solution by intuition is that the business shall increase the service capacity to reduce the probability of queueing. However, expansion of service capacity will apparently increase the fixed costs, and thereby variable cost. How to optimize a system between revenue loss and the cost to maximize the benefit is a big issue for business.

Several researches regarding queuing models of service systems have been studied (Lambert et al. 1987; Liao 2007; Dharmawirya et al. 2012; Muslu et al. 2014; Ullah et al. 2014; Xin et al. 2014). Liao (2007) has issue a formula, which functions waiting cost to be balking loss. With this formula, decision makers have the capability of determining the optimal pricing strategy by minimizing total cost including service cost and waiting cost. Muslu et al. (2014) have proposed a simulation model for restaurant to estimate the waiting cost coming up because of queuing. Xin et al. (2014) have proposed a simulation model $M/M/c$ for restaurant management, which has the holdings of yield management. The study has used the price discrimination and the seat allocation to maximize the expectation of the restaurant's profit. The manager can decide to make the seat allocation dynamically according to the optimal value.

[1] Department of Information Management, National Pingtung University, Taiwan

Previous studies usually applied deterministic models, in which single estimate is used to represent the value of each variable. Tyagi et al. (2014) have proposed a stochastic model to study the quality of service in restaurant. The study has estimated the probability distributions of the outputs, allowing for random variation in one or more inputs over time. The measurement of overall performance service, such as utilization rate, waiting time queue length and the probability of potential customers to balk have been analyzed by using *Little*'s formula.

Ghaleb et al. (2015) have issued a simulation model for KSU Main Student Restaurant by using Arena simulation toolkit. Performance measures, such as the average waiting time in system and the average number of customers in queues, are evaluated in this study. Several alternatives are ranked based on preference weighting of customer and dish order. This study has proved to reduce the average waiting time and has get better service quality in restaurant.

Recently, several mobile ticket (MT) APPs (Saxena et al. 2014; Liu et al. 2016) have been developed to allow a customer to draw a ticket of service number before he/she arrives at service desk.

The study has also proposed an analytical model that derives the probability an MT customer misses his/her turn when he/she arrives. With MT APP, the waiting time for service has been proved to reduce significantly. Solmaz et al. (2012) have presented a model of the movement of visitors in a theme park in order to realize the queuing of the attractions. The behavior of visitors walking toward the attractions in the theme park can be considered as deterministic. The proposed model has been validated by comparing the data generated by a simulation model to a real-world GPS traces of visitor movement.

In this paper, we first study the probability of would-be customers to leave using stochastic model by applying *M*/*M*/*c*/*K* parallel-server, and determine model. We give some reasons why stochastic model is not suitable in our case and deterministic model, finally, is chosen. We make some experimental simulation to estimating probability in which ranges of values for each variable, such as the restaurant capacity, the queue length and the waiting room capacity are used. The experimental result has shown that the proposed system is beneficial to reduce the probability of would-be customers to leave by controlling the queue length within some range. The rest of this paper is organized as follows. Section 2 describes the proposed model. Experiment and evaluation are discussed at section 3. Finally, we conclude this paper.

2. The proposed scheme

Let □ be the number of customer arrival per minute and □□be the rate of catering service to be completed per minute; thus, 1/□□is the constant catering service time.

Let be the utilization ratio and $_0$ be the idle ratio, we have 1

Since is a probability distribution, we utilize the boundary condition that (1)

We first consider a parallel-server model, *M*/*M*/*c*/*K* model (Little & Graves, 2008), in which a limit is placed on the number allowed in the system. We know where However, the units of arrive at known points in time and service times are fixed constants in this study of Bossanova Chain Restaurant. Therefore, we choose deterministic queuing as our model and there are no probability distributions associated with this study. Since is the geometrics series and < 1, the sum of the terms of geometric progression is therefore (2)

From equation (1), by timing () for both sides of equation, we have

(1) = 1 (3)

From equation (1) and (3), we have

(1) (4)

The steady-state solution is (5)

We have the following assumptions.

- The restaurant capacity is set to be *c*.
- The would-be customers balk and leave when the queue length grows to a certain size *q*. We may consider the value *q* to be the tolerated threshold for the customers to stay or leave. The certain size *q* can be viewed as a finite system-capacity constraint, limiting the amount of waiting room.
- The number of customers in waiting room is limited, set to be *m*. From equation (5), the possibilities of would-be customers to leave are described as follows.

Experiments and evaluation

In this section, we use MatLab R2015a to create and experiment the proposed model. The data in the simulation regarding the number of arrival customers is offered by Bossanova chain restaurant. Fig. 1 has shown the possibilities of would-be customers to leave with growing size of restaurant capacity. We fix the value of *q*=10, *m*=40 and vary the value of *c* (60, 70, 80, 90, 100). We have found that a large *c* value will decrease possibility of would-be customers to leave. Fig. 1 with fixed value *q*=10, *m*=40 Fig. 2 represents the possibilities of would-be customers to leave with increasing waiting room capacity. We take *c* and *q* as a constant (100 and 10, respectively) while varying the value of *m* (15, 20, 25, 30, 35, 40). We can see that the difference between these results is insignificant. We may conclude that waiting room capacity is not the critical factor to force customers balking. Fig. 2 with fixed value *c*=100, *q*=10

Fig. 3 illustrates the possibilities of would-be customers to leave on seeing the increasing queue length needed to be tolerated. We set up *c* and *m* as a constant (100 and 40, individually) and change the value of *q* (10, 15, 20, 25, 30, 35). We have found that the growing tolerated threshold *q* will lower the possibilities of would-be customers to leave. Fig. 3 with fixed value *c*=100, *m*=40

Conclusions

The performance of the proposed model is highly dependent on the arrival rate of customers. The experiment has been carried out to validate the proposed model. It is desirable for manager to balance the restaurant capacity and the queue length to maximize the profit. By using the proposed model, the manager can evaluate the impact of various actions they have adopted. Recently, the evolution of smartphone has raised the popularity and usage of mobile APPs. In the future, we plan to develop a booking APP, which allows customers to reserve the required restaurant space through their smartphone in advance. In this way, the customers can shorten the waiting time in lines.

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