Chapter 30
Performance Analysis of a Markovian Queuing System with Reneging and Retention of Reneged Customers

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ABSTRACT

In this chapter a finite capacity single server Markovian queuing system with reneging and retention of reneged customers is considered. It is envisaged that a reneging customer may be convinced to stay for his service if some customer retention mechanism is employed. Thus, there is a probability that a reneging customer may be retained. Steady-state balance equations of the model are derived using Markov chain theory. The steady-state probabilities of system size are obtained explicitly by using iterative method. The performance measures like expected system size, expected rate of reneging, and expected rate of retention are obtained. The effect of probability of retaining a reneging customer on the performance measures is studied. The economic analysis of the model is performed by developing a cost model. The optimum service rate and optimum system capacity are obtained using classical optimization and pattern search techniques. The optimization carried out helps to identify the optimum customer retention strategy from among many.

INTRODUCTION

In the current scenario of population explosion and globalization of international commerce and trade, the queuing problems have gained a lot of significance in the decision making process. Queuing theory has revolutionized the industry and logistics sector apart from its immense applications in many other areas like city traffic, air traffic, bio-sciences, population studies, health sector etc. Queuing with customer impatience has special significance for the business community as it has a very negative effect on the revenue generation of a firm.

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A customer is said to be impatient if he tends to join the queue only when a short wait is expected and tends to remain in the line if his wait has been sufficiently small. Impatience generally takes three forms. The first is balking, deciding not to join the queue at all up on arrival; the second is reneging, the reluctance to remain in the waiting line after joining and waiting, and the third is jockeying between lines when each of a number of parallel service channels has its own queue, Gross and Harris (1985). A very nice review on queuing systems with impatient customers has been presented by Wang et al. (2010). They have surveyed various queuing systems according to various dimensions like customer impatience behaviors, solution methods of queuing models with impatient customers, and associated optimization aspects.

Queuing systems with customer impatience find their applications in a variety of areas. For instance, in supply chains of perishable items, the perishable items like vegetables, fruits etc. in the congestion situations become worthless if they are not supplied to the retailers (customers) at proper time as they may get spoiled i.e. the perishable items can be modelled by the reneged customers in the queuing modelling. In call centres usually a calling customer hangs up before service agent and thus gets reneged. In packet switched communication networks with time critical traffic, a packet loses its value if it is not transmitted within a given time interval. The patients (customers) who leave the emergency rooms in hospitals without being seen are also considered as reneged customers. Kidney transplant waiting system can be considered as a queue with reneging; where reneging occurs because a customer that is waiting for a kidney may die.

Customer impatience is harmful to any business. It leads to loss of potential customers. Keeping in mind the negative impact of customer impatience on business of any firm, the concept of retention of reneged customers is introduced in this chapter. It is envisaged that a reneging customer may be convinced to stay in the queue for his service by employing a certain customer retention strategy. Thus, a reneging customer may be retained in the queue for his service with probability q (say) and may not be retained with probability p=(1–q), that is, he may not be convinced and finally abandons the queue. In this chapter a finite capacity single server Markovian queuing system with reneging and retention of reneged customers is considered. The steady-state solution of the model is derived iteratively. The cost-model is made and the optimization of the model is also performed.

BACKGROUND

The notion of customer impatience appeared in queuing theory in the work of Haight (1957). He considered a model of balking for M/M/1 queue in which there was a greatest queue length at which an arrival would not balk. This length was a random variable whose distribution was same for all customers. Haight (1959) studied a queue with reneging. Ancker and Gafarian (1963a) studied M/M/1/N queuing system with balking and reneging, and derived its steady state solution. Ancker and Gafarian (1963b) obtained results for a pure balking system (no reneging) by setting the reneging parameter equal to zero. Gavish and Schweitzer (1977) considered a deterministic reneging model with the additional assumption that arrivals can be labeled by their service requirements before joining the queue, and they are admitted only if their waiting time in the system does not exceed some fixed amount. Robert (1979) discussed in detail the reneging phenomenon of single channel queues. Baccelli et al. (1984) considered customer impatience in which a customer gives up whenever his patience or waiting time is larger than a random threshold.