Abstract

In this thesis, a humble attempt has been made to contribute to two fields of queuing literature viz reneging and balking.

Queues are painful but inevitable. In general, a queue is a line of people or things waiting to be handled, sometimes in sequential order starting at the beginning or top of the line or sequence. More generally, a queue is a sequence of work objects that are waiting to be processed. In the literature of queuing theory, it is often assumed that once a customer joins the queue, it stays on in the system until it completes its service. However, in real life, this is not exactly true. In our day-to-day life, customers are hard-pressed for time. Customers, who join a queue, have a patience time beyond which they are not willing to wait. If service does not begin within this patience time, he leaves the system. For example, when internet browser requests a particular website, it takes a little time for the server hosting the website to be accessed by the browser. During this time, the browser may get impatient and disconnect. The phenomenon in which customer leaves the system without receiving service or leaves the system before completion of service is known as reneging.

Reneging considered in literature is mostly of two types-deterministic and Markovian. In deterministic reneging, each customer is assumed to have a fixed patience time. If service is not completed within this timeframe, the customer reneges. In contrast, in Markovian reneging each customer has a random patience time following Poisson law.
Depending upon when the customers could possibly renege, reneging customers can be classified into two types viz reneging till beginning of service (henceforth referred to as R_BOS) and reneging till end of service (henceforth referred to as R_EOS). R_BOS can be observed in queuing system where customer can renege only as long as it is in the queue. Once it begins receiving service, it cannot renege. In case the reneging distribution is R_BOS, the customer will renege i.e. leave the system in case service does not begin before expiry of his patience time whereas under R_EOS, the customer would renege in case service is not over before the expiry of the patience time. Thus in case of R_EOS, the customer may depart either from the queue or from the service station with partial and incomplete service. A common example of first type is the barbershop. A customer can renege while he is waiting in queue. However once service commences i.e. hair cut begins, the customer cannot leave until hair cut is over. Hospital emergency room/O.T. handling critical patients is a common example of second type. Such a patient may expire while receiving service i.e. while receiving treatment. This thesis analyzes R_BOS and R_EOS separately.

Additionally, depending on the nature of the reneging rate, reneging can be divided into two parts- position independent reneging (henceforth referred to as PIR) and position dependent reneging (henceforth referred to as PDR). Reneging phenomenon where reneging rates remain constant irrespective of the position of the customer in the system is called position independent reneging (PIR). In contrast, if reneging rate which is a function of the position in which the customer finds itself in
it is called position dependent reneging (PDR). Under PIR, the reneging rate of the customer would not change as it progresses in the system. On the other hand under PDR, the reneging rate would change with change in the position of the customer in the system. In this thesis, we analyze different types of queuing model with these two types of reneging rate. Position dependent reneging is an important focus of this thesis because not much work appears to be available in literature with PDR.

In queuing parlance, the phenomena of customers arriving for service to a non-empty queue and leaving without joining the system is known as balking. Balking is not possible from an empty queue. When a new arrival thinks that his or her anticipated delay is too long, the arrival can balk without joining the system. Balking phenomena is commonly observed in our day to day life. Similar to reneging, depending on the balking nature of customer, balking can be divided into two types: state independent balking (henceforth referred to as SIB) and state dependent balking (henceforth referred to as SDB). In state independent balking (SIB), the balking rate does not depend on the state of the system. It remains fixed in all the states of the system. On the other hand, in state dependent balking (SDB), balking rate of the customer depends on the state of the system. In other words, in this type of balking we can say that higher the queue size higher is the probability that the customer will balk, balking probabilities being a function of system state. In this thesis, different queuing models have also been analyzed considering these two types of balking.
In queuing literature, most of the queuing models are analyzed considering reneging of R_BOS type. Reneging of type, R_BOS finds little mention. Further, explicit closed form expressions of different performance measures are not always available for specific queuing models. Additionally there has been very little work where reneging and balking has been simultaneously considered. The objective of this thesis is to derive closed form expressions of different performance measures for various queuing models under the assumption that customers can balk as well as reneg. Even though there has been some work using the concepts of reneging and balking in queuing theory, however, there are various queuing models where closed form expressions under these concepts are not available. The work in this thesis will make an effort to address these gaps in literature. These are the only concepts through which customers are lost to queuing system. It may be mentioned here that loss of a customer means ‘business loss’ which is something avoided by any system manager in our modern competitive world. In view of its importance, fresh measures from the point of view of different stakeholders of a queuing system are designed.

There are nine (9) chapters in this thesis. The first chapter contains the introduction. Literature Review is given in chapter 2. In other chapters of the thesis, some well known queuing models have been presented and their related performance measures are also discussed with the complexity of reneging and balking added to the models. Different queuing models considering position independent reneging with state independent and state dependent balking are analyzed in chapter 3, chapter 4, chapter 5 and chapter 6. In chapter 3, a multiserver Markovian queuing model
(M/M/k) is analyzed with position independent reneging considering two types of balking. In chapter 4, M/M/c/c model where balking is not possible, is discussed with position independent reneging of type R_EOS. A finite buffer multiserver Markovian queuing model (M/M/c/k, c<k) is discussed again with position independent reneging and two types of balking in chapter 5. In this chapter, we also discuss the M/M/1/k model as a special case to M/M/c/k model. In chapter 6, we discuss an Erlangian service time model (M/E_{c}/1/1) where system capacity is restricted to one customer only with the assumption that customers are of reneging type (R_EOS). Chapter 7 and chapter 8 of the thesis deal with position dependent reneging. In chapter 7, we discuss the M/M/k model with position dependent reneging and state independent and state dependent balking. M/M/1 model with position dependent reneging and two types of balking is also discussed in this chapter as a special case. In chapter 8, we present the analysis of a finite buffer single server Markovian queuing model (M/M/1/k) considering position dependent reneging with two types of reneging rules. State independent and state dependent balking are also included in the analysis of this chapter. In chapter 3-8, we present closed form expressions of different performance measures like mean system size, mean queue size, mean reneging rate, proportion of customers lost etc. together with sensitivity analysis. A numerical example has been discussed for each model to demonstrate the usefulness of results derived. Chapter 9 is the concluding chapter of this thesis.

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