A REVIEW ON BULK QUEUE WITH SERVER BREAKDOWN MODELS

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Abstract

This review article presents an overview of bulk arrival and bulk service with breakdown QM's. The concept of bulk arrivals and bulk service has a new significance in the world of reality. To prevent the problem of traffic congestion, researchers must concentrate their efforts on developing models and processes to address the issue. Numerical methods of QM's are critical in many industries, notably in production lines, to alleviate traffic congestion. This study seeks to give analysts, researchers, and industry professionals enough information to model congestion problems and extract various performance indicators to improve the QS's.

Keywords: Bulk arrival, Bulk service, Vacations, Breakdown.

1. Background and preliminaries

In order to improve the total service of the customers, queueing theory has been widely used as an operations management strategy to assess and simplify workforce needs, scheduling, and inventory. A.k.Erlang, a Danish mathematician, statistician, and architect, is credited with inventing not only queuing theory, but also the field of telephone traffic engineering as a whole.

Chaudhry and Templeton [73] provided a thorough examination of bulk queuing. A great place to start with customised modelling is with bulk arrivals analysis, which is a simplified version of our normal named customer analysis. To simulate a hospital outpatient department with a weekly clinic, a fixed-capacity transportation link, and an elevator, batch arrivals were used to represent bulk supplies and batch services. Under some conditions, networks of such queues are known to exhibit a product form of fixed distribution. Users enter in groups, and each group is served continuously in batch-arrival batch-service QM. In networking and telephony devices, such as multiple processors computer networks, where each programme requires the loading of memory units from a primary memory store, such queueing strategies begin to provide an example for performance measurement. A circuit-switched telecoms system that accommodates a number of traffic types, such as voice, video, and data, all of which have varying broadband requirements and holding durations.

Bailey [74] gets credit for developing bulk service QM's. He created the method, which he called "fixed-batch service." The server always serves a particular lot of customers in each group in fixed-batch service QS's. Kendall pioneered the embedded Markov-chain approach. This is accomplished through the use of regeneration points. Using Kendall's terminology for single

queueing nodes, $MX/MY/1$ indicates a $M/M/1$ queue with entries in groups defined by the random variable X and services in bulk given by the random variable Y. $GI^X/G^Y/1$ is extended in the same way as the $GI/G/1$ queue.

The following is a summary of the paper: The models of bulk arrival queues with breakdown are discussed in Section 2. The objective of Section 3 is on bulk service queues with breakdown. Finally, Section 4 presents the conclusion and summary.

2. Bulk arrival queues with server breakdown

A. M. Sultan et al. [34] explored a multi server, bulk arrival $(M^{[x]}/M/C; C-1/FCFS)$ QM using an extended Monte Carlo simulation. Because of the system breakage, the system can only serve with C or (C-1) servers. Average queue size, Average waiting time, and blocking probability were all established as measures of system efficiency. Simulation of the complete system yields numerical results. The performance evaluation of the finite buffer bulk and bunch service $GeoX/GY/1/K+B$ queue with several vacations, which could be employed in large wireless connections as well as other systems analysed by Seok Ho Chang and Dae Won Choi[35]. The Steady State(SS) probabilities and periods of the quantity of items in the system were provided at three different eras: departure, random, and arrival. Various helpful performance measurements were also been offered, such as the loss probability, the mean delay in the packet queue. The operation of a $M[x]/G/1$ QS under vacation criteria with startup/closedown timings was examined by Jau-Chuan Ke [36]. When all of the clients in the system have been processed, the server stops working at the closedown time. The server uses one of two vacation policies after shutdown: (1) multi vacation policies or (2) SV policies. In particular, the system features for the vacation models were examined. In a SS situation, Ahmed M.M Sultan [37] developed a workable solution for batch arrival queuing difficulties caused by the breakage of one of the heterogeneous servers. Due to the limitless number of possible variations in bulk queues and the breakage of one of the servers, massive tables with exact results were generated with different queueing variables. An $M^{[x]}/G/1$ QM's with an unreliable server and a SV policy was presented by M. Haridass and R. Arumuganathan [38].

While the server was running, it was susceptible to breakage, and the arrival time was determined by the server's up and down states. The time taken for anything to fail is exponentially distributed, and repair times are also distributed in a basic way. With the help of a numerical illustration, a cost model for QS's was also explored. The Two stage N-policy $M^X/M/1$ QS with startup times and server breakdowns was explored by V. Vasanta Kumar et al. [39]. The ideal value of N was determined using a cost function. Moreover,in addition to the N policy, the study of a QS with alternative vacation rules was also looked forward. In an MX/G(a, b)/1 queuing model with periodic vacations and closedown periods, S.Jeyakumar and B. Senthilnathan [40] tested the effect of the server breakage without interruption. It's also been noticed that when the rate of refurbishment rises, the projected line length lowers. G.Ayyappan and S.Shyamala [41] extended a single server with a BV and a random breakage. Transient solutions SS and probability generating function (PGF) were both assessed explicitly. N.A. Hassan and S.A. Hoda Ibrahim [42] demonstrated a recursive method for solving problems involving multi-level QM's in SS. When modifying the characteristics of a system, this method has been used to provide many of the system efficiency metrics. When modifying system parameters, the breakage of servers has an impact on system efficiency metrics. Charan Jeet Singh et al. [43] developed a single server QM with vacation, where goods are sent in bulk. The PGF of the number of components in the system was calculated using the Supplimentary Variable Technique (SVT), which can then be used to produce evaluation metrics like the average number of parts of the system, average waiting time, and so on.

In their examination of a bulk arrival two-stage retrial queueing models with balking, reneging, orbital search, and server breakdown, J.Ebenesar Anna Bagyam et al.[44] discussed the problem of delay time and reserved time. SVT provides an analytical solution to this model. In their study, Sushil Ghimire et al.[45] looked at a bulk QS with a fixed batch size of 'b' with users entering

the system in a Poisson manner and being segregated exponentially with the rate. Using PGF method, we may derive equations for W_q, W_s, L_q and L_s after constructing the mathematical model. S. Suganya [46] investigated into a $M[X]/G/1$ that has SOS, Multi Vacation, breakdown, and Repairs. The SVT is used to calculate the PGF of the number of consumers in the wait. This concept is applicable to large-scale production and communication networks. Madhu Jain and Amita Bhagat [47] generalized at how to deal with impatient consumers in the bulk arrival $M/G/1$ retry wait and changed the vacation policy. Zaiming Liu and Yang Song [48] examined a batch arrival $M^X/M/1$ queue model with functioning breakdown. WV is not the same as taking a break from work. Communication systems, transportation systems, production systems, and so on are all examples of this.

S. Maragathasundari [49] investigated a three stage heterogeneous service bulk arrival QM with various vacation policies. All arriving consumers must go through all three steps of service. The server can take a long vacation if he or she desires. The QS SS results are derived. In an $M^X/G(a,b)/1$ queuing model, M. Haridass and R.P. Nithya [50] generalised the server breakdown with interrupted vacation. In addition, a cost model has been built. A feedback QM with Bernoulli server vacation, multiple phases of unit service, and random server failure was reviewed by Sundar Rajan et al.[51]. The expected number of units and SS PGF had been calculated. Gautam Choudhury and Mitali Deka [52] analysed the queue size distribution due to busy time commencement era, and the waiting time distribution at random eras. In addition, several reliability indices and the system reliability function's LT were calculated. The concept of bulk arrivals was researched by S.P. Niranjan and K. Indhira [53]. To avoid a congestion problem, researchers must concentrate their efforts on developing models and processes to address the issues. It can assist researchers, engineers, and statisticians in the application of these models. G.Ayyappan et al. [54] investigated a bulk arrival with two different types of general bulk service QM with server breakage and modified M-vacation. The stationary queue size distribution at a random era, the busy period distribution, and the waiting time distribution were all generalised by Gautam Choudhury and Mitali Deka[55]. The LT of the system reliability function were also calculated.

R. P. Nithya and M. Haridass [56] developed a bulk QM that included a breakdown, batch control, and several vacations. The findings can also be utilised to make managerial decisions about how to reduce overall costs and they found the optimum operating policy in a QM. In practise, Charan Jeet Singh et al.[57] proved that a wide range of queuing system models for various capacity issues may be investigated in a general environment by taking into account the broad dispersion of service operations, bulk arrival, and unreliable servers.In this model, the stochastic principle was utilised to analyse a huge, unreliable arrival queue with vital services under the hypothesis of a Bernoulli feedback schedule. Many industries, such as telephone, wireless mobile networks, industrial production systems, and others, have real-world queueing challenges. G. Ayyappan and R. Supraja [58] explored an $M^X/G(a,b)/1$ QM with two stages of service subjected to system breakages and BV. The SVT was used to find performance indicators such as system state probabilities, average queue size, and queue length in the queue. S. Jeyakumar and B. Senthilnathan [59] investigated a variable bulk service estimation approach with numerous WV's and server breakdowns. The queue size was calculated for various arrival rates, service rates during WV's, service rates during regular periods, and WV duration. G. Ayyappan and P.Thamizhselvi [60] presented two categories of batch arrivals: high-priority and non-priority (retrial) clients, both of whom were treated with non-preemptive priority. Bernoulli Feedback, low-priority client collisions, orbiting search, and a revised BV for an unpredictable server, featured a breakdown and a time delay before repairs can begin. Customers arrive at this location via the compound Poisson process.

G. Ayyappan and S. Karpagam [61] looked at a generic bulk service with a backup server, an unpredictable arrival rate, multiple vacations, a server failure, and a second optional repair. Using a multiple vacation policy, G. Ayyappan and M. Nirmala [62] investigated the transient and SS behaviour of the $MX/G(a,b)/1$ queue with breakdown and two stages of repair with delay. In addition, the PGF of the queue size at any arbitrary and departing era was obtained.

According to the numeric values, the average queue length and waiting time grows as the arrival rate, breakge rate, and average queue size and waiting time of the batch of consumers increases. It's also been noticed that as service and repair rate rises, the projected line size and waiting time for a batch of clients decreases. $M^{[X]}/G(a,b)/1$, a QS with multiple vacation, closedown, essential, and optional repairs was generalised by G. Ayyappan and T. Deepa [63]. When the queue length drops below, the server close down and goes into multiple vacations. G. . The general bulk service queueing strategy with broken and repaired backup servers, numerous vacations, and a reservice request control policy was studied by G. Ayyappan and S. Karpagam [64]. It has also been observed that the predicted wait length grows when the primary server's rate of vacation does.

An innovative recoverable server QM with bulk input and state-dependent levels was examined by Charan Jeet Singh et al. [65], taking into consideration generic repair possibility, time to repair, and service processes. The server can offer two levels of service, the first of which is required and the second of which is optional. Jitendra Kumar and Vikas Shinde [66] discovered explicit mathematical equations for real-world challenges like customer dispatching methods for bulk arrivals and bulk services with multi-servers that include a mix of customers with systems holding and cancellation methods. MATLAB-9 was used to calculate the numerical results. This model can be analysed with time dependent arrival and service rates, which gives our model a more realistic feel. G. Ayyappan and R. Supraja [67] explored a bulk arrival non-Markovian queueing system with balking under BV, breakage, and repair under BV, breakage, and repair. A single server Markovian WV queue with customer balked and breakage was developed by R. Kalyanaraman and A. Sundaramoorthy [68]. Furthermore, the arrival rates has been affected by the state of the server. For a system that provides three stage of heterogeneous services for consumers that renege during server vacation and system outage periods, Samuel Ugochukwu Enogwe and Sidney Iheanyi Onyeagu [69] proposed a single server batch arrival QM. Queuing performance metrics including the probability of the system being idle, the utilisation factor Lq, Ls, Wq, and Ws were also calculated. G. Ayyapan and J. Udayageetha [70] examined a general retrial queueing system with priority services using M[X1], M[X2], /G1,G2/1. In this research, the system is entered by two distinct client types from separate classes using several independent compound Poisson processes. And also, they examined the server adheres to the pre-emptive priority principle how when it comes to working breakdown, startup/closedown times, and Bernoulli vacations with generic vacation periods. According to the non-preemptive priority service rule, G. Ayyappan et al.[71] suggested a single server serve two groups of consumers. In this paper, defined breakdowns are explored along with admission control, balking, and Bernoulli vacation. The server slows down service for the current client when the system experiences a breakdown, and then the repair work starts. Additionally, it is explained that a policy of admission control is in place to prevent the server from allowing all users to access the system. Two individualistic batch arrival queues with rapid feedback, a modified Bernoulli vacation, and server breakdown are incorporated in this study's steady state analysis by G. Ayyappan at al.[72] Priority and ordinary clients go into two different categories that need to be taken into account. And they are also talking about the non-preemptive priority discipline suggested by this approach.

3. Bulk service queues with server

K. C. Madan [1] explored a single channel QM in groups of fixed size $b(\geq 1)$ with Poisson arrivals and exponential service. The service channel, on the other hand, is liable to breakagess that happen at times. For the SS, the PGF of the queue size was obtained. I. P. Singh et al. [2] investigated a system that serves a fixed-size batch and is prone to random breakage. After repairs, the system enters an idle state before returning to a working state. The LT techniques were used to obtain the various transition probabilities as well as the SS solution. R. Nadarajan and D. Jayaraman [3] studied a Markovian tandem queue with two units and included general bulk service in unit II and server vacation in unit II, random breakage in both units, and a

finite interval waiting room. The SS probabilities and conditions were derived using the Matrix Geometric concept. Madhu Jain [4] used the PGF method to produce an analytical and explicit queue size distribution for distinct states. The mean queue length in a SS for various states were also determined. Madhu Jain and Poonam Singh [5] generalised a broad bulk service QM with repeated delayed vacations and a service time that's also state-dependent. In these environments, several real-life transportation systems, such as shuttle bus routes, cabs, fast lifts, and tour operators, can be shown.

Madhu Jain and Praveen Kumar Agrawal [6] examined a state-dependent $M/E_k/1$ QM's with server breakage and vacation time. The length of a server's vacation and its duration has been exponentially distributed. In both a WV and a busy period, service times has been considered to be Erlangian distributed. Investigation can be improved by adding bulk input/service. Lotfi Tadj and Gautam Choudhury [7] analysed a bulk service QS that had an ineffective server, Poisson input, and regular maintenance and processing times. A condition of stability has been established, along with SS system size distributions. The best management strategy was explored, with examples given to illustrate the point. Mathu Jain and Anamika Jain[8] studied a QM that includes WV's and server breakages, both of which require a series of phases of repair before operation can be restored. Some performance criteria were established. The influence of different variables was investigated using a sensitivity analysis. By applying the concept of multi optional repair, Madhu Jain et al.[9] investigated the unstable $M/E_k/1/WV$ queue. This approach is more stable and flexible since it combines the concepts of WV and service disruption due to server breakage. The SS equations that defines the model has also been built. $M/G/1$ queue Gautam Choudhury and Mitali Deka[10] presented that each customer requires two stages of service, the server is unprdictable and may fail at any time during the service, and the server is on a BV schedule.

Vikas Shinde and Deepali Patankar [11] studied with the departure of anxious clients and server vacations. They created the equations for SS probability as well as various system performance metrics, and also developed a cost model to establish the best service charge. Jau-Chuan Ke et al. [12] examined a multi-server QM with infinite capacity and a second optional service (SOS) channel. The optimization problem was solved using the quasi-Newton method and the Particle Swarm Optimization (PSO) method. The multistage batch arrival queue, including reneging on vacation and breakage times, was thoroughly analyzed. Sivagnanasundararam et al. [13] used SVT to produce SS solutions, and the average waiting time and average delay length. This concept can be applied to communication networks as well as large-scale manufacturing businesses. Under SS conditions, Sanjeet Singh and Naveen Kapil[14] examined the optimal operation of a single replaceable and server in a Markovian queuing system. The server's breakage and repair times are expected to be exponentially distributed. R P Nithya and M Haridass [15] analysed queue length distribution and also discussed the implications of various parameters on the performance of the system. S. Sasikala and K. Indhira [16] analysed a QM where customers were being served in batches in a bulk service, which can be fixed or variable in size. They explained why the service rate may be affected by the number of people in line for service. S. Jeyakumar and B. Senthilnathan [17] explained a model for variable bulk service queueing with various WV's and server breakages During WV's, the length of the queue was also obtained for different arrival and service rates.

M.Thangaraj and P.Rajendran [18] investigated batch arrival QM with two types of service patterns and a SV. S. Sasikala et al. [19] studied the SS behaviour of the M X / G(a,b) /1 queue in the presence of server downtime, numerous vacations, setup time, and N-policy. Using the PGF technique, the performance of the proposed QM may be measured. S.Bharathidass et al.[20] discussed single server Markovian arrival and Erlangian bulk service queues with state reliable rates. The system's state probabilities and expected number of units were explicitly calculated. G.Ayyappan and S.Karpagam [21] examined a batch arrival general bulk service single server QS with server breakage and optional second repair, stand-by server, balking, variable arrival rate, and many vacation. It has also been found that as the service rate of the main server increases, the projected queue size and waiting time decreases. Jitendra Kumar and Vikas Shinde [22]

developed a methodology for dealing with bulk arrivals and bulk service queues. L_q, L_s, W_q and W_s response times, as well as the efficiency of the server corresponding to consumers, have all been measured. MATLAB-9 was used to calculate the numerical results. Using the additional variable technique, Madhu Jain et al.[23] generalised the permanance modelling and analysis of a single server general service QM's with service interruption. M.Thangaraj and P.Rajendran [24] created and investigated batch arrival QM's with two types of service patterns and two types of vacations. Messaoud Bounkhel et al.[25] analysed a Markovian QS and used a numerical method based on operators to calculate the SS system size probabilities, as well as used a scientific method to calculate the PGF of these probabilities. The performance of a non-Markovian bulk service queuing models with an server, a stand-by server, loss and feedback, N-policy, and varied vacation Bernoulli schedules was investigated by G. Ayyappan and S. Karpagam [26] .The stand-by server has only been used while the primary server is being repaired. The queue size PGF was calculated, along with certain key performance indicators.

Srinivas R. Chakravarthy et al. [27] reported their findings in the setting of a single server queue with batch Markovian arrivals and a general service time distribution, regardless of batch size. For the general model, the SS probability vector has been determined almost directly, and we showed how explicit solutions look in a number of particular instances. Using reasoning from renewal theory, Niek Baer et al. [28] proposed a novel decomposition-based solution strategy for such queues, as well as they found the range of the wait period metric for multi-type server systems. The performance analysis of a non-preemptive priority $M/M/1$ queuing model with system breakage and repair time was conducted by K. Ruth Evangelin and V. Vidhya [29]. Investigation was done on the SS changes that occur in the equations of the queuing system using the complementary variable approach. Finally, the waiting time can also be computed using Little's formula, and a graphical depiction.Shanthi et al.[30] generalised a new numerical technique and utilized it to evaluate the transient stability of a bulk service queueing system with a server maintenance and breakage model using an infinite generator matrix and basic matrices. N.A. Hassan [31] demonstrated a simulation technique for solving SS problems involving multi-level QM's. When modifying the characteristics of a system, this method has been used to provide many of the metrics of system efficiency. When modifying system parameters, the breakage of servers had an impact on system efficiency metrics. In this study, G.Ayyappan and M.Nirmala [32] investigate the frustration of the client with an unreliable bulk queueing system with two forms of vacation. The server is allowed to take either a type I vacation or a type II vacation, subject to the size of the queue. And they also say that the server may experience malfunctions, and it requires a lot of setup time before repairs can commence. In this research, Rani Rajendiran and Indhira Kandaiyan [33] analysed the transient scrutiny of a batch arrival feedback queueing system with balking and two phases of variable service with differing levels of service subjected to Bernoulli vacation. They say that if the server is unable to accommodate the customer's request when they arrive, they also have the choice to deny services and exit the service area.

4. Conclusion

In this paper, a comprehensive review has been done on bulk queue with server Breakage models. One of the main reasons for conducting this survey is to get insight into the bulk arrival and bulk service models with breakages. These models are widely used and it plays a prominent part in the sectors of telephones, wireless mobile networks, and industrial production systems. The topics connected to bulk models with Breakage, which has been discussed in various fields, have been synthesized. A wide spectrum of literature has been examined, with suitable citations.

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