Bulk service queueing process with accessible batch, applied to public transport system

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We consider a passenger transport vehicle that commutes between an office/organization and the "central point" of the city. On its way to the office, it stops to collect passengers at $k-1$ intermediate "bus stops". All those who board the vehicle are bound to the office. We label the central point as node/stage 1 and the office as node $k+1$, which is the absorbing state. Intermediate stops are labelled from 2 to k. Node 1 has infinite capacity whereas, for intermediate stops, the capacity of the intermediate node j is N_j, $j = 2, 3, \ldots, k$. The vehicle progressively moves from node 1 to node k, and on completion of service in k, the vehicle returns to the destination. The vehicle takes an exponentially distributed amount of time to go from node j to $j+1$, $j = 1, 2, \ldots, k$. The service time parameter depends on the node number and the number of passengers while leaving the node. We adopt an accessible batch service policy. The batch service policy is the general bulk service rule (a, b) as introduced by Neuts in 1967. Here a is the quorum, and b is the maximum that can be accommodated in a service batch. The duration time of the vehicle has a halt for passenger boarding is exponentially distributed with a parameter that depends on the number of passengers boarding there and, possibly on the node number also. The condition for system stability is established. Under this condition, several system state characteristics are computed. Based on these measures a cost function is constructed and numerically analyzed.

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