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Wadea Ameen, Mohammed AlKahtani, Muneer Khan Mohammed, Osama Abdulhameed, Abdulaziz Mohammed El-Tamimi

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Wadea Ameen[ab], Mohammed AlKahtani[a], Muneer Khan Mohammed[b], Osama Abdulhameed[a], Abdulaziz Mohammed El-Tamimi[a]

[a]Industrial Engineering Department, King Saud University,

[b]Princess Fatima Alnijiris's Research Chair for Advanced Manufacturing Technology (FARCAMT Chair, Advanced Manufacturing Institute, King Saud University.

Corresponding author's e-mail: wadeaameen@gmail.com

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a b s t r a c t

The buffer allocation problem concerning the size and location of storage between the stages of a flow line is a critical research area in the design of production lines. In this study, a production system consisting of two unreliable stages and a buffer between them is considered; the first stage incorporates two identical machines in parallel and the second stage consists of a single machine. A simulation model is designed and used to evaluate the effect of the buffer capacity and the repair rates of machines on production line efficiency. The results revealed the capacity of buffer that yields the maximum production line efficiency with various repair rate values.

1. Introduction

A production line is defined as a series of workstations that are linked together by the handling systems that transfer parts from one station to the other. Stochastic flow lines are typically subjected to disruptions due to the variations in the processing times and failure of the workstations. These disruptions cause the production line to be idle and result in decreased throughput. In order to reduce or eliminate the effect of these disruptions, buffers are placed in between the machines. The buffer storage enhances the throughput of the production line by reducing the blocking and starving time of the workstations, thereby improving the flow line efficiency. Increasing the size of the buffer space between machines results in increasing the throughput of a stochastic production line but to a certain extent. Production lines have a limit of space that can be allocated for buffers and they add an inventory costs as well. Moreover material handling is required to maintain the operational process; thus, the buffer allocation problem translates into an optimization problem of stochastic system involving many variables (Tezcanet al.,2001). In production line the buffer zones divide the line into stages—two stages if one storage buffer is used and three stages if two storage buffers are used at two locations along the production line. In general, $n - 1$ storage buffers exist for an n-stage line, as illustrated in Figure 1(Roser and Tanaka).

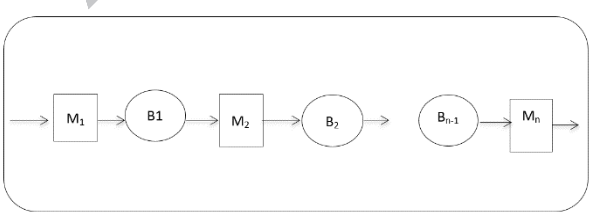

Fig1: Buffer storages in flow lines

The study of the effects of machine failures and storage capacities on the efficiency of production flow lines has attracted significant interest. Exact solutions have been found multistage lines consist unreliable machines. Wijngaard (1979) investigated the effect of interstage buffer on the output of two-stage flow production line when the production rate, breakdown rate, and repair rate are unequal (Wijngaard, 1979). El-tamimi and Savsar studied the availability of an automated production line involving two unreliable machines connected by a buffer and serviced by one repairman. The stochastic model was modeled by using the Markovian technique. The repair and failure rates were unequal, while the production rates were equal. The result presented the effect of the buffer size on the availability and on the total cost (El-tamimi and Savsar1987). Mohant et al. identified the optimal buffer storage to maximize profit of stages facilities with finite buffer storage between them. The service time of both stages are exponentially distributed. The results demonstrated that the mathematical model enables the accurate calculation of the optimum size of the buffer stock between two consecutive operations exhibiting exponentially distributed operation times (Mohanty and Kulkarni1989). Gupta et al. presented a straightforward mathematical formulation of a two-station problem with an interstage buffer and a central buffer for bulk storage, and its effect on the system cost of a two-stage production line was considered for the case where the two production milts have unequal production rates. A mathematical model was created to identify the optimal buffer capacity level and number of material handler trips while minimizing the total system cost. Two straightforward strategies were compared. The created model presented a straightforward methodology to determine the cost-effectiveness of two potential alternate manufacturing strategies (Gupta and Houshyar1990). Savsar considered an automated production system with two unreliable stages and a buffer, in which the first stage consists of two identical machines in parallel exhibiting similar failure, repair, and production rates, and the second stage consists of one machine. Moreover, he considered the buffer as exhibiting finite capacity and the production rate of the first and second stages to be equal with one repairman for each stage. An analytical stochastic model was developed and solved to determine the production line efficiency. The presented model yielded exact solutions to the extended buffer storage (Savsar 1992). Gopalan et al. considered a two-stage flow-line production system (two machines) has an inter-stage, end buffer and end inspections. The inter-stage and end inspections are instantaneous, and the end buffer is of finite capacity. The failure of machines I and II is not considered. A stochastic model is created to model the system and analytical expressions for the idle time, percentage utilization, blocked duration with arbitrary distributions of processing times at both stages of production, and exponential supply and demand pattern have been obtained by using the state-