Simulating a Pharmaceutical Supply Chain to Prevent Drug Shortages

Problem Statement
Shortages of prescription drugs have reached and maintained at a very high level for the past 10 years. This is mainly caused by pharmaceutical companies implementing a non-resilient supply chain, which is very vulnerable to disruptions. Drug shortages can lead to high costs. The median length of a shortage is 14 months.

Research Gap
There is a need to evaluate the resiliency of pharmaceutical supply chains to disruptions. In past work, we have developed a closed-form queueing model of supply chain availability. We developed a simulation model to validate the closed-form model, conduct analyses with relaxed assumptions, and produce distributional results.

Solution Approach

Inputs and Outputs
Inputs:
- Supply Chain Characteristics
  - Failure rates
  - Recovery rates
  - Number of facilities in each echelon
- Model Settings
  - Time horizon
  - Number of replications

Outputs:
- Average Availability of the System (the percent of time demand can be met)
- Expected Shortage Time
- Average Uptime
- Average Downtime

Results
With one facility at each echelon of the supply chain, the average availability is 86.2% which corresponds to a shortage of 13.8%.
With an additional supplier, the average availability is 93.2%. With redundancy at each echelon, the average availability is 99%.

Conclusions
The supply chain without redundancy is not very resilient. Substantial improvements can be seen if an extra supply is added. The supply chain with two facilities in each echelon is very resilient.

Possible extensions include: adding inventory to make the simulation more realistic and determining the most efficient configuration by considering costs.

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