Chapter 9

The Impact of Variability on Process Performance: Throughput Losses

After having analyzed waiting times caused by variability, we now turn to a second undesirable impact variability has on process performance: *throughput loss*. Throughput losses occur in the following cases, both of which differ from the case of flow units patiently waiting for service discussed in Chapter 8:

- There is a limited buffer size and demand arriving when this buffer is full is lost.
- Flow units are impatient and unwilling or unable to spend too much time waiting for service, which leads to flow units leaving the buffer before being served.

Analyzing processes with throughput losses is significantly more complicated compared to the case of patient customers discussed in Chapter 8. For this reason, we focus our analysis on the simplest case of throughput loss, which assumes that the buffer size is zero, that is, there is no buffer. We will introduce a set of analytical tools and discuss their application to time-critical emergency care provided by hospitals, especially trauma centers. In these settings, waiting times are not permissible and, when a trauma center is fully utilized, incoming ambulances are diverted to other hospitals.

There exist more general models of variability that allow for buffer sizes larger than zero, yet due to their complexity, we only discuss those models conceptually. Again, we start the chapter with a small motivating example.

9.1 Motivating Examples: Why Averages Do Not Work

Consider a street vendor who sells custom-made sandwiches from his truck parked along the sidewalk. Demand for these sandwiches is, on average, one sandwich in a five-minute time slot. However, the actual demand varies, and thus sometimes no customer places an order, while at other times the owner of the truck faces one or two orders. Customers are not willing to wait for sandwiches and leave to go to other street vendors if they cannot be served immediately.