

Supermarket check-out system

You have been approached by the manager of a certain supermarket who wishes to have their customer check-out system analysed. The goal is to obtain a detailed picture of how the system currently works and to investigate possible improvements that could potentially save resources and/or shorten waiting time for customers.

Make the following assumptions regarding the system.

The supermarket is open between 8.00am and 8.00pm, Monday to Saturday.

- A. Inter-arrival times of customers follow an Exponential distribution and customers arrive at a rate that varies in time according to the table below.

	The average number of customers arriving
8am – 11am	2 per minute
11am – 6pm	2.2 per minute
6pm – 7:50pm	1.7 per minute
7:50m – 8pm	Arriving customers are not allowed in.

- B. There are 6 self-service tills and 3 cashier tills. There is one queue for all self-service tills and one other queue for all cashiers.
- C. On average, 60% of customers join the queue for self-service check-out till and 40% join the queue for a cashier.
- D. Data on the service times for the self-service check-out tills and for the cashier service were collected over a certain period and stored in the file *Durations.xlsx* available in the DLE. Use this information in order to specify service times distributions through histograms.
- E. On average, 1 in every 4 customers need assistance with the self check-out. There is one member of staff who provides assistance for all six self-service points. When this happens, it takes time according to normal distribution with mean 0.8 minute and standard deviation 0.06 minute in addition to the usual self check-out time.
- F. Customers waiting longer than 6 minutes will change the queue if the other queue is shorter.

Task 1

Use SIMUL8 to implement the queuing system described above. Simulate the check-out process for one working day from the point where customers arrive at the check-out to the point where they leave. Estimate the following along with their 95% confidence intervals using **500 runs** of one working day:

- (i) the average waiting time spent in a queue for self-service check-out and for cashiers, respectively;
- (ii) the percentage of time self-service check-out machines and cashiers, respectively, are busy;
- (iii) the proportion of customers queuing longer than 4 minutes.

Task 2

Investigate how characteristics (i)-(iii) will be affected if

- (a) there are two assistants at the self-service check-out instead of one;
- (b) there are two cashiers working throughout the day instead of three;
- (c) cashiers work according to shifts: two cashiers between 8am and 11am, three cashiers between 11am and 6pm and two cashiers between 6pm and 8pm.

Task 3

Prepare a **report** in which you summarise your findings for the manager. The summary should refer to relevant numerical statistics, tables and graphs. You should clearly explain and visualise how the system is affected by the modification proposed in Task 2. In particular, include supporting evidence as follows:

- (a) the warm-up period and the results collection period,
- (b) key results from your simulations with appropriate confidence intervals,
- (c) histograms of queuing time with commentary.