Solutions Manual

# Module C: Waiting Line Models

1a. 

1b. 

1c. 

1d. 

Cognitive Domain: Knowledge

Difficulty Level: Easy

2a. 

2b. 

2c. 

2d. 

Cognitive Domain: Knowledge

Difficulty Level: Easy

3. The system’s utilization is 66%, and if all customers had appointments 6 minutes apart and took exactly 4 minutes per customer, there would be no waiting line. However, there is variability in the arrival and service process, so there will be times when lines form and other times when the server is idle for several minutes.

Cognitive Domain: Comprehension

Difficulty Level: Medium

4a.



4b.



Cognitive Domain: Knowledge

Difficulty Level: Medium

5a. 

5b.

5c. 

Cognitive Domain: Knowledge

Difficulty Level: Medium

6a. 

6b. 

6c. ; 

Cognitive Domain: Knowledge

Difficulty Level: Medium

7a. ;  

7b. ; ; 

Cognitive Domain: Comprehension

Difficulty Level: Hard

8a. 

8b. 

8c. 

8d. 

Cognitive Domain: Knowledge

Difficulty Level: Medium

9a. P0 = .11

9b. Lq = 2.84

9c. Ws = 0.19

9d. P5 = .07

9e. Pn>0 = 0.89

Cognitive Domain: Knowledge

Difficulty Level: Medium

10a. Ws = 0.2; Waiting cost = .2 x 10 x 10 x $35 = $700

10b. Labor = $20 x 1 x 10 = $200; System = $200 + $720 = $920

10c. Ws = 0.12; Waiting cost = .12 x 10 x 10 x $35 = $420; Labor = $20 x 2 x 10 = $400; System = $820

10d. A two-server system is less expensive.

Cognitive Domain: Knowledge

Difficulty Level: Medium

11abcd.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *Time Period* | *λ* | *μ* | *S* | *11a: P0* | *11b: Lq* | *11c: Ws* | *11d:Lqmax* |
| Morning | 12 | 15 | 2 | .54 | .06 | .05 | 2 |
| Afternoon | 18 | 20 | 3 | .40 | .03 | .05 | 2 |
| Evening | 25 | 30 | 3 | .43 | .02 | .03 | 3 |

Cognitive Domain: Knowledge

Difficulty Level: Medium

12. P0 = .37; Lq = 0; Wq = 0; Ls = 1; Ws = .13 minutes

Cognitive Domain: Knowledge

Difficulty Level: Medium

13. P0 = .06; Lq = 0.76; Wq = 0.09; Ls = 3.42; Ws = .43

Labor cost = $100 x 10 = $1,000; Waiting cost = .43 x 10 x 8 x 150 = $5,160; System cost = $6,160

Cognitive Domain: Analysis

Difficulty Level: Medium

14a. P0 = .13; Lq= 0.04; Wq = 0.3 minutes; Ls = 2.04; Ws = .25

Labor cost = $100 x 10 = $1,000; Waiting cost = .25 x 10 x 8 x 150 = $3,000; System cost = $4,000

14b. The five-dock system is less expensive than the four-dock system.

Cognitive Domain: Application

Difficulty Level: Hard

15a. utilization = 0.83

15b. P0 = 0.04

15c. Lq = 3.51

15d. Wq = 0.07

15e. Ws = 0.12

15f. Ls = 6.01

Cognitive Domain: Knowledge

Difficulty Level: Medium

16. Ws = 4.71; cost of labor and waiting is $87.63 for one technician.

Ws = 3.1; cost of labor and waiting is $63.69 for two technicians; hence, hire a second tech.

Cognitive Domain: Application

Difficulty Level: Hard

17. Ws = 3.98; cost of labor and waiting is $141.38 for one technician.

Ws = 2.17; cost of labor and waiting is $80.32 for two technicians; hence, hire a second tech.

Cognitive Domain: Application

Difficulty Level: Hard

18. Ws = 0.17; cost of labor and waiting is $142.22 for four clerks.

Ws = 0.1; cost of labor and waiting is $91.33 for five clerks; hence, hire a fifth clerk.

Cognitive Domain: Application

Difficulty Level: Hard

19a. Wq = 0.07; Lq = 2.84

19b. If the service time remains 2.4 minutes, the system will need a minimum of four servers so the system service rate can exceed the customer arrival rate at the maximum rate of 80 per hour. With four servers, the Lq = 2.39 and Wq = 1.8 minutes.

Cognitive Domain: Application

Difficulty Level: Hard

20a. Lq = 1.6

20b. Ws = 0.2

Cognitive Domain: Knowledge

Difficulty Level: Medium