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| EGC_Black | Student Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_    **Eastern Goldfields College**  Mathematics Essentials 2015  Application 2 – Join the Queue Solutions  1 |

Notes and Calculator Allowed **TIME:** 90 min  **TOTAL MARKS**: 49

This practical application is worth 8% of your course mark.

**Equipment needed**: calculator, notes, ruler, dice, random number generator, plain paper for working.   
  
**Activity 2 Quiet Time Checkout Numbers (24 Marks: 1, 2, 1, 1, 1, 2, 6, 2, 2, 2, 2, 2 )**

At a supermarket checkout, you cannot always guarantee the rate at which customers arrive. In this activity you need to simulate the arrival of customers to the checkout. Where customers are served every 2 minutes and there is up to and including, 6 customers at any one time.

1. What method will you use to simulate the number of new customers that arrive to the checkout per minute?

Roll one 6-side die OR number generator in: excel OR calculator.

The number on the die/generator will represent the number of people arriving at the checkout per minute

1. Using your method of simulation and assuming that one customer is served every 2 minutes, complete the following table.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **One checkout open** |  |  |  |  |  |  |  |  |  |  |
| Time (minutes) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| New customers |  |  |  |  |  |  |  |  |  |  |
| Customers served | 0 | 1 | 0 | 1 | 0 | 1 |  |  |  |  |
| Number in queue |  |  |  |  |  |  |  |  |  |  |

Various answers ( I mark new Customers/ 1 mark no. in queue)

1. Using your results, what is happening to the queue length?

The queue is getting very long very quickly. It is increasing.

1. Now consider the situation if another checkout was opened. Repeat the simulation for **two checkouts** open and two customers may be served every two minutes, complete the table below.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Two checkouts open** |  |  |  |  |  |  |  |  |  |  |
| Time (minutes) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| New customers |  |  |  |  |  |  |  |  |  |  |
| Customers served | 0 | 2 | 0 | 2 | 0 | 2 |  |  |  |  |
| Number in queue |  |  |  |  |  |  |  |  |  |  |

Various answers (must be all correct to get the mark)

1. What happened to the queue length, with an extra checkout opened?

The queue is shorter, but still very long. May be longer (F.T. from their table)

1. Should more checkouts be opened? Why/why not?

Yes, because the queue is still very long or as customer numbers have increased or

More customers can be served.

1. Repeat your simulation for further checkouts opened.   
   1. The rate for the number of customers that can be served every two minutes changes according to the number of checkouts opened. Complete the table below stating the rate of customers that can be served, given the number of checkouts opened.

|  |  |
| --- | --- |
| Number of  Checkouts Open | Rate (number of customers / 2 minutes) |
| 1 | 1 customer / 2 minutes |
| 2 | 2 customers / 2 minutes |
| 3 | 3 customers / 2 minutes |
| 4 | 4 customers / 2 minutes |
| 5 | 5 customers / 2 minutes |

One mark each

* 1. Complete the tables below.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Three checkouts open** | | |  |  |  |  |  |  |  |  |
| Time (minutes) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| New customers |  |  |  |  |  |  |  |  |  |  |
| Customers served | 0 | 3 |  |  |  |  |  |  |  |  |
| Number in queue |  |  |  |  |  |  |  |  |  |  |

Various answers One mark

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Four checkouts open** | | |  |  |  |  |  |  |  |  |
| Time (minutes) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| New customers |  |  |  |  |  |  |  |  |  |  |
| Customers served | 0 | 4 |  |  |  |  |  |  |  |  |
| Number in queue |  |  |  |  |  |  |  |  |  |  |

Various answers One mark

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Five checkouts open** | | |  |  |  |  |  |  |  |  |
| Time (minutes) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| New customers |  |  |  |  |  |  |  |  |  |  |
| Customers served | 0 | 5 |  |  |  |  |  |  |  |  |
| Number in queue |  |  |  |  |  |  |  |  |  |  |

Various answers One mark

1. Reviewing all of the simulations for Activity 2, what was the **least** number of checkouts needed for good service? How did you decide?

Answer as per their results with reason

1. Why is the least number important to the supermarket manger?

It is important because he must pay extra wages to employ more people at checkouts.

(Less staff = less pay) (or supervise less staff)

1. Explain a limitation of this simulation?

* Some minutes no customers could arrive, but the model doesn’t show this.
* Customers do not all take the same time to go through a checkout.
* Supermarkets usually have a speedy lane for low number of items.
* Some customers take less than 2 minutes.
* Checkout for small no. of items not considered. (Any 2 – there are others)

1. Identify one way this simulation is:
   1. similar to a supermarket;

Waiting times are realistic i.e. most times you WILL wait

* 1. different to a supermarket.
* Customers don’t take the same time
* Doesn’t allow for ‘no customers’ i.e. quiet times
* Customers don’t take exact no. of minutes

1. List two assumptions that have been made?

* Customers take the same time to go through a checkout
* All customers arrive within 2 minutes of each other
* There will always be at least one customer

**Activity 3 Peak Hour Checkout Numbers (11 Marks: 1, 2, 4, 3, 1)**

It is now peak hour at the simulated supermarket. This means you can up to 12 customers arriving at any one time to a checkout.

1. What method will you use to simulate the number of new customers that arrive to the checkout per minute?

Roll a 12 – sided die OR number generator in: excel OR calculator

( Cannot roll two 6-sided dice )

1. Using your method of simulation, complete the table below. Sample answer below

(one mark new customers/ one mark no. in queue)

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Five checkouts open** | | |  |  |  |  |  |  |  |  |
| Time (minutes) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| New customers | *5* | *6* | *10* | *12* | *2* | *6* | *11* | *7* | *8* | *2* |
| Customers served | 0 | 5 | 0 | 5 | 0 | 5 | 0 | 5 | 0 | 5 |
| Number in queue | *5* | *6* | *16* | *23* | *25* | *26* | *37* | *39* | *47* | *44* |

1. Justify why more open checkouts are required.
2. 44 customers (one mark)
3. 44 customers waiting at a rate of 5 served every 2 minutes means the 44th customer must wait 17.6 minutes. (Approx 18 mins) (2 marks)
4. Yes, The queue is unacceptably long at the end of 10 minutes (one mark)
5. Repeat the simulation for 6, 7 and 8 checkouts opened. (one mark each)

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| **Six checkouts open** | | |  |  |  |  |  |  |  |  |
| Time (minutes) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| New customers |  |  |  |  |  |  |  |  |  |  |
| Customers served | 0 | 6 |  |  |  |  |  |  |  |  |
| Number in queue |  |  |  |  |  |  |  |  |  |  |

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| **Seven checkouts open** | | |  |  |  |  |  |  |  |  |
| Time (minutes) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| New customers |  |  |  |  |  |  |  |  |  |  |
| Customers served | 0 | 7 |  |  |  |  |  |  |  |  |
| Number in queue |  |  |  |  |  |  |  |  |  |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Eight checkouts open** | | |  |  |  |  |  |  |  |  |
| Time (minutes) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| New customers |  |  |  |  |  |  |  |  |  |  |
| Customers served | 0 | 8 |  |  |  |  |  |  |  |  |
| Number in queue |  |  |  |  |  |  |  |  |  |  |

1. Have you reached the minimum number of checkouts open for good customer service? Justify your answer?

Possibly - Students need to consider what an “acceptable wait” is. (Relate to their answer)