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Customer Waiting Time in Department of Labour, Kuala Terengganu: A Queuing Approach

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Abstract

Businesses adopt queuing mechanism as it can improve efficiency and provide economic use of resources. Some business segment that normally adapted queuing theory include assessing staff scheduling, productivity, performance, and customers waiting time. This article will adopt queuing theory to current service provided by Department of Labour, Kuala Terengganu. As the department is committed to provide quality services to its customer, the level of satisfaction and current queueing time need to be investigated. To achieve this, four elements in queueing theory – arrival rate, the queuing discipline, the service and also the cost structure are utilized. Arrival rate is measured as way in which customer arrives at this department and entered for receiving a service. Single server queuing model is known as infinite queue length model (exponential service) was used in this study. This model is based on certain assumptions about queuing, as the arrivals are described by Poisson probability distribution and arrive from infinite population. This study has demonstrated that, majority of the customers are dissatisfied with services offered and the major cause of dissatisfaction is the long waiting time. Sunday shows the busiest day at Department of Labour, Kuala Terengganu when there are too many customers and duty officer faced a hectic day on Sunday, followed by Thursday and Wednesday. Department of Labour, Kuala Terengganu needed to do the other internal procedures for reducing waiting times and thus ensuring an effective services system. This study recommended of adding a new checkout counter and hiring another employee to help duty officer improve the operation at Department of Labour, Kuala Terengganu.

Keywords: Customer's satisfaction, Queuing model

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INTRODUCTION

Businesses adopt queuing mechanism as it can improve efficiency and provide economic use of resources (Magnus et al., 2017). Some business segment that normally adapted queuing theory include assessing staff scheduling (Véricourt & Jennings, 2011; Kadry et al., 2017; Andersen et. al., 2019), productivity (Raj et al., 2018; Afolalu et al., 2019; Hernández-González et al., 2019), performance (Alenany & El-Baz, 2017; Freeman, 2017; Xiao et al., 2018), and customers waiting time (Liu et al., 2017; Putra et al., 2017; Qin et al., 2019). This theory is also versatile as it is also able to handle various operational situations despite the lack of accurate predict arrival rate of customers and service rate of service facility of facilities (Obinwanne, 2015). In dealing with customer satisfaction, effective queueing system is among the critical factor that contribute to satisfied customers (Mwangi & Ombuni, 2015; Vahdani et al., 2013; Abiodun, 2017). Consequently, a long waiting time serves as indicator of poor quality and in needs for improvement.

Kotler (2000) defined customer satisfaction as a person's feeling of pleasure or disappointment resulting from comparing a product or service's perceived performance or outcome in relation to her or his expectations. While Parasuraman et al., (1988) defined customer's expectation as what the customer wants from the product or service they have purchased, and further, perceived quality is explained as the customer's judgment about a product/service's overall excellence or superiority. Thus, it is natural to understand that customer satisfaction can be defined in simple terms as perception minus expectation (Teas, 1993; Lee & Lambert, 2000). Hamka (2018) suggested that receiving service is one of important element in customer satisfaction, in which it reflects company's quality that provide the services. If the performance is not satisfactory, customer is dissatisfied, while if the performance matches the expectation, the customer is satisfied. When performance exceeds expectations, customers are very happy or happy. Yusuf & Kazeem (2015) also elaborated customers' evaluation of service quality is affected not only by the actual waiting time but also by the perceived waiting time.

This article will adopt queuing theory to current service provided by Labour Department, Kuala Terengganu. In this department, among its function is to handle any type of labour complaints from both employers, as well as employees. However, among critical issues is the large volume complaints received from customers that need to be handled. These complaints comprise of various labour issues such as salary payments, employees stop working without notice, foreign worker's requests, no annual leave and no service contract. Besides counter service, they also offer phone service, resulting to complaints received from this channel. Every customer who come in are in the queue system and need to wait to be served by the duty officer. On daily average, more than ten customers need to be served. However, only one officer in duty is allocated a day despite number of customers that arrived, resulting to long queue for their turns to be served. Nevertheless, the duty officer need to also tend to other commitments. These include pre-set appointment with the customers for inspection, involving in court case, and some other related duties. Due to the lack of other addition of personnel, the officer in charge cannot take a rest if too many customers arrived. On average, 20 minutes per customer is allocated while being served. Besides, this officer also need to answer outside call. Normally, on Sunday and Thursday are the most hectic days with many incoming calls together with in-house customers to be served (*Note that in this district, weekend is on Friday and Saturday*).

This department understands that high satisfaction level among customer is important as it can improve overall perception on the effectiveness of this department. Currently, customers need to wait significant amount of time before being served. On average, one customer needs to wait for 31 minute to one hours before being served by duty officer. Understandably, such long queue leads to low satisfactory. As the department is committed to provide quality services to its customer, the level of satisfaction and current queueing time need to be investigated. Adopting queuing theory is able to reduce average time spend by a customer to receive service, and will increase customer's satisfaction toward this service. To achieve this, four elements in queueing theory – arrival rate, the queuing discipline, the service and also the cost structure are utilized.

METHODOLOGY

Study Design

Questionnaires are structured carefully to make it more understandable for the customers to answer all the questions. Questionnaires were categorized into three section with the total number of ten questions are given, with ordinal and nominal scale are constructed.

Data

Data collections to be used in the study are from primary data and secondary data. Primary data is obtained from the customers who arrived the Department of Labour, Kuala Terengganu in first quarter of year 2019. Customers need to answer the questionnaire prepared to them based on their satisfaction level and perspective on service towards this department after receiving services by duty officer. Secondary data is attained from published journal and online sources.

Sampling

This study adopted observational research method, in which data is gathered for the same subjects repeatedly over a period of time. The sampling method used is convenient sampling, with 236 sample size (customers) was selected from overall 608 customers.

Measurement Procedure

In this article, several measurement procedures will be considered. First, we adopt the single server model. Single server queuing model is known as infinite queue length model (exponential service). This model is based on certain assumptions about queuing, as the arrivals are described by Poisson probability distribution and arrive from infinite population. Then, single waiting line and each arrival waits to be served regardless of the length of the queue and no balking take place. Table 1 show list of formulas for single server model.

Table 1. Formula of Single Server Model

	Formula
Probability that there is no customers are in the queuing system	$P_0 = (1 - \frac{\lambda}{\mu})$
Average number of customers in the system	$L = \frac{\lambda}{\mu - \lambda}$
Average number of customers in the waiting line	$L_q = \frac{\lambda^2}{\mu(\mu - \lambda)}$
Average time customer spends waiting and being served	$W = \frac{1}{\mu - \lambda}$
Average time customer spends waiting in the queue	$W_q = \frac{\lambda}{\mu(\mu - \lambda)}$
Probability that server (officer) is busy (utilization factor)	$U = \frac{\lambda}{\mu}$
Probability that server is idle	$I = 1 - U$

Arrival rate is measured as way in which customer arrives at this department and entered for receiving a service. Whenever the customers arrived at a rate that exceeds the processing system rate, a line and queue would be formed. Arrivals of customer may come in a single or in a batches, and they also may come in consistently space or in a completely random manner. They can also leave if on arrival, they find that the line is too long. The queue discipline is the first come first serve. Single server model and service time follows exponential distribution. According to Magnus et al., (2017), the arrival of customers is represented by the inter arrival time between successive customers whereas service is described by the service time per time customer. There are two parameters involves in the single server model which are

- λ: *the arrival rate (average number of arrivals per time period)*
- μ: *the service rate (average number served per time period)*

In addition, the measurement procedure that this study has been conducted by using Microsoft Excel. The purpose of using Microsoft Excel is to evaluate the formula for single server model. We also need to find the arrival rate and service rate before calculating all the formula for single server model. Table 2 illustrates the formulation for adopted queueing system.

Table 2. Arrival Rate and Service Rate Formula

	Formula
Total Arrival Rate	The total number of customers based on days
Average Arrival Rate	(Total Arrival Rate / 8 hour) / number of days for each day
Total Service Rate	The maximum number of customer that Department of Labour, Kuala Terengganu predict which is 60 customers per day
Average Service Rate	Total Service Rate / 8 hour) / number of days for each day
Total Arrival Rate (3 month)	The total of average arrival rate / 3
Total Service Rate (3 month)	The total of average service rate / 3

DISCUSSION

Table 3 shows that the average time customers need to wait is between 16 minutes to 30 minutes with 46.38%. Based on Table 3, there is 5.53% customers who are waiting for more than one hour to make an inquiry, meanwhile the number of customers who waited 31 minute to one hour is 90 customers with 38.3%. The highest number of customers at waiting line is around 16 minutes to 30 minutes with 46.3% and there are only 9.79% customers who waited for 10 to 15 minutes before being called by duty officer. From the result, we can conclude that many customers dissatisfied with the waiting line at Department of Labour, Kuala Terengganu.

Table 3**.** Number of customers based on the waiting time they need to wait

The waiting time customers needed to wait before being served	Total number of customers	Percentage number of customers
>One hour	13	5.53%
31min-1hour	90	38.30%
16min-30min	109	46.38%
10 min-15 min	23	9.79%

The finding suggested that at current, this department failed to deliver its prior commitment that aims to provide the highest standard in customer's service. One of its main principles is to be able to anticipate the customer's needs and preference. Its client charter also state that customer will be serve within 15 minutes of waiting time, with 20 minutes service time per customer. However, although the waiting time performance is not met and not satisfactory, customers are very satisfied with the service given by the staffs at the counter and by duty officer.

Present System

Table 4 depicts the arrival and service rate for five days. For instance, there are four Sundays in January. The total number of customers who come to the office on that four days would be divided by 8 hour in a day. This is consistent with 8 hours of service provided by duty officer in a day. We divide once again the result by the number of days that involved on Sunday which is 4 days. This leads to the average arrival rate on Sunday in January can be calculated as 1.179. To get the average arrival rate on Sunday for three months, all average of arrival rate from January until March are summed up and divided it by 3, thus obtained 1.581 customer per hour.

Meanwhile, for service rate, the department predicts that the maximum number of customers does not exceed 60 customers per day in a month. So, we assume 60 customers divide by 8 hours and the number of days involved for that day in three months. To get the average service rate on Sunday for the three months, we total all number of average service rate from January until March and divided by 3, thus obtained 1.75 customer per hour. Here, we got five λ and five μ, means there is one λ and one μ for each day as Table 4.

Table 4. λ and μ for each day

Day	$\boldsymbol{\lambda}/\mu$
Sunday	$\lambda_1 = 1.581 \ and \ \mu_1 = 1.7500$
Monday	$\lambda_2 = 1.0560 \ and \ \mu_2 = 2.2917$
Tuesday	$\lambda_3 = 1.1010 \ and \ \mu_3 = 1.9583$
Wednesday	$\lambda_4 = 1.1440 \ and \ \mu_4 = 1.9583$
Thursday	$\lambda_5 = 1.4500 \ and \ \mu_5 = 1.7500$

Table 5 show the parameter for the single server model that follows exponential distribution. From here, we can easily see the busiest day in a week and thus propose recommendation to improve organization's performance to be more efficient. We can see that on Sunday, probability no customer in the queuing system is the lowest which is 9.64%, followed by Thursday (17.14%) and Monday shows the highest probability that there are no customers in the waiting line that is 53.94%. Follow through, the average of the number of customers in the system also indicates Sunday is the highest (9.37344 customer per hour).

The average number of customers in the waiting line for three months also showed that Sunday is the highest with 8.46984 customers per hour and in average, duration for their waiting time before being served is 5.35625 minutes. Meanwhile, Monday and Tuesday show the lowest value of average number in customer in the waiting line (0.39337 minutes and 0.72136 minutes) and the time they are spending in the queuing before being called by duty officer (0.37265 minutes and 0.65536 minutes). As we can see, there are many customers in the waiting line on Sunday because the duty officer takes 20 minutes to serve per customer. Note that Sunday also show the highest in average customer spends before being served by duty officer which is 5.92768 minutes. Consensually, the probability of server is busy on Sunday is the highest with 90.39%.

Table 5**.** Parameter for Single Server Model in Department of Labour, Kuala Terengganu

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY
Probability there no customer in queuing system ($\boldsymbol{P_0}$)	0.09640	0.53938	0.43794	0.26264	0.17143
Average number of customers in system ($\boldsymbol{L}$)	9.37344	0.85400	1.28342	2.80754	4.83333
Average number of customers in waiting line ($\boldsymbol{L_q}$)	8.46984	0.39337	0.72136	2.07017	4.00476
Average time customer spends waiting and being served ($\boldsymbol{W}$)	5.92768	0.80902	1.16600	1.94428	3.33333
Average time customer spends waiting in the queue ($\boldsymbol{W_q}$)	5.35625	0.37265	0.65536	1.43364	2.76190
Probability the server is busy ($\boldsymbol{U}$)	0.90360	0.46062	0.56206	0.73736	0.82857
Probability the server is idle ($\boldsymbol{I}$)	0.09640	0.53938	0.43794	0.26264	0.17143

In conclusion, we can say that Sunday show the busiest day at Department of Labour, Kuala Terengganu when there are too many customers and duty officer faced a hectic day on Sunday, followed by Thursday and Wednesday. Such finding is realistic, as Sunday is a public holiday for private sector, thus gives opportunities for customers to come for services in the public sector.

Figure 1 reveals the probability of the server is busy for five consecutive days in the first quarter 2019 (January, February, March). We can see that the most hectic days is on Sunday (90.34%) followed by Thursday (82.86), Wednesday (73.74%), Tuesday (56.21%) and lastly on Monday (46.06%). Here, we introduced two scenarios for current practice at Department of Labour, Kuala Terengganu to be more efficient which are by introducing a new checkout counter (Scenario A) and adding one employee to help duty officer (Scenario B).

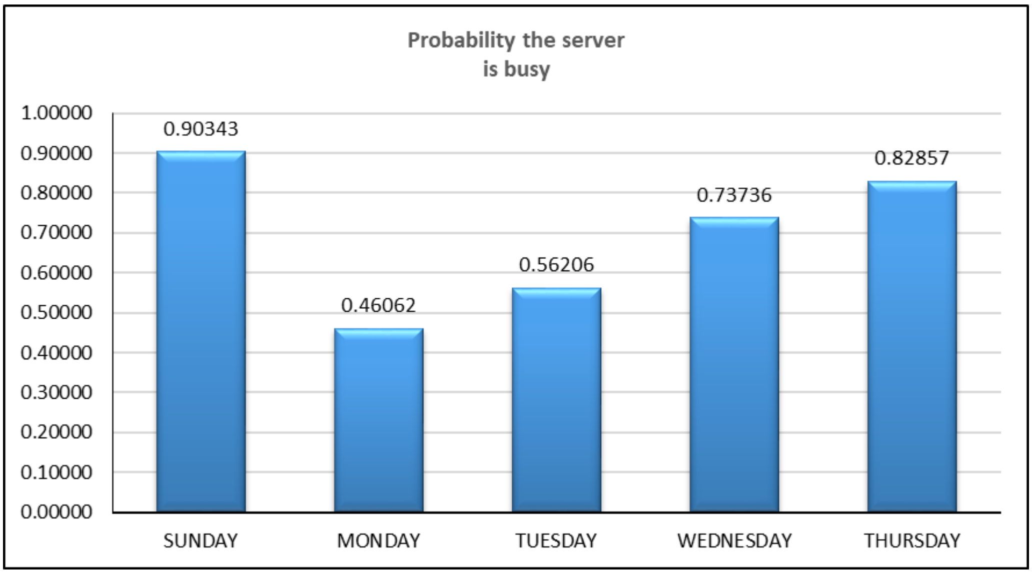

Figure 1. Probability the server is busy for current practice

Scenario A: Adding New Checkout Counter

We calculated arrival rate (λ) and service rate (μ) for scenario A which is by introducing a new checkout counter in Department of Labour, Kuala Terengganu. Based on Table 6, by following similar calculation as Table 2, the new total arrival (λ) and service rate (μ) for Scenario A are obtained except for total arrival rate. The number of customers based on day must being divided first by 2.

Table 6. λ and μ for each day (Scenario A)

Day	$\boldsymbol{\lambda}/\mu$
Sunday	$\lambda_1 = 0.796$ *and* $\mu_1 = 1.7500$
Monday	$\lambda_2 = 0.542$ *and* $\mu_2 = 2.2917$
Tuesday	$\lambda_3 = 0.567$ *and* $\mu_3 = 1.9583$
Wednesday	$\lambda_4 = 0.579$ *and* $\mu_4 = 1.9583$
Thursday	$\lambda_5 = 0.740$ *and* $\mu_5 = 1.7500$

Table 7 indicate the result for all the parameter for single server model for Scenario A, which is by introducing a new checkout counter at Department of Labour, Kuala Terengganu. Result in Table 7 show that probability there is no customers in the queuing system is significantly increase by 45% on Sunday. The time customer will spend in waiting line on Sunday reduce by 8 minutes. They do not have to wait for a long time before being called to meet the officer in duty. Meanwhile, by introducing a new checkout counter, the probability the server is idle also increase to 44.87%. Duty officer have enough time to do another work on his/her duty period.

Table 7. Parameter for Single Server Model in Department of Labour, Kuala Terengganu (Scenario A)

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY
Probability there no customer in queuing system (P_0)	0.54514	0.76349	0.71046	0.70434	0.57714
Average number of customers in system (L)	0.83438	0.30977	0.40753	0.41978	0.73267
Average number of customers in waiting line (L_q)	0.37952	0.07326	0.11800	0.12411	0.30982
Average time customer spends waiting and being served (W)	1.04822	0.57153	0.71875	0.72501	0.99010
Average time customer spends waiting in the queue (W_q)	0.47679	0.13517	0.20811	0.21436	0.41867
Probability the server is busy (U)	0.45486	0.23651	0.28954	0.29566	0.42286
Probability the server is idle (I)	0.54514	0.76349	0.71046	0.70434	0.57714

Scenario B: Adding One Personnel

We also calculated arrival rate (λ) and service rate (μ) for scenario B, which is by hiring one duty officer in Department of Labour, Kuala Terengganu (Table 8). Furthermore, Figure 2 show probability the server is busy for five days in first quarter of 2019 (January, February, March) if a new checkout counter is opened at Department of Labour, Kuala Terengganu. From the figure, we can see that the probability the server is busy significantly decrease for all five days with reduce by 44.9% on Sunday, 22.31% on Monday, 27.25% on Tuesday, 44.17% on Wednesday and 40.57% on Thursday. We can conclude that the most hectic day that many customers come to make inquiry is still on Sunday followed by Thursday, Wednesday, Tuesday and lastly on Monday but it is less busies.

Table 8. λ and μ for each day (Scenario B)

Day	$\boldsymbol{\lambda}/\mu$
Sunday	$\lambda_1 = 1.5813\ and\ \mu_1 = 1.8542$
Monday	$\lambda_2 = 1.0556\ and\ \mu_2 = 2.4306$
Tuesday	$\lambda_3 = 1.1007\ and\ \mu_3 = 2.0417$
Wednesday	$\lambda_4 = 1.1444\ and\ \mu_4 = 2.0417$
Thursday	$\lambda_5 = 1.4500\ and\ \mu_5 = 1.8333$

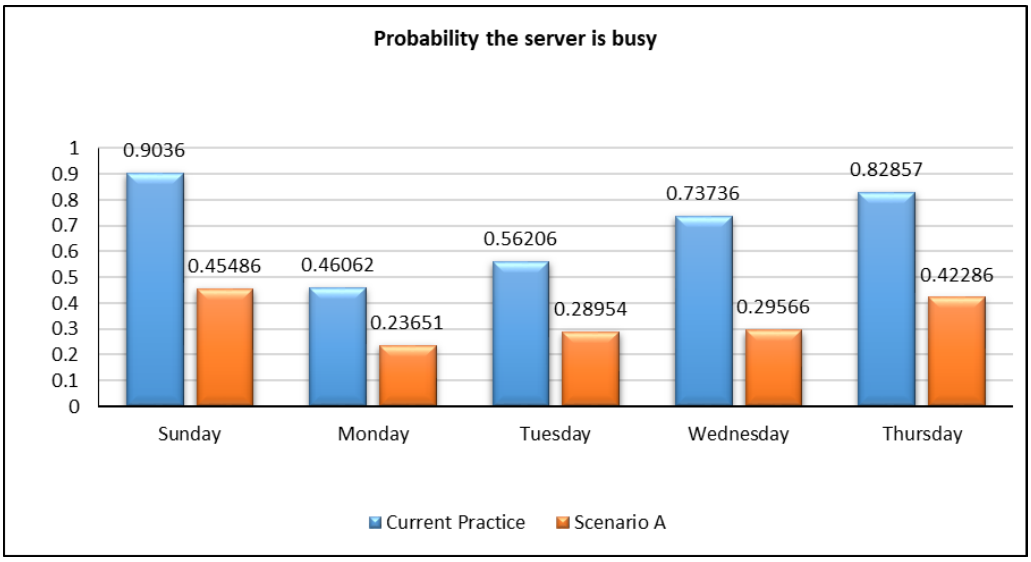

Figure 2. Comparison between probability the server is busy for current practice and Scenario A

Moreover, we also got the arrival rate and service rate for Scenario B by following similar calculation as Table 2. But, maximum number of customer that Department of Labour, Kuala Terengganu predict is increasing to 70 customers per day. Table 9 show parameter single server model for Scenario B which is by adding one duty officer at Department of Labour, Kuala Terengganu. Result in Table 9 show that probability there is no customers in the queuing system is significantly increase by 5% on Sunday. The time customer will spend in waiting line on Sunday reduce by 3.52884 minutes. Meanwhile, by adding another one duty officer will increase probability the server is idle to 14.72%. The process of providing services to customer become more effective.

Table 9. Parameter for Single Server Model in Department of Labour, Kuala Terengganu (Scenario B)

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY
Probability there no customer in queuing system (P_0)	0.14720	0.56570	0.46090	0.43950	0.20910
Average number of customers in system (L)	5.79380	0.76770	1.16970	1.27540	3.78290
Average number of customers in waiting line (L_q)	4.94100	0.31580	0.63060	0.71490	2.99200
Average time customer spends waiting and being served (W)	3.66410	0.72730	1.06270	1.11450	2.60890
Average time customer spends waiting in the queue (W_q)	3.12480	0.31580	0.57290	0.62470	2.06350
Probability the server is busy (U)	0.85280	0.43443	0.53910	0.56050	0.79090
Probability the server is idle (I)	0.14720	0.56557	0.46090	0.43950	0.20910

Based on Figure 3, it shows the probability the server is busy for five days in first quarter of 2019 (January, February, March) by adding another one duty officer at Department of Labour, Kuala Terengganu. We can see that the probability the server is busy only had small significantly decrease for all five days which is reduce 5% on Sunday, 3% on Monday, 3% on Tuesday, 17% on Wednesday and 4% on Thursday.

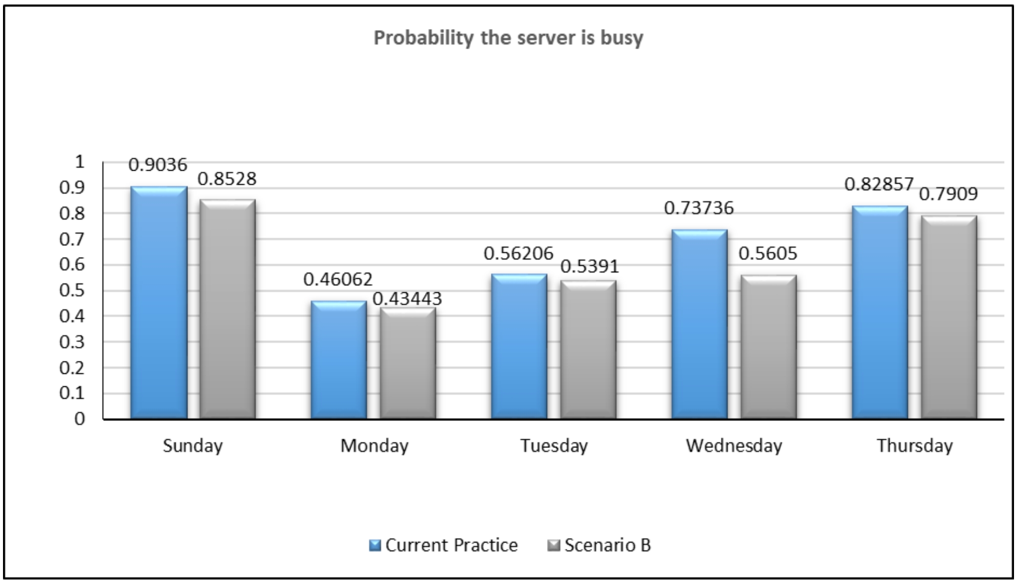

Figure 3. Comparison between probability the server is busy for current practice and Scenario B

Finally, Table 10 shows the result for both scenarios which are by opening a new checkout counter and hiring another employee to help duty officer reduce waiting time customers need to wait before being served at Department of Labour, Kuala Terengganu compared to the present system. We can see improvement in duty officer's performance on five days for both scenarios.

Table 10. Comparison probability the server is busy between current practice, Scenario A and Scenario B

Probability the server is busy (U)	Present System	Scenario A	Scenario B
Sunday	0.9036	0.45486	0.8528
Monday	0.46062	0.23651	0.43443
Tuesday	0.56206	0.28954	0.5391
Wednesday	0.73736	0.29566	0.5605
Thursday	0.82857	0.42286	0.7909

For instance, probability the server is busy with the present system on Sunday is 90.36%. Both scenarios are efficient due to improved performance by 44.87% for Scenario A and 5% for Scenario B. We can see that Scenario A give much more impact to reduce waiting line at Department of Labour, Kuala Terengganu than Scenario B. However, adding a new checkout counter may need much cost for the renovation. Meanwhile, if Department of Labour, Kuala Terengganu hired another one employee to help duty officer providing services to customers, they need to pay salary to new employee as the officer in duty's payment.

Conclusion

Queuing theory is a great management tool that often gets overlooked, especially in servicing department. Good application of this effective management tool can yield impressive results. The goal of this study is to model current practice of waiting lines of Labour Department by applying queuing theory as it relates to customer satisfaction and waiting time. Waiting in line will always be prevalent in our society.

By better understanding queuing theory, Department of Labour, Kuala Terengganu can make informed decisions that can provide beneficial impact on the satisfaction level among its stakeholders which are customers, employees and staffs. There are several tools such as adding a new checkout counter and hire another employee that can assist in the process of improvement the services to the customers. This study has demonstrated that, majority of the customers are dissatisfied with services offered and the major cause of dissatisfaction is the long waiting time. Labour Department, Kuala Terengganu needed to do the other internal procedures for reducing waiting times and thus ensuring an effective services system.

From this study, there are a few recommendations that can improve the operation at Labour Department, Kuala Terengganu which are adding a new checkout counter and hiring another employee to help duty officer. Due to financial limitation, recommendation for this study is in hiring another employee to help duty officer in providing services to the customers only on hectic days which are on Sunday and Thursday. This extra employer can be in the form of contract staff to cut the hiring cost even more.

We assume duty officer can handle customers on Monday, Tuesday and Wednesday as normal since the number of customers needed services are not many as on Sunday and Thursday. Introducing a new checkout counter is not a best solution for Labour Department, Kuala Terengganu as it may incur too much of additional cost as it involves with physical renovating and also not cost effective in which, they will only be functional for 2 days in a week.

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