Applied Mathematics and Computational Intelligence
Volume 10, No.1, Dec 2021 [87-100]

Modeling and Simulation of the Queuing System at University Parcel Centre (UPC)

Nurul Nazihah Hawari[1], Lye Lee Chen[2], and Nurfarahhanis Shaiful Nizad[3]

[1,2,3]School of Quantitative Sciences,
Universiti Utara Malaysia

Corresponding author : nnazihah@uum.edu.my

Received: 15 November 2021; Accepted: 16 April 2021; Available online: 19 April 2021

ABSTRACT

The purpose of this study is to model and simulate the parcel collection process at the University Parcel Center (UPC) using a Discrete Event Simulation (DES) approach. At UPC, upon arrival, students will join the queue to receive services; including identify their parcel number for collection, notify the staff their parcel number and wait for the staff to search the parcel from the store, and make payment for the services. Based on observation, it indicates that the parcel collection process is a time-consuming process. Hence, a simulation model is developed to evaluate the current performance based on the performance measures of the average waiting time and average total time in system, the utilization of resources, and, the number in queue. Using Arena software, the simulation model is developed to identify the bottleneck of the current system performance. Later, few alternatives are tested to improve the current system performance. From findings, the best alternative has reduced the minutes for the average waiting time, and the average total time in system respectively. The reduces in the waiting time and the total time in system has results in the increment of students' satisfaction level towards UPC services performance.

Keywords: Discrete event simulation, parcel collection, queuing, waiting time, Arena

1 INTRODUCTION

Malaysian Communication and Multimedia Commission (MCMC) has carried out the internet users' survey in 2018. The finding indicated that online shopping was increased from 48.8% in 2016 to 53.3% in 2018. It portrays that the online shopping or online purchase behavior has become trending. Nowadays, mobile devices allow users to manage daily tasks in more convenient way such as paying bills online, using online food delivery services, search information, do online shopping, and many more. Generally, students in Universiti Utara Malaysia (UUM) also prefer shopping online than buying physically at shops. Student accommodation hall in UUM is called as Inapan Siswa Pelajar (Inasis) is divided into 4 main routes which are Route A which covers Inasis Mas, Inasis TNB, Inasis Proton and Inasis Tradewinds; Route B which covers Inasis Petronas, Inasis Grantt, Inasis Sime Darby, Inasis TM, Inasis MISC, Inasis BSN, Inasis University Inn, and Inasis Maybank; Route C which covers Inasis YAB, and Inasis Muamalat; and Route D which covers Inasis SME Bank, and Inasis Bank Rakyat.

Before 2019, students may collect their parcel at their own Inasis main office. However, since the first quarter of 2019, Students Accommodation Centre (SAC) in UUM has eliminate the parcel collection system at each student accommodation Inasis office. Currently, all the students' parcels will be sent directly to the University Parcel Center (UPC) in UUM, instead of delivered to specific

Inasis. Thus, the students are required to self-collect their parcel at UPC within a specified period and make payment based on the parcel's weight. Extra charge may occur if the students are failed to collect their parcel within the specified period that has been mentioned by UPC through email. Currently, the services at UPC are not satisfying as many problems exist such as the long numbers of customers in queue, the long waiting time, and inefficiency server (system), which lead to customer service dissatisfaction among the students. Therefore, the focus of this paper is to develop a simulation model of the queuing system at UPC in UUM, to identify the bottleneck and provide alternatives for customer service improvement.

2 LITERATURE REVIEW

Existing in literature, many studies has been carried out to analyse the system performance of customer services. Most common approaches that have been utilised in analysing system performance for customer service improvement are system dynamics [1];[2], linear programming [3], service quality [4], and disctrete-event simulation [5];[6];[7]. Most past research did employs discrete event simulation approach to identify bottleneck and suggest alternatives for improvement. Computer simulation modelling has been used since the 1950s and has been proven as a successful and useful tool to support decision making. It has been successfully applied in many different areas and has experienced a particularly dramatic increase in popularity due to its wide range of applicability [8]. It can be used for performance evaluation, system design, decision-making, and planning [9]. Simulation is defined as the imitation of the operation of a real-world process or system over time whereby it is used to describe and analyse the behaviour of a system, ask what-if questions about the real system, and aid in the design of real systems [8].

The simulation studies did covers wide ranging aspect of applications. In 2015, [10] studied the queuing system at King Khalid Hospital outpatient Riyadh KSA. The outpatients have been categories in three types which is Type 1, Type 2, and Type 3. By using software Arena, they evaluated three best alternatives in this case. The average waiting time, average number waiting in queue and total serve time are the performance measures of this case. In 2016, [11] analysed the queuing problem at the UniMall. The UniMall only provided single payment counter with applies first come first serve (FCFS) basis policy which results in the long queue and lead to customer's dissatisfaction. Arena software is used to develop a simulation model of queuing system at the UniMall and the best alternative is evaluated to reduce improve the system performance and increase the customer satisfaction. Earlier [12] carried out a research to improve the emergency department performance. The purpose of the study is to generate the new framework to become more efficiently identify the patients flow in emergency department of government hospital. The finding shows that the best out of fourteen scenarios developed is considering priority for emergency department patients in the MRI and CT scan wards over non-emergency department patients together with add five mobile beds in inpatient ward and a financial department, respectively.

In financial field, [13] utilizes simulation software named FITNESS to develop a simulation model of queuing system at a bank located in Johor Bahru, Malaysia. Originally, the bank provides 4 counters and 2 tables of customer service. The simulation output is evaluated based on the performance measures of server's idle time and busy time. The finding shows that the best alternative is to add a new counter, and remove the service table, together with standardizing the shift of all counters. Furthermore, a study by [14] titled "Simulation Process of Isfahan Post Office using Arena" develops a simulation model to identify the unutilized or inefficiency counters. The findings help the management team provide better quality of service towards their customers.

Another study in 2016, [15] analyse the queuing system at the Department of Immigration, in Johor Bharu, Malaysia. Customers must wait long in queue to renew or create a new passport in the department. Recently, a research conducted by [16] study queuing problem at check-in system in an airport. There are two ways for customer to check-in which is the self-check-in kiosks, and the manual check-in at the counter. A simulation model is developed using Arena software, and the result highlight that waiting time has been reduce significantly through self-check-in kiosks, and automatic immigration screening. From the literature, it is proven that discrete event simulation is a suitable approach to analyse the queuing system at services industry to improve the customer satisfaction level.

3 RESEARCH METHODOLOGY

To achieve the research objectives, modelling and simulation of services process at UPC is required to evaluate the current system performance. By using Arena simulation software, the inter-arrival data, searching process data, and parcel collection and payment data, is analysed using Input Analyzer to define the data distribution type for data inputs in the simulation model. The performance measures of the system performance are the average waiting time, the average total time, and the utilization of resources. Well defined research framework and simulation model development process is vital as it helps in accomplish the research objectives fully [13];[14]. Figure 1 depicts the simulation modelling process.

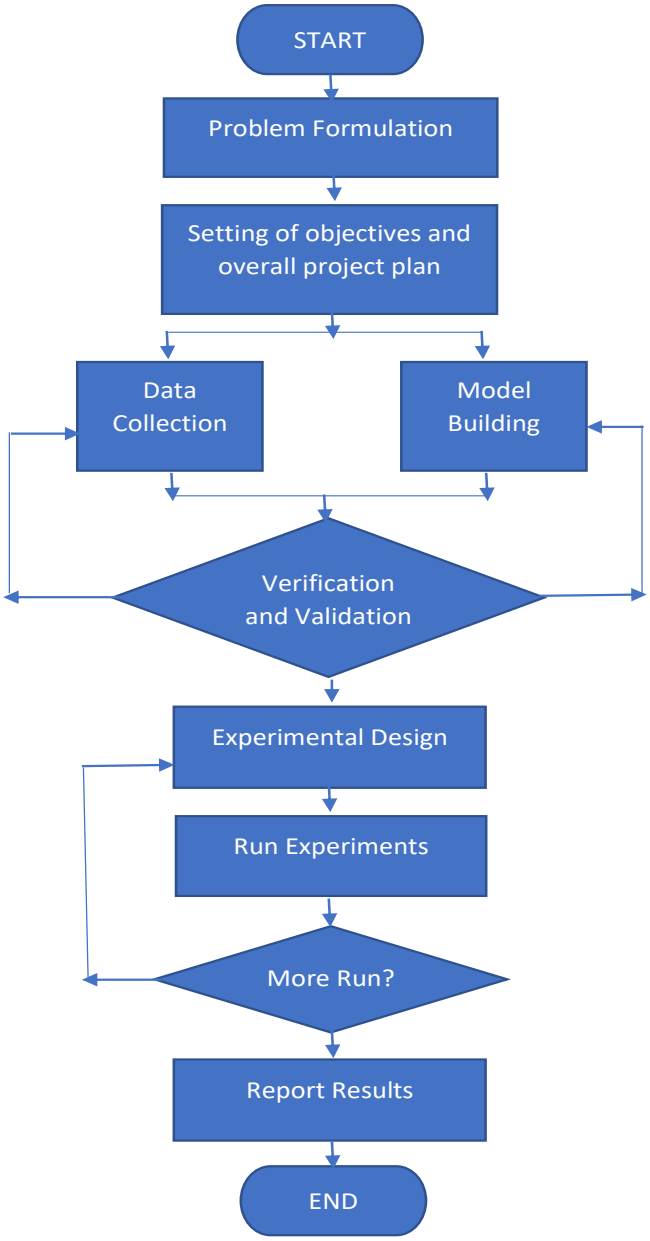

Figure 1: Simulation modelling process

3.1 Description of Case Study

Currently, UPC did not employ any automated system in handling the students parcel number. The "Parcel_name_list" is a list manually provided for students to search their parcel number. After students found the parcel number, they will proceed to the parcel collection & payment counter. In general, students will go through 2 steps of processes which is searching parcel number, and parcel collection and payment. Based on observation, the parcel collection process is a time-consuming process due to the limited or lack of resources. The resources of UPC are the "Parcel_name_list" and "staff". There are two counters for both processes respectively: counter for searching parcel number, and another counter for parcel collection and payment. Table 1 summaries the variables that involves in this simulation study.

Table 1: List of variables

Entity:	Student (who get services from UPC)
Process:	• Searching parcel number • Parcel collection and payment
Resource:	• Parcel_name_list • Staff
Resource Capacity:	• Parcel_name_list_1 (Parcel recorded 1 day before) • Parcel_name_list_2 (Parcel recorded 2 day before) • Parcel_name_list_3 (Parcel recorded 3 day before) • Parcel_name_list_4 (Parcel recorded 4 day before) • Parcel_name_list_5 (Parcel recorded 5 day before) • Staff_1 • Staff_2
Counter:	• 2 counters for searching parcel number • 2 counters for parcel collection and payment

UPC UUM operates from 9:00a.m. to 6:00p.m., and the lunch hour is 1:00p.m. until 2:00p.m., daily. There are four counters which represent both processes: searching parcel number, and parcel collection and payment, respectively. There are two counters for the process of searching parcel number, and the resources for this counter is the "Parcel_name_list". Meanwhile, another two counters for parcel collection and payment have two staffs for each counter correspondingly. All the collected data is analysed using the Arena Input Analyzer to define the expression of the data distribution.

The performance measures involve are the average waiting time in system, maximum waiting time in system, average total time in system, number in queue in the counter and utilization rate of all resources. For this study, the input variables are the inter-arrival time, and the services time. The expression of the inter-arrival time is Exponential distribution, -0.5+ EXPO (1.61). Whereas the expression for service time for searching parcel number is Weibull distribution, 0.5 + WEIB (2.18, 1.79). However, the expression for service time for parcel collection and payment is Erlang distribution, 0.5 + ERLA (0.799,4) (Refer Figure 2 until Figure 4). The base time unit of the simulation model is minutes.

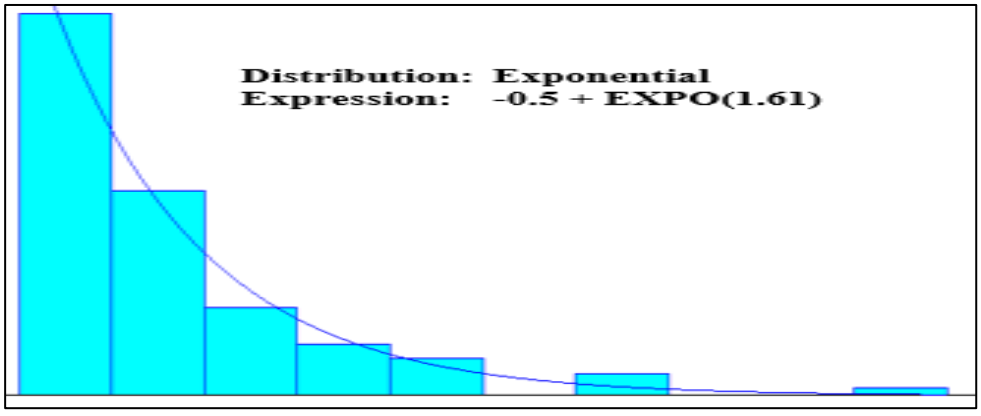

Figure 2: Distribution of inter-arrival time

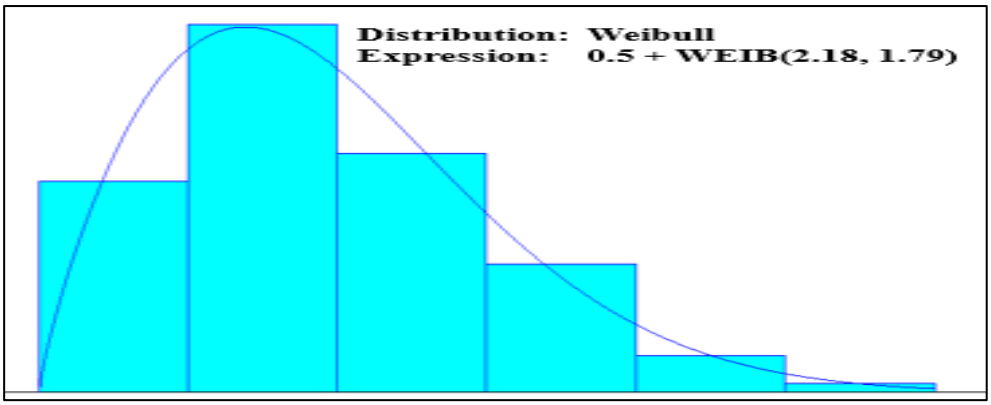

Figure 3: Distribution of service time at the searching parcel number process

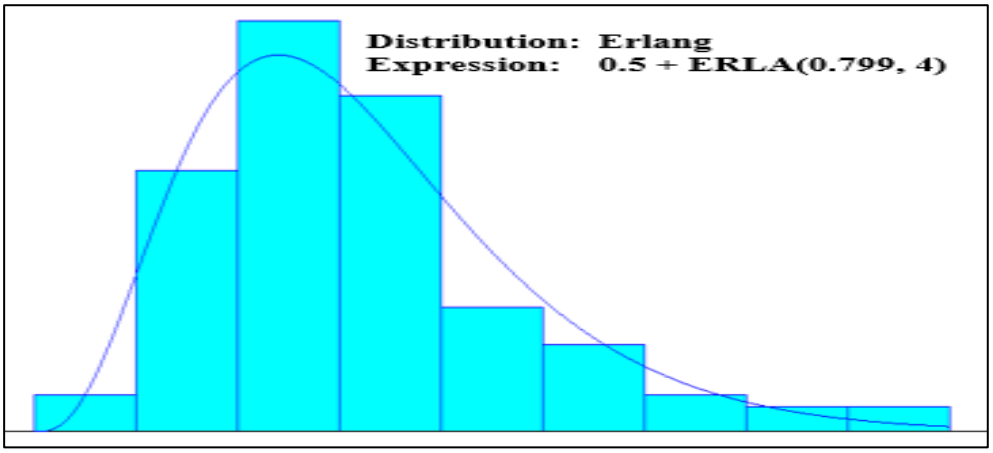

Figure 4: Distribution of service time at the parcel collection and payment counter

Simulation software Arena is most common application in literature for discrete event simulation model development [10];[11];[14];[15];[16]. Other than Arena, a software call FITNESS also has the same function for simulation model development [13]. This study employs Arena simulation software for model development. Figure 5 illustrates the model logic of the simulation model at the University Parcel Centre in UUM using Arena simulation software.

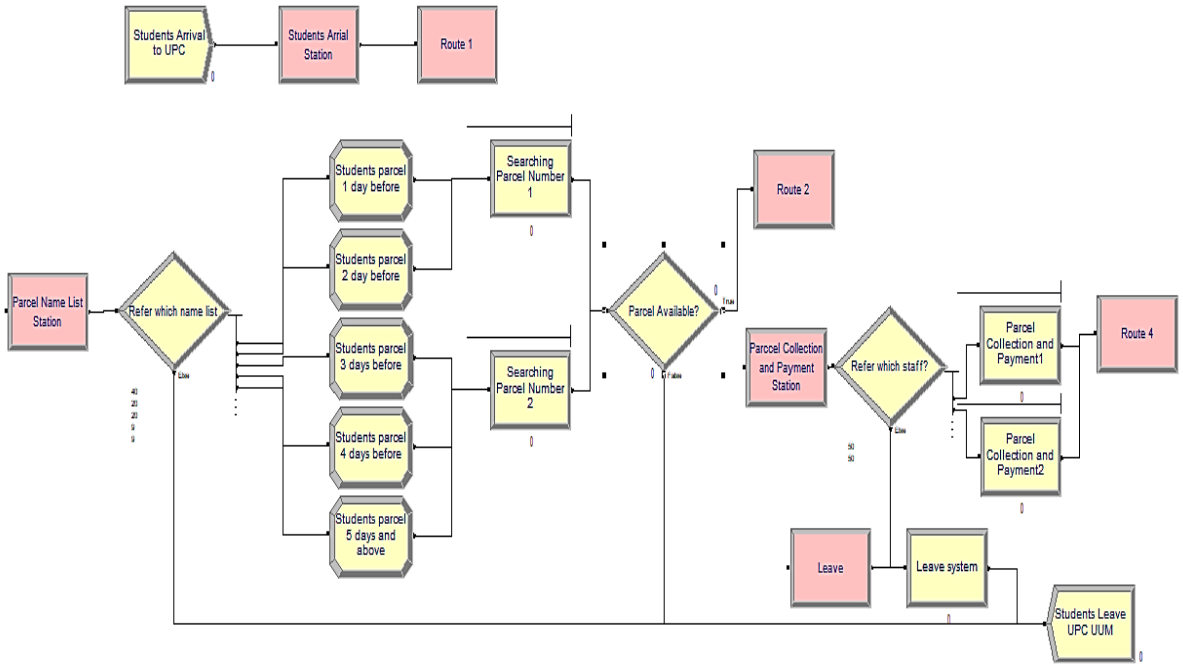

Figure 5: Model logic of the simulation model at the University Parcel Centre

From Figure 5, students arrive randomly at UPC. Next, students will decide to refer to which "Parcel_name_list" based on the parcel received day at UPC. The assign model represents the assign for the students referring to "Parcel_name_list_1" (parcel arrived 1 day before); referring to "Parcel_name_list_2" (parcel arrived 2 days before); referring to "Parcel_name_list_3" (parcel arrived 3 days before); referring to "Parcel_name_list_4" (parcel arrived 4 days before); and referring to "Parcel_name_list_5" (parcel arrived 5 days before). There are two counters with two separate queues for the searching Parcel_name_list process. After the students has got their parcel number, they will go straight to any available staff at the next counter of parcel collection and payment. There are two counters operate with two staffs for the parcel collection and payment process. At the parcel collection and payment counter, students will wait while the staff search the parcel at the storage place, and students make payment once the parcel received, and leave the UPC.

3.2 Model Verification and Validation

The developed simulation model is verified and validated before is used for analysis. Verification is performed to verify the developed model mimics real system. Whereas validation process defined as the process of reaching an acceptable level of confidence that inferences drawn are current and applicable in the real-word system being represented. Model verification and validation must be performed towards developed simulation model to assure the model are accurate and mimics real-world system [10];[11];[12];[13];[15]. In this study, the accuracy between the simulation output and actual output is evaluated. The number of replications in this simulation run is 5 times. As a result, the actual output in this case is 108 students and the simulation output are 99 students. Based on the validation formula, the result of 8.33% confirm that the model is valid as it in the range of ± 10%.

$$Model\ Validation\ = \frac{Simulation\ Output\ -\ Actual\ Output}{Actual\ Output}\ x\ 100\%$$

$$= \frac{99 - 108}{108} \, x \, 100\%$$

$$= 8.33\%$$

4 ANALYSIS AND FINDING

In 5 times replication, Table 2 summaries the output of maximum average waiting time in system, maximum average total time in system, maximum waiting time in queue, maximum number in queue, utilization rate of resources. The total production from the simulation is 62 (62.8) students out and 99 (99.80) students enter the system, meanwhile 37 students still work in progress (WIP). From Table 2, the average waiting time and average total time in system are 6.7499 minutes and 133165 minutes, respectively. The average number in queue for process searching parcel number 1 and process searching parcel number 2 are 7 (6.6679) students and 1 (0.7920) respectively. From Table 2, the utilization of "Parcel_name_list_1" and "Parcel_name_list_2" both are 0.9174 (91.741%). It reflects the fact that there are long queue and long waiting time. Therefore, it proves that it might be a bottleneck influence the students (customers) satisfaction towards UPC services performance.

Table 2: Summary of simulation output

Performance Measure	**Replication**					**Average**
	1	2	3	4	5	
Total Production	64	65	60	62	63	62.8
Waiting time in system						
Average Waiting time in system	6.9617	7.5705	7.0013	4.6333	7.5826	6.7499
Maximum waiting time in system	39.6183	52.8030	42.6921	22.7769	37.3909	52.8030*
Total time in system						
Average total time in system	13.2376	14.3967	13.9933	10.9547	14.0002	13.3165
Maximum total time in system	46.5461	61.1896	55.7070	29.3664	41.7961	61.1896*
Average waiting time in queue						
Searching Parcel_name_list_1	5.1679	5.9458	3.1598	2.4708	5.3703	4.4229
Searching Parcel_name_list_2	3.9991	1.8227	2.3931	1.5770	2.4196	2.4423
Parcel collection & payment 1	2.1743	3.6022	6.4760	2.5592	2.6816	3.4987
Parcel collection & payment 2	2.3275	3.9141	3.4556	2.7957	2.6079	3.0202

Maximum waiting time in queue						
Searching Parcel_name_list_1	65.798	50.829	12.949	18.550	35.190	65.798*
Searching Parcel_name_list_2	38.259	11.121	17.166	15.708	20.659	38.259*
Parcel collection & payment 1	12.694	23.951	42.076	22.504	20.551	42.076*
Parcel collection & payment 2	13.230	23.302	27.661	17.629	12.490	27.661*
Average number in queue						
Searching Parcel_name_list_1	4.8979	8.2408	12.199	3.3306	4.6713	6.6679
Searching Parcel_name_list_2	1.2693	0.62278	0.61823	0.56509	0.88504	0.79209
Parcel collection & payment 1	4.2376	4.9986	4.9043	3.1883	2.4908	3.9639
Parcel collection & payment 2	10.769	2.7769	4.8400	7.3204	3.9805	5.9374
Maximum number in queue						
Searching Parcel_name_list_1	9	17	22	11	16	22*
Searching Parcel_name_list_2	5	3	5	3	4	5*
Parcel collection & payment 1	12	16	10	9	6	16*
Parcel collection & payment 2	18	6	10	15	15	18*
Utilization						
Parcel_name_list_1	0.97241	0.90794	1.0000	0.78110	0.92562	0.91741
Parcel_name_list_2	0.97241	0.90794	1.0000	0.78110	0.92562	0.91741
Parcel_name_list_3	0.70526	0.75709	0.57123	0.73430	0.64391	0.68236
Parcel_name_list_4	0.70526	0.75709	0.57123	0.73430	0.64391	0.68236
Parcel_name_list_5	0.70526	0.75709	0.57123	0.73430	0.64391	0.68236
Staff_1	0.88393	0.96199	0.94235	0.90238	0.92562	0.92325
Staff_2	0.98709	0.95643	0.95687	0.90238	0.94025	0.94860

4.1 Alternative Development

The result of simulation output indicated that there is bottleneck in the system. Thus, we propose a few alternatives, and evaluate the system performance based on the alternatives. The alternatives are as follows:

- Alternative 1: Increase the capacity of "Parcel_name_list" up to two without generated a new counter.
- Alternative 2: Hire another one staff for parcel collection & payment counter.
- Alternative 3: Increase the capacity of "Parcel_name_list" up to two and hire one staff for parcel collection & payment counter together with generate a new counter for both counters, respectively.

From Table 2, the maximum number in queue at searching parcel number has 7 students. Thus, the first alternative is to increase the capacity at this process counter. The high utilisation rate for Staff_1 and Staff_2 makes we consider the second alternative which to hire additional staff for parcel collection and payment process. Lastly, for the third alternative, we add a new counter for both counter processes respectively, so students should be able to leave the system in the shortest total time in system. Table 3 to Table 5 depicts the simulation output for each alternative.

Table 3: Simulation output of Alternative 1

Performance Measurement (Alternative 1)	**Replication**					**Average**
	1	2	3	4	5	
Average Waiting time in system	3.9164	3.8309	4.0241	3.2895	4.2177	3.8557
Average Total time in system	10.429	10.480	10.246	9.6138	10.806	10.315
Utilization						
Parcel_name_list_1 & 2	0.75845	0.65862	0.70538	0.67745	0.74218	0.70842
Parcel_name_list_3 & 4 & 5	0.31615	0 .33514	0.32752	0.46445	0.35983	0.36062
Staff_1	0.93756	0 .97355	0.95550	0.87656	0.97544	0.94372
Staff_2	0.93454	0 .89019	0.96337	0.95455	0.91949	0.94372

From Table 3, it shows that the average waiting time in system significantly decreases from 6.7499 minutes to 3.8557 minutes. It proves that the by adding the capacity of "parcel_name_list" up to two has significantly affect the waiting time. The average total waiting time in system also decreases from 13.3165 minutes to 10.315 minutes. The utilization for "parcel_name_list_3 & 4 & 5" was not fully utilized which 0.36062 (36.062%). This might be due to the reason that mostly

parcels have been collected within two days' time. However, the other resources are fully utilized at the utilization rate 70% and above.

Table 4: Simulation output of Alternative 2

Performance Measurement (Alternative 2)	**Replication**					**Average**
	1	2	3	4	5	
Average Waiting time in system	6.1339	4.6653	5.3901	6.0709	3.3080	5.1136
Average Total time in system	12.696	11.024	12.227	12.783	9.8179	11.7096
Utilization						
Parcel_name_list_1 & 2	0.95273	0.92921	1.0000	0.88588	0.98049	0.94966
Parcel_name_list_3 & 4 & 5	0.81631	0.67819	0.77934	0.78057	0.83318	0.77752
Staff_1	0.85493	0.89057	0.90804	0.91537	0.91174	0.89613
Staff_2	0.70444	0.65597	0.64485	0.55060	0.55484	0.62214
Staff_3	0.49685	0.68182	0.91556	0.94313	0.72607	0.75269

From Table 4, by adding another staff at the parcel collection and payment counter, the average waiting time and the total waiting time in system are reduced significantly to 5.1136 minutes, and 11.7096 minutes respectively. However, the utilization of "Staff_2" is 0.62214, but utilization of other resources remains high which is 70% and above.

Table 5: Simulation output of Alternative 3

Performance Measure (Scenario 3)	**Replication**					**Average**
	1	2	3	4	5	
Average Waiting time in system	4.4283	2.3512	6.0117	6.2757	3.7582	4.565
Average Total time in system	11.060	9.1787	12.565	13.039	10.095	11.1875
Utilization						
Parcel_name_list_1	0.40973	0.31463	0.29351	0.37083	0.54546	0.38683
Parcel_name_list_2 & 3	0.24823	0.40071	0.32400	0.39796	0.43627	0.36143
Parcel_name_list_4 & 5	0.25807	0.23127	0.17893	0.09355	0.20936	0.19424
Staff_1	0.98967	0.90763	0.78629	0.90096	0.80010	0.87693

Staff_2	0.84378	0.63777	0.85355	0.75146	0.90663	0.79864
Staff_3	0.49685	0.68182	0.91556	0.94313	0.72607	0.75269

As for the third alternative, a new counter is added for both main processes. From Table 5, the average waiting time and average waiting time in system has been reduce from 6.7499 minutes, 13.3165 minutes to 4.565 minutes, 11.1875 minutes, respectively. Both waiting time reduced to 6.5666 minutes and 2.129 minutes, respectively. Even though the total time in system has significantly reduced, however, the utilization of all "Parcel_name_list" is not fully utilized, which the utilization rate at below 70%. Consequently, the utilization of the new added staff is below 70%.

Table 6: Result comparison based of alternatives.

Performance Measurement (Comparison)	**Alternative**			
	Initial	1	2	3
Average Waiting time in system	6.7499	**3.8557**	5.1136	4.565
Average Total time in system	13.3165	**10.315**	11.7096	11.1875
Utilization				
Parcel_name_list_1	0.91741	0.70842	**0.94966**	0.38683
Parcel_name_list_2	0.91741	0.70842	**0.94966**	0.36143
Parcel_name_list_3	0.68236	0.36062	**0.77752**	0.36143
Parcel_name_list_4	0.68236	0.36062	**0.77752**	0.19424
Parcel_name_list_5	0.68236	0.36062	**0.77752**	0.19424
Staff_1	0.92325	**0.94372**	0.89613	0.87693
Staff_2	0.94860	**0.94372**	0.62214	0.79864
Staff_3	-	-	0.75269	0.75269

Table 6 compares the simulation output for all alternatives conducted. Alternative 1 is the best alternative which significantly reduced the average waiting time and the average total time in system which is 3.8557 minutes, and 10.315 minutes, respectively. Thus, from the analysis and findings, the best solution is to increase the capacity of "Parcel_name_list".

5 CONCLUSION

Discrete event simulation has been employed in this research to model and simulate the parcel collection process at University Parcel Centre in Universiti Utara Malaysia. From early observation, the parcel collection process is a time-consuming process. Students must spend about maximum of an hour for parcel collection and payment process. Thus, a simulation model

is developed using Arena software, to identify the bottleneck in the current system performance. Later, a few alternatives are tested to improve the system performance at UPC. The findings show that the average waiting time, and the average total time is significantly reduced to 3.8557 minutes and 10.315 minutes respectively, by increased the capacity of "Parcel_name_list" resource. Findings from this study provides the UPC management to improve the overall system performance, and eventually increase the customer satisfaction level.

REFERENCES

[1] H. Sapiri, J. Zulkepli, N. Ahmad, N. Z. Abidin, and N. N. Hawari, *Introduction to System Dynamics Modelling And Vensim Software*. Sintok, Kedah. UUM Press, 2017.

[2] F. H. A. Rahim, N. N. Hawari, and N. Z. Abidin. "Supply & Demand of Rice in Malaysia: A System Dynamics Approach," *International Journal of Supply Chain Management*, vol. 6, no. 4, pp.1-7, December 2017.

[3] S. Madankumar and C. Rajendran, "A mixed integer linear programming model for the vehicle routing problem with simultaneous delivery and pickup by heterogeneous vehicles, and constrained by time windows," *Sādhanā*, vol. 44, no. 39, 2019, doi: https://doi.org/10.1007/s12046-018-1048-y .

[4] P. Özkan, S. Süer, İ. K. Keser, and İ. D. Kocakoç, "The effect of service quality and customer satisfaction on customer loyalty: The mediation of perceived value of services, corporate image, and corporate reputation," *International Journal of Bank Marketing*, vol. 38, no. 2, pp. 384–405, 2019, doi: https://doi.org/10.1108/IJBM-03-2019-0096 .

[5] S. Gumus, G. M. Bubou, and M. H. Oladeinde, "Application of queuing theory to a fast food outfit: a study of blue meadows restaurant," *Independent Journal of Management & Production*, vol. 8, no. 2, pp. 441-458, 2017, doi: https://doi.org/10.14807/ijmp.v8i2.576 .

[6] H. He and Z. Hu, "Analysis of Fast Food Service Capability Based on Flexsim Modeling and Simulation," *IOP Conference Series: Materials Science and Engineering*, vol. 394, p. 052005, 2018, doi: https://doi.org/10.1088/1757-899X/394/5/052005 .

[7] M. Z. H. A. Jalal, W. L. H. M. Desa, M. K. M. Nawawi, R. Khalid, R. Ramli, W. K. Abduljabbar, "Road Traffic Congestion Solution sing Discrete Event Simulation," *International Journal of Innovative Technology and Exploring Engineering*, vol. 8, no. 5S, pp. 53-57, 2018.

[8] R. M. Tahar, *A practical approach to computer simulation modelling*. Serdang, Selangor: Universiti Putra Malaysia Press, 2006.

[9] C. G. Panayiotou, C. G. Cassandras and Wei-Bo Gong, "Model abstraction for discrete event systems using neural networks and sensitivity information," in *2000 Winter Simulation Conference Proceedings (Cat. No.00CH37165)*, Orlando, FL, USA, 2000, vol.1, pp. 335-341, doi: 10.1109/WSC.2000.899736.

[10] M. H. Alhaag, T. Aziz and I. M. Alharkan, "A queuing model for health care pharmacy using software Arena," in *2015 International Conference on Industrial Engineering and Operations Management (IEOM)*, Dubai, United Arab Emirates, 2015, pp. 1-11, doi: 10.1109/IEOM.2015.7093849.

[11] T. C. Xian, C. W. Hong, and N. N. Hawari, "Modeling and simulation of queuing system for customer service improvement: A case study", in *The 4th International Conference on Quantitative Sciences and its Applications (ICOQSIA 2016)*, 2016, vol. 1782, no. 1. doi:10.1063/1.4966087

[12] H. Eskandari, M. Riyahifard, S. Khosravi, and C. D. Geiger, "Improving the emergency department performance using simulation and MCDM methods," in *Proceedings of the 2011 Winter Simulation Conference (WSC)*, 2011, pp. 1211-1222.

[13] N. Madadi, A. H. Roudsari, K. Y. Wong, and M. R. Galankashi, "Modeling and Simulation of a Bank Queuing System," in *Proceedings - 2013 Fifth International Conference on Computational Intelligence, Modelling and Simulation*, 2013, pp. 209-215.

[14] S. Sharifi, S. M. Sajadi, and M. M. Tavakoli, "Simulation process of Isfahan post office using Arena," *International Journal of Services and Operations Management*, vol. 17, no. 1, pp. 50-66, 2014, doi: 10.1504/IJSOM.2014.057995.

[15] J. Lim, N. Azriani and M. Nor, "Simulation by Queuing System at Immigration Department," *International Academic Research Journal of Social Science*, vol. 2, no. 1, pp. 112-119, 2016.

[16] D.-U. Kim, M.-S. Jie, and W.-H. Choi, "Airport Simulation Based on Queuing Model Using ARENA," *International Journal of Advanced Science and Technology*, vol. 115, pp. 125–134, 2018.