Simulation Driven Appointment System Model for a License Processing Office in the Philippines

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Abstract

Transportation is one of the necessities in our life today. Along with the increase in the number of cars and roads being made is the increase in the demand for driver's licenses. With the numerous land transportation offices, few issue new driver's licenses and therefore has to serve many applicants who exert a lot of time and effort to complete the application process which normally takes more than four hours to be completed. Time, being a very important factor in our daily decisions, is the concern of this study. This study aims to lessen the total time to complete the process and so is the minimum waiting time of 46% by designing an appointment system developed and tested using simulation and system improvement. Sensitivity Analysis was used to see how waiting time and running time was affected under various realistic circumstances. Results have shown a decrease in waiting time to 9%. To further improve the results of the study, research on the factors affecting and degree of punctuality of license applicants and change in the utilization employees after the application can be made.

Keywords
Simulation, promodel, driver's license application, appointment scheduling, waiting time

1. Introduction

Ease of transportation in a country is one of the signs of economic status. Each day, thousands of motor vehicles are being used to get to the destination, especially in capital regions. Private vehicle use has grown rapidly during the last decades and around 80% of these vehicles were primarily used for personal transportation, i.e., cars and motorcycles (Steg 2003). Along with the increase in the number of cars and roads being made is the increase in the demand for driver's licenses. In the Philippines, issuance of driver's licenses and renewals are under the jurisdiction of the license processing office. In 2015, a total of 1,424,410 permits and licenses (25 percent) were issued in the National Capital Region, according to the data from the License Processing Office Annual Report (2016).

There are three types of driver's licenses in the Philippines, which are student's permit, non-professional license and professional license. Based on the data from the license processing office, NCR has handled the most license cases with 26.6% of the total (LTO 2016). Not all branches handle the issuance of the new driver's license because of different limitations. As a result, more transactions are held in these few branches. Many people complain about the handling of the processes in LTO. Getting a driver's license means spending hours waiting to complete the process which is something that most people resent doing.

A lot of studies covered different techniques on how to lessen waiting time in queue. For every study, a different approach was used with different methods of analysis and testing was applied. In a study by Chen et al. (2015), a computer simulation software was used while Mashhour's (2008) Design of Experiments was used to test relationships of factors and derive optimal formulas. Zonderland et al. (2009), studied existing models and theories which were simply modified to fit the needs of a specific setting then applied simulation to see the effects on the performance indicators.

Government offices such as the Department of Foreign Affairs and National Statistics Office have long adapted the scheduling approach to shorten waiting times and length of the queue in the office. It uses an online appointment system to allow applicants to select their preferred time given the available periods or slots. Appointment system was initially used in healthcare (Walter 1973, Nara et al. 2010, Chen et al. 2015) but because of the growing demand for different kinds of services, it has been applied to different industries for better services and customer satisfaction (Creemers et al. 2010). While other government offices have already made use of the concept of combined information systems and queuing models in their processes, not all have fully adapted this. LTO still follows the simple rule of first come first serve.

This study aims to design a batch scheduling for the application of an appointment system and to apply and evaluate different scheduling rules on the setting of LTO. Its main objective is to reduce total waiting time by at least 25% and ensure completion of the application process within a day. Statistics show that the number of people acquiring driver's licenses is consistently increasing almost every year. Mondays and Fridays are the busiest days of the week (LTO 2016). The office can serve all the applicants for the renewal and permit but not for applicants for the new license. It used to take only a day to finish the application process for new driver's license but recent problems concerning capacity have arisen. Now, there is no more certainty that when a customer starts the process he/she will be able to complete it within a day. Gathered data show that even though applicants can complete it within the day, most of the time spent at the office is waiting time. The overall waiting time of applicants makes up an average of 64.01% of their time spent in the process.

2. Literature Review

Queuing affects any kind of business because it determines how efficient the business operates. Waiting Queue structures affect perceptions of how long the waiting time can possibly be. Rafaeli et al. (2002) examined the relationship between the design of a queue and the attitudes of people waiting. Customers may feel helpless in wait for the unknown duration or with unknown results (Peterson et al 1993). Single queue makes a person think more that the waiting time will be longer than waiting in a multiple server queue. The study of Zhang et al. (2000) compared two types of queuing systems, namely the single-channel and multiple channel queues. The single channel queuing which is normally used in banks and multiple channel queuing normally used in fast food chains were interchanged. The study only concludes that single server is more efficient but because of reasons such as space and customer reasons, multiple server is still preferred in fast food chains.

According to Shtrichman et al. (2001), analysis and simulation help even the army achieve savings and improvements in the quality of service. To solve the long waiting times of applicants in the army office, one of the changes made was the calculation of average service time spent at each station. During subsequent simulation runs, the arrival patterns and station data were changed. The patterns used were shortest-expected-waiting time. To consider bottlenecks, rerouting was done. Part of the recommendations was improving the layout to easily identify the desks where applicants should proceed to. An analysis of Queuing systems for the empirical data of supermarket checkout service is made in the study of Nafees (2007). The researcher tried to estimate the waiting time and length of queue and used queuing simulation to obtain a sample performance result and obtain estimated solutions for multiple queuing models. Other than these hours, there is a possibility of short queues in a model, hence no need to open all checkout counters for each hour. Increasing more than a sufficient number of servers may not be the solution to increase the efficiency of the service by each service unit.

Simulating systems have long been used in different industries such as healthcare, production planning, and offices. There are different performance indicators for every process. There is no one set of parameters and patterns that are used that can be applied in any industry or process because of the varying demands, process flow, capacities, costs, and priorities. The common problems that led to these studies are incapability to satisfy demand and excessive waiting time in the queue. While scheduling system is used mainly in service industries like healthcare, its concept is applied used in comparing the outcomes of patterns and determining the most beneficial one. Previous studies show that people's behavior is affected by the current state of a system when they arrive. Some of the factors that affect it are the importance of the process that they will undergo, perception of fairness on the process and length of queue upon arrival (Rafaeli et al 2003). Because of the varying and complex factors of a system, the derivation of seemingly optimal rules does not always produce optimal schedules. What appears to be the optimal solution for most cases is the combination of different rules and reorganization of the processes or steps in the system.

3. Methodology

Several random time observations were made in the system to gather data on the quantity of demand, arrival rate, waiting time and processing time. The time in and time out for every station were recorded using the stopwatch method to determine the amount of time being spent waiting and being processed in each step. The equation shown below is used in time study to determine the number of samples needed to acquire a certain level of confidence in the accuracy of the solved mean that will represent an important figure in the study.

$$n_0 = \frac{Z^2pq}{e^2} \tag{1}$$

Hypothesis Testing was done to validate the hypotheses as demand is higher on peak days and waiting time is longer. Distribution Testing was also performed to determine the distribution of applicant arrivals and processing times. The data were tested against Normal, Poisson and Exponential Distribution which are the common ones used in queuing problems.

Promodel is the simulation software used in developing and evaluating the system. It is used in the study to determine the effects of modifying the application process by analyzing the results produced by the software. Different schedules are simulated which are made by varying the batch size and the time interval for every batch and simulating different scheduling rules, namely shortest processing time, longest processing time and varying percentage of arrivals depending on time.

To evaluate the simulation of the current and proposed schedules, the following variables were identified: (1) average total waiting time, (2) number of people on queue and (3) total processing time. System improvement was done by analyzing and changing the sequence of steps in the process for improvement. Sensitivity analysis helped test the proposed system's robustness (Swenson et al. 2010) as possible delays in the system or changes in pattern happen to ensure the effectiveness of proposed changes. Hypothesis testing was done to ensure consistency of results.

$$\textit{Total time in the System} = \textit{validation} + \textit{picture and validation} + \textit{picture and signature} + \textit{cashier} + \textit{lecture} + \textit{exam} + \textit{approving} + \textit{releasing} \tag{2}$$

$$\textit{Waiting time} = \textit{Total time in the system} - \textit{Total Processing time} \tag{3}$$

4. Results and Discussion

4.1 Systems Model

The applicant must first visit the customer service window for validation of IDs and get the application form for a new driver's license. Many applicants come to LTO with an application form as it is available online for printing to save time. After filling up the form, the applicant will proceed to the medical testing area to have his/her vision and hearing tested. Any medical test from an LTO accredited medical testing centers are accepted. The medical testing area is not part of LTO so it is not included in the time study of the process. After the test, the applicant will go to Windows 18 and 19 for the verification, picture, and signature taking. This takes an estimate of 1.5 minutes. The next step is to go to the cashier to pay for the transaction fees. The cashier is shared with applicants applying for renewal, duplicate and other license-related transactions. The applicant can now go to the lecture and examination waiting area for his/her name to be called before he/she can enter. This step is supposed to be done by batch of 25. Applicants are given 120 minutes to review in the lecture room. When the time is up they are called to enter the examination room and take the multiple choice test. They are allowed to take the exam for 120 minutes. The applicants are allowed to submit their papers before the time. The papers are forwarded by batch (usually up to 15) to the checker. The exams are checked by a machine. They proceed to the practical driving test area where their skills in driving are tested. Very few applicants take the driving test. It is only applicable to those applying for manual vehicle restrictions and professional licenses. Then the approved applicant can now pay at the cashier once the name is called to pay for the driver's license. From the cashier, the documents are forwarded to the releasing window to process their license. The newly registered drivers will wait until their names are called to pick up their license at the releasing window.

To determine the allowable time range of arrival of applicants, the maximum time of the process was measured wherein the total processing time of the seven stations is 2.1 hours as shown in Figure 1. Simulating the process, the researchers used the Promodel software to determine the following parameters: simulation time, percent utilization, average total time in the system, average waiting time in every station, the total number of exits in every station and average contents of the stations.

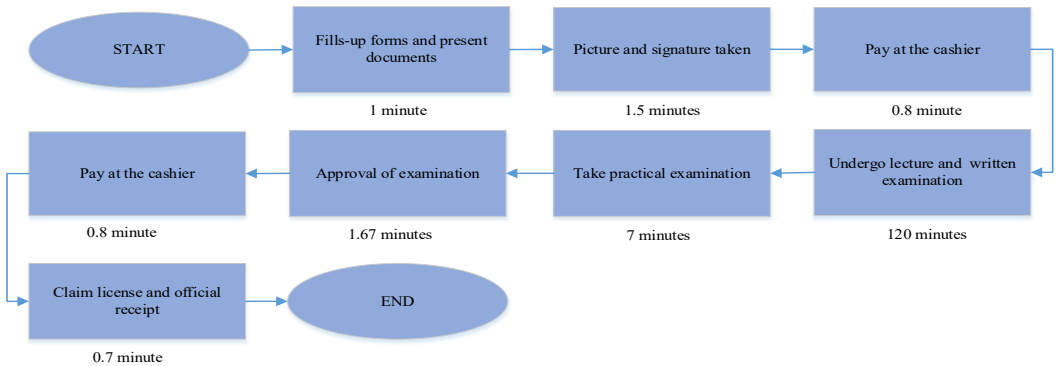

Figure 1. Current Application Process

Demand varies from day to day. The busy days are usually Mondays and Fridays. These are the days when there are applicants most likely unable to complete the process within a day. To prove the information acquired from the interview that there are more applicants on Mondays and Fridays, data for the number of applicants arriving acquired were classified based on whether they are the considered peak days, Monday and Friday or non-peak days, Tuesday, Wednesday and Thursday.

It was proven using statistical analysis that there is a significant difference in the quantities of arrivals on peak days and non-peak days. By performing T-test which is used to test the means of two samples, the hypothesis, that demand is higher on peak days (Monday and Friday) than non-peak days (Tuesday, Wednesday and Thursday), means that demand is not evenly distributed throughout the week causing high variability on the workload. A significant difference means that there is also a difference between the waiting times of applicants on these days.

. Table 1. Comparison Peak and Non-Peak Days Waiting Time

	TWT	Standard Dev	MF	Standard Dev
1	143	687.19	87	10491.61
2	78	1504.33	217	760.18
3	120	10.33	230	1646.04
4	110	46.05	185	19.61
5	70	2188.90	140	2443.18
6	171	2939.19	190	0.33
7	107	95.76	323	17841.33
8	202	7261.47	127	3897.33
9	110	46.05	209	383.04
10	111	33.47	190	0.33
11	81	1280.62	225	1265.33
12	93	565.76	110	6308.90
13	61	3112.05	226	1337.47
14	178	3747.19	193	12.76
Total	1635	23518.36	2652	46407.43
Mean	116.79	1809.10	189.43	3569.80
	$t_{0.05}$	**1.71**	**3.71**	*significant*

The behavior or trend of the arrivals of applicants for new, renewal and student permit were analyzed to simulate the real situation in the license processing office. The most common types of distribution test used in analyzing arrivals are Normal, Exponential and Poisson. Results showed that the arrival of applicants for new and renewal do not follow any of the mentioned distributions while the arrival of applicants for student permit follows the Poisson distribution.

Thus, after testing and failing the distribution tests normally used, the most convenient way to effectively simulate a system is by computing the percentage of arrivals per range of time. These percentages shall represent the number of arrivals for every hour in the simulation model. This is allowable as long as the simulated model will be proven accurate in reporting the simulation time of the system, total system time and waiting time of the applicants in the process.

In the present state, 12 applicants are taken-in in the lecture room. They seldom wait for the applicants to accumulate to 25, the maximum capacity of the room, especially during non-peak days because that will result in too much waiting time. Queues are always formed in the lecture room since applicants are not allowed to take the test one by one and have to accumulate and grouped before they are allowed to enter.

4.2 Promodel Simulation

The model was formulated starting with the creation of the layout of the licensing office to see the flow of events. The stations or windows, evaluation, picture and signature ampi, cashier, approving and releasing, are set as the locations of the model and the three kinds of applicants - new, renewal and student permit served as the entities. The number of arriving entities, their time of arrivals, processing times for each of the stations and the sequence of going to the stations was entered in the model as well. See the figure below for the complete listing of the model.

```
*****************************************************************************
*                                                                           *
*                        Formatted Listing of Model:                        *
* C:\Users\tin_s_000\Documents\THESIS TIME!\trial runs\henmanpuku\complete.MOD *
*                                                                           *
*****************************************************************************

  Time Units:                          Minutes
  Distance Units:                      Feet

*****************************************************************************
*                              Locations                                    *
*****************************************************************************

  Name                  Cap       Units Stats        Rules                 Cost
  --------------------- --------- ----- ------------ --------------------- ------------
  Validation            1         1     Time Series  Oldest, FIFO,
  Queue_Validation      INFINITE  1     Time Series  Oldest, FIFO,
  Queue_Cashier         INFINITE  1     Time Series  Oldest, FIFO,
  Cashier               1         1     Time Series  Oldest, FIFO,
  Queue_AMPI            INFINITE  1     Time Series  Oldest, FIFO,
  AMPI                  1         1     Time Series  Oldest, FIFO,
  Queue_Lecture         INFINITE  1     Time Series  Oldest, FIFO,
  Lecture               25        1     Time Series  Oldest, FIFO,  First
  Written_Examination   25        1     Time Series  Oldest, FIFO,
  Queue_Practical       INFINITE  1     Time Series  Oldest, FIFO,
  Practical             1         1     Time Series  Oldest, FIFO,
  Queue_Approving       INFINITE  1     Time Series  Oldest, FIFO,
  Approving             1         1     Time Series  Oldest, FIFO,
  Queue_Releasing       INFINITE  1     Time Series  Oldest, FIFO,
  Releasing             1         1     Time Series  Oldest, FIFO,

*****************************************************************************
*                              Entities                                     *
*****************************************************************************

  Name             Speed (fpm)  Stats        Cost
  ---------------- ------------ ------------ ------------
  New              150          Basic
  Renewal          150          Basic
  Student_Permit   150          Basic
  FAIL             150          Basic

*****************************************************************************
```

```
*****************************************************************************
*                              Processing                                   *
*****************************************************************************
                                     Process                          Routing
 Entity          Location            Operation                 Blk  Output          Destination         Rule
 --------------- ------------------- ------------------------- ---- --------------- ------------------- ------------
 New             Queue_Validation    Newt=CLOCK <>             1    New             Validation          FIRST 1
 New             Validation          WAIT 1                    1    New             Queue_Cashier       FIRST 1
 New             Queue_Cashier                                 1    New             Cashier             FIRST 1
 New             Cashier             WAIT 0.8                  1    New             Queue_AMPI          FIRST 1
 New             Queue_AMPI                                    1    New             AMPI                FIRST 1
 New             AMPI                WAIT 1.5                  1    New             Queue_Lecture       FIRST 1
 New             Queue_Lecture       IF ENTRIES<Queue_Lecture> > 120 THEN
                                     <
                                      ACCUM 7
                                     >
                                      ELSE
                                     <
                                      ACCUM 12
                                     >
 New             Queue_Lecture                                 1    New             Lecture             FIRST 1
 New             Lecture             WAIT 60                   1    New             Written_Examination FIRST 1
 New             Written_Examination WAIT T<40,50,60>          1    New             Queue_Practical     0.100000 1
                                                                    New             Queue_Approving     0.900000
 New             Queue_Practical                               1    New             Practical           FIRST 1
 New             Practical           WAIT 7                    1    New             Queue_Approving     FIRST 1
 New             Queue_Approving     IF ENTRIES<Queue_Approving> > 120 THEN
                                     <
                                      ACCUM 7
                                     >
                                      ELSE
                                     <
                                      ACCUM 8
                                     >
 New             Queue_Approving

                                                               1    New             Approving           FIRST 1
 New             Approving           WAIT 1.62                 1    New             Queue_Cashier       0.800000 1
                                                                    FAIL            EXIT                0.200000
 New             Queue_Cashier                                 1    New             Cashier             FIRST 1
 New             Cashier             WAIT 0.8                  1    New             Queue_Releasing     FIRST 1
 New             Queue_Releasing                               1    New             Releasing           FIRST 1
 New             Releasing           LOG "CYCLE TIME", NEWT
                                     WAIT 0.67                 1    New             EXIT                FIRST 1

 Renewal         Queue_Cashier                                 1    Renewal         Cashier             FIRST 1
 Renewal         Cashier             WAIT 0.8                  1    Renewal         Queue_AMPI          FIRST 1
 Renewal         Queue_AMPI                                    1    Renewal         AMPI                FIRST 1
 Renewal         AMPI                WAIT 1.5                  1    Renewal         Queue_Releasing     FIRST 1
 Renewal         Queue_Releasing                               1    Renewal         Releasing           FIRST 1
 Renewal         Releasing           WAIT 0.67                 1    Renewal         EXIT                FIRST 1
 Student_Permit  Queue_Cashier                                 1    Student_Permit  Cashier             FIRST 1
 Student_Permit  Cashier             WAIT 0.8                  1    Student_Permit  EXIT                FIRST 1

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```

```
Renewal        Queue_Cashier                          1    Renewal        Cashier            FIRST 1
Renewal        Cashier            WAIT 0.8            1    Renewal        Queue_AMPI         FIRST 1
Renewal        Queue_AMPI                             1    Renewal        AMPI               FIRST 1
Renewal        AMPI               WAIT 1.5            1    Renewal        Queue_Releasing    FIRST 1
Renewal        Queue_Releasing                        1    Renewal        Releasing          FIRST 1
Renewal        Releasing          WAIT 0.67           1    Renewal        EXIT               FIRST 1
Student_Permit Queue_Cashier                          1    Student_Permit Cashier            FIRST 1
Student_Permit Cashier            WAIT 0.8            1    Student_Permit EXIT               FIRST 1

*******************************************************************************
*                                  Arrivals                                   *
*******************************************************************************

  Entity         Location         Qty Each         First Time Occurrences Frequency  Logic
  -------------- ---------------- ---------------- ---------- ----------- ---------- ------------
  New            Queue_Validation 127; newcycle                1
  Renewal        Queue_Cashier    90; renewalcycle             1
  Student_Permit Queue_Cashier    1                180        60          P(4)

*******************************************************************************
*                                 Attributes                                  *
*******************************************************************************

  ID         Type         Classification
  ---------- ------------ ---------------
  Newt       Integer      Entity

*******************************************************************************
*                              Arrival Cycles                                 *
*******************************************************************************

  ID           Qty / %      Cumulative   Time (Hours) Value
  ------------ ------------ ------------ ------------ ------------
  renewalcycle Percent      No           1            32
                                         2            43
                                         3            11
                                         4            8
                                         5            6
  newcycle     Percent      No           1            20
                                         2            64
                                         3            14
                                         4            2
```

Figure 2. Formatted Listing of the Current System in Promodel

To prove the accuracy of the simulated model, a T-test was completed to determine if there was a significant difference in the actual system and the model's total process time. Results show in Table 2 that there is no significant difference between the times acquired through sampling and system times resulting from the Promodel. Thus, these analyses of variance assured that the model can very well represent the real situation, and accurate enough to be reliable in producing realistic and accurate outcomes.

Table 2. T-test Result on Actual and Model's Total Time

	Actual	std dev	Promodel	std dev
1	193	870.25	238.221466	0.33003932
2	176	2162.25	234.5308544	18.19109624
3	188	1190.25	237.31349	2.197706942
4	194	812.25	235.7814902	9.087007136
5	240	306.25	242.2345294	11.82378363
6	228	30.25	243.0894667	18.4342295
7	210	156.25	236.8751038	3.689675221
8	258	1260.25	234.6616505	17.09248627
9	248	650.25	237.1168364	2.819444454
10	290	4556.25	248.1346778	87.21171499
Ave.	222.5	11994.5	238.7959565	170.8771837
		36.50646822		**4.357333329**
	$t_{0.05}$	-1.401645936	< 1.734	Reject
				no significant difference

4.3 Systems Improvement

4.3.1 Application Appointment System

To implement the system without the use of an Online Appointment System, applicants can call the nearest LTO branch and give their selected time of arrival based on the appointment schedule and the quantity. The only requirement for this proposal is a receptionist who will be receiving the calls and entertaining the inquiries about the schedule. In appointing the arrival time of the applicants, the aim was to lessen the queue lengths as short as possible and this could only happen if the arrival times were varied to prevent them from coming at the same time. A

combination of varying batch arrival size and accumulation quantity was simulated to see their individual and combined results. The table below shows the effect of internal batching on applicant processing. Results showed that an arrival size of 5 and accumulating 5 applicants at each step in the process results in the shortest waiting time of 34 minutes, thus making this accumulation size the best option in standardizing the system's internal procedure.

Table 3. Results of Batched Arrivals

Internal batching						
Qty Each	Occurences	Frequency				
Accum of 25			Running time	Avg Total Time	Avg Waiting Time	% waiting time
25	5	60	9	234	110	47
				203		
Accum of 15						
3	42	8	8.62	195	72	37
5	25	14	8.7	191	70	36
8	16	22	8.84	193	70	36
10	13	27	8.83	192	69	36
13	10	36	9.11	199	75	38
25	5	60	9.17	223	99	44
				198.8		
Accum of 10						
3	42	8	8.49	181	59	32
5	25	14	8.46	174	52	30
8	16	22	8.73	178	55	31
10	13	27	8.76	175	53	30
13	10	36	8.95	180	58	32
				177.6		
Accum of 5						
Qty Each	Occurences	Frequency				
3	42	8	8.31	163	41	25
5	25	14	8.24	156	34	22
8	16	22	8.41	159	37	23
10	13	27	8.49	160	37	23
13	10	36	8.62	160	37	23
25	5	72	8.79	158	36	23
				159.3		

4.3.2 Rerouting of Stations

The researchers also tried to evaluate if changing the sequence of the application process will have a significant effect on the reduction of waiting time. Stations that cannot be interchanged and have to be consecutively sequenced were taken into consideration. The figure shows the feasible pattern generated.

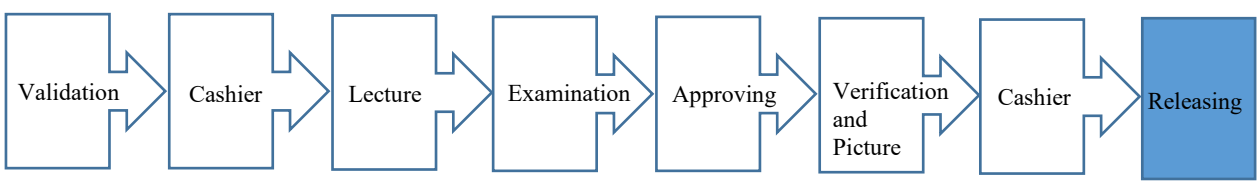

Figure 3. Propose Flow of Application Process

In the current application process, applicants' picture and signature are taken at an average of 1.5 minutes before they proceed in taking the examination. In this step, new and renewal applicants share the same location which creates a long queue. This step is unnecessary for 20% of new applicants who failed the written test and do not qualify to get a license. This will automatically reduce the number of applicants that will go through Picture and Signature AMPI therefore, it was placed on the latter part of the process. With all factors consistent and applying this change of route, from the normal average waiting time of 112 minutes, it was effortlessly reduced to an average of 83 minutes showing a significant difference of 29 minutes. The simulation time or running time of the process also decreased from 8 hours to 7.88 hours.

4.4 Effectiveness of Proposed Changes

The final model consists of the following improvements: (1) standardizing the batch processing to a maximum accumulation of 5, (2) 14 minutes of inter-arrival time per batch, and (3) changing the route into Validation - Cashier - Lecture - Examination - Picture and Signature AMPI - Cashier - Releasing. These are the results of selecting the best time based on the criteria: waiting time, total time in the system and simulation time.

Table 4. Effect of System Changes

	Running time (hr)	Avg Total Time	Avg Waiting Time	% waiting time
Present	8.09	231	108	47
Rerouting	7.88	216	83	38
Rerouting & Appointment	8.2	140	9	7

The model was run and replicated 15 times to check its precision and accuracy as well as verify its stability. With a 90% confidence level and within the allowable error of 5%, the required number of samples was determined to get a reliable mean of 1. Thus, having performed 15 runs is enough to prove the effectiveness of results acquired in the study, shown in the table below.

Table 5. Validation of Results for Waiting Time

	Avg Time Waiting (MIN)	std dev
1	11.2	0.8
2	12.3	0.0
3	11.1	1.1
4	11.8	0.1
5	11.6	0.3
6	11.3	0.6
7	14.1	3.9
8	11.6	0.3
9	12.4	0.1
10	12.7	0.3
11	12.7	0.3
12	12.1	0.0
13	11.6	0.3
14	13.4	1.7
15	12.1	0.0
total	182.1	10.0
mean	**12.1**	0.8

4.5 Sensitivity Analysis

In reality, people do not always arrive exactly on time. It is natural to be a few minutes late or earlier. An appointment system can only be affected by the degree of lateness on the arrival of applicants, so it is important to consider the applicants' *natural* lateness. Since there is no system downtime, this is the only expected reason for the delay in the process. The table below shows the comparison between the original (the proposed system) and its variation considering different instances. The first case is having a delay by one hour in the arrival of the first batch, thus, they all accumulate in the second hour. The second case is maximizing the longest step in the process which is the

Examination. It was maximized to one hour for all applicants resulting in finishing the test by members of a batch at the same time. The third case is having a delay by one hour in the arrival of the first batch and the last batch. The first case worsened by adding a delay at the later part of the process to see how badly it affects the simulation time.

Table 6. Results of Different Delays on System

					ORIGINAL				First batch Delayed by 1 Hour				Maximum Written Exam of 1 Hour				First and Last Batch Delayed by 1 Hour			
ACCUM 5					Running time	Avg Total Time	Avg Waiting Time	% waiting time	Running time	Avg Total Time	Avg Waiting Time	% waiting time	Running time	Avg Total Time	Avg Waiting Time	% waiting time	Running time	Avg Total Time	Avg Waiting Time	% waiting time
10	10	10	20	50	8.55	176	53	30	9.5	171	49	28	8.62	180	48	27	9.49	182	50	27
5	5	20	20	50	8.68	186	61	33	9.51	173	51	30	8.62	183	51	28	9.52	182	49	27
10	10	20	20	40	180	56	31	132	9.14	159	37	23	8.25	170	38	22	9.15	170	37	22
ACCUM 5																				
5	25	14			8.24	156	**34**	22	8.82	132	**11**	9	8.2	140	**9**	7	8.71	160	27	17
8	16	22			8.41	159	37	23	8.86	136	16	11	8.34	146	15	10	8.8	150	19	13
10	13	27			8.49	160	37	23	8.76	135	14	11	8.38	145	14	9	8.83	149	**18**	12
13	10	36			8.62	160	37	23	8.94	140	19	14	8.71	151	19	13	8.91	156	24	15
25	5	72			8.79	158	36	23	8.55	147	26	18	8.9	159	27	17	9.51	161	28	18
ACCUM 10																				
5	25	14			8.46	174	52	30	8.91	148	27	18	8.3	157	25	16	8.84	172	40	23
8	16	22			8.73	178	55	31	9.1	154	33	21	8.56	163	31	19	8.97	166	34	20
10	13	27			8.76	175	53	30	9.02	150	28	19	8.58	157	25	16	9	166	34	21

The best models chosen were all from accumulating 5 while varying arriving batch quantities which were 5, 8 and 10.

5. Conclusion

In a system where applicants arrive on their preferred schedule, there is a possibility of not being able to finish the process and be asked to come back on the next day or not being accommodated at all. Unscheduled arrival also renders applicants to longer process and waiting time. In the current license application process, waiting to be accommodated in the lecture room and approval station brings the highest waiting time in the system with an average time of 68 minutes and 20 minutes, respectively. With the proposed system, only 6 minutes on the average will be the waiting time of each applicant for the lecture and 9 minutes for the approval, while time in queue for validation is 0.33 min, 1.26 for Picture and Signature AMPI, 0.28 min for cashier, 2 min for approving and 0.11 min for releasing.

To achieve this, the application and evaluation of different scheduling rules on the process were done by varying the arrival batch size, accumulation size, changing the arrival sizes depending on time and changing the distribution of arrivals in these schedules. The study was able to decrease the waiting time by more than 25% and ensuring the completion of the process on the same day of starting the process. With the improved model, with the same quantity of applicants being accommodated, time in the system was reduced by evenly distributing arrivals giving room for more applicants, as having a fixed arrival schedule gives the applicants knowledge of the allowable arrival times.

To strengthen the accuracy of the results of the study and improve the schedule to better suit the time preferences of applicants coming in LTO, it is recommended to have research on the factors that affect their time of arrival, delay, and decision on their planned time of arrival. For future studies, the information system for the appointment system can be made. A more detailed study can also be made about the idleness of employees and the effect of having noon break and identify if other internal factors can attribute to the present waiting time and possibly affect the proposed model. A detailed study on the behavior of the demand for license processing for all kinds of the license can also contribute to helping better understand the reasoning behind the arrivals of customers, thus establish even more stability and better prediction of demand for the process.

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