An Adaptation of Industry 4.0: Comparison between the Implemented Queuing System of Land Transportation Office and Proposed System Applying Monte Carlo Simulation, Lean Management, and Analytical Hierarchy Process Method

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Abstract

Land Transportation Office (LTO) is the agency in the Philippines responsible for the issuance of licenses and permits. Queuing time has been a major issue faced by the agency for several years due to processes that were unnecessary that prolong the waiting time of a customer. The current queuing system implemented by the LTO, after numerous complaints, turns out to be ineffective and inefficient. This study aims to assess and modify the current queuing system implemented by the LTO for the renewal of license and to propose a simulated procedure as a conceptual implementation of the proposed queuing system. Lean Management was used to dissect the processes and to eliminate unnecessary steps in the current queuing system. The researchers applied both actual and optimized data in Monte Carlo Simulation to compare the current system from the proposed change. After comparing the results using paired t-test, the study concluded that there is a significant difference between the current queuing system and the proposed queuing system. Furthermore, Analytical Hierarchy Process (AHP) Method helped the researchers compare the criteria that impact the system. The development of the website, removal of waste-considered processes, and substitution of value-added procedures from a no-value added steps helped reduce the time spent of a customer for the renewal of the license.

Keywords

Land Transportation Office, Lean Waste Management, Monte Carlo simulation, Analytical Hierarchy Process, queuing time

1. Introduction

1.1 Background of the Study

Products are either given to consumers in output in terms of goods that are tangible or services that are intangibles. In the sense of services, its characteristics, as being of high quality is difficult to evaluate. This is because services are delivered through decision-making procedures, and under public sectors such as government agencies, which are ruled over by strict laws and regulations (Ocampo et al., 2017). Likewise, government agency throughout history handles a major role in promoting the general welfare of a country. Government agencies are responsible for processing perhaps the most important and fragile documents, hence requiring enough and efficient ways of performing such duties. The development, which can be referred to as work quality is the key determinant in improving a public sector in terms of effectiveness and efficiency. Quality customer service has become among the most pressing issues discussed and pursued in the public and corporate arena (Rashid, 2008). The speed of service, which is a major problem in the Philippine government, reflects how efficient the system is by which affects customer satisfaction.

With the huge population that the Philippines has, it would be necessary to provide efficient ways in performing the government official and staffs' duties. According to the study of Larson (1987), effective queue management makes the customers feel better; thus, resulting in good service feedback and giving the customers another reason to come back. One of the essential techniques in achieving the successes of a business is to implement a good queuing system. An inefficient queuing system that causes delay can affect the customer's attitude and view towards the establishment. According to the annual report released by the LTO (2017), the government agency processed an average driver's license of about 5,633,853 licenses from the year 2012 to 2017. This calls for a more efficient queuing system. People who wanted to have their own driver's license waited for hours, which means the current queuing time of the Land Transportation Office (LTO) is inefficient. Indeed, the processing of a driver's license with so many options is a painful task, that is why creating systems and instruction that lessens effort and usage of resources will help reduce difficulty in service. The current trend, which is Industry 4.0, is the fourth industrial revolution that envisions automating almost everything with minimal participation of employees in the workplace to have an easy and efficient system for processing (Dadios et al., 2018). Due to this future adaptation, the LTO could be able to adapt the system change starting from a small expansion. This will be done by the implementation of automation in the renewal processing of licenses.

1.2 Gap of Missing Information

The inefficiency of waiting for line management in a government agency was covered in the study of Capulong et al. (2017). Their study showed the significant differences between the proposed solution, which recommends an online application, and the existing queuing system of the Philippine Statistics Authority (PSA). From the study, it can be claimed that government agencies need further observations and improvement. The LTO has an online system for reservation and scheduling of visits. However, according to the LTO Directory (2020), there are only 19 out of 174 district branches nationwide that offer online appointments. Moreover, LTO released a public advisory notifying that customers should be aware of the expected downtime and system glitch as which can cause delays and postponed appointments (LTO, 2019). Thus, the new system needs improvement. In Industry 4.0, the system could be automated and be done at the convenient time and place of the client. Rather than having to wait in line for hours, clients may finish all requirements without the need of going to the branch by online processing and would be catered with a schedule to surrender the old license and obtain the renewed version.

1.3 Objectives

The main objective of this study is to reduce the queuing time and modify the process used by the Land Transportation Office in renewing drivers' licenses. The specific objectives of this study are as follows: (1) to assess the current performance of the LTO in terms of waiting time and process time, (2) to determine factors that affect the speed of queuing time, (3) to propose an effective queuing system that will reduce the queuing time for issuance of renewal license, (4) to apply tools such as Lean Waste Management baseline, Value Stream Mapping, takt time, and Monte Carlo Simulation on both systems to determine if there are any improvements (5) to compare the results of the proposed change to the original process based from the Monte Carlo Simulation to see if there will be any significant differences using paired t-test, (6) and to utilize Analytical Hierarchy Process (AHP) method for the quantification of criteria and alternatives.

1.4 Significance of the Study

The useful and relevant information acquired from the study can be beneficial for the agency itself since the data and information gathered are all based on the performance and actual data from the specific agency. Information found on the study can be used as related literature for future similar studies and the data can be used as a basis for possible implementation by the government. Also, the result of this study would be of help in minimizing queuing time for other processes in the government. Moreover, this study could be used as a baseline for future research involving the reduction of queuing time in a service operating industry.

1.5 Scope and Limitations

The study focused on improving the existing queuing system used by the LTO in the renewal of licenses. The actual data included in the study was observed for one day (Monday) since the researchers used a simulation and do not need further data collection. The researchers only based the actual data on LTO's branch in San Juan District Office and in the official annual report released by the LTO. The researchers applied Lean Management on both the current and proposed systems to identify unnecessary processes that may be done using a different approach. Takt time was only used to determine the possible number of customers that can be catered if the proposed change was

implemented. Monte Carlo Simulation was also applied to the said systems and used paired T-test as a statistical tool to determine the efficiency and effectivity of the current and proposed system. For the demonstration of the proposed solution, only a sample procedure or prototype of the instrument will be presented by the researchers, and no costing was included in the study.

2. Literature Review

According to the Land Transportation Office (LTO) (2016), the agency holds the responsibility of adjudicating the traffic cases, collecting the revenues for the government, enforcing the land transportation rules and regulations, inspecting and registering motor vehicles, and issuing licenses and permits. According to the Land Transportation Office reports from 2013 to 2017, despite having the least number of requirements, still, there were more new license applications than license renewals. Renewal of driver's license only requires the duly accomplished application for driver's license and a medical certificate stating that the applicant is mentally and physically fit to drive. Issuance of renewal of driver's license consists of five procedures: getting a queue number, submitting all the documents required, photo taking and signature taking, paying all the charges and fees, and claiming the card (LTO, 2017). However, these procedures have problems in building up queues that make the queuing time even much longer.

Queuing time throughout the years became somewhat a focus field of research since it is the commonly encountered conflict by different companies and agencies. Queuing time is the time allotted to a certain task or can be considered as the waiting time needed to perform an action. The queuing management is responsible for monitoring the efficiency of a queuing system (Larson, 1987). The efficiency of a queuing system reflects the customer's satisfaction, thus requires agencies, companies, incorporations, and others to provide an effective queuing system. Thus, having a good queuing system would give the agency a better image and would also lessen the negative feedbacks about their services. According to the study of Janita and Miranda (2018), in recent years, there is an increase in recommendations in the global associations that encourages the Governments to install the innovative technologies in their system to lead the modernization of the Government and to improve the transparency and their services to the public. Lean Management, as the most effective methodology intended for process development, maybe a great instrument as management modifies or improves their current system (Urban, 2015). And one of the most essential aspects of Lean Production and Management is Takt Time. Takt Time is the maximum time allotted for each process to satisfy the customers' demands (Carr, 2016).

According to Zezulka et al. (2016), people should know the abilities and what Industry 4.0 can contribute to different fields since it is already introduced in different types of systems. Industry 4.0, as a new industrial step, maximizes the capabilities brought by technology. However, before the implementation of new processes, a simulation is needed to be done. According to Hosseinpour & Hajihosseini (2009), simulation is an assumption of tasks and settings that it is in the real world. Simulation is said to be applied and practiced in many different forms of processes or methods. It helps in observing and stating the behaviors of an existing system.

The Monte Carlo Simulation is the compatible simulation that can be used in the study since it is used to compute for the probability of success and failure towards a certain topic, whether an applied variable has a significant difference with the existing system (Harrison et al. 2018).

Apart from generating results for complex methods, it is essential for companies or any kind of service provider to identify which among the possible methods will be more effective and beneficial for the company and its consumers. In this case, the application of the Analytical Hierarchy Process (AHP) method is utilized to determine which among the alternatives is more beneficial and suitable for a given situation (Brunelli, 2015). In the same article, it mentioned that the utilization of AHP requires criteria or subjective judgments in the decision analysis to identify which alternative is more efficient and effective.

3. Methods

3.1 Conceptual Framework

This study used a descriptive-comparative approach since two variables are examined and analyzed. Application of Value Stream Mapping, Lean Waste Management Baseline, and takt time were constructed since the modifications applied on the system were based on the findings and recommendations from Lean Management. The Value Stream Mapping was used to demonstrate the dissected flow or process as well as the operation time and activity ratio of the workers. On the other hand, the researchers utilized the Lean Waste Management Baseline to determine the unnecessary processes to eliminate wastes. Lastly, takt time served as a basis in determining the minimum number of customers that can be catered to in the obtained lead time. The improvements done on the system were only a design proposed by the researchers, thus the data used in the proposed change were only based on the gathered data with the current queuing system implemented by the agency. With that, the researchers created a comparison using the

historical data of the current queuing system of the LTO and utilized this in the Monte Carlo Simulation (MCS). The actual data gathered were the basis of the frequency table and generated random numbers using different methods. Generating random numbers is necessary since these values are the key component applied in MCS, then underwent Chi-Square test to prove that the set of random numbers are acceptable to represent true values. There are two MCS included in the study, one is for the current queuing system and the other is for the proposed queuing system. A statistical treatment, specifically paired t-test, was necessary to help determine if there are any significant differences between the two variables. Providing a sample procedure or prototype of the proposed queuing system was essential to help understand and visualize how the recommended system works. Furthermore, the application of the Analytical Hierarchy Process (AHP) method was done to compare the current and proposed system in terms of selected criteria.

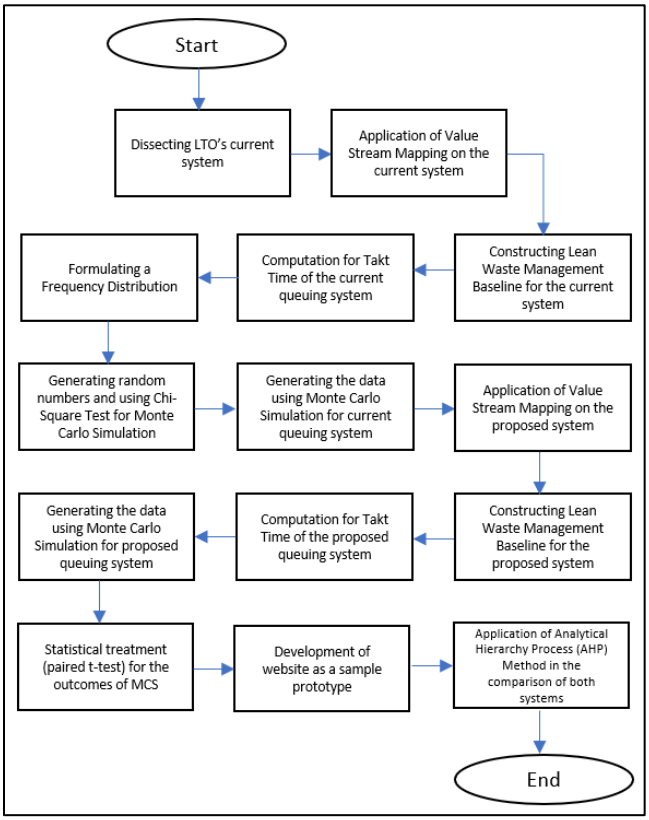

Figure 1. Conceptual Framework

4. Data Collection

On gathering the actual data, the time spent of the customers on every window or step was observed and recorded. The researchers applied a time and motion study to successfully obtain the data required in this study. The data gathered were the actual time at the start and end of every window. The obtained time from the end of the previous window to the start of the succeeding window was subtracted to get the waiting time of a specific customer, and the end time and start time of the same window were subtracted to obtain the customers' process time.

5. Results and Discussion

5.1 Graphical Results

The LTO's current processes involve the customer arriving at the branch, taking his queue number at the guard as step 1, then proceeding to window 1 for the passing of requirements as step 2. The 3rd step would be the photo and signature taking in window 3. Afterward, step 4 would be the payment in window 6. Next would be the re-evaluation of the information given by the customer which will serve as step 5. Finally, the last step would be the release of the renewed license which is also done in window 1. The process flow is seen in the Value Stream Mapping in figure 2.

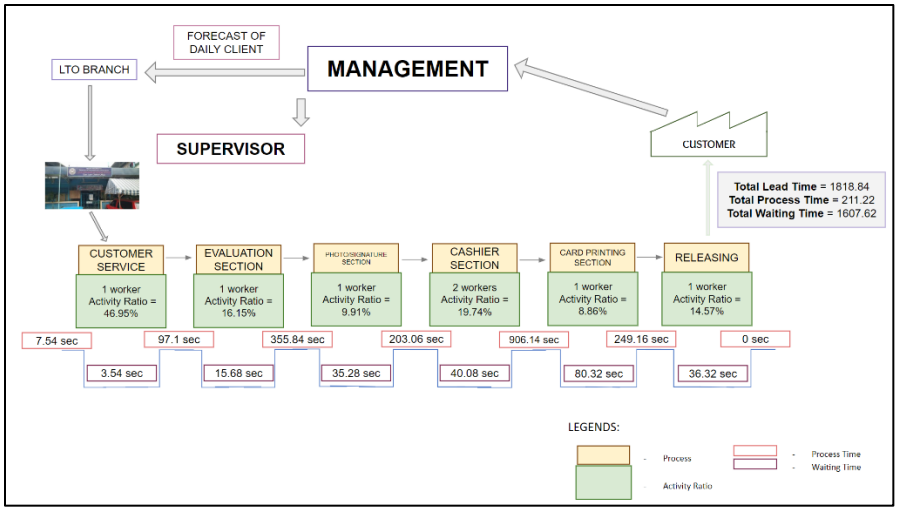

Figure 2. Value Stream Mapping of the Current System in LTO

Figure 2 shows that the total lead time, which is the total time of process time and waiting time, is 1818.84 seconds, the total process time is 211.22 seconds, and the total waiting time is 1607.62 seconds. This means that a single customer is expected to spend around 30 minutes in the whole system to finish the renewal of the license. However, the longest time an applicant had encountered to renew a license was 18787 seconds, or 5.2 hours, including the completion of documents, issuance of queue number, evaluation of documents, encoding of the information, taking of photo, signature and biometrics, payment, and printing of license cards. This inconsistency signifies that there is really a problem in the system of the LTO. The Value Stream Mapping also showed the Activity Ratio per window. This shows the percentage of the process done by the workers in the specific window. Having a very small result shows that a customer spends more time waiting. In addition, almost all windows are fully operational since there are only 6 windows available despite having 13 processes. As a result, there are multiple tasks done per window or step that the branch thought would help to lessen queuing time.

Taking the whole process into account, takt time was used to indicate that the LTO must at least serve 200 customers per day in a span of 8 hours. This shows that the takt time per customer should be 144 seconds or less to be more efficient and effective. It is evident in figure 2 that workers and staffs spend a total of 211.22 seconds for a single customer.

$$Takt\ time = \frac{net\ time\ available\ for\ work}{customer\ demand\ in\ that\ time} \quad (1)$$

$$Takt\ time = \frac{8\ hours\ x\ \frac{60\ mins}{1\ hr}\ x\ \frac{60\ sec}{1\ min}}{200\ customers}$$

$$Takt\ time = 144\ seconds\ per\ customer$$

Lean Waste Management Baseline was used to clearly present the detailed process of how a license is renewed. By this method, waste, no value-added, and value-added processes can be clearly determined. Wastes do not change or contribute to production. They take time in the process, but no value is considered in their process. On the other hand, no value-added are processes that do not have value but are still essential to complete the service, and value-added are processes that are necessary (Taylor, 2018).

First Baseline					
Waste	No Value Added	Value Added			
	Where?	Who?	What?	Time?	Value?
	Customer Service (ENT)	Guard	Lines up for the checking of documents	4 sec	
			Check completeness of documents	2 sec	
			Issue queuing number to applicants	1.54 sec	
			Lines up for the submission of documents	81.42 sec	
	Evaluation Section (W1)	Inspector Aide	Evaluates documents presented	15.68 sec	
			Encodes txn at the LTO-IT system	320.56 sec	
	Photo/Signature Section (W3)	Staff	Takes photo	26.11 sec	
			Takes signature for LTO-IT system	9.17 sec	
			Completes the customer's information	162.98 sec	
	Cashier Section (W6)	Cashier	Receives payment for license fees	40.08 sec	
	Card Printing Section (W1/W2)	Staff	Encodes DL data at DERMALOG system	825.82 sec	
			Takes photo	34.6 sec	
			Takes signature	22 sec	
			Takes biometrics	23.72 sec	
			Prints license cards	212.84 sec	
	Card Releasing	Staff	Releases cards	36.32 sec	
				Total time: 1818.84 sec	

Figure 3. Lean Waste Management Baseline of the Current System in LTO

As seen in figure 3, there are a lot of processes that need to be eliminated. Some processes are repeated steps thus, do not help, rather these processes cause delays and prolong the waiting time of a customer.

5.2 Numerical Results

Moreover, the study used Monte Carlo Simulation (MCS) as a statistical and simulation tool to determine possible results. Since the proposed system is not yet implemented, the MCS allowed the researchers to compare both systems as it only requires historical data that can be a basis for the applied random numbers which will then represent the performance of both systems. In the MCS, researchers used seconds as a unit of measurement when identifying and discussing time and were divided to 10000 to have a higher significant figure in the simulation (Chen et al., 2015).

Table 1. Monte Carlo Simulation for the Current System

Results of MCS for Actual Procedures	
Average time spent in the system	8008.2 seconds
Average waiting time	6679.68 seconds

Afterward, the researchers computed the average time spent in the system by dividing the sum of service time by the sample size. As seen in Table 1, the results showed that an average waiting time of 6679.68 seconds or 1.86 hours is idle by customers before being catered, and an average of 8008.2 seconds or 2.22 hours is spent by customers on the whole system.

The researchers first applied statistics to compare the gathered data and data produced by the MCS of the current system on Windows 1, 2, 3, and 6. Since all the two-tailed t-test of each window showed the same conclusion, the researchers used one window as a sample comparison. Upon the computation, the results of the four windows accepted the null hypothesis since the t-value is less than the critical value, which by condition means that there is no significant difference between the variables. This indicates that the random numbers produced and were used in the MCS had a uniform distribution, this means that the set of values are acceptable to represent the real value data. The results were also the same in the comparison of the current data and proposed data in window 1 and releasing. This indicates that the MCS of the current system is acceptable as well to represent the results of the actual procedures.

5.3 Proposed Improvements

The researchers created a website as a prototype for the implementation of the new queuing system. With this, it would be easier to understand and visualize the difference between the two systems in terms of procedures and application. In the recommended change, applicants of renewal of the license will be able to lessen their processes inside an LTO branch by using the website. As shown in figure 4, customers will be able to renew their licenses online.

Figure 4. Land Transportation Office Website for the New Queuing System

Customers would have access to submitting their online application form, as well as paying the required amount of payment using different payment methods. By this, they would be experiencing only necessary processes inside an LTO branch such as the photo, signature and biometrics taking, evaluation section, and release of their licenses. Moreover, the new system will work as a client-server. The clients or the customers would be submitting requirements online and will be received by local servers or the workers inside an LTO branch. After receiving the data, they will be transmitting this towards the central server. The central server will serve as the distributor of information to all the local servers so that any branch can access the information gathered by other local servers nationwide. However, the clients will be restricted in accessing the information collected by the servers. This system will help LTO to easily receive and send data to other branches. The creation of the website along with its database is an example of adaptation to Industry 4.0. The automation simulated by the researchers lessens human efforts since certain procedures like the submission of requirements can be done online. This new approach towards a queuing system not only lessens human efforts but also showed how effective the idea of Industry 4.0 is since technology can handle a large amount of data and procedures.

The completion of Lean Management and Monte Carlo Simulation helped the researchers predict the expected performance of both systems and aided in determining which among these systems are more effective. These two instruments showed the differences in values and dissected the processes of the two systems to show their efficiency. For the results of Lean Management, the proposed solution improved the current system of LTO as they can cater to more customers within their specific working hours. The conditions that apply for the changes are the dissemination of rules for the photo taking, coordination of payment collection industries with the LTO Management so customers can hand their payment through different payment facilities and centers, centralization of the server so they need not encode the information repeatedly, and submission of documents through the online site of LTO.

Second Baseline					
Waste	No Value Added	Value Added			
	Where?	Who?	What?	Time?	Value?
	Customer Service (ENT)	Guard	Issue queuing number to applicants	1.54 sec	
			Lines up for the submission of documents	81.42 sec	
	Evaluation Section (W1)	Inspector Aide	Evaluates documents presented	15.68 sec	
			Encodes txn at the LTO-IT system	320.56 sec	
	Photo/Signature Section (W3)	Staff	Takes photo	26.11 sec	
			Takes signature for LTO-IT system	9.17 sec	
			Completes the customer's information	162.98 sec	
	Card Releasing	Staff	Releases cards	36.32 sec	
				Total time: 653.78 sec	

Figure 5. Lean Waste Management Baseline of the Proposed System in LTO

Through this, time-consuming yet unnecessary processes have been eliminated as well as processes that could be done through alternative methods as seen in figure 5. It is noticeable that from the first baseline which has 13 processes, the total processes in the proposed system were lessened to eight processes. As seen in the new Value Stream Mapping in Figure 6, there are only four distinct major processes in the system. With that, the researchers were already able to decrease the total time spent by a single customer inside the LTO branch. It is evident that the proposed system will be of great value having the value-added time decreased from 211.22 seconds in the original Value Stream Mapping in figure 2 to 88.82 seconds in Figure 6, a 58% improvement.

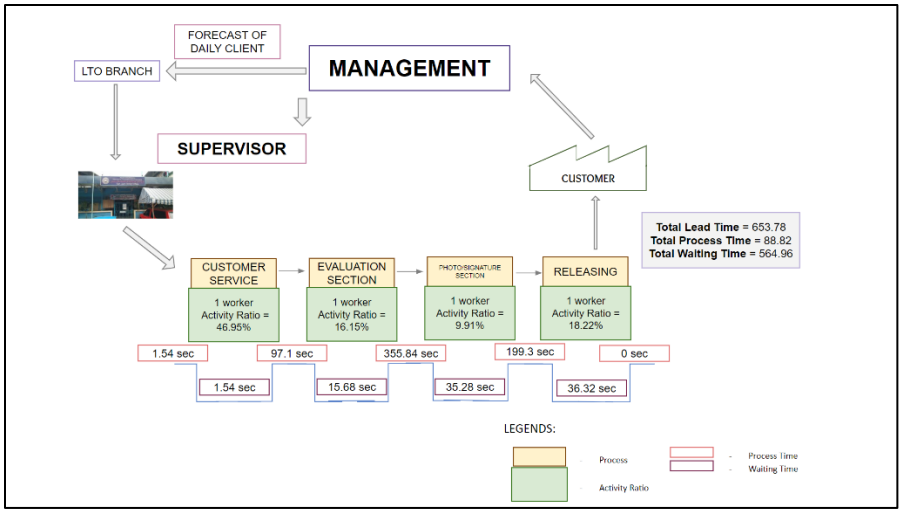

Figure 6. Value Stream Mapping of the New System

This dramatic decrease showed how time-consuming the excluded processes of the current queuing system used by the LTO are, compared to the proposed queuing system of the researchers. Based on figure 6, it is expected that the modified system will save a total of 122.4 seconds in time spent by a customer during the process. Along with the reduction of the value-added time, there is a decrease in the number of total lead times from 1818.84 seconds, the lead time dropped to 653.78 seconds. The proposed system eliminated the 1165.06 seconds, which is not essential for the completion of the process. A 64%-time improvement from the current system.

$$Takt\ time = \frac{net\ time\ available\ for\ work}{customer\ demand\ in\ that\ time} \quad (1)$$

$$88.82\ seconds = \frac{8\ hours\ x\ \frac{60\ mins}{1\ hr}\ x\ \frac{60\ sec}{1\ min}}{X\ customer}$$

$$Number\ of\ customers\ per\ day = 324\ customers$$

As noticed, the expected 200 customers quota per day can still be increased up to 324 per day. After eliminating the non-value and waste processes, the time was reduced by about 64%. This implies that the proposed system is a lot better than the current system used by the LTO.

The study used Monte Carlo Simulation to predict data and to compare whether which system is more effective; however, the simulation requires sets of random numbers as a basis in predicting possible values. With this, the researchers were able to generate data without implementing the proposed system. The study used multiplicative congruential, mixed congruential, mid square, additive, and quadratic methods in generating random numbers. The researchers generated 50 random numbers for each method. Moreover, these sets of random numbers should be validated using Chi-Square Test. All the results indicated that the critical value is greater than the computed value; therefore, the data set were normally distributed which means these random numbers are acceptable.

Evaluation of MCS of Proposed System	
Average time spent in the system	4134.56 seconds
Average waiting time	3205.98 seconds

As the MCS was performed for the proposed system, the simulation showed that an average waiting time of 3205.98 seconds or 0.89 hours is idle by customers before being served, and an average of 4134.56 seconds or 1.15 hours is spent by customers on the entire system as seen in table 2. The modification applied by the researchers

decreased both the average waiting time and the average time spent on the entire system compared with the current system by 48% and 52% respectively.

5.4 Validation

Although the proposed system was not yet implemented by the LTO, it is necessary to determine whether there are any significant differences between the expected performance of the proposed system and the current queuing system of the agency. To better improve reliability, the researchers applied paired t-test on the set of data produced by the different tools that the researchers used in the study to determine if the values are normally distributed and to identify which system is more effective based on the average time spent by a customer in the entire system. The conditions of the statistical treatment will indicate whether there is a significant difference or none. If the results accepted the null hypothesis, this means that there is no significant difference. On the other hand, if the results rejected the null hypothesis, this means that there is an improvement that occurred on the variables. The result of the paired t-test showed that the t-value is far greater than the critical value; this implies that there is a significant improvement that occurred on the proposed system compared to the current queuing system used by the LTO.

To reinforce the previous comparisons between the current and proposed systems, the researchers constructed criteria that evaluated the performance of both systems with the application of the Analytical Hierarchy Process (AHP) method. There are eight (8) criteria involved and is described as follows: *Time Spent for Completion of Requirements (1), Time Spent for Cashier (2), Time Spent for Release of Cards (3), Convenience: Time Spent in Queue (4), Speed of Service: Time spent in the entire system (5), Flexibility of Payment Options (6), Centralized Server (7), and Scheduling of Appointment (8).*

The analysis began with the evaluation of the weight factors of each criterion that impacts the performance of the systems. The weight factor of each criterion was based on the LTO's Citizen's Charter and Lean Management. Results showed that the most influential criterion is Convenience with a value of 20.9%. It is followed by the criterion Centralized Server having a value of 17.7%. In addition, 13.6% goes to Time Spent for Completion of Requirement, 11.9% for Time Spent for Release of Cards, 9.6% for Speed of Service, and lastly a 6.2% goes to the Scheduling of Appointments.

Furthermore, results showed that in every criterion excluding Time Spent in Cashier, the proposed system is more advantageous thus performs better than the current queuing system. However, the criterion Time Spent in the Cashier depicted no significant difference, which means that it does not impact both systems.

Subsequently, figure 7 is a graphical representation of the difference in performance based on the criteria used by the researchers. Evidently, the proposed system achieved a better result having an overall performance of 75.7%. In contrast, the current system only had a 24.3% performance and only had a close result with the proposed system specifically in the criterion Time Spent in Cashier. With that being said, the result of the AHP method clearly indicates that the proposed system is more effective and advantageous especially when achieving the criteria.

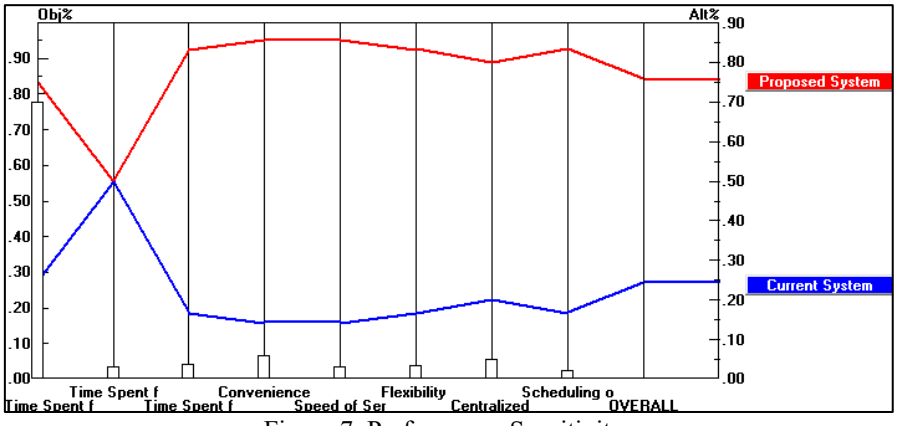

Figure 7. Performance Sensitivity

6. Conclusion

Queuing management system is an important part of any industry that can affect the service's efficiency (Uthman, 2017). This system starts from the time of the customers' arrival to the fulfillment of their service. After interpreting the results by illustrating and showing the comparisons done through the different tools mainly Value

Stream Mapping, Lean Waste Management Baseline, Takt Time, Monte Carlo Simulation, and Analytical Hierarchy Process Method, it can be concluded that through the proposed queuing system, LTO's services can still improve.

With the lack of proper queuing system management, customers in LTO allot time more than the expected duration. This resembles the poor implementation of the management regarding the queuing system to the agency itself. Moreover, due to the unnecessary processes, they do not meet their daily quota per day and have the employees exceed their time spent in the workplace, and they are forced to perform multiple tasks at once.

For the proposed change, the application form, submission of a medical certificate, selection of mode of payment, and scheduling can be done online. Centralization of the server along with a database will also be implemented to refrain from encoding the data repeatedly. However, clients are restricted from accessing the data gathered in the server. In addition, reminders will be included on the website so that the customers will be aware of the policies and restrictions before proceeding to the selected branch to avoid conflicts. With these processes, the customers will only have their photo, signature, and biometrics taking in the LTO branch and wait for their license cards to be processed.

Based on the Value Stream Mapping and Lean Waste Management Baseline of both the current and proposed system, from a total process time of 211.22 seconds, there is an improvement of about 58% as it decreased to a total process time of only 88.82 seconds. From their daily quota of 200 customers despite not meeting it due to delays, Takt Time demonstrated that implementing the proposed system can cater to about 324 customers. Furthermore, a 52% improvement can be seen in the proposed change based on the simulated results in the MCS. From an average total time spent of a customer of 8008.2 seconds or 2.22 hours, the proposed changed lessened the average time spent of a customer to 4132.56 seconds or 1.15 hours. The comparison between the current and proposed queuing system through the AHP method also indicated that the performance of the modified system is proven to be more efficient and effective upon the consideration of the essential criteria (i.e., *Time Spent for Completion of Requirements, Time Spent for Cashier, & Convenience: Time Spent in Queue*) that measure how well a system is performing.

According to Martin et al. (2015), batch processing influences system performance for which it can result in longer lines and can result to longer waiting time, while in a statement found in the study of Rehman (2014), online processing is a live processing, *e.g.,* when a customer fills up some form. It is also processing right away and at the same time. On the other hand, branch processing will be processed after a couple of days. Another is that in online processing, errors in the form will be automatically detected unlike for branch processing, which will just be notified after it is printed. Comparing the two statements, the online process is much better than batch processing (Rehman, 2014).

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