# An Adaptation of Industry 4.0: Modifying the Implemented Queuing System in Philippine Statistics Authority Applying Monte Carlo Simulation

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## Abstract

The Philippine Statistics Authority (PSA) is a government agency responsible for handling civil registration services which include the responsibility for issuing birth, death, and marriage certificates. The tasks given to the PSA face difficulty in managing queuing time for studies have shown that the PSA has an inefficient and ineffective queuing system. The current queuing system of the PSA involves an online application, but the certificates requested are delivered after a few days or weeks. The walk-in application faces long waiting times for customers, thus resembles poor queuing management. This study aims to resolve the long queuing time experienced by customers in requesting birth certificates. The study used Define, Measure, Analyze, Design, and Verify (DMADV) process to determine the bottlenecks in the current queuing system and to provide modifications or alternative solutions that will reduce the waiting time of customers. Monte Carlo Simulation was also utilized to generate expected results for both the current and proposed solutions. Upon the utilization of tools, the researchers were able to provide two alternative systems. The first alternative incorporated a Kiosk machine and was proven to be significantly different from the current queuing system but was not able to drastically reduce the queuing time. The second alternative applied a Hybrid approach as it used online processing to replace some processes in the current queuing system. Results showed that the second alternative was significantly better and more efficient than the other two queuing systems.

## Keywords

Philippines Statistics Authority, DMADV, Monte Carlo simulation, queuing time, online processing, kiosk

## 1. Introduction

### 1.1 Background of the Study

The quality of service has been an essential factor in attaining any field or industry's successes, as service quality mirrors how companies or businesses meet the customers' demands. Like any other industry, government agencies hold the responsibility of providing services to people. As government agencies are tasked to accommodate different matters, it is important to promote and maintain good quality services. Thus, proper queuing management must always be heeded as this is closely intertwined with customer satisfaction. The Philippine Government, in the year 2013, authorized the legislation of centralizing four (4) data-producing government agencies which led to the establishment of the Philippine Statistics Authority (PSA) (Espey, 2018). The Philippine Statistics Authority is one of the government agencies established in the Philippines that is mainly tasked to provide relevance and reliability in statistics, and services for civil registration in accordance with rules, regulations, and laws. They are in charge of the collection, analysis, and publication of statistical information of the Filipinos. According to Medina-Howe (2020), the issuance of a birth certificate is one of the most requested files in PSA as it is a requirement for almost all registration

in the Philippines. According to Kahanding (2019), the division chief of PSA, there is an increase of 2000 to 3000 in the daily average request for the issuance, authentication, and certification of civil registry documents. Moreover, the division chief also stated that the Pasay City branch caters the greatest number of customers among other branches. She also mentioned that an average of 2 to 3 hours is spent by customers for the whole process. With that, the management must always assure the efficiency of the queuing system implemented by the said agency. Based on observation, occurrences of problems such as long queues are commonly caused by manual checking of documents and requirements and manual encoding of information. With that, an adaptation of Industry 4.0 would be of great help to the agency and the customers. As defined, Industry 4.0 refers to the trend that incorporates the concept of automation to minimize the need for manpower and manual processing (Marr, 2018). Adapting this current would reduce the repetitive tasks done by workers and would lessen the total time spent of a customer in the said agency.

### 1.2 Gap of Missing Information

Incompetence and inefficiency of queuing management in the Philippine Statistics Authority (PSA) was discussed in the study of Capulong et al. (2017). Their study emphasized that despite having delivery for documents and online applications, long queues in walk-in of certificate requests are still being encountered by clients and customers. This thus depicts that there is still a problem regarding their queuing management. However, their study was not able to determine the bottlenecks in the queuing system. Therefore, this study will focus on verifying the possible causes of long queues and delays and be able to eliminate unnecessary processes for a more efficient service provision.

### 1.3 Objectives

The main objective of the study is to determine the possible causes behind the occurrence of delays and long queues in requesting birth certificates in PSA. This study specifically aims the following: (1) to identify the different factors affecting the long queueing lines; (2) to analyze and evaluate the current queuing system implemented by the agency; (3) and to provide a sample procedure that depicts a more efficient queuing system that will serve as a conceptual implementation of the proposed queuing system.

### 1.4 Significance of the Study

Upon the achievement of the said objectives, this study will be beneficial to the following: (1) for the agency itself – since the data used in the analysis are all based on the actual performance of the said agency, therefore the possible implementation of the proposed system would be reliable and applicable; (2) for other government agencies – since they could adapt the proposed queuing system for better service; (3) and for future researchers since it can be used as a baseline for other government agencies facing similar issues.

### 1.5 Scope and Limitations

This study only focused on birth certificate requests and will disregard other documents that can be obtained in the PSA Serbilis Pasay outlet. The data used were gathered by applying time and motion study, in the year 2020. There were three hundred three (303) customers considered in this study. The gathered data considered in the study was obtained and observed for one day (Friday) since the researchers used a simulation, thus does not require the further collection of data. Furthermore, the researchers applied DMADV process method and Monte Carlo Simulation to both current and proposed queuing systems. Paired t-test was used as another statistical tool to determine whether there is a significant difference between the two. Moreover, the study did not include any costing or implementation method since the study only focuses in providing solutions or alternative queuing systems.

## 2. Literature Review

The Philippine Statistics Authority (PSA) is responsible for planning, developing, distributing, and implementing policies, rules, and regulations as well as organizing the government-wide programs managing the production of national statistics, wide-ranging identification system, and civil registration services concurrently aiming to deliver efficient government services (Espey, 2018; PSA, 2021). Furthermore, the law delegated PSA to keep and preserve birth, marriage, and death certificates of a Filipino citizen as this verifies the legal status of every Filipino (PSA, 2021).

Philippine Statistics Authority stated that a birth certificate is vital documentation authenticating the birth of a child. There are several agencies and departments including the Department of Foreign Affairs (DFA), Bureau of Internal Revenue (BIR), and Social Security System (SSS) that would require an original or certified true copy of the birth certificate of an individual upon application for identification cards, passport, and license—that's why a lot of people are still requesting for their birth document (Batongbakal, 2020; PSA, 2021). Additionally, the requisition of the said document only requires the duly accomplished request form, and it can be done in three ways: PSA Serbilis Online, walk-in at Census Serbilis Centers, and walk-in at SM Business Centers. The online requisition usually takes 4-8 working days after payment. On the other hand, walk-in at Census Serbilis Centers would only take an hour to two working hours after application, while walk-in at SM Business Centers would take 7-8 working days (PSA, 2021). However, PSA primarily concerns the improvement of the queuing system in the walk-in centers as this increases the number of working hours or days per individual request.

According to a study by Sridhar, M. S (2001), when the demand for a service exceeds the ability to deliver that service, long queues develop. Because of inaccurate predictions or calculations, proper service capacity decisions become very challenging. From the point of view of a consumer in line, it is critical that the customer would be informed about how long it will take before being catered or receiving service. According to studies, consumers' perceptions of equality in a service center have a significant beneficial impact on customer satisfaction with the service. (Sridhar, M.S., 2001). With this, if the queuing system of service is ineffective, it is important that the management should modify and implement processes or queuing systems that meet customer satisfaction.

Queuing theory is a subject within the area of operations management that focuses on the formal study of waiting time. It employs mathematical models and performance indicators to evaluate and, ideally, enhance the flow of consumers through a queueing system. Also, it has a wide range of applications and is widely utilized in the service industry. Staff schedules, working environments, productivity, customer waiting time, and customer waiting environment have all been evaluated using queueing theory in the past. (Nosek & Wilson, 2001).

Nowadays, researchers or analysts are challenged to design or create systems or processes that will benefit the company while considering factors such as customer satisfaction, queuing time, and etc. With this, analysts utilized different tools to either design a system or modify an existing process. According to Yeole (2011), one quality improvement tool is called the DMADV or the Define, Measure, Analyze, Design, and Verify process method which is under the well-structured methodology called Six Sigma. This tool is often on designing or modifying new products, services, and processes. The main goal of this tool is simply to create an alternative method or process that is expected to surpass the performance of the existing system. To achieve the goal of this approach, different types of analysis can be incorporated. One of which is the Root Cause Analysis (RCA). The root cause analysis (RCA) method is used to investigate and categorize the underlying causes of events that influence safety, health, the environment, quality, dependability, and productivity (Rooney, J et al., 2004). RCA is a technique for determining not just what happened and how it happened, but also determine "why" this occurrence happened.

Upon determining the possible bottlenecks, it is necessary to further support the claims with statistical tools. Queuing Theory is usually paired with statistical approaches or techniques to understand and to create systems that were designed to surpass the previous methods or queuing systems in terms of queuing time and other aspects of a process. Monte Carlo Simulation is one of the most common tools, developed in the 1940s, utilized for simulating data sets. It uses random sequences of numbers to produce data that are indifferent to the true solution of a problem (Sin & Espuña, 2020). Monte Carlo Simulation is a computer-based analytical method that uses statistical sampling techniques to create a model for real-life systems or processes. With this, it generates estimations or probabilities to obtain successful outcomes (Adekitan, 2014). As mentioned, one of the key components of a Monte Carlo Simulation is the use of random numbers in which are generated through the use of random number generators. There are different random number generators that are used to produce a set of data. Since Monte Carlo Simulation uses random numbers, it is essential for analysts to test whether the set of random numbers can represent true solutions.

A chi-square test is commonly used as a statistical test that is utilized to compare a set of random numbers to actual data or true solutions. This test intends to ascertain if there is a difference between the set of random numbers and actual observed data to come up with a decision on whether the set of random numbers can represent a true solution. Hence, a chi-square test provides a better comprehension and interpretation of the relationship among the data of the two variables (Hayes, 2020).

With the constant desire for improvement, technology has become an instrument in developing concepts or processes to improve certain aspects of a method made to deliver products or services to society efficiently and more effectively. Industry 4.0 is a global trend by which aims to promote digitalization and automation of processes or systems not only to reduce the necessary involvement of manpower, but also because it allows companies to improve the overall performance of a manufacturing process (Tay, Chuan, Aziati, & Ahmad, 2018). According to Rüttimann and Stöckli (2020), this trend enables queuing systems to drastically improve especially because of the technological capabilities to run methods or steps using alternatives. Some of the methods or adaptations that have been done under Industry 4.0 is the automation of processes through online processing and kiosk machines. According to Adam (2017), a lot of services were able to provide a reliable solution to their systems using online processing. On the other hand, Kiosk machines are self-service technology that requires less assistance. The use of Kiosk machines was proven to improve customer's convenience and experience, reduce waiting time, and increase customization (Vakulenko et al., 2019).

## 3. Methods

### 3.1 Conceptual Framework

The study utilized a descriptive-comparative approach, for this includes two (2) variables, namely the current queuing system of the PSA and the proposed queuing system, to identify bottlenecks that exist within the system and to provide modifications that are expected to increase the efficiency and effectivity of the queuing system. The study applied DMADV Process along with Root Cause Analysis, Flowcharts, and Pareto Diagrams to determine the factors that affect the performance of the queuing system implemented by the PSA. Moreover, the study also used Monte Carlo Simulation (MCS) to create a comparison between the current and proposed queuing system by simulating the complete flow for requesting birth certificates. With this, the researchers gathered actual data that served as a basis for the frequency table used in the MCS, along with generating sets of random numbers using random number generators (i.e., Additive and Multiplicative Random Number Generator). Upon generating random numbers, it is necessary to apply a Chi-Square test to determine whether the generated random numbers are accepted to represent the true data. Furthermore, the study used statistical treatment, specifically paired T-test, to determine whether the proposed queuing system by the researchers is significantly different from the queuing system implemented by the PSA. Refer to Figure 1 for the conceptual framework of the study.

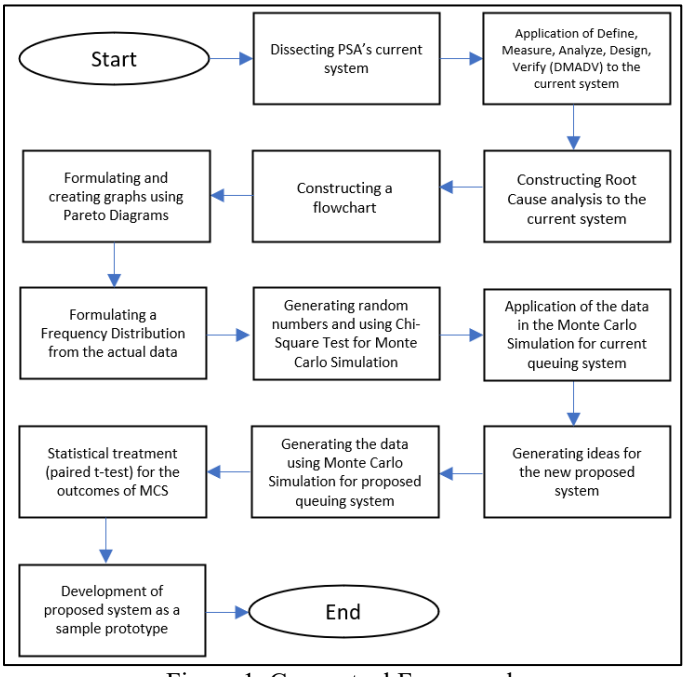



Figure 1. Conceptual Framework

## 4. Data Collection

For the data gathering, the researchers collected actual data, where it indicates the time spent of the customers for every station (process) involved in requesting birth certificates. This incorporates the waiting and process time of each

customer in every station. To perform this, the researchers applied a time and motion study, specifically the continuous timing method to suffice the needed data for the study.

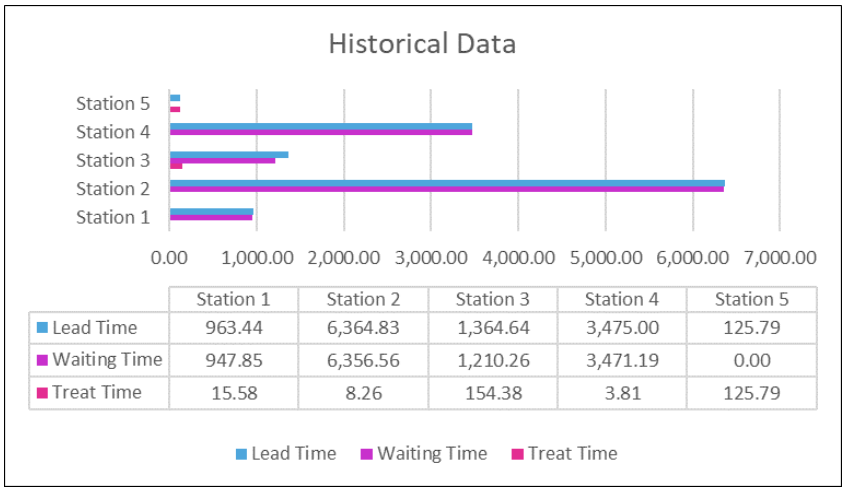
## 5. Results and Discussion

### 5.1 Graphical Results

The Define, Measure, Analyze, Design, Verify (DMADV) process is a tool used in Six Sigma that can be applied to design and to improve processes or services. It is composed of five phases or stages that aim to provide an alternative system or flow that is expected to perform better than the current system. The study used DMADV to identify bottlenecks in the current queuing system of the PSA and to provide improvements or modifications for the reduction of queuing time in requesting birth certificates.

For Phase 1 (Define): A study conducted by Capulong et al. (2017) mentioned that the Philippine Statistics Authority (PSA) currently has an inefficient and ineffective queuing system despite having to implement an online application and delivery for documents. Based on their findings and observation, the customers experience long queues to process their desired certificates. With this, the researchers would like to fill the gap of their study which means the study will focus on identifying bottlenecks and will provide possible solutions to resolve this conflict. Currently, the PSA's queuing system is composed of 5 steps: (1) acquiring request form, (2) issuing of queuing number, (3) payment section, (4) receipt checking, (5) signing of receiving the form and obtaining the target document. The study will evaluate the procedure but will only be limited to the process for birth certificates. To achieve this goal, the researchers gathered actual data measuring the processing time and waiting time for each station.

For Phase 2 (Measure): As aforementioned, it is essential to gather data that measures the time spent by a customer in the entire system. The study used purposive sampling as they purposely selected customers that request birth certificates. Based on the results, 303 respondents were included and considered in the study. Using the continuous timing method, the researchers observed for the entire working hours to gather data measuring the process and waiting time of each customer for every process.




| | Station 1 | Station 2 | Station 3 | Station 4 | Station 5 |
|---|---|---|---|---|---|
| Lead Time | 963.44 | 6,364.83 | 1,364.64 | 3,475.00 | 125.79 |
| Waiting Time | 947.85 | 6,356.56 | 1,210.26 | 3,471.19 | 0.00 |
| Treat Time | 15.58 | 8.26 | 154.38 | 3.81 | 125.79 |

Figure 2. Treat Time per Station

In phase 2 of the DMADV process, the researchers also identified the average treat time and waiting time of the customers. Based on figure 2, the total average treat time spent by customers is 294.10 seconds or 4.90 minutes, the total average waiting time experienced by the customer is 11784.33 seconds or approximately 3.27 hours, while the average lead time or the time spent of a customer to the entire process is 12078.43 seconds or 3.36 hours. Evidently, the customers spent 97.57% of their time waiting to finish the entire process. Long queues or poor customer flow may indicate that the customers experience queuing delays, thus depicts how inefficient and ineffective the queuing system is (Hall, 2006, as cited in Qureshi et al., 2013). With that, the study focused on identifying bottlenecks and reducing queuing time.

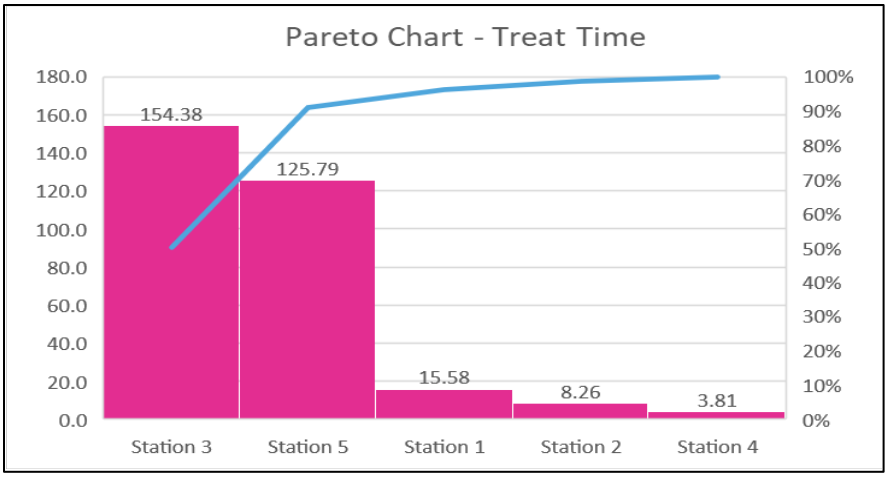



Figure 3. Pareto Chart – Treat Time

For phase 3 (Analyze): To determine the bottleneck of the process, it is necessary for the researchers to find the average time spent by the customers for each process. As seen in figure 3, it is evident that stations 3 and 5 are responsible for most of the time spent by the customers being catered to in the entire system. Combining these stations, 91.02% of the process is spent on station 3 (payment section) and station 5 (signing of received form and claiming of birth certificate.

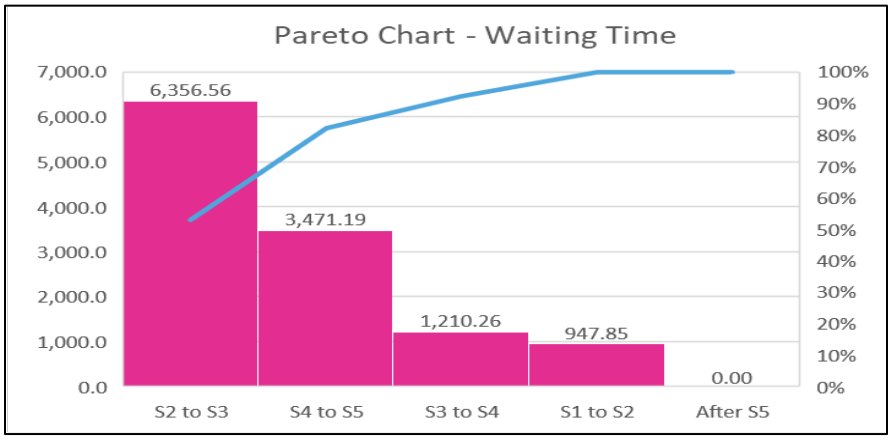



Figure 4. Pareto Chart – Waiting Time

Furthermore, figure 4 depicts what process takes the longest waiting time. Evidently, customers spent most of their time lining up for the payment section. As figure 3 showed that the payment section tends to have the longest treat time, the preceding customers needed to wait for that long to be catered. Subsequently, the researchers utilized a Lean Management Tool, specifically Root Cause Analysis to identify and specify factors that affect the queuing system. As seen in figure 5, the researchers identified four (4) major factors that affect the long queues in requesting birth certificates in the PSA. These factors are described as follows: (1) Methods, (2) Workplace, (3) Customers, (4) Manpower. Through observation, the researchers determined the occurrences of the possible problems that cause the delay.

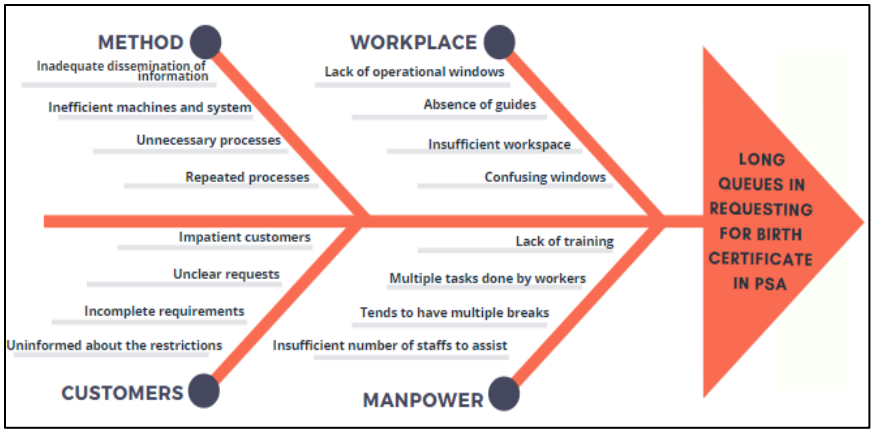



Figure 5. Root Cause Analysis

In relation to the observation and the breakdown of processes found in figure 6, it is evident that there are methods that can be considered unnecessary or can be replaced with an alternative to reduce the queuing time. For instance, part of the process in station 1 is the checking of the completeness of documents. However, a repetition of this step can be encountered in station 2, and the said documents will only be collected in station 3. With this, the researchers identified that this repetitive task causes delays in station 3, which explains why the waiting time between stations 2 and 3, as seen in figure 4, is longer compared with the other stations. This repeated task also increases the treat time on the said station. Despite this observation, the researchers believed that this may only reduce the treat time as well as the waiting time for and before station 3 on a minimum level, thus an alternative solution is needed.

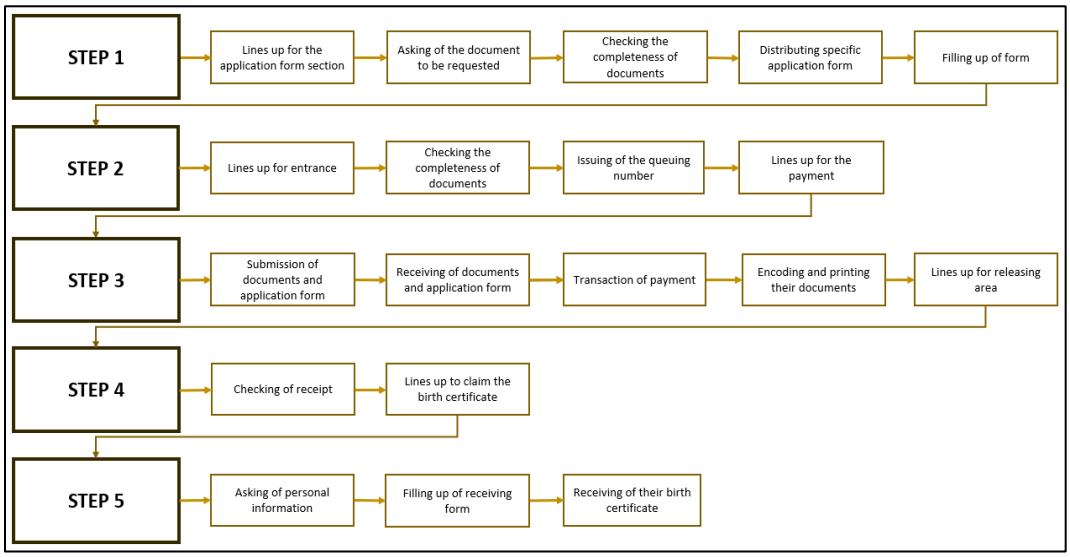



Figure 6. Flow Chart: Birth Certificate Request Process

## 5.2 Numerical Results

Furthermore, the study also used a simulation, specifically the Monte Carlo Simulation (MCS), as a statistical tool to determine the expected performance of both the current and proposed queuing system. Although the proposed queuing system is not yet implemented, the researchers can use the historical data from the current queuing system of the PSA and utilize this to generate set of random numbers. The random number generators used in this study are the Additive Congruential Method, the Multiplicative Congruential Method, the Mixed (Linear) Congruential Method, and the Mid Square Method. To briefly discuss how the random numbers were generated, the researchers used the lead time from the historical data as the seed number and assigned a value of 10000 as the modus $M$ since one condition for random number generators is that the modulus $M$ should be greater than the other values (Schegel, 2018). Also, the researchers ensured that the seed number and the modulus $M$ are relatively prime with one another.

Table 1. MCS of Current System for the used in PSA

| Evaluation of MCS of Proposed System | |
|---|---|
| Average time spent in the system | 19040.68 seconds |
| Average waiting time | 18783.49 seconds |

Using Monte Carlo Simulation for the current queuing system of the PSA, the researchers were able to calculate the average time spent in the system, as seen in table 1, and the average waiting time. The average time spent in the system is 19040.68 seconds or approximately 5.29 hours, while the waiting time is 18783.49 seconds or approximately 5.22 hours. Comparing the result of the MCS to phase 2 of the DMADV process, it showed a similar analysis that most customers spend their time waiting than being catered. As formerly mentioned, the repetitive task and unnecessary processes may have increased the waiting time as well as the lead time experienced by customers for requesting birth certificates.

### 5.3 Proposed Improvements

After analyzing the current queuing system of the PSA, the researchers proceeded to phase 4 (Design) with a goal to find alternatives or ways to improve the process utilized for requesting birth certificates. Since the researchers were able to identify the bottlenecks, the researchers decided to modify the queuing system by removing repeated processes and replacing some processes with alternatives. The researchers were able to create 2 process flow that is expected to perform better than the current queuing system. For the first alternative, the researchers decided to utilize the Kiosk machine as an alternative method for the payment transactions, and for the second alternative, the researchers described the queuing system as a Hybrid Queuing System.

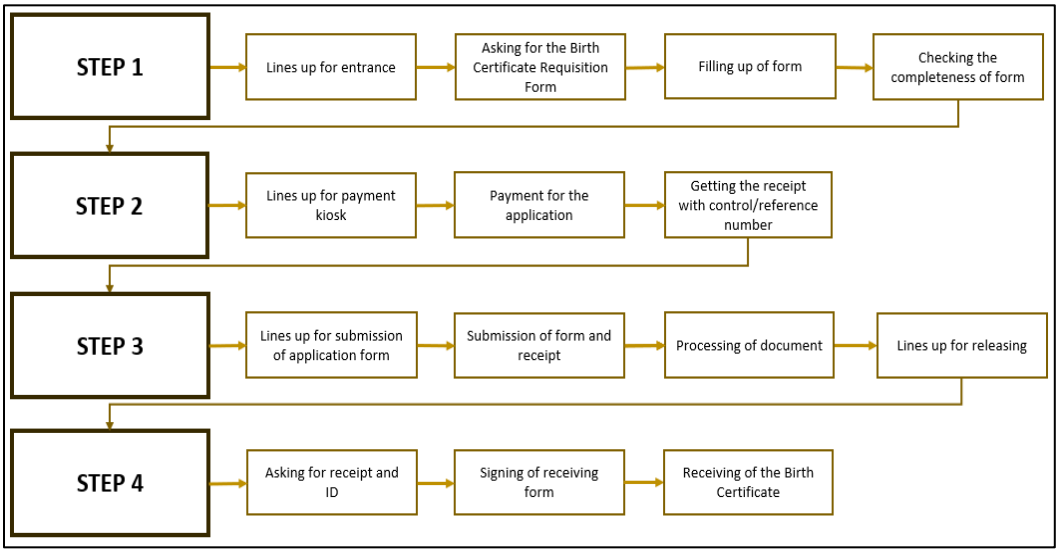



Figure 7. Flow Chart: Kiosk Queuing System

As seen in figure 7, the researchers reduced the number of stations from 5 windows to 4 windows, which also resulted in a decrease in the total number of processes done in the entire queuing system from 19 processes to 14 processes. The major difference between the current queuing system of the PSA to the proposed Kiosk queuing system is the automation of the payment section for which the customers will utilize the machine for payment and receiving for receipt. To determine the expected or possible performance of the Kiosk Queuing System, the researchers used Monte Carlo Simulation to predict the total waiting time and total time spent of customers in the entire system.

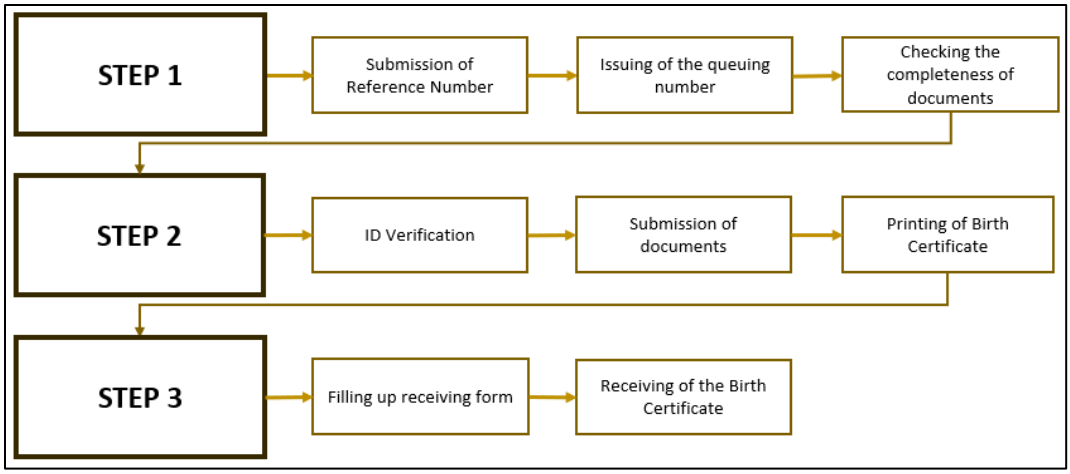



Figure 8. Flow Chart: Hybrid Queuing System

Another alternative queuing system proposed by the researchers is the hybrid queuing system as seen in figure 8. The PSA currently has an online application for birth certificates. However, the birth certificate will be received after a few days or weeks (PSA, 2021). In comparison with the proposed system, the hybrid queuing system will have a similar interface with the current online application of the PSA. However, processes such as submission of requirements, payment, and verification of I.D. are done online and then customers are given the reference numbers needed to claim the birth certificate on any PSA branch. As seen in figure 8, the proposed queuing system will reduce the number of stations needed by customers to claim their birth certificates to 3 stations along with 8 specific processes. Despite the reduction of stations and processes done for each window, it is necessary to generate data for comparison of the three queuing systems. With this, the researchers proceeded to phase 5 of the DMADV approach which is to verify whether how the queuing systems will perform through either monitoring real values or simulating results through different simulation tools. In this study, the researchers utilized Monte Carlo Simulation, as the primary tool for phase 5, to simulate the process of both alternatives for which will allow the researchers to predict the total waiting time and total time spent by customers in the entire system.

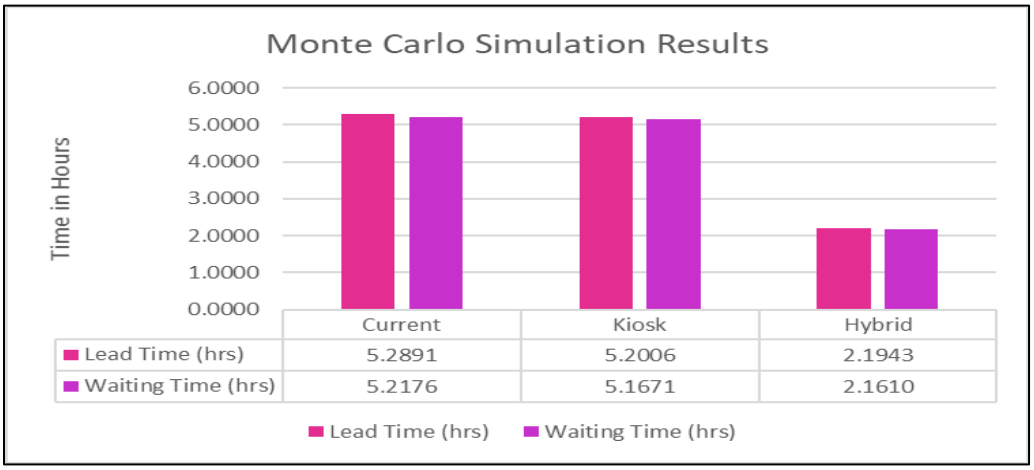



Figure 9. Summary of MCS Results

After applying Monte Carlo Simulation to all of the queuing systems, may it be the current and proposed process, the researchers were able to determine the expected performance of every queuing system included in the study. Through Monte Carlo Simulation, the study was able to determine the possible waiting time and lead time of each queuing system. As seen in figure 9, it is evident that the hybrid queuing system designed by the researchers gave the lowest lead time or time spent by customers in the entire system with a total time of 2.1943 hours. Moreover, it also has the least expected waiting time compare with the two systems. Although the Kiosk queuing system was able to reduce the stations and processes done for acquiring a birth certificate, the difference in lead time and waiting time to the current

queuing system of the PSA is very minimal compare with the performance of the hybrid queuing system. The researchers believed that Kiosk queuing system was not able to greatly reduce the lead time and waiting time because the bottleneck of the current queuing system was only replaced by a machine rather than finding a better alternative. This means that the only difference between the Kiosk queuing system and the current queuing system of the PSA is the person or object being utilized to process the customer's payment. In contrast, the hybrid queuing system was able to eradicate the bottleneck of the current queuing system by simply using third-party alternatives or payment methods. This allowed the researchers to significantly reduce the lead time and waiting time.

### 5.4 Validation

With the application of Monte Carlo Simulation in this study, researchers tested the acceptability of the set of random numbers generated to represent true data by using a Chi-Square Test. The null hypothesis in this statistical treatment is described as: *there is no significant difference between the data thus shows a uniform distribution*. As seen in table 2, all random number generators excluding Mid Square Method showed a higher critical value (x2 theo) than the computed value (x2 obs). This means that the set of random numbers can be used to represent true data.

Table 2. Results of Chi-Square Test

| Random Number Generator | Computed Value (X2 obs) | Critical Value (X2 theo) | Decision |
|---|---|---|---|
| Additive | 10.56 | 16.919 | Accept Ho |
| Multiplicative | 4.82 | 16.919 | Accept Ho |
| Mixed (Linear) | 5.34 | 16.919 | Accept Ho |
| Mid Square | 2736 | 16.919 | Reject Ho |

Furthermore, the researchers also applied paired t-test to the results of the Monte Carlo Simulations to determine whether there is a significant difference between the three systems. As seen in table 3, all the paired t-tests indicated that there is a significant difference in performance among the queuing system since the p-value is less than 0.05. Despite the results of the Kiosk queuing system, it is still significantly different than the current queuing system based on the results of the paired t-test.

Table 3. Summary of the Paired-Sample t-tests

| Comparison (Queuing Systems) | Critical Value | Mean Difference | Standard Deviation | SE Mean | p-value | t-value |
|---|---|---|---|---|---|---|
| Current vs Kiosk | 1.968 | 318.5 | 355.6 | 20.4 | 0.00 | 15.59 |
| Current vs Hybrid | | 11141 | 6615 | 380 | 0.00 | 29.32 |
| Kiosk vs Hybrid | | -10823 | 6686 | 384 | 0.00 | -28.18 |

## 6. Conclusion

Queuing lines have always been a part of any industry that deals with goods and services (Troanca, 2014). Inevitably, waiting lines have always been an aspect that analyst tries to minimize since it can gradually become a source of conflicts. Ineffective management of queuing systems results in negative outcomes such as declines in demand and poor customer satisfaction (Chowdhury, 2018). With the importance of good queuing management, the researchers assessed the Philippine Statistics Authority's queuing system for requesting birth certificates for which the study had determined to be ineffective.

Due to the poor queuing management of the PSA, customers with a desire to obtain birth certificates spent an average time of 5.29 hours in the entire system just to finish the process. Also, customers were forced to wait for about 5.21 hours just to receive their birth certificates. These long queues resemble conflicts within the system for which the researchers would like to address. With this, the study used DMADV methodology to identify the bottlenecks of the current queuing system used by the PSA and to provide alternative queuing systems or modification that is expected to perform better than the existing queuing system.

In this study, there are two alternative systems proposed by the researchers that were proven to be effective and better than the current queuing system. The first alternative utilized a Kiosk machine to replace the payment section. The replacement done by the researchers was able to reduce the processes from 19 to 14 specific processes. However, even with the modification, the researchers were not satisfied with the results since it did not significantly reduce the waiting

time of the customers and the overall time spent by the customers in the entire system. This led to another alternative which was then called the Hybrid queuing system. This queuing system combined the capabilities of online processing and the current queuing system to produce a faster and more effective method for obtaining birth certificates. Results showed that from 19 processes, the researchers were able to decrease this up to 8 processes for which allowed the researchers to greatly reduce the waiting time and lead time of the customers. The second alternative was able to reduce 58.51% of the original lead time and 58.58% of the waiting time. Comparing the two alternatives proposed by the researchers, it is evident that using the Hybrid queuing system will significantly reduce the waiting time and lead time experienced by customers, thus indicates that the system is the most effective and efficient queuing system suitable for requesting birth certificates.

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