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# Utilization of Queuing Systems: Enhancing Service Efficiency in a Coffee Shop Through Multi-Server, Multi-Customer Flow Process

**China Allysa R. Dela Cruz, Bianca Angeline Catherina Mae S. Gedaria, Julianne Grace C. Gomez, Hannah Mae R. Bertulfo, Justine Troy C. Espiritu, Shane Maryneth M. Solima, Louiella V. Pagunsan, Jose Marie Carrillo, Edrian T. Untalan and Maricar M. Navarro**
Industrial Engineering Program
College of Engineering and Architecture
Technological Institute of the Philippines
Quezon City, Philippines
qcardelacruz@tip.edu.ph, qbacmsgedaria@tip.edu.ph, qjgcgomez01@tip.edu.ph, qhmbertulfo@tip.edu.ph, qjtespiritu@tip.edu.ph, qsmsolima01@tip.edu.ph, qlvpagunsan@tip.edu.ph, qjm-carrillo@tip.edu.ph, qetuntalan@tip.edu.ph, mnavarro.ie@tip.edu.ph

## Abstract

Queueing theory, a vital component of operations research, analyzes the behavior and performance of service systems through mathematical models of lines or queues. This study aims to enhance the queue management system of Coffee Shop Business in Quezon City by addressing prolonged waiting times and customer congestion during peak hours, which have led to decreased service efficiency and employee fatigue. Through the application of queueing theory formulas, specifically Single Server, Multiple Customer for the present analysis, while Multiple Server, Multiple Customer for the proposed solution. Furthermore, the study utilized time and motion studies (TMS) and MATLAB simulations to assess current operational inefficiencies. The data collected from direct observation and interviews revealed a high server utilization rate of 80%, with customers spending up to 30 minutes in the system during peak periods. By implementing an additional server, the simulation showed a reduction in utilization to 40%, a decrease in average customer waiting time in the system to approximately 7 minutes, and queue waiting time to just over 1 minute. These improvements significantly enhanced system performance, enabling faster service delivery and reduced congestion. The study recommends implementing a multi-server queuing system during peak hours to reduce customer wait times and improve service efficiency. Future studies may explore customer behavior analytics and integrate digital queue management systems for further optimization.

## Keywords

Coffee Shop, Operations Research, Queueing Theory, MATLAB Simulation, Queue Management

## 1. Introduction

Queueing theory is a mathematical discipline that analyzes waiting lines, their operational features, structural configurations, and optimization procedures. It studies important parameters like customers' arrival rate, the service delivery method employed, and customer behavior when demand exceeds the capacity of available services (Kalwar et al. 2021). This theory is used in various industries like telecommunications, transportation, healthcare, and retail, where waiting time management and service efficiency are paramount (Kumar et al. 2020). Misra et al. (2023) point out that well-managed queues are vital for equitable resource distribution and minimizing delays in cases of availability constraints. Poorly designed queueing systems lead to undue congestion, lowered operational efficiency,

and higher customer dissatisfaction (Alenezi et al. 2020). In general, queueing theory describes everyday experiences such as waiting in line and offers actionable, data-driven recommendations to solve complex operational problems in contemporary service systems (Naik & Mahajan 2022).

In today's fast-paced service environments, efficient customer flow management has become a crucial problem for most firms. Whether in restaurants during peak dining hours, hospitals with admissions, or banks with heavy volumes of transactions, sluggishness in providing services can lead to dissatisfaction, decreased quality of service, and loss of customers (Suleiman & Haruna 2022). Service sectors are adopting data-driven policies focusing on demand-service capacity balance to remain competitive. Researchers have discussed several methods of reducing waiting times, including using simulation methods and mathematical models to increase the efficiency levels of operations (Bibi et al. 2021). Evidence shows that facilities like restaurants benefit from forecasting customer arrival times to efficiently manage staff levels and maximize table turnover rates (Jayalalitha & Krishnamoorthy 2021). Likewise, medical facilities use the same approaches to reduce patient waiting times while optimizing care delivery (Setiawan et al. 2021). These approaches enhance service quality and increase long-term operational effectiveness and customer loyalty (Yu et al. 2024; Aini et al.2021).

Effective customer queue management is a key concern in service-based systems where demand will likely exceed available service capacity. Several recent studies have shown that single-server and multi-server queueing models can improve waiting times, customer flow, and overall service performance. Ogunwolu and Oladejo (2022) presented strong empirical evidence that multi-server models can significantly reduce waiting time in situations of high demand. Liu et al. (2021) discussed the effect of customer abandonment on the performance of the queue, illustrating the efficacy of matrix-analytic methods to analyze such systems. On the other hand, Ghosh and Goswami (2021) highlighted the utility of stochastic modeling in describing the behavior of queues under random arrival and service processes. Janani and Ravichandran (2020) also utilized single-server and multi-server models to describe customer waiting times in real-world business situations. They illustrated the applied relevance of queue analysis in the distribution of resources. This study analyzed customer flow to further understand waiting times and queue lengths using the principles and formulas of queueing theory.

### 1.1 Problem Statement

Observations show that the coffee shop struggles with managing customer flow during peak hours, leading to long queues, dissatisfied customers, and staff fatigue due to task imbalance. The inefficiencies in service processes need an improved queue management system and operational adjustments.

### 1.2 Objectives

The general objective of this study is to evaluate and improve the queue management system of a selected coffee shop located in Quezon City, with the aim of reducing customer waiting time and optimizing operational performance during periods of peak demand. The specific objectives of this study are as follows:

1. To analyze the current queueing process of the coffee shop through a time and motion study.
2. To determine the root causes of customer congestion using the Ishikawa diagram.
3. To evaluate system performance using queueing theory and Kendall's notation (M/M/1).
4. To simulate the current and proposed queueing systems using MATLAB.
5. To reduce average customer waiting time and improve server utilization by implementing a multi-server configuration.
6. To propose and assess an improved queueing system design through quantitative analysis.
7. To enhance customer experience and service efficiency based on validated simulation results.

## 2. Literature Review

Understanding the dynamics of customer behavior, operational challenges, and service efficiency is crucial for coffee shop businesses, especially as demand continues to grow among students and young adults. This literature review explores the rising trend in caffeine consumption, the implications on service operations in cafés, and the application of analytical tools such as queueing theory, MATLAB simulations, and time studies in improving business efficiency.

It also discusses the role of baristas, service patterns, and facility layout design in enhancing productivity and customer satisfaction.

Over the past years, consumption of caffeinated drinks has increased significantly despite the negative effects that have been mentioned by others before, and its popularity keeps increasing, particularly on young adults or college students, as it serves as an aid when studying (Dahlawi et al. 2024). Aside from identifying that coffee, chocolate bars, and soft drinks are among the list of most consumed products by students, the study of Alfaifi et al.(2022) highlights the high level of caffeine beverage consumption in students. This further solidifies the claim of Dahlawi et al. (2024) that drinking caffeinated beverages helps in finishing students' work. Moreover, caffeinated beverages have an impact on students' academic performance academically and even their lifestyle, which causes it to become an essential part of the students' lives (Abando et al. 2022)

In order to analyze and understand the waiting in line in different situations, queueing theory, a mathematical study, was utilized. The model developed through queueing theory is able to be utilized in anticipating the queue lengths and waiting time (Goswami, Rao, & Verma 2023). It aims to identify how long the waiting line is and how many customers are waiting in line. As students continuously consume caffeine drinks, its popularity keeps on growing. The continuous popularity of cafes resulted in an increase of the number of customers, which posed challenges such as longer waiting times or longer queues, which can lead to an issues regarding management as well as customer frustration, as stated by Ramadhani et al. (2024). Queues can be viewed as insufficient service due to leading to longer waiting times (Purnomo et al. 2021 as cited in Ramadhani et al. 2024).

Baristas are in charge of making the drinks while also being the face of the brand, as the interaction between the customers and employees has a significant impact on the experiences of the customers themselves. The role is not limited to that as baristas are also expected to be prepared in handling the high number of customers during peak hours while maintaining the quality of service they offer and keeping in mind the time taken to serve each customer (DataCalculus, n.d.). First Come, First Served or FCFS is a type of queue wherein people will line up to get to the counter. Their arrival will be the basis of their service time, as when lining up, the people who follow will have to wait for their turn or wait for the first ones to finish. FCFS is also considered as the most common service pattern in various places (Adewusi, Adigun, & Adigun 2022). Matlab or 'Matrix Laboratory' has a wide range of abilities starting from analytical tasks, to data visualization and analysis, while also helping in building models and running of simulations. Matlab continuously added more features over the years that catered to the needs of different researchers in various fields, making it useful in solving different problems. With this, it has become a reliable tool for researchers in different fields. Aside from that, due to its versatility, it has become a renowned tool in the research community (Srinivas et al. 2023).

Competitions regarding the improvement of quality of production are expected to always be present in the industry through leveling up the efficiency and effectiveness of a company. Through these methods, its main objective is to reduce the waste in the company. To measure the progress of a company towards its goal, both efficiency and effectiveness are observed along with productivity. Through the utilization of the Time Study Methods it helps individuals in assessing the task completion time of a skilled worker at a certain quality level. It serves as a tool in assisting in choosing the best job execution methods and the number of people needed for the job, which will eventually lead to increased efficiency in the workplace. Moreover, it aids businesses in choosing the best equipment or machines to buy (Kalne & Mehendale 2022).

In summary, literature highlights a growing demand for caffeinated beverages, particularly among students, contributing to increased foot traffic in cafés. This growth necessitates improvements in queue management, staffing, and layout design to enhance service efficiency and customer satisfaction. Tools like queueing theory, MATLAB, and time studies have been proven effective in diagnosing inefficiencies and guiding data-driven improvements in service operations. Overall, optimizing café operations through these methods can reduce waiting times, improve productivity, and support sustainable business growth. There has been a significant rise in the consumption of caffeinated drinks among students and young adults, yet numerous coffee shops still face challenges with lengthy wait times during peak hours. Previous research has not adequately examined the joint application of queuing theory, MATLAB simulations, and Time and Motion Studies to improve service efficiency and labor distribution. This gap underscores the necessity for a unified, data-driven approach to enhance operational effectiveness and customer satisfaction in cafés experiencing high demand.

## 3. Methods

The methods covered the study's framework, defining its inputs, processes, and expected outputs. Data were obtained from both primary and secondary sources, employing a quantitative approach to ensure objective measurement and analysis. There are three parts to methodology: the research design and study, the method being used, and the collection of data (De la Piedra, 2019).

### 3.1. Research Design

This study employed quantitative research design with a one-week observational period from March 1 to March 8, 2025, focusing on the peak hours between 10:00 A.M. and 12:00 P.M. at a coffee shop in Quezon City. Quantitative research involves systematic collection and analysis of numerical data to answer research questions and test hypotheses, allowing for statistical analysis and the identification of patterns between variables (Singh, 2021). It was selected to assess customer arrival rates, service durations, queue lengths, and server utilization. In addition to the quantitative approach, the research adopted a descriptive research design, which aimed to objectively and accurately describe the characteristics of a phenomenon. Observational methods were employed to document customer flow, including arrival times, service start and end times, and time spent in the system.

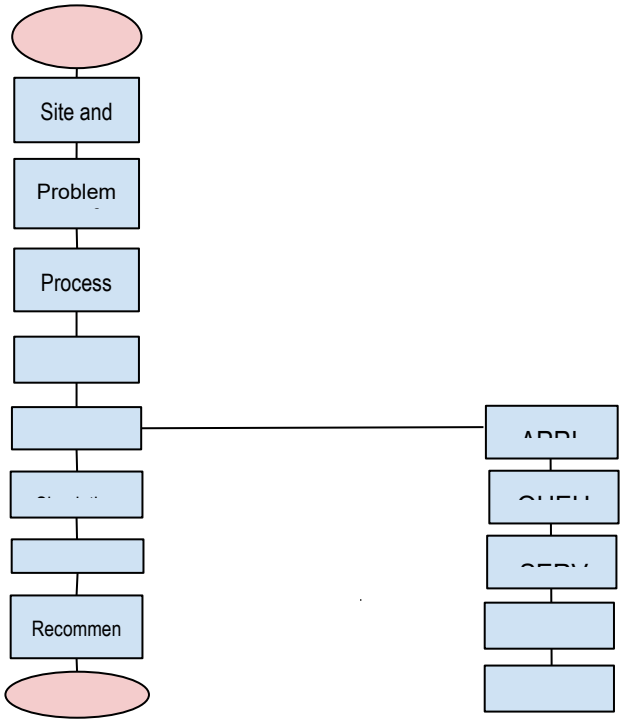


Figure 1. Research Methodology Utilizing Queuing Theory in the Coffee Shop

The research methodology was systematic in addressing the analysis and improvement of the service system through the application of queuing theory. The methodology started with observation of the process and field, followed by the identification of the main issues, like bottlenecks and waiting times. It proceeded with detailed process mapping and flow analysis to graphically map the system. Data gathering was followed to obtain the necessary performance indexes. The data were processed through the application of queuing theory, and simulations were executed using tools like MATLAB or Excel. The findings were interpreted to derive insights, resulting in actionable suggestions and propositions for system improvement. The right-hand side shown in Figure 1 is the queuing model stages: arrival, queue, service, waiting time, and departure.

## 4. Data Collection

As a way to record customer arrival patterns, service time, and order processing procedures, observations were made. Furthermore, conducting interviews with the business owner yielded insightful information about the company's history and assisted in identifying possible issues that could affect the effectiveness of customer service.

### 4.1 Present Data

Table 1. Average Customer per Hour (Observed from 10 AM - 12 PM Daily)

| DAYS | DATE | | NUMBER OF CUSTOMERS |
|---|---|---|---|
| Day 1 | March 1, 2025 | Saturday | 14 |
| Day 2 | March 3, 2025 | Monday | 15 |
| Day 3 | March 4, 2025 | Tuesday | 13 |
| Day 4 | March 5, 2025 | Wednesday | 13 |
| Day 5 | March 6, 2025 | Thursday | 15 |
| Day 6 | March 7, 2025 | Friday | 16 |
| Day 7 | March 8, 2025 | Saturday | 18 |
| **Total number of customers in 7 days** | | 104 | |
| **Average number of customers per day** | | 15 | |
| **Average customer per hour (2 hours)** | | 7.5 | |

Based on the data presented in Table 1, which shows the number of customers at a coffee shop over seven consecutive days from March 1 through March 8, 2025, significant trends in customer flow during peak hours can be identified. A total of 104 customers are recorded throughout the week. Divided by seven days, this results in an average of about 15 customers per day. The data focuses specifically on peak hours, from 10:00 a.m. to 12:00 p.m., rather than the entire working day. In these 2 hours, the average number of customers per hour is calculated by dividing the daily average (15) by 2, resulting in an average of 7.5 customers per hour during peak time. The customer pattern shows a consistent build-up toward the latter part of the week, with Friday and Saturday experiencing the highest numbers of customers, 16 and 18, respectively, while Monday and Tuesday have the lowest, with 13 customers each. This indicates that although customer numbers fluctuate, there is a distinct pattern of increasing customer volume toward the end of the week, especially approaching the weekend.

Table 2. Present Observation of the Coffee Shop

| **DAYS** | **DATE** | | **Average Service Time per Customer per Day (minutes)** |
|---|---|---|---|
| Day 1 | March 1, 2025 | Saturday | 5.93 |
| Day 2 | March 3, 2025 | Monday | 5.8 |
| Day 3 | March 4, 2025 | Tuesday | 6.31 |
| Day 4 | March 5, 2025 | Wednesday | 5.85 |
| Day 5 | March 6, 2025 | Thursday | 5.8 |
| Day 6 | March 7, 2025 | Friday | 6.5 |
| Day 7 | March 8, 2025 | Saturday | 6 |
| **Average Service Time per Customer (in minutes)** | | 6.03 | |

The service process was tracked for one week from March 1 to March 8, 2025, with emphasis on peak hours between 10:00 A.M. and 12:00 P.M. The average time to serve each customer daily was monitored to observe how well the system performs. On March 1 (Saturday), the average time was 5.93 minutes. March 3 (Monday) and March 6 (Thursday) recorded averages of 5.85 and 5.8 minutes, respectively. The maximum time taken was on March 7 (Friday) at 6.5 minutes, which likely indicates a higher number of customers and workload. March 4 (Tuesday) also recorded a spike at 6.31 minutes. Meanwhile, March 5 (Wednesday) and March 8 (Saturday) recorded times of 5.8 and 6.0 minutes, respectively. After tracking the data for seven days, the average service time per customer is approximately 6.03 minutes. This measure helps evaluate system performance and supports planning for service improvements.

## 5. Results and Discussion

This section presents the results obtained from system analysis along with the proposed results generated using MATLAB, providing a comparison between the present performance and the proposed system.

Table 3. Summary of Results of the Present System and Proposed System

| | **Present System** | **Proposed System** | **Savings** |
|---|---|---|---|
| Utilization rate | 80% | 40% | 40% |
| Probability of the coffee shop having zero customers | 20% | 42.86% | 22.86% |
| Probability that the system will be at total capacity | 14% | 1% | 13% |
| Average number of customers in the queueing system | 4 customers | 1 customer | 3 customers |
| Average waiting time for a customer | 30 minutes | 7.14 minutes | 22.86 mins or 76.2 % |
| Average number of customers in the queue | 3.2 customers | 0.15 customer | 3.05 customers |
| Average waiting time in the queue | 24 minutes | 1.14 minutes | 22.86 mins or 95.3% |

Table 3 shows significant inefficiencies in the existing queueing system, particularly during peak hours. Through time study observations, Ishikawa analysis, and simulations using queueing theory in MATLAB, it was determined that the current single-server setup operates at approximately 80% utilization. Under this configuration, customers spend an average of 30 minutes in the system, with 24 minutes spent waiting in the queue. When a multi-server configuration was simulated, system utilization dropped to 40%, the average time in the system decreased to 7.14 minutes, and the average queue time was reduced to just 1.14 minutes. The number of customers in both the queue and the system also declined significantly. These results indicate a substantial improvement in operational efficiency, customer service quality, and workload distribution, ultimately contributing to enhanced overall performance.

## 5.1 Proposed Improvements

The data and findings obtained from the analysis of the coffee shop's current queueing system, as well as the recommended upgrades developed from MATLAB simulations, confirm the recommendation for the adoption of a multi-server system as the most effective means of enhancing service delivery and overall business performance. The following recommendations are given based on the findings and analysis to conclude the study objectives and to address the queueing problems observed.

### 5.1.1 Additional Barista

According to the queueing theory calculations and MATLAB simulations, it is highly recommended that the shop to hire at least one additional barista to transition from the existing single-server (M/M/1) system to a multi-server (M/M/s) system. The existing system, with a server utilization factor of 0.8, makes customers wait for an average of 30 minutes in the system, of which 24 minutes are spent waiting in line. The suggested multi-server system dramatically enhances these values, lowering the server utilization to 0.4, the average time in the system for around 7 minutes, and the average queue waiting time to slightly more than 1 minute. With more baristas, the company can serve more customers efficiently, decrease customer dropout because of excessive waiting, and enhance overall satisfaction.

### *5*.1.2 Improve Equipment and Workflow

Apart from enhancing manpower, this study suggests enhancing the availability and layout of equipment and tools in the working environment. Observations showed that a shortage of necessary equipment, like espresso machines, is a factor in delaying service. Buying more machines and configuring the workstation to facilitate smooth flow will enable baristas to accomplish tasks simultaneously without hindering one another. More organized assignment of tasks by

server and improved workspace design would minimize crowding in the back of the counter and optimize operations during busy times.

### 5.1.3 Designation of a Dedicated Service Area for Additional Staff

To facilitate the new baristas and equipment addition, the use of dedicated service stations in the café is required. Every barista must have a designated space with adequate room and access to equipment and ingredients to prevent overlapping duties and physical congestion. Well-defined working spaces, as proposed in the layout, will increase efficiency and minimize the likelihood of delay due to lack of space and disorganization.

## 6. Validation

Figure 2 shows the result of the present system of the coffee shop using MATLAB Software. The analysis shows a server utilization of 0.8, indicating it's busy 80% of the time. Customers spend an average of 30 minutes in the system, with 24 minutes spent waiting. An average of 4 people are in the queue, suggesting long wait times and frequent queue buildup. According to Caruelle et al. (2023), the longer waiting time of a client decreases customer satisfaction. The customer experience is influenced by various factors, moreover, investigations indicate that the feelings of the customers regarding their experience with the brand has a significant impact on its success (Yang et al. 2017; Franky & Yanuar Rahmat Syah 2023). A pleasant experience with the brand increases trust, loyalty, and satisfaction of the customers, the belief and satisfaction will then create a degree of relationship with the product (Prentice & Loureiro, 2017; Xie, Poon, & Zhang, 2017; Franky & Yanuar Rahmat Syah 2023). The strong emotional relationship that brands foster with the customers increase the obtained profit (Don Reisinger 2017; Franky & Yanuar Rahmat Syah 2023).

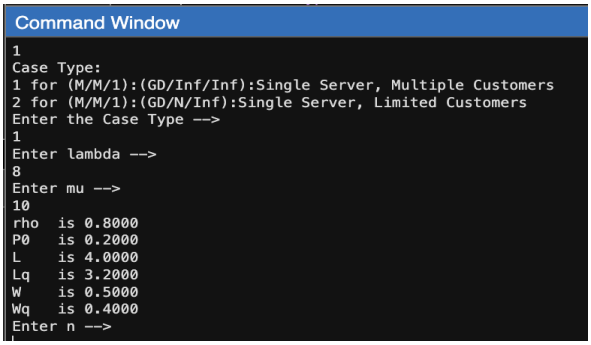


Figure 2. MATLAB (Present)

## 6.1 Queueing Theory Calculations (Present)

The queueing theory calculations are based on the M/M/1 model, with an arrival rate (λ) of 8 and a service rate (μ) of 10. The system utilization (ρ) is 0.8, meaning the server is busy 80% of the time. Although this may appear manageable, it indicates a system nearing overload. The probability that the system is empty ($P_0$) is only 0.2, showing that it is occupied most of the time. On average, there are 4 customers in the system (L), with 3.2 of them waiting in line (Lq), which suggests significant queue buildup. Customers spend an average of 0.5 time units in the system, with 0.4 of those in the queue.

The noticeably longer waiting time in the present data calls for a proposed solution for the identified problem. Utilizing the Matlab Programming Codes (Navarro, n.d.), the data indicates that the lambda or arrival rate is 8 customers per hour (Table 1) and the mu or service rate is 10 customers per hour (Table 2, in minutes).

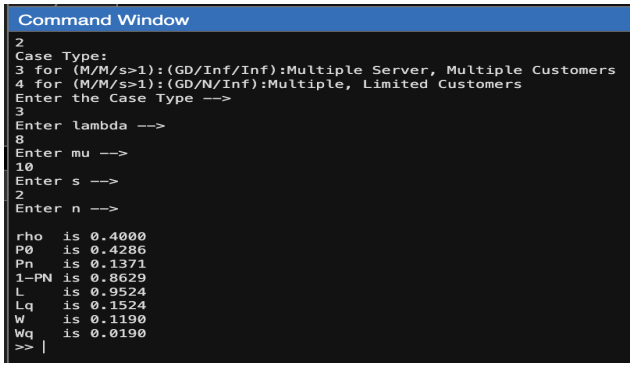


Figure 3. MATLAB (Proposed)

Figure 3 presents the proposed system designed to reduce the long waiting time identified in the current setup. The recommendation involves increasing server capacity to better accommodate customers. In the proposed setup, the arrival rate remains at 8 customers per hour, with an average service rate of 10 per hour. Service utilization drops to 0.40, indicating that the server is occupied only 40% of the time. The data also shows a significant improvement in waiting time: the total time spent in the system decreases to 0.1190 hours (7.14 minutes), while the average waiting time in the queue drops to 0.0190 hours (1.14 minutes). Notably, the average number of customers in the queue is significantly reduced, suggesting that customers are served almost immediately and lines remain short.

### 6.2 Queueing Theory Calculations (Proposed)

The queueing theory calculations for the proposed system using an M/M/s model with two servers shows the utilization rate ($\rho$) is 0.4, indicating a less congested system. The probability of zero customers in the system ($P_0$) is 0.4286, which is much higher than the current system, showing improved availability. The average number of customers in the queue (Lq) is significantly reduced to 0.1524, and the total number in the system (L) is 0.9524. The average time a customer spends waiting in the queue (Wq) is only 0.019 time units, and 0.1190 time units in the system overall (W). This reflects a well-optimized system with minimal delays and no signs of overload.

## 7. Conclusion

In analyzing the current queuing process of the coffee shop, data was gathered through a time and motion study conducted from March 1 to 8, 2025. Over the observation period, a total of 104 customers were recorded, with peak hours occurring between 10:00 A.M. and 12:00 P.M., and an average service time of just over six minutes. This fulfilled the first objective of the study. The second objective was addressed through the use of an Ishikawa diagram, which identified key factors contributing to customer congestion: insufficient staffing, inadequate equipment, ineffective queue management, and the absence of performance tracking. These factors led to excessive waiting times and inefficient service delivery.

To meet the third and fourth objectives, queuing theory and Kendall's notation (M/M/1) were used to model the current system. Simulations conducted using MATLAB revealed that the single-server setup had a server utilization rate of approximately 80%, with customers spending an average of 30 minutes in the system, 24 minutes of which were spent waiting in line. Upon simulating a multi-server setup, system utilization decreased to 40%, while the average time in the system was reduced to 7.14 minutes and the queue time to just 1.14 minutes. Additionally, the number of customers in both the system and the queue significantly declined, indicating improved process performance.

These results addressed the fifth and sixth objectives, as the implementation of a multi-server system significantly reduced waiting times and improved server utilization. Based on the findings, the proposed improvements included hiring an additional barista, upgrading equipment and workflow, and establishing a dedicated service area for each staff member. These changes would allow for smoother operations, task specialization, and minimized congestion. As a result, customer experience would be enhanced, meeting the seventh objective of the study.

The findings support existing literature that emphasizes the value of queuing theory in enhancing service efficiency and customer satisfaction. Kumar and Kumar (2024) note that queuing models improve service quality by enabling

better workload distribution, while Aniceto et al. (2024) highlight that queuing theory contributes to greater productivity and reduced congestion in service systems. Overall, the study confirms that the adoption of a multi-server queuing system in a coffee shop setting leads to substantial improvements in operational efficiency, customer service quality, and overall business performance.

### 7.1 Future work

Future works are suggested to extend the present work by taking observations for a longer duration of time, including various times of the year, like festivals and off-seasons, to observe customer flow patterns more extensively. It is also suggested to study the real-world application of the proposed system to test the results obtained from the simulation and assess long-term performance. Furthermore, evaluating the cost-effectiveness of hiring staff and equipment, gauging the effect on customer retention, and evaluating dynamic staffing models that can react to actual demand may aid the business in making more effective strategic choices. Further studies include predictive analytics to assist with forecasting customer influx and planning accordingly.

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## Biographies

**China Allysa R. Dela Cruz** is a 3rd year BS Industrial Engineering student at the Technological Institute of the Philippines – Quezon City (TIP QC), currently serving as an officer of ORIENTS and the LORSO Representative of the Payopitongpitik Society (PEER). She was also part of organizations like Inhinyera, BYP, and ACE-Q. A consistent Dean's Lister and academic achiever since grade school, she graduated from Cainta Catholic College (CCC) under the STEM strand with High Honors and Best in Research. She is a Certified Lean Six Sigma White Belt (CLSSWB), dedicated to enhancing her skills in process improvement and quality management as she prepares for a future in the field.

**Bianca Angeline Catherina Mae S. Gedaria** is a 3rd-year BS Industrial Engineering student at the Technological Institute of the Philippines (T.I.P.), a DOST scholar, and a consistent academic lister. She has experience as a campus journalist, cartoonist, and TV scriptwriter/reporter. Certified in Lean Six Sigma White Belt and Project Management Essentials, she actively leads in ORIENTS as Auditor (formerly P.R.O.), serves as Vice President of the Payongpitik Society (PEER), and is a member of the Political Science Society. Her past affiliations include BYP and ACE-Q. With a keen interest in the airline and marine industries, she aims to drive innovation and impact in these sectors.

**Julianne Grace C. Gomez** is a passionate student at the Technological Institute of the Philippines (TIP) and a cum laude graduate of Jose Rizal Institute. Eager to learn and grow, she believes education goes beyond books—it's about self-discovery and personal development. Julianne enjoys engaging in school activities and collaborative projects that challenge her. She values teamwork, discipline, and perseverance in achieving her goals. Focused and driven, she aims to make the most of her school years, build a meaningful career, and inspire others while creating a positive impact on society.

**Hannah Mae Bertulfo** Hannah is a dedicated third-year student at the Technological Institute of the Philippines (TIP). A proud alumna of St. Clare College of Caloocan, she was recognized for her academic excellence. Passionate about learning and self-growth, she actively engages in extracurricular activities, valuing teamwork and responsibility. To her, education goes beyond academics—it shapes character and prepares one for life's challenges. Hannah enjoys collaborative work and believes perseverance is key to success. She is committed to completing her studies and building a meaningful career while contributing to her community.

**Justine Troy C. Espiritu** is a third-year BS in Industrial Engineering student at the Technological Institute of the Philippines – Quezon City. A graduate of Occidental Mindoro National High School, he earned numerous academic honors, including the "Best Research" award. His passion for innovation and problem-solving led him to pursue the STEM strand in senior high school and eventually Industrial Engineering. Now, he continues to sharpen his analytical and technical skills, aspiring to contribute innovative solutions to the field.

**Shane Maryneth M. Solima** She is a third-year BS Industrial Engineering student at the Technological Institute of the Philippines - Quezon City (TIP-QC) and currently serves as the Public Relations Officer of the Industrial Engineering Department Student Council. With a background in journalism as a former editor, she brings creativity and communication skills to her role, curating content for the council's social media. Beyond academics and leadership, she enjoys writing short stories and poetry, and draws inspiration from classic films in her free time.

**Louiella V. Pagunsan** is a passionate Industrial Engineering student at the Technological Institute of the Philippines – Quezon City. As Vice President of the Organization of Industrial Engineering Students, she fosters collaboration and academic growth. A Gokongwei Brothers Foundation–URC scholar for nearly three years, she reflects excellence and service, actively facilitating GBF events. Beyond academics, she enjoys watching series and bonding with her baby sister. Her adaptability and broad skill set continue to fuel her success and leadership.

**Jose Marie Carrillo** is a third-year industrial engineering student at the Technological Institute of the Philippines - Quezon City (T.I.P. - Q.C.). He is dedicated to applying the knowledge gained from previous leadership experiences, such as being a student mentee of the Supreme Council and Industrial Engineering Department Student Council (IE DSC) of T.I.P., Q.C. from 2022-2023, Vice Mayor of the IE DSC (T.I.P. Q.C.) year 2023 - 2024 to lead a team that will be capable of solving the various risks that may be discovered within companies.

**Edrian T. Untalan** is a BS Industrial Engineering student at T.I.P. Quezon City, combining academic excellence with active leadership. He serves as Secretary of the IE Department Student Council and Director for Archives and Documentation of the T.I.P. Association of DOST Scholars for the A.Y. 2024-2025, ensuring efficient documentation

and organizational flow. Formerly involved in campus journalism as an Editorial Writer and Column Editor, He values responsibility, growth, and lifelong learning, viewing every task as a chance to improve and achieve.

**Maricar M. Navarro** holds the esteemed titles of ASEAN Engineer (AE) and Professional Industrial Engineer (PIE), accredited by the ASEAN Federation of Engineering Organisations (AFEO) and Philippine Institute of Industrial Engineers (PIIE). She currently serves as a Professor in both Undergraduate and Graduate School Program of Technological Institute of the Philippines, bringing over 18 years of combined experience in industry, academia, and research. Her expertise spans optimization of production processes, facility layout design, warehouse operations, and service delivery. Dr. Navarro's current research interests focus on financial optimization and decision-making in operations research. She earned both her master's and Ph.D. in Industrial Engineering from MAPUA University. As an associate member of the National Research Council of the Philippines (NRCP) and member of PIIE, Dr. Navarro contributes significantly to advancing research initiatives and professional standards in Industrial engineering and related fields. Her dedication and expertise make her a pivotal figure in both academic circles and national research endeavors.