Proceedings of the International Conference on Industrial Engineering and Operations Management

Publisher: IEOM Society International, USA DOI: 10.46254/NA10.20250327
Published: June 17, 2025

Utilizing Multiple-Server, Limited-Customer Queuing Theory to Enhance E-Jeepney Operations in Quezon City, Philippines

Edrian T. Untalan, Grace E. Ceballos, John Angelo A. Santiago, Angelica P. Jaquias Beverly T. Melchor, Emmanuel Querubin S. Ocampo, Ralph Jason F. Delos Santos Jose Marie Carillo, Bianca Angeline Catherina Mae S. Gedaria and Maricar M. Navarro
Industrial Engineering Program
College of Engineering and Architecture
Technological Institute of the Philippines
Quezon City, Philippines
qetuntalan@tip.edu.ph, qgeceballos@tip.edu.ph, qjaasantiago@tip.edu.ph
qaapjaquias@tip.edu.ph, qbtmelchor@tip.edu.ph, qeqsocampo@tip.edu.ph
qrjfdelossantos@tip.edu.ph, qjm-carillo@tip.edu.ph, qbacmsgedaria@tip.edu.ph
mnavarro.ie@tip.edu.ph

Abstract

Queuing theory, a field dedicated to modeling and predicting the behavior of service systems facing random demand, systematically examines the formation, operation, and management of queues or waiting lines. This study aims to analyze and evaluate the impact of the E-Jeepney Cooperative's lack of a queuing system and to propose improvements based on queuing theory principles. Faced with increasing demand and limited terminal space, the current absence of a standardized queuing and dispatching system has resulted in the overutilization of vehicles, prolonged passenger wait times, and inefficient resource allocation. This study analyzed current operations to pinpoint bottlenecks and inefficiencies. Key performance metrics, including arrival and service rates, waiting times, and system utilization, were calculated and compared between the existing and proposed terminal layouts. The study utilized a multiple-server, limited-customer queuing model in the proposed system, which significantly improved terminal efficiency by reducing the utilization rate from 119.09% to 47.43% and decreasing the average queue waiting time from 12 minutes to less than one minute. This paper concludes that the strategic application of queuing models and simulation can substantially improve public transport service delivery, offering practical insights for operators and policymakers seeking to modernize urban mobility systems. Future works of this study should explore continuous improvement efforts by utilizing other approaches and alternative methodologies, such as goal programming and other meta-heuristics approaches.

Keywords
E-Jeepney, MATLAB Simulation, Operations Research, Public Transport, Queuing Theory.

1. Introduction
Operations Research has been integral to decision-making processes since World War II. In the contemporary landscape, the evolution of business interactions across multiple platforms has significantly transformed business dynamics, introducing a heightened level of uncertainty. Queuing theory was developed to model and predict the behavior of service systems responding to randomly occurring demand. It involves the systematic study of queues or

waiting lines, focusing on their formation, functioning, and management. In the expansion of urban areas, an efficient public transportation system is crucial for supporting mobility and congestion reduction. Among the public utility vehicles employed in the Philippines, modern electric jeepneys emerged as one of the PUVs. E-jeepneys are electric vehicles based on diesel-fueled jeepneys. These electric-powered jeepneys are a far more eco-friendly alternative to diesel ones (Cuaresma et al. 2022).

With the implementation of queuing theory and other industrial engineering tools, this study aims to thoroughly analyze the current setup and identify key problem areas of the E-Jeepney Terminal. Through simulation and performance measurement, the research seeks to quantify delays, identify bottlenecks, and ultimately propose an improved queuing and dispatching strategy. The goal is to enhance the overall efficiency of the terminal operations, reduce passenger waiting times, and maximize the utilization of available E-Jeep units. The E-Jeepney terminal is located at Eastwood, a well-developed area known for its bustling business environment, high foot traffic, and modern infrastructure. Eastwood is strategically situated along major thoroughfares such as C-5 and E. Rodriguez Jr. Avenue, providing access for commuters and employees within its nearby business districts. The company accommodates numerous electric jeepney units serving Eastwood's surrounding areas.

1.1 Problem Statement

The study identified several issues within the E-Jeepney Terminal based on on-site observations. The E-Jeepney Terminal lacks a standardized and systematic approach for managing the dispatch and circulation of its 20 E-Jeep units. The absence of an organized queuing system, combined with maintenance issues, contributes to service inefficiencies. These inefficiencies result in unpredictable headways, extended passenger waiting times, and suboptimal utilization of E-Jeep capacity.

1.2 Objectives

The general objective of this study is to analyze and evaluate the impact of the lack of a queuing system and maintenance challenges on the E-Jeepney Terminal, and to propose queuing theory-based solutions and improvements.

1. To Analyze passenger arrival patterns at the E-Jeepney Terminal.
2. To Assess the service rate of the E-jeepneys fleet and develop a queuing theory model of the current system.
3. To Quantify key performance metrics (waiting times, queue lengths, utilization).
4. To Evaluate the impact of lacking a formal E-jeep queue and overutilization.
5. To Propose and evaluate queuing theory-based improvements to the E-jeepney queuing system.
6. To Recommend strategies for an improved queuing system and enhanced maintenance for the E-Jeepney Terminal.

2. Literature Review

Queuing theory is a fundamental area in operations research, offering a structured method for analyzing the behavior of waiting lines in various real-world systems. Its application in organizational decision-making facilitates efficient resource allocation, workforce management, and improved customer service (Saini et al. 2024). It is widely used across industries, including transportation, where the M/M/C/N queuing model supports traffic management strategies (Liu, 2025). In high-demand environments, queuing theory also helps evaluate customer satisfaction and perceived service quality (Bournassenko 2025). Queuing theory has played a vital role in the manufacturing sector by providing a structured method for optimizing processes and improving operational flow. Through the analysis of waiting times and resource utilization, it helps identify areas for improvement, ultimately increasing productivity, minimizing delays, and enhancing overall efficiency in manufacturing operations (Aguilar et al.2024)

For transportation terminals, estimated queuing time plays a critical role in assessing efficiency and reliability. Factors such as overtaking rules and vehicle departure contribute to overflow queues, highlighting service challenges that significantly affect passengers (Birhan, 2024). Priority scheduling allows more efficient use of existing resources, involving just a certain number of vehicle units at any one period without affecting the passengers' experience. Different research, such as quantitative analysis in scheduling, has frequently referred to these ideas. (Ripon et al., 2025)

The transition to modern jeepneys requires greater financial investment due to higher vehicle costs and operational requirements. These may include hiring salaried personnel, forming cooperatives or corporations, and implementing various fleet management systems. A comparative analysis between modern and traditional jeepneys shows that, although modernized units require more capital, they often yield higher returns over time (Gaspay et al. 2024). The utilization of modernized jeepneys positively created a higher behavioral intention for people concerning the increasing price of petroleum. This influence on individuals considering the use of public transportation leads to a more positive attitude towards it (Zulueta et al. 2024). In many queuing systems, determining waiting times and queue lengths is essential for informed decision-making and optimal system design.

The variable L represents the average number of units in the system, consisting of those in the queue (Lq) and those being served (Ls). Likewise, the average time a unit spends in the system (W) is the sum of waiting time (Wq) and service time (Ws) (Devi, 2023). Kendall's notation is mostly used to define single queuing nodes, representing distribution away from existence and unifying advent through lining, describing dissemination that favors beat being an errand. M/M/1 line is an uninvolved representation in which unique single-favour posts develop as specified by toxicant citations (N. Munusamy 2022). To support such computations, Matrix Laboratory (MATLAB) provides a robust programming environment for numerical analysis, data visualization, and algorithm development. It includes built-in commands and functions that facilitate mathematical modeling and simulation (Hussein, 2023). This MATLAB Simulation tool performs well as it provides a precise and accessible platform for calculating and viewing data (Harra et al. 2025).

Transport efficiency is often studied within the context of economic efficiency, focusing on the relationship between output and input. It measures how effectively resources like labor, fuel, and capital are used to maximize mileage and transport output (Wang et al. 2023). In addition, an efficient system of transport provides an advantage in terms of political aspects, as it may unify and justify the nation's condition. It also encourages the provision of more equitable services and strengthens the country's security against external threats (Felina et al. 2025). Recent studies have used mixed-integer programming to analyze how terminal layout and equipment capacity impact container transport efficiency. Key considerations include container yard size, proximity to railway tracks, and operational workflow. Results suggest that minimizing internal distances can reduce costs and enhance productivity. Additionally, sustainability assessments show that both parallel and vertical layouts offer comparable levels of energy efficiency and CO_2 emissions (Zhang 2023). The basic concept of transportation system planning is based on layout optimization and graph theory related to research on the shortest path problem sets.

Recent studies highlight the significant role of queuing theory in optimizing processes within the manufacturing sector. However, its application in public transportation, particularly within E-Jeepney Cooperatives—remains underexplored. This study addresses this research gap by applying queuing theory to analyze and improve the operational processes of E-Jeepney terminals. The objective is to enhance operational efficiency, improve service performance, and optimize overall terminal operations by streamlining queuing systems, minimizing idle time, and increasing service rates.

3. Methods

The methodology of the study employed a descriptive and observational research design to analyze the queuing system of the E-Jeepney Terminal in Quezon City. The researchers aimed to understand the current operational inefficiencies without manipulating variables, instead observing the natural behavior of the system. Descriptive analysis allowed for the identification of key issues, while observational techniques provided first-hand insights into queue formation, dispatch intervals, and passenger waiting times.

To evaluate the system's performance, the researchers applied a single-server, limited-customer queuing model, which is suitable for scenarios where both service capacity and queue space are restricted. Key performance indicators such as arrival rate, service rate, waiting time, and idle time were calculated. These metrics provided a quantitative understanding of system behavior and highlighted areas needing improvement. The study was further supported by the use of MATLAB software, which enabled the simulation and modeling of the queuing scenarios. Through these simulations, the researchers could analyze the current system and test proposed changes under controlled, replicable conditions. Primary data were gathered through direct field observation and structured interviews with cooperative personnel, including the chairperson. Secondary data were obtained from related literature, government publications, and organizational documents. These sources collectively ensured a comprehensive data set for analysis.

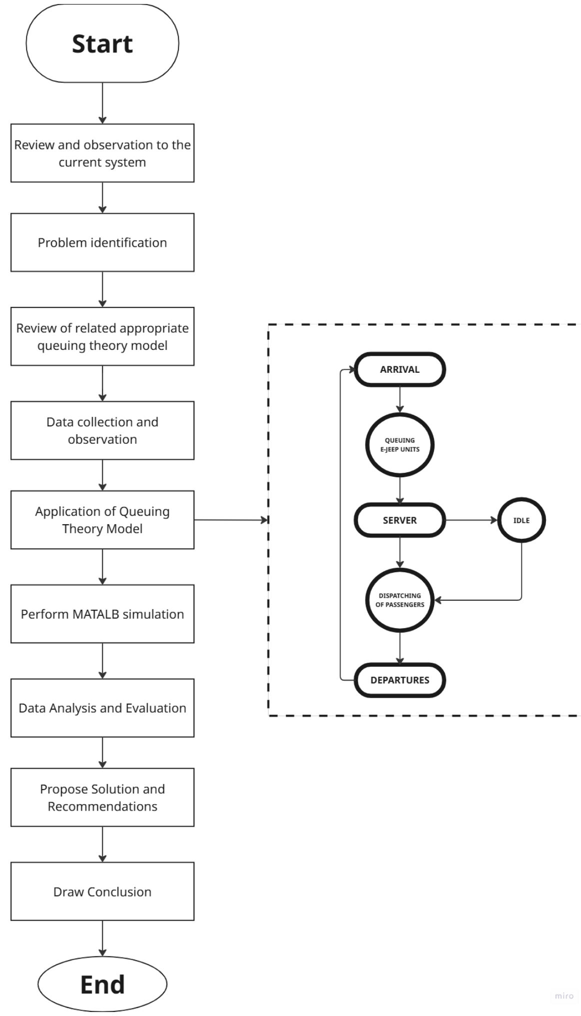

Figure 1. Case Methodology Utilizing Queuing Theory in E-Jeepney Cooperative

This study employed analytical tools such as time studies, Kendall's notation, and Poisson distribution to model service and arrival processes. Queueing theory equations and MATLAB simulations were used to compute and validate performance metrics for both current and proposed systems. This approach enabled data-driven recommendations to reduce idle time, improve dispatch efficiency, and enhance the E-Jeepney system's overall performance and passenger experience.

4. Data Collection

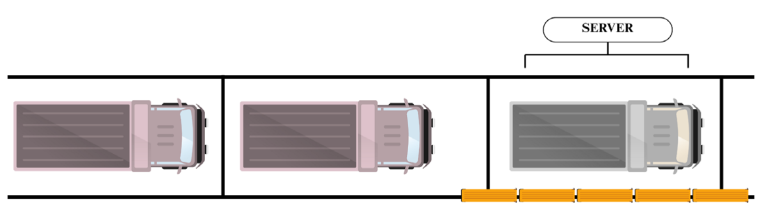

Figure 2. Layout of the Present System

Figure 2 illustrates the layout of the current system, which follows a single-server, limited-customer model. One terminal slot is allocated for an E-Jeepney to serve passengers, while two additional slots are designated for the waiting queue. Overall, the system can accommodate up to three E-Jeepneys at a time.

Table 1. Average Arrival Rate of E-Jeeps

DAYS	DATE	AVERAGE ARRIVAL RATE
1	March 12	7.1429
2	March 13	6.5714
3	March 14	6.6429
4	March 15	6.9286
5	March 16	6.7857
6	March 17	6.0000
7	March 18	6.8571
8	March 19	6.9286
9	March 20	7.1429
10	March 21	6.0000
11	March 22	6.7857
12	March 23	7.5714
13	March 24	6.5714
14	March 25	7.1429
15	March 26	6.2143
16	March 28	6.4286
17	March 29	7.0714
18	April 2	7.0000
19	April 3	6.6429
20	April 4	6.7143
21	April 5	6.2143
22	April 10	6.3571
23	April 11	5.7143
24	April 12	6.2143
25	April 14	7.4286
26	April 15	6.9286
27	April 16	5.9286
28	April 21	6.7143
29	April 22	6.5000
30	April 23	6.1429
31	April 25	6.5714
Average Arrival Rate		**6.6406**

Table 4.1 shows the average arrival rate based on observations from Day 1 to Day 31, covering the period from March 12 to April 25, 2025. The rate was calculated by determining the number of arrivals per hour for each day, then getting the average of these values. The overall average arrival rate was 6.6406 units per hour, derived from all 31 daily observations. This indicates that, on average, approximately 6.64, or about 7 E-Jeeps, arrive at the E-Jeepney Terminal.

Table 2. Average Service Rate of E-Jeeps

DAYS	DATE	AVERAGE SERVICE TIME
1	March 12	0:09:05
2	March 13	0:09:43
3	March 14	0:09:18
4	March 15	0:07:59
5	March 16	0:08:03
6	March 17	0:12:24
7	March 18	0:13:20
8	March 19	0:10:17
9	March 20	0:08:28
10	March 21	0:12:55
11	March 22	0:08:21
12	March 23	0:11:03
13	March 24	0:09:26
14	March 25	0:08:47
15	March 26	0:12:06
16	March 28	0:09:24
17	March 29	0:07:42
18	April 2	0:09:56
19	April 3	0:08:40
20	April 4	0:09:46
21	April 5	0:12:02
22	April 10	0:13:06
23	April 11	0:14:57
24	April 12	0:16:11
25	April 14	0:11:13
26	April 15	0:12:12
27	April 16	0:14:19
28	April 21	0:08:45
29	April 22	0:12:24
30	April 23	0:12:39
31	April 25	0:09:16
Average Time (in minutes)		**0:10:46**
Average Time/Hour		**5.576 or 1/1.1743 per hour**

Table 2 presents the average service time for each day across 31 observations. The service rate was determined by first calculating the hourly average for each day, followed by computing the overall average. The final average service time, based on all 31 observations, is 10 minutes and 46 seconds, which is equivalent to 5.576 units per hour or approximately 1 service every 1.1743 hours.

4.1 Queuing Theory Equations

Table 3. Queuing Theory Equations of the Present and Proposed System

Parameter	Present Data	Proposed Data	Description
Utilization	$\rho = \frac{\lambda}{\mu}$	$\rho = \frac{\lambda}{s\mu}$	This indicates the average utilization of the server.
The probability that exactly n customers are in the system.	$P_n = \rho^n P_0$	$P_n = \rho^{n-s} \frac{\left(\frac{\lambda}{\mu}\right)^s}{s!} P_0$	calculates the probability of having exactly n customers in the system, based on the number of servers and the queue capacity.
The probability that there is no customer in the queue(the server is idle).	$P_0 = \frac{1-\rho}{1-\rho^{N+1}}$	$P_0 = \left[\sum_{n=0}^{s-1} \frac{\left(\frac{\lambda}{\mu}\right)^n}{n!} + \frac{\left(\frac{\lambda}{\mu}\right)^s}{s!} + \frac{1-\rho^{N-s+1}}{(1-\rho)}\right]^{-1}$	The probability of zero customers in the system represents the chance that all servers are idle and the queue is empty.
The expected number of customers in the queue.	$L_q = L - \frac{\lambda}{\mu}$	$L_q = \frac{(\frac{\lambda}{\mu})^{s+1}\rho_0}{(s-1)!\,(s-\frac{\lambda}{\mu})^2}\left[1-\rho^{N-s+1} - (N-s+1)(1-\rho)\rho^{N-s}\right]$	It calculates the expected number of customers in the queue, representing the average number of consumers waiting to be served.
The expected number of customers is in the queueing system	$L = \frac{\rho[1-(N+1)\rho^N + N\rho^{N}}{(1-\rho)(1-\rho^{N+1})}$	$L = Lq + \frac{\underline{\lambda}}{\mu}$ $where; \underline{\lambda} = \lambda(1-P_N)$	It estimates the total number of customers in the system, including both those waiting in the queue and those currently being served.
The expected waiting time in the system	$W = \frac{L}{\underline{\lambda}}$	$W = \frac{L}{\underline{\lambda}}$	It indicates the expected time a customer spends in the system, including both waiting and service time.
The expected waiting time in the queue	$Wq = \frac{Lq}{\underline{\lambda}}$	$Wq = \frac{Lq}{\underline{\lambda}}$ or $Wq = W - \frac{1}{\mu}$	It calculates the expected time a customer spends in the queue, representing the average waiting time before service begins.

5. Results and Discussion

5.1 Numerical Results

Table 4. Queuing Theory Calculations of the Present System

Parameter	**Calculation**
Utilization Rate	$\rho = \frac{6.6406}{5.576} = 1.1909 \text{ or } 119.09\%$
Probability of the terminal having zero E-Jeeps	$P_0 = \frac{1 - 1.1909}{1 - 1.1909^{3+1}} = 0.2062 \text{ or } 20.62\%$
Probability that the system will be at total capacity	$P_{n=3} = 1.1909^3(0.2062) = 0.3188 \text{ or } 31.88\%$
Average number of E-Jeeps in the queueing system	$L = \frac{1.1909\,[1 - (3+1)1.1909^3 + (3)1.1909^{3+1}]}{(1 - 1.1909)(1 - 1.1909^{3+1})} = 1.7165 \text{ or } 2 \text{ units}$
Average number of E-Jeeps in the queue	$L_q = 1.7165 + \frac{6.6406}{5.576} = 0.9053 \text{ or } 1 \text{ unit}$
Average waiting time for an E-Jeep	$W = \frac{1.7165}{6.6406} = 0.3795 \text{ hours or } 22.77 \text{ minutes}$
Average waiting time in the queue	$Wq = \frac{0.9053}{6.6406} = 0.2001 \text{ hours or } 12.006 \text{ minutes}$

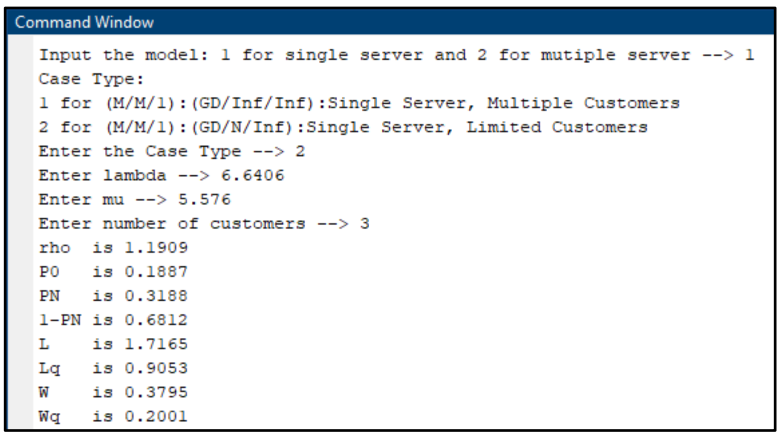

Figure 3a. MATLAB Results of the Present System

Table 4 and Figure 3 present the results of the MATLAB simulation, which reveal key performance metrics of the current system. The utilization rate is 1.1909, or 119.09%, indicating overutilization—meaning demand exceeds the system's capacity. The probability that the terminal is idle (P_0) is 0.1887, or 18.87%, while the probability that exactly three E-Jeepneys are operating in the system (P_n) is 0.3188, or 31.88%.

On average, there are approximately 1.7165 E-Jeepneys (rounded to 2) in the queuing system, as represented by the value of L, and the average waiting time (W) is 0.3795 hours, or roughly 23 minutes. The expected number of E-Jeepneys in the queue is Lq = 0.9053 (about 1 unit), with an average queue waiting time (Wq) of 0.2001 hours, or approximately 12 minutes, before an E-Jeepney can occupy a terminal slot.

5.2 Proposed Improvements

This study proposed three system improvements for the E-Jeepney Terminal. The first involves increasing the service rate; the second recommends adding an additional slot or server within the terminal; and the third combines both strategies: increasing the service rate and adding another slot. All three proposals had a significant impact on the queuing system and terminal slot utilization. Among these options, this study selected the third proposal, as it produced the most favorable results.

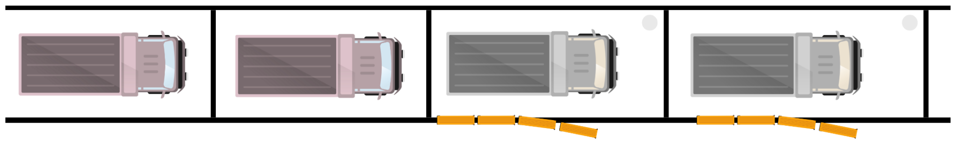

Figure 4. Layout of the Proposed System

Figure 4 shows the layout of the proposed system, featuring an additional terminal slot. With the redesigned terminal configuration and simulation using MATLAB, the study demonstrated notable improvements. The proposed system suggests more efficient slot utilization, shorter waiting times, and an overall enhancement in the operational efficiency and service performance of the E-Jeepney Terminal.

The proposed system aims to optimize terminal operations by accommodating E-Jeepneys at optimal capacity, thereby facilitating smoother operations, reducing average waiting time, and minimizing delays and inefficiencies. By fully maximizing the terminal's capacity to manage peak demand without overburdening a single slot, the introduction of an additional slot is projected to shorten queues and ensure continuous, reliable service. This recommendation is anticipated to yield practical improvements in service reliability, accommodate a greater number of passengers, and enhance the overall profitability of the E-Jeepney Cooperative.

To fully realize the benefits of the additional slot, it is essential to increase the service rate. This can be achieved through the implementation of efficient loading, unloading, and dispatching procedures, enabling the terminal to handle a higher volume of E-Jeepneys. Such a preventive measure will allow the system to accommodate more passengers without overloading the terminal, thereby reducing the utilization rate and preventing system congestion. These enhancements will ensure the continuity of smooth operations, even during peak hours.

5.3 Validation

Table 5. Queuing Theory Calculations of the Proposed System

Parameter	Calculation
Utilization Rate	$\rho = \frac{6.6406}{2(7)} = 0.4743 \text{ or } 47.43\%$
Probability of the terminal having zero E-Jeeps	$P_0 = \left[\sum_{n=0}^{s-1} \frac{\left(\frac{6.6406}{7}\right)^0}{0!} + \frac{\left(\frac{6.6406}{7}\right)^1}{1!} + \frac{\left(\frac{6.6406}{7}\right)^2}{2!} + \frac{1-0.4743^{4-2+1}}{(1-0.4743)}\right]^{-1} = 0.2440 \text{ or } 24.40\%$
Probability that the system will be at total capacity	$P_{n=7} = 0.4743 \frac{\left(\frac{6.6406}{7}\right)^2}{2!} 0.2440 = 0.0247 \text{ or } 2.47\%$
Average number of E-Jeeps in the queueing system	$L = 0.1015 + \frac{6.4766}{7} = 1.0267 \text{ or } 1 \text{ unit}$
Average number of E-Jeeps in the queue	$L_q = \frac{(\frac{6.6406}{7})^{2+1}(0.2440)}{(2-1)!\,(2-\frac{6.6406}{7})^2}[1-0.47^{4-2+1}-(4-2+1)(1-0.47)0.47^{4-2}]$ $L_q = 0.1015 \text{ or } 1 \text{ unit}$
Average waiting time for an E-Jeep	$W = \frac{1.0267}{6.4766} = 0.1585 \text{ hours or } 9.51 \text{ minutes}$
Average waiting time in the queue	$Wq = \frac{0.1015}{6.4766} = 0.0157 \text{ hours or } 0.942 \text{ minutes}$

```
Command Window
Input the model: 1 for single server and 2 for mutiple server --> 2
Case Type:
3 for (M/M/s>1):(GD/Inf/Inf):Multiple Server, Multiple Customers
4 for (M/M/s>1):(GD/N/Inf):Multiple, Limited Customers
Enter the Case Type --> 4
Enter lambda --> 6.6406
Enter mu --> 7
Enter s --> 2
Enter N --> 4
rho  is 0.4743
P0   is 0.2440
PN   is 0.0247
1-PN is 0.9753
L    is 1.0267
Lq   is 0.1015
W    is 0.1585
Wq   is 0.0157
>>
```

Figure 3 b. MATLAB Results of the Proposed System

Figure 3 illustrates the MATLAB simulation results of the proposed system. The system's utilization rate significantly decreased from 119.09% to 47.43%, reflecting a 71.76% reduction. The average number of E-Jeeps in the system dropped from 2 units to 1 unit, while the average number in the queue remained constant. Notably, the average waiting time per E-Jeep was reduced from 22.77 minutes to 9.51 minutes, and the average queue waiting time decreased sharply from 12.006 minutes to 0.942 minutes, marking an 11.064-minute improvement. These results indicate more efficient slot utilization, shorter waiting times, and an overall enhancement in the operational efficiency and service performance of the E-Jeepney Terminal.

6. Conclusion

A systematic evaluation of the queuing dynamics at the E-Jeepney Terminal revealed key performance metrics that support the effectiveness of the proposed facility layout. Through the application of queuing theory and computational analysis using MATLAB, it was demonstrated that adding a terminal slot and increasing the service rate could significantly enhance system efficiency. The study attained its general objective, which was to analyze and evaluate the impact of the lack of a queuing system and the prevailing maintenance challenges at the E-Jeepney Terminal, and to propose queuing theory-based solutions and improvements. Passenger arrival patterns were thoroughly analyzed, providing insights into demand trends and peak usage periods. The service rate of the E-jeepney fleet was assessed, and a queuing theory model of the current system was developed to serve as a framework for performance evaluation. Key performance metrics, such as waiting times, queue lengths, and system utilization, were quantified, allowing for a comprehensive assessment of the terminal's operational efficiency.

The present system showed a utilization rate of 119.09%, which was substantially reduced to 47.43% under the proposed system, an improvement of exactly 71.76%. This translates to smoother operations for E-jeepneys, station personnel, and commuters alike. Furthermore, total capacity usage decreased from 31.88% to just 2.47%, reflecting a notable reduction of 29.41%. The average waiting time for E-jeepneys was also significantly lowered, from 22.77 minutes to 9.51 minutes, resulting in a time savings of 13.26 minutes and a reduction in queue lengths. Additionally, the average delay experienced decreased dramatically from 12.006 minutes to only 0.942 minutes, an improvement of 11.064 minutes that enables more immediate boarding. The results of the study demonstrated that the proposed system not only optimizes terminal performance and reduces idle time but also enhances the overall commuter experience, minimizes inefficiencies, and contributes to increased operational profitability.

References

Aguilar, F., Baldiviso, A. J., Caguete, J. B., Laylo, J. D., Sakai, Y., Sanchez, R. K., Navarro M., Queuing System Analysis: Manufacturing Productivity Improvement in the Book Manufacturing Firm, Proceedings of the 5th Asia Pacific Conference on Industrial Engineering and Operations Management, Tokyo, Japan, September 10, 2024, https://doi.org/10.46254/AP05.20240184.

Birhan, M. Queuing analysis and optimization of public vehicle transport stations: A case of South West Ethiopia region vehicle stations. International Journal of Industrial Optimization, 5(1), 31–44. https://doi.org/10.12928/ijio.v5i1.7963, 2024.

Bournassenko, G. . On queueing theory for large-scale CI/CD pipelines optimization. arXiv. https://doi.org/10.48550/arXiv.2504.18705, 2025.

Cuaresma, N. A. S., Patalinghug, Q. S. L., & Viejo, R. C. B.. Feasibility study of e-jeepney as an alternative mode of transportation in Complex and Solenad 2, Nuvali, Santa Rosa City, Laguna. eJournal of Science and Technology, 18(1). https://www.ejournals.ph/article.php?id=18974, 2022.

Devi, S.. Basics fundamentals and the applications of queueing theory. https://www.researchgate.net/publication/370845009_Basics_Fundamentals_and_the_Applications_of_Queueing_Theory, 2023.

Felina, Zia., Agustien, M. & Kadarsa, E. (2025). Strategies To Improve Public Transportation Services For Students of The University Of Bengkulu. Journal Eduvest. Vol 5 (4): 3403-3415 E-ISSN: 2775-3727

Gaspay, S. M., & Salison, A. J.. The economics of e-jeepney transport operations: Business models, enabling factors, and current challenges (ICSC Report 1.2). International Council for Sustainable Development. https://icsc.ngo/wp-content/uploads/2024/03/ICSC_Report-1.2_The-Economics-of-EJeepney-Transport-Operations_14Mar24.pdf, 2024.

Harra, A. B., Raissouni A., & Belattmania, A. Tidenergy: A MATLAB-based tool for global tidal energy computation and visualization using the FES2014b tide model. Software X. Volume 30, 2025.

Hussein, A. T.. MATLAB and simulation. [Self-published]. https://www.researchgate.net/publication/371987917_MATLAB_and_Simulation, 2023.

Liang, M.; Wang, W.; Chao, Y.; Dong, C. Layout Planning of a Basic Public Transit Network Considering Expected Travel Times and Transportation Efficiency. Systems 2024, 12, 550. https://doi.org/ 10.3390/systems12120550

Liu, J.. Configuration of electric vehicle charging facilities based on queuing theory. Theoretical and Natural Science, 92(1), 129-133. https://doi.org/10.54254/2753-8818/2025.22038, 2025.

Munusamy, N.. Queuing Theory In Multi-Channel Model Of Waiting Lines With Boundary Value Method. International Journal of Mechanical Engineering and Mechatronics. 7(4):1860-1867, 2022.

Ripon, Md. B.B. Enhancing Bus Scheduling Efficiency in Rajshahi City, Bangladesh Through Linear Programming Approach, e-ISSN: 2828-9986 https://ejournal.unib.ac.id/index.php/jsds/index

Saini, B., Singh, D., & Sharma, K. C.. Exploring the role of queueing theory in manufacturing: An analytical study. International Research Journal on Advanced Engineering and Management, 2(03), 256-266. https://doi.org/10.47392/IRJAEM.2024.0039, 2024.

Wang, L., Lu, F., Han, B., Zhang, Q., & Zhang, C.. Simulation-based optimization of transport efficiency of an urban rail transit network. Applied Sciences, 13(3), 1471. https://doi.org/10.3390/app13031471, 2023.

Zhang, X., Gu, Y., Yang, Y., & Liu, B.. Comparing the efficiency of two types of yard layout in container terminals. Sustainability, 15(9), 7195. https://doi.org/10.3390/su15097195, 2023.

Zulueta, T.M.T.; Ong, A.K.S.; German, J.D.; Gumasing, M.J.J.; Chico, J.C.D. Implications of the Progression to Sustainable Public Transportation: An Insight into Modern Jeepney Shift from the Philippines. Sustainability 2024, 16, 3912. https://doi.org/ 10.3390/su16103912

Biographies

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.

Grace E. Ceballos is a third-year Industrial Engineering student at T.I.P. Quezon City and a DOST RA 7687 scholar. Serving as Vice Mayor of the IE Department Student Council for A.Y. 2024–2025 and Director for Academic Affairs of the T.I.P. Association of DOST Scholars, she's passionate about leadership and service. A dedicated volunteer with YMCA and the LEO Club, she also brings years of award-winning journalism experience. For her, growth stems from experience—both in life and leadership.

John Angelo A. Santiago is a third-year Industrial Engineering student at T.I.P. Quezon City and currently serves as Auditor of the IE Department Student Council for A.Y. 2024–2025. Known for his strong leadership and analytical skills, he actively participates in student organizations, mentorship programs like Y.L.E.A.P. and Six Sigma, and various leadership initiatives. He is committed to fostering growth, engagement, and learning within his community

Angelica Anne P. Jaquias is a third-year BS Industrial Engineering student at T.I.P. Quezon City who actively balances academics with student leadership. She currently serves as Mayor of the IE Department Student Council for the academic year 2024–2025 and Vice Governor of the CEA Council, after previously holding the role of Public Relations Officer. Known for her strong leadership and communication skills, Angelica is passionate about collaboration, believing that teamwork drives meaningful progress and positive change.

Beverly T. Melchor is a third-year Industrial Engineering student at T.I.P. Quezon City and a Quezon City government scholar. Currently serving as Treasurer of Organization of Industrial Engineering Students (ORIENTS) for A.Y. 2024–2025, she balances leadership with academic excellence. A Certified Lean Six Sigma Yellow Belt, she brings strong organizational skills, a solid work ethic, and a passion for continuous improvement.

Emmanuel Querubin S. Ocampo is currently pursuing a bachelor's degree in Industrial Engineering at the T.I.P. Quezon City while simultaneously working as a call center agent. In his role, he handles customer service tasks for United Airlines, demonstrating strong work ethic and dedication during graveyard shifts. Despite the demanding schedule, he remains committed to maximizing his learning experience in class, ensuring that every opportunity to gain knowledge and develop his skills is fully utilized.

Ralph Jason F. Delos Santos is a BS Industrial Engineering student at T.I.P. Quezon City who complements his academic journey with hands-on experience as an encoder at a logistics company. In this role, he ensured accurate and timely data entry, sharpening his attention to detail and deepening his understanding of supply chain operations. Committed to growth, he actively applies his classroom knowledge to real-world challenges, bridging theory and practice.

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

Bianca Angeline Catherina Mae S. Gedaria is a 3rd-year BS Industrial Engineering student at T.I.P. Quezon City and a DOST scholar. A consistent VPAA lister and former class valedictorian, she has received numerous academic awards and led award-winning research. She holds certifications in Lean Six Sigma and Project Management. Currently the Auditor of OIES, she's also active in PEER and PSS, with prior roles in BYP and ACE-Q. A former campus journalist and TV scriptwriter, she hopes to innovate in the airline and marine industries.

Maricar M. Navarro is an ASEAN Engineer (AE) and Professional Industrial Engineer (PIE), accredited by AFEO and PIIE. She is a professor at the T.I.P. Quezon City, teaching both undergraduate and graduate programs, with over 18 years of experience in industry, academia, and research. Her expertise includes production optimization, facility layout, warehouse operations, and service delivery. Her current research centers on financial optimization and operations decision-making. A Ph.D in Industrial Engineering and Masters graduate from MAPUA University, she is also an associate member of the NRCP and a member of PIIE, actively contributing to research and professional advancement in Industrial Engineering.