

Optimization Of Multi-Server Queue System at PT Bank Syariah Indonesia Kc Meulaboh Imam Bonjol Using The Discrete Event Simulation (DES) Simulation Approach

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Abstract. An unoptimized queuing system can negatively impact customer satisfaction and the operational efficiency of a bank. This study aims to develop and optimize a simulation model of a Multi-Server System queue at PT. Bank Syariah Indonesia KC Meulaboh Imam Bonjol. The method used is Discrete Event Simulation (DES), modeled with the assistance of AnyLogic software. Data were collected through direct observation, interviews, and documentation over two working days during operational hours. The model was developed using the Activity Cycle Diagram (ACD) approach and tested using several experimental scenarios. Simulation results indicate that the optimal scenario successfully reduces customer waiting time and improves server utilization. Validation was conducted using the Mean Absolute Percentage Error (MAPE) method, yielding a result of 0.99% for the actual system and 0.0038% for the experimental simulation, indicating that the simulation model accurately represents real-world conditions. Therefore, the developed simulation model can be used as a decision-support tool to improve service quality in Islamic banking.

Keywords: Queue, Discrete Event Simulation, Multi Server System, Activity Cycle Diagram, AnyLogic, MAPE.

1 Introduction

The merger that established Bank Syariah Indonesia (BSI), combining Bank Syariah Mandiri, BNI Syariah, and BRI Syariah, was intended to strengthen Islamic banking in Indonesia and expand its presence in the global market [1]. Banking service performance is closely related to customer satisfaction and service ethics [10]. Long queues and waiting times can reduce service efficiency; queueing theory provides the analytical basis for studying these effects [6], while empirical studies of bank queues have demonstrated the relevance of multi-queue and multi-server analysis [3, 18].

Multiserver capacity allocation and load balancing are also important when service demand is uneven [4].

Discrete Event Simulation (DES) is widely used to represent stochastic operational systems and to test improvement alternatives without disrupting the real system [8, 11, 12, 17]. Its applications include spare-parts inventory planning [2], healthcare queues [5], fast-food and culinary services [14, 19], retail service queues [20], and manufacturing-layout improvement [23]. Business-process modeling and simulation tools further support the translation of operational flows into executable models [9].

Related operational research also demonstrates the broader use of quantitative prediction [7, 13], queue-based resource allocation in communication systems [15], service-process management in pharmaceutical care [16], asset-management optimization [21], and web-based information delivery [22]. Although these studies address different domains, they reinforce the use of structured data and computational models for operational decision support. Accordingly, this study applies DES and the Activity Cycle Diagram (ACD) to analyze and optimize the multi-server queue at PT. Bank Syariah Indonesia KC Meulaboh Imam Bonjol.

2 Methodology

This study employed the Discrete Event Simulation (DES) method with a quantitative approach. The research was conducted at PT. Bank Syariah Indonesia KC Meulaboh Imam Bonjol, Aceh Barat. Data were collected through direct observation of queuing processes, structured interviews with staff, and documentation during operational hours (08:00–17:00) over two working days. The simulation model was developed using the Activity Cycle Diagram (ACD) and implemented with AnyLogic software. The model design included Customer Service, Teller, and ATM services. Several experimental scenarios were created to evaluate system performance. Validation was conducted using the Mean Absolute Percentage Error (MAPE) method to compare simulation results with real-world data. The number of replications is determined by the formula:

$$n = (Z * \sigma / E)^2$$

Model validation using MAPE with the formula:

$$MAPE = (1/n) \sum |(y - \hat{y})/y| \times 100\%$$

3 Result And Discussion

A summary of the simulation results shows improved server utilization and reduced wait times.

3.1. Activity Cycle Diagram (ACD) System Modeling

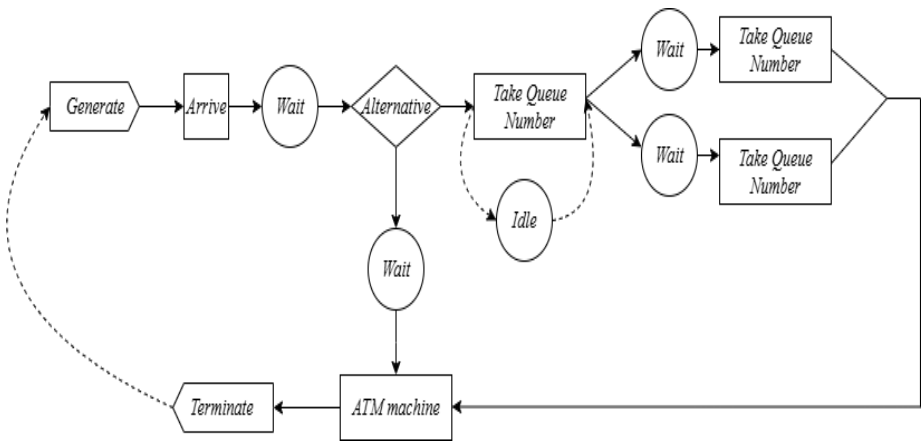


Figure 1. Activity Cycle Diagram (ACD) Modeling

Figure 1. above shows a diagram of the customer queuing system activity at a bank. The process begins with a customer entering the system (Generate), then arriving and waiting. After that, the customer is directed to the service according to their needs through a decision (Alternative), namely choosing to go to the ATM or enter to take a queue number with Customer Service, or Teller. Each service has a waiting stage (Wait) before being served. After receiving service, the customer exits the system through the Terminate Customer process. This diagram illustrates the service flow and helps in analyzing the efficiency of the queuing system.

3.2. Anylogic Modeling Simulation

This section provides the simulation scenario based on Anylogic Modeling simulation configuration.

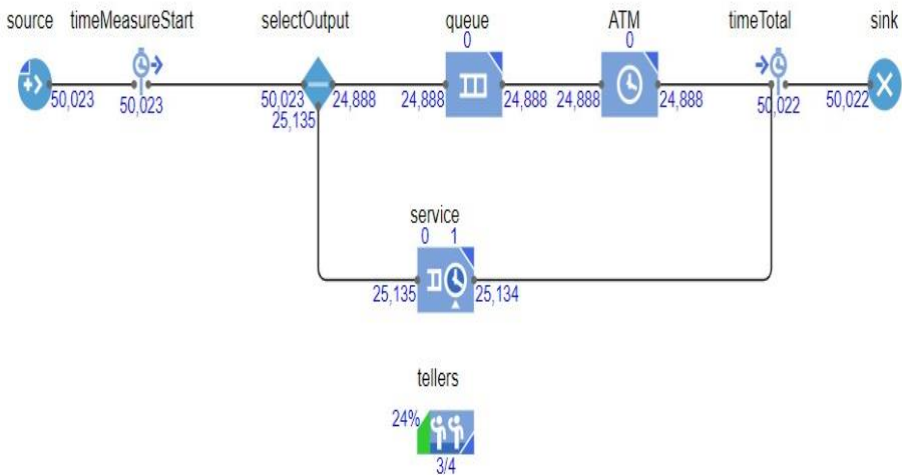


Figure 2 Anylogic Simulation of Real System Modeling
Source: Anylogic Software 2025

Figure 2 shows a queue simulation in AnyLogic. A total of 50,023 entities enter from the "source" and are then distributed to four different ATMs and one "service." After being processed at one of the ATMs or services, all entities eventually head to the "sink." 15% of the total available tellers are busy.

3.3. Service Utility Graph

The following graph shows the average utility for each server during the real-world simulation and experimental periods.

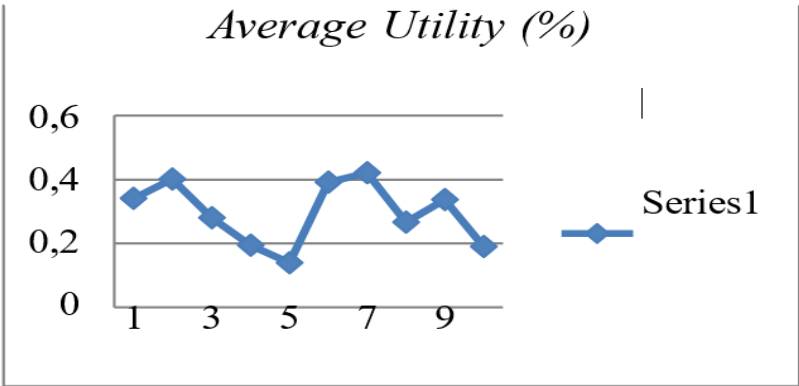


Figure 3. Average Experimental Server Utilization Graph
Source: Anylogic Software Data Processing 2025

Thus, the graph analysis of average utility (%) obtained 2 replications with the highest utility at data point (2), the utility reached around 0.40% indicating an initial increase in utilization. The highest peak was recorded at data point (7), with a utility of around 0.42%, indicating the most intensive queue load period.

3.4. Descriptive Queue Statistics

The following are the descriptive statistics for customer wait times for each service:

Table 1. Descriptive Statistics of Waiting Time (Seconds)

Server	Minimum	Maksimum	Average	Standar Deviasi
ATM machine	0,087	0,147	0,031	0,028
Teller	0,127	0,154	0,046	0,018
Customer Service	0,166	0,455	0,15	0,20

Source: Data Processing Easyfit 2025

Based on the statistical results presented in Table 1, the highest average waiting time was found in Customer Service at 0.15 with a standard deviation of 0.20, indicating high variation. Teller services had an average waiting time of 0.046 with low variation. Meanwhile, ATM machines showed the best performance with an average waiting time of 0.031 and the smallest variation.

The validation stage is carried out by comparing the simulation model output with actual field data. The method used is the Mean Absolute Percentage Error (MAPE), with the formula:

- 1. Validation Results of MAPE Calculation of Real System Model (%)

$$MAPE = \sum_{t=1}^n \left| \frac{0.99}{1} \right| \times 100\% = 0,99 \%$$

- 2. MAPE Calculation Validation Results of Experimental Model (%)

$$MAPE = \sum_{t=1}^n \left| \frac{45,02}{10} \right| \times 100\% = 0,0038 \%$$

Table 2. Model Validation Results

Model	MAPE(%)	Information
Real System	0.99	Valid
Experimental Simulation	0.0038	Very Valid

Source: Anylogic Software Data Processing 2025

4 Conclusion and Recommendations

This study demonstrates that the queuing simulation model using DES and ACD at PT. Bank Syariah Indonesia KC Meulaboh Imam Bonjol effectively reduces customer waiting times and improves server utilization. Validation results with MAPE (0.99% and 0.0038%) confirm that the model is accurate and representative of real conditions. Figures 4 and 5 document the customer queue and waiting-area conditions observed during field data collection.

It is recommended that the simulation results be used as a basis for more effective queue management, further developed with additional variables, and tested at other branches to continuously improve the quality of Islamic banking services.



Figure 4. Observed customer queue in the branch service area.



Figure 5. Observed customer waiting area during field data collection.

References

1. Bank Syariah Indonesia, "About Us." [Online]. Available: <https://www.bankbsi.co.id/company-information/tentang-kami>. [Accessed: Oct. 17, 2024].
2. A. R. Baihaqy, Analysis of spare part inventory policy to machines availability and throughput using discrete event simulation approach (Case study: PT Steel Pipe Industry of Indonesia), Final Project, TI 184833, 2019.
3. R. Budiman, D. Hatidja, and M. S. Paendong, "Queueing system analysis at PT Bank Negara Indonesia (Persero) Tbk, Manado branch office," *Jurnal Matematika dan Aplikasi D'Cartesian*, vol. 9, no. 1, pp. 8–15, 2020.
4. M. D. Erlangga and A. Prihanto, "Multiserver reliability analysis using load balancing with denial of service method," *Journal of Informatics and Computer Science*, 2022.
5. A. S. Elfahmi, Healthcare queueing system analysis using discrete event simulation approach (Case study: Pakem Health Center, Sleman), Undergraduate Thesis, Universitas Negeri, 2023.
6. D. Gross, J. F. Shortle, J. M. Thompson, and C. M. Harris, *Fundamentals of Queueing Theory*, 4th ed. Hoboken, NJ: John Wiley & Sons, 2016.
7. H. W. Herwanto, T. Widiyaningtyas, and P. Indriana, "Application of linear regression algorithm for rice yield prediction," *Jurnal Nasional Teknik Elektro dan Teknologi Informasi (JNTETI)*, vol. 8, no. 4, p. 364, 2019, doi: 10.22146/jnteti.v8i4.537.
8. Jerry, *Discrete-Event System Simulation*. Prentice Hall International Series in Industrial and System Engineering, p. 377, 2015.
9. N. K. Kadir, "Survey of open-source business process modeling and simulation applications," *Matics*, vol. 10, no. 2, p. 59, 2019, doi: 10.18860/mat.v10i2.5164.
10. Kasmir, *Customer Service Ethics*. Jakarta: PT Raja Grafindo Persada, 2017.
11. A. M. Law and D. W. Kelton, "Building valid, credible, and appropriately detailed simulation models," in *Simulation Modeling and Analysis*, 3rd ed. Singapore: McGraw-Hill, 2020, pp. 264–291.
12. D. Monte, "Definition of simulation, objectives, types, models, and implementation steps," 2020. [Online]. Available: <https://artikelsiana.com/pengertian-simulasi-tujuan-jenis-modellangkah-penerapannya/>. [Accessed: Jun. 25, 2021].
13. V. R. Prasetyo, H. Lazuardi, A. A. Mulyono, and C. Lauw, "Application of RapidMiner for predicting Rupiah exchange rate against US Dollar using linear regression method," *Jurnal Nasional Teknologi dan Sistem Informasi*, vol. 7, no. 1, pp. 8–17, 2021, doi:10.25077/teknosi.v7i1.2021.8-17.
14. A. D. Rizqullah, R. D. Rahmawati, M. K. Bagaskoro, O. N. Aibi, and D. Rolliawati, "Queueing system model using discrete event simulation method in fast food outlets (Case study: McDonald's Darmo Surabaya)," *Jurnal Sistem Informasi (JSI)*, 2023.
15. J. Sukri, "Bandwidth analysis using per connection queue method," *Rabit: Jurnal Teknologi dan Sistem Informasi Univrab*, vol. 2, no. 2, pp. 136–151, 2017.
16. E. M. Surahman and I. R. Husen, *Basic Concepts of Pharmaceutical Services Based on Pharmaceutical Care*. Bandung: Widya Padjajaran, 2011.
17. N. Siswanto, E. Latiffianti, and S. Wiratno, *Discrete system simulation implementation using Arena software*. Surabaya: ITS Tekno Sains, 2018.
18. S. R. Siregar and Pristiwanto, "Simulation of multiple queue multiple server application in bank queues using discrete event simulation method," *MEANS (Media Informasi Analisa dan Sistem)*, 2016.

19. M. Shofiudina, S. A. Nur Aini, M. S. Ihsan, R. A. T. Wibowo, and D. Rolliawati, "Discrete event simulation for business culinary service analysis (Case study: Gacoan Merr)," *JITU: Journal of Informatic Technology and Communication*, 2024.
20. S. Safitri, L. Perdananda, I. Nabilah, R. M. Azani, and M. J. Shofa, "Application of single channel single phase queue simulation model in ice cream outlets, Serang City," *Jurnal Teknik Industri*, 2024.
21. T. N. Wijaya, "Institutionalization of revenue center paradigm for optimal state asset management (Case study at Surabaya State Asset and Auction Service Office)," *Media Riset Akuntansi, Auditing & Informasi*, vol. 17, no. 2, pp. 173–190, 2017.
22. Waryanto, "Niagahoster," Jan.22,2021.[Online].Available:<https://www.niagahoster.co.id/blog/pengertian-website/>. [Accessed: Apr. 28, 2021].
23. D. Yulianto and S. B. Pamungkas, "Application of systematic layout planning and discrete event simulation for factory machine layout improvement in heavy equipment component industry," *Jurnal Teknik Industri*, vol. 6, no. 2, pp. 146–159, 2017.

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