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Designing Improvement of Service effectiveness Using M/M/1 and M/M/S Queue Models (Case Study: Customer Arrivals at Jatim Park Tourist Destination During Holidays and Peak Hours)

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Abstract - Queueing is a collection of people lined up to wait to be served, after which they leave the queue. Queuing activities often arise due to ineffective or suboptimal service times, resulting in longer wait times. To maximize and schedule service time optimally, queueing models such as M/M/1 and M/M/S systems are utilized. This study applies these models to analyze the queuing system at the Jatim Park tourist destination. This research aims to determine the effectiveness of service at the ticketing counters of Jatim Park during holidays. Data on visitor arrival times and average service times were collected to initiate the study. The data analysis aims to optimize service effectiveness at the Kampung Coklat tourist area by implementing the FCFS (First Come, First Served) queueing method and the M/M/S system. The findings suggest that the optimal number of teller servers needed to serve visitors effectively is 2. The analysis also identifies that the longest queue occurs between 10:00 AM and 11:00 AM, with 3 visitors waiting at its peak. The average number of visitors in the queue during this period is approximately 1.3 or 1 visitor. Based on these results, the study concludes that the service effectiveness at the Kampung Coklat tourist area is sufficiently optimized.

Keywords : Queue Models, Jatim Park Tourist Destination, Designing Improvement of Service.

I. INTRODUCTION

Jatim Park is a tourist destination with high-quality service facilities. Established in 2004, this attraction offers educational experiences through various rides with diverse facilities and techniques. Additionally, Jatim Park provides a range of food options, local agricultural products, livestock, and more. This makes Jatim Park a popular destination for individuals and families to spend their holidays. Visitors come not only from the surrounding areas but also from outside Malang and Batu, even from outside the East Java province.

The long queues during holidays and peak hours at Jatim Park affect service efficiency. The long waiting times, lengthy service processes, and the number of arrival counters are concerns for the public regarding Jatim Park. Service during holidays and peak hours is not as crowded compared to regular days. Queue models M/M/1 and M/M/S are alternatives to determine the effectiveness of service at Jatim Park by analyzing arrival patterns and service times.

Therefore, a comparative analysis of the queue system during holidays is needed to address these issues and ensure the system runs smoothly without compromising the service effectiveness at Jatim Park. This research aims to determine the effectiveness of the service and apply a queuing model using comparative methods to find solutions for improving the queuing system.
the service is complete, customers leave the system.

II. LITERATURE REVIEW

Definition of Queue

A queue is a collection of people (or entities) standing in a specific line to be served (Jaman, 2014; Mahessya, 2017). Several basic components in a queuing system are involved, with the entities being referred to as customers (Nengsih & Yustanti, 2017). These customers are served according to queue discipline rules (Alrosyid et al., 2019; Alfita et al., 2023). Once

1.1. Queue System Analysis

The time between service completion follows an exponential distribution.

** M/M/1 Queue System**

Using queue notation, the following results are obtained (Hidayat et al., 2020):

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1. **Service Intensity Factor**
\[
\rho = \frac{\lambda}{\mu}
\]

2. **Average Waiting Time**
\[
W = \frac{1}{\mu - \lambda}
\]

3. **Average Number of Visitors**
\[
L = \frac{\lambda}{\mu - \lambda}
\]

Where:
- \(\lambda \) = Arrival rate
- \(\mu \) = Service rate

4. **Idle Time Percentage**
\[
P_0 = 1 - \frac{\lambda}{\mu}
\]

5. **Number of Visitors in the System**
\[
P_n = \frac{\lambda^n}{n!} \cdot \frac{1}{\mu^{n} \cdot (\mu - \lambda)}
\]

6. **Total Cost**
\[
\text{Total Cost} = \text{Waiting Cost} + \text{Service Cost}
\]

1.2. Queue Models

Several queue models are used, including single-server systems (M/M/1) and multi-server systems (M/M/S) (Suban et al., 2022).

a. M/M/1 System

The M/M/1 system is characterized by (Hermanto et al., 2019; Purwanto, 2021):
- A single queue with an unlimited or unbounded number of customers
- Poisson-distributed arrivals
- Unlimited source of arrivals
- Queue discipline is typically FCFS (First Come, First Served)

b. M/M/S System

The M/M/S queue model involves multiple servers (KA, 2020; Murnawan, 2023).

M/M/S Queue System

Queue formulas for the M/M/S model include:

1. **Probability of 0 People in the System (P0)**
\[
P_0 = \frac{1}{\sum_{n=0}^{M-1} \frac{(\lambda/\mu)^n}{n!} + \frac{(\lambda/\mu)^M}{M! \cdot (1 - \lambda/(M \cdot \mu))}}
\]

2. **Average Number of Visitors in the System (Ls)**
\[
L_s = \frac{\lambda}{\mu - \lambda} \cdot \frac{1}{M!} \left[\frac{M \cdot \lambda}{\mu - \lambda} + \sum_{n=0}^{M-1} \frac{(\lambda/\mu)^n}{n!} \right]
\]

3. **Average Waiting Time in the Queue (Ws)**
\[
W_s = \frac{L_s}{\lambda}
\]

4. **Average Number of Visitors in the Queue (Lq)**
\[
L_q = L_s - \lambda
\]

5. **Average Waiting Time in the Queue (Wq)**
\[
W_q = \frac{L_q}{\lambda}
\]

DATA PROCESSING

Data collected from Jatim Park is processed and calculated to determine the average waiting time and queue length for customers. Microsoft Excel is used for data analysis.

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III. RESEARCH METHODS

Data Collection

Data collection was done by directly observing the ticket counters at Jatim Park, focusing on arrival patterns and service times. Observations included the time customers entered the queue, waited, and received service.

Table 1. Average Visitor Arrival per Hour on Holidays

TIME INTERVAL	AVERAGE ARRIVAL
08:00 – 09:00	350
09:00 – 10:00	480
10:00 – 11:00	520
11:00 – 12:00	450
12:00 – 13:00	430
13:00 – 14:00	325
14:00 – 15:00	280
15:00 – 16:00	140

From Table 1, the peak arrival time is 10:00 – 11:00 with 520 visitors, while the lowest is from 15:00 – 16:00 with 140 visitors. The total average visitor service rate (μ) is calculated as:

$$\mu = \frac{\text{Total Average Arrival}}{\text{Total Hours}} = \frac{350 + 480 + 520 + 450 + 430 + 325 + 280 + 140}{8} = 371 \text{ visitors/hour}$$

M/M/1 Analysis

1. **Service Utilization Rate (ρ)**
$$\rho = \frac{\lambda}{\mu} = \frac{350}{371} = 0.94$$

2. **Average Number of Visitors in the System (L)**
$$L = \frac{\lambda}{\mu - \lambda} = \frac{350}{371 - 350} = 17$$

3. **Average Number of Visitors in the Queue (Lq)**
$$L_q = \frac{\lambda^2}{\mu (\mu - \lambda)} = \frac{350^2}{371 (371 - 350)} \approx 16$$

4. **Average Waiting Time in the System (W)**
$$W = \frac{1}{\mu - \lambda} = \frac{1}{371 - 350} \approx 0.0476 \text{ hours (2.8 minutes)}$$

5. **Average Waiting Time in the Queue (Wq)**
$$W_q = \frac{L_q}{\lambda} = \frac{16}{350} \approx 0.046 \text{ hours (2.6 minutes)}$$

M/M/S Analysis

1. **Probability of 0 People in the System (P0)**
$$P_0 = \frac{1}{\sum_{n=0}^{M-1} \frac{(\lambda/\mu)^n}{n!} + \frac{(\lambda/\mu)^M}{M! \cdot (1 - \lambda/(M \cdot \mu))}}$$

2. **Average Number of Visitors in the System (Ls)**
$$L_s = \frac{\lambda}{\mu - \lambda} \cdot \frac{1}{M!} \left[\frac{M \cdot \lambda}{\mu - \lambda} + \sum_{n=0}^{M-1} \frac{(\lambda/\mu)^n}{n!} \right]$$

3. **Average Waiting Time in the Queue (Ws)**
$$W_s = \frac{L_s}{\lambda}$$

4. **Average Number of Visitors in the Queue (Lq)**
$$L_q = L_s - \lambda$$

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5. **Average Waiting Time in the Queue (Wq)**
\[
W_q = \frac{L_q}{\lambda}
\]

IV. CONCLUSION

Based on the analysis using M/M/1 and M/M/S methods:

1. Optimal Service Facilities: Two service counters (servers) are optimal for Jatim Park. The current setup with two service counters is appropriate.
2. Service Efficiency.

REFERENCES

1. Alfita, A., Hidianti, A. T., Dwiyansyah, A. P., Sakti, B.Y., Nugroho, A. A., & Radianto, D. O. (2023). Pemodelan dan Simulasi Antrian di Kicleanshoes. *KOLONI*, *2*(1), 310-317.
2. Alrosyid, H., Lukmandono, L., & Prabowo, R. (2019, March). Optimasi Proses Impor Komponen Kapal Pada Supply Chain Management Menggunakan Monte Carlo. In *Prosiding Seminar Nasional Hasil Penelitian LPPM Universitas PGRI Madiun* (pp. 199-206).
3. Ardy Hidayat, A. H., Reza Firsandaya Malik, R. F. M., & Siti Nurmaini, S. N. (2020). Group Decision Support System (GDSS) dengan Metode Entropy untuk Menentukan Prioritas Antrian Layanan Rumah Sakit Menggunakan Multiple Channel Model (M/M/s). *JATISI (Jurnal Teknik Informatika dan Sistem Informasi)*, *7*(2), 114-125.
4. Hanggara, F. D., & Putra, R. D. E. (2020). Analisis Sistem Antrian Pelanggan SPBU Dengan Pendekatan Simulasi Arena. *Jurnal INTECH Teknik Industri Universitas Serang Raya*, *6*(2), 155-162.
5. Hermanto, M. Z., Pratiwi, I., Tamalika, T., & Husin, I. (2019). Analisis sistem antrian dengan metode simulasi. *Jurnal Desiminasi Teknologi*, *7*(1).
6. Jaman, J. H. (2014). Penerapan Multiple Channel Model M/M/1 Antrian Pendaftaran di Rumah Sakit MNX. *Syntax: Jurnal Informatika*, *3*(01).
7. KA, A. P. (2020). Optimalisasi Antrian Dengan Metode Multi Chanel Single Phase (M/M/S). *KOCENIN Serial Konferensi (E) ISSN: 2746-7112*, (1), 2-2.
8. Mahessya, R. A. (2017). Pemodelan dan Simulasi Sistem Antrian Pelayanan Pelanggan Menggunakan Metode Monte Carlo Pada PT. Pos Indonesia (Persero) Padang. *Jurnal Ilmu Komputer*, *6*(1), 15-24.
9. Mollah, M. K., & Prabowo, R. (2022, November). Penentuan Produksi Optimal untuk Pembuatan Panci Alumunium Tradional Dengan Pendekatan Sistem Antrian (Studi Kasus: Home Industry Ngingas-Waru Sidoarjo). In *Prosiding Seminar Nasional Sains dan Teknologi Terapan*.
10. Murnawan, H. (2023). Analisis Perbandingan Pelayanan Sistem Antrian Pada Bisnis Makanan Online Dengan Menggunakan Peendekatan Model M/M/I dan M/M/S (Studi Kasus: Restauran Soto Madura Tapak Siring– Surabaya). *Jurnal SENOPATI: Sustainability, Ergonomics, Optimization, and Application of Industrial Engineering*, *4*(2), 136-143.
11. Nengsih, M. K., & Yustanti, M. V. (2017). Analisis Sistem Antrian Pelayanan Administrasi Pasien Rawat Jalan Pada Rumah Sakit Padmalalita Muntilan. *Managament Insight: Jurnal Ilmiah Manajemen*, *12*(1), 68-78.
12. Purwanto, T. A. (2021). Analisis Sistem Antrian Menggunakan Software Simulasi Arena Pada PT Indomobil Trada Nasional (Nissan Depok). *IKRA-ITH Informatika: Jurnal Komputer dan Informatika*, *5*(2), 54-66.
13. Suban, A. L., Itu, S. M., Nagen, R., & Rai le'o, Y. M. (2022). Analisis Sistem Antrian Pembayaran Registrasi Mahasiswa Dengan Model Antrian Single Channel-Single Phase Pola M/M/1. *Increate-Inovasi dan Kreasi dalam Teknologi Informasi*, *8*(1).
14. Susanto, E., & Fidianti, S. E. (2016). Analisis Perbandingan Sistem Antrian Model M/m/1 dan M/m/s untuk Pelayanan Pbb di Dpkad Kabupaten Purwakarta. *Eqien-Jurnal Ekonomi dan Bisnis*, *3*(2), 19-30.

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DOI : https://doi.org/10.36456/tibuana.7.2.9360.107-111 *e*-ISSN 2622-2035

15. Wiranda, D. (2022). Analisis Sistem Antrian Layanan Teller Dengan Menggunakan Metode Multi Channel-Single Phase (M/M/S) Untuk Mengoptimalkan Pelayanan. *Jurnal Riset Manajemen dan Bisnis*, 71-80.