



Analysis of The Number of Buses at Lempake Bus Station in Samarinda

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Abstract. Mass transportation plays a vital role in reducing carbon emissions and enhancing sustainability in urban environments. This study focuses on analyzing bus availability through simulation to optimize the efficiency and effectiveness of public transportation systems. The simulation model represents passenger arrivals and choices between two bus destinations, utilizing parameters such as bus arrival times, waiting times, and terminal capacity. Results demonstrate variations in passenger waiting times and bus utilization across destinations, with destination A experiencing an average wait of 1.84 minutes and destination B, 3.92 minutes. The model shows balanced passenger distribution, with an average of 13 waiting passengers for each route, indicating current bus capacity sufficiency. This study provides insights into using simulation as an analytical tool to improve bus station operations thereby minimizing passenger waiting times. Future research is needed to explore the factors that influence people's willingness to use mass transportation

Keywords: Bus Availability, Bus Station, Public Transportation, Waiting Time, Simulation

1 Introduction

Mass transportation plays an important role in reducing carbon emissions, especially in urban areas with dense traffic. Increasing mass transportation services can reduce the level of private vehicle use, which is the main source of CO₂ emissions in big cities [1]. Transitioning from private vehicle usage to more sustainable public transport alternatives enables cities to substantially decrease emissions. Mass transportation not only reduces carbon emissions, but also reduces the use of fossil fuels, helping to create greener and more sustainable cities [2]. Mass transportation analysis is essential to support the low-carbon development agenda and improve air quality in urban areas. Expanding the public transportation network is important to achieve sustainable development and improve air quality.

The examination of optimal bus capacity is crucial for sustainable public transport planning. Effective planning can alleviate congestion and enhance the efficiency of the entire transport system [3]. Increased passenger demand, particularly during important

events, can result in substantial congestion and prolonged waiting times due to inadequate transport coordination [4]. Consequently, accurate bus capacity analysis can facilitate the construction of more effective routes and schedules, consequently reducing waiting times and enhancing passenger satisfaction [5]. Moreover, modifying bus capacity in response to fluctuating demand is crucial during unforeseen disturbances in the transportation system [6].

Simulation in transportation analysis can be used to understand and optimize complex transportation systems. By using simulation methods, researchers can model various possible scenarios in a transportation system, such as changes in traffic volume, variations in vehicle types, and the impact of new transportation policies [7]. In addition, simulation in mass transportation planning has many significant benefits, especially in improving the efficiency and effectiveness of the transportation system. By using simulation, planners can evaluate various transportation scenarios and policies without having to make physical changes in the field, which can save time and costs [8]. Simulations also allow testing of various policies and strategies without having to make physical changes in the field, which can save time and costs [9]. Simulation can help decision makers to derive policies that result in fewer queues [10]. By modeling the various variables and parameters that affect a transportation system, simulations allow for in-depth analysis of how changes in one aspect can affect the entire system [11]. Therefore, the application of simulation in mass transportation planning not only improves operational efficiency, but also supports data-based and sustainable decision-making in the development of better transportation systems in the future. Transportation simulation modeling can use Arena software using the Transporter Module. With this transportation model, decision makers can run simulations with various scenarios to obtain optimal strategies [12].

Research on bus capacity analysis at terminals using simulation has been conducted by several researchers which have produced significant findings. One interesting study is conducted by Lindberg, which uses discrete event simulation to analyze bus terminal capacity. This study shows that by modeling various operational variables, such as bus arrival times and passenger service times, a better understanding of how terminal capacity can be optimized to improve service efficiency can be obtained [13]. From the background described above, this study aims to analyze the number of buses at the terminal using simulation.

2 Materials and Methods

The following is an explanation of the steps in the simulation creation and analysis process

- **Creating a Bus Terminal Simulation Model**

The initial step in creating a bus terminal simulation model is to build a digital representation of the system to be analyzed. This includes modeling the bus arrival process, stopping time, number of passengers, passenger flow, and bus departure

from the terminal. Define Parameters and Variables: Set key parameters such as bus arrival time, bus capacity, passenger waiting time, and terminal capacity.

- Verification and Validation

Description: Verification and validation are carried out to ensure that the simulation model is accurate and reliable. Verification ensures that the model runs according to the initial design, while validation ensures that the model represents real conditions. Verification: Test the model components to ensure that each component is performing according to the designed logic. For example, check that buses actually arrive at the times specified in the model. Validation: Compare the simulation results with real-world data from the bus terminal (if available) or with field observations. This aims to confirm that the model exhibits behavior that is consistent with the actual system.

- Creating Scenarios

Description: Scenarios are created to test various operational situations that might occur at the bus terminal. Each scenario allows for analysis of the impact of a particular change, such as increasing the number of buses, changing the schedule, or adding facilities.

- Running the Simulation

Description: This step involves running the simulation model according to the scenarios that have been created. The simulation model will process the flow of buses and passengers based on the settings that have been determined.

- Analyzing Results

Description: After the simulation is complete, the results of each scenario are analyzed to identify patterns, trends, and performance differences between the scenarios tested. This analysis helps in making data-driven decisions for improving terminal operations. Summarize the simulation results by highlighting the best scenario and the steps that support optimal bus terminal performance.

3 Results

The model created can be seen in Fig. 1. The condition of someone wishing to take a bus is represented by the model that was made. After arriving at the terminal, potential passengers select a bus based on the route they have chosen. Next, potential traveler confirm that seats and the bus are available at the chosen location. Passengers will head straight to the bus if one is available, and the bus will travel to its destination. In the event that there are no seats available, potential passengers will wait until there are seats available.

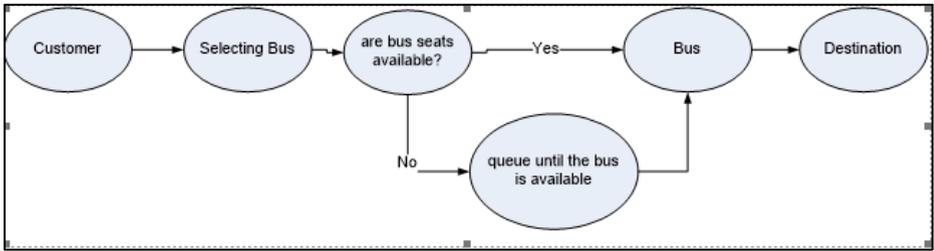


Fig. 1. Results of the passenger model at the bus station

From the designed model, simulation software was developed, as shown in Fig. 2. This model utilizes 17 components representing two bus destinations. Incoming passengers choose between these two buses based on their planned travel destination. The software includes a transport feature, which links one station to another. Upon running the simulation, the outcomes, displayed in Fig. 3, show groups of passengers and buses assigned to different destinations. During the simulation, 60 passengers boarded buses for Destination A, while 30 boarded for Destination B. Additionally, 4 buses were allocated for Destination A, and 2 buses for Destination B. Passengers bound for Destination A experienced an average waiting time of 1.84 minutes, whereas those heading to Destination B waited an average of 3.92 minutes. The average number of passengers waiting for both destinations A and B was 13.

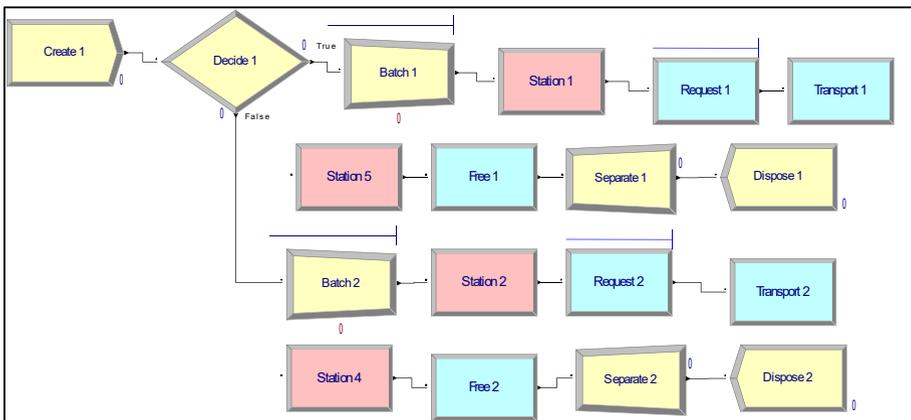


Fig. 2. Bus Passenger Simulation Model

Number Out	90
A	60
B	30
Number of Bus A	4
Number of Bus B	2
Time	
	Waiting Time
Batch 1.Queue	1.84
Batch 2.Queue	3.92
	Number Waiting
Batch 1.Queue	13.92
Batch 2.Queue	13.38

Fig. 3. Report of Simulation

4 Discussion

The design of the model for simulation has representative data from a real system for a bus station with two destination directions. Where passengers at the bus station are random arrivals, and the model accommodates passengers to choose using the decide module. Then passengers will wait if the bus is not yet available, or the bus seat capacity is full.

In the software using batch facilities to collect passengers according to the capacity of the bus seats. After the bus capacity is fulfilled, the bus will run to the destination station and passengers will exit the bus as individuals with the separate module facility then go to the dispose module and exit the system.

The simulation results show that buses with destination A have more passengers and the number of buses than destination B. Passengers for destination B are 67% and passengers for destination A are 33% of passengers for both destinations. In addition, the simulation also found that destination B has a longer average waiting time than buses with destination A, which is 3.92 minutes. While for destination A it is 1.84 minutes. This shows that passengers who want to go to destination A at Lempake bus station wait an average of 3.92 minutes. In addition, each bus destination has a relatively similar number of passengers waiting, which is around 13 people. This shows that the capacity of the number of buses and seats available is still sufficient, as seen from the queue time, and the number of people queuing is not too large for both destinations.

This sufficient number needs further research whether the sufficient passengers are due to many other prospective passengers using private vehicles or travel and the reasons they do not use Public Buses as mass transportation

5 Conclusions

The design of the simulation model can describe the situation of passengers arriving at a bus station with 2 destination directions. The simulation of the model can be run to analyze the number of buses in 1 day, the number of passengers, the number of queues and the queue time for buses in two directions. From the simulation results, it was found that the capacity of buses to A and B was still within sufficient limits. It can be seen from the length of the queue and the number of people waiting for the bus to depart is still within a reasonable amount.

For further research, it is necessary to conduct research by considering the reasons why people do not want to use buses as public transportation.

References

1. Jing, Q. L., Liu, H. Z., Yu, W.Q., He, X.: The Impact of Public Transportation on Carbon Emissions—From the Perspective of Energy Consumption. *Sustainability (Switzerland)* **14**(10), 6248 (2022).
2. Jelti, F., Allouhi, A., Tabet Aoul, K.A.: Transition Paths towards a Sustainable Transportation System: A Literature Review. *Sustainability (Switzerland)* **15**(21), 15457 (2023).
3. Codeca, L., Cahill, V.: Using Deep Reinforcement Learning to Coordinate Multi-Modal Journey Planning with Limited Transportation Capacity. *SUMO Conference Proceedings* **2**, 13–32 (2022).
4. Proffitt, D.G., Bartholomew, K., Ewing, R., Miller, H.J.: Accessibility planning in American metropolitan areas: Are we there yet? *Urban Studies* **56**(1), 167–192 (2019).
5. Liu, R., Wang, N.: Data-Driven Bus Route Optimization Algorithm under Sudden Interruption of Public Transport. *IEEE Access* **10**, 5250–5263 (2022).
6. Li, L., Zhu, G., Wu, D., Xu, H., Ma, P., Liu, J., Li, Z., He, Y., Li, C., Wu, P.: Land suitability assessment for supporting transport planning based on carrying capacity and construction demand. *PLoS ONE* **16**(2), (2021).
7. Sudibyo, T.: Pengaruh Pembatasan Jenis Kendaraan Terhadap Kinerja Ruas Jalan. *Jurnal Teknik Sipil Dan Lingkungan* **8**(03), 177–182 (2023).
8. Dewi, K.P., Sumabrata, J.: Simulasi Penerapan Kebijakan Sistem Transportasi Perkotaan Menggunakan Software Pluto. *INTECOMS: Journal of Information Technology and Computer Science* **6**(1), 398–405 (2023).
9. Budiawan, W., Arvianto, A., Adam, N.P.: Kajian Awal Simulasi Komputer Model Kebijakan Penentuan Jumlah Optimal Armada Bus Rapid Transit (Brt) Semarang. *Simetris : Jurnal Teknik Mesin, Elektro Dan Ilmu Komputer* **7**(1) (2016).
10. Utomo, D.S., Indrayana, M., Widiastuti, R.: Application of Simulation for Cinema Queue Policy in the COVID-19 Era. *ICSET: International Conference on Sustainable Engineering and Technology* **1**(1), 57–62 (2022).

11. Wijayanto, D., Djanggu, N.H., Prima, F.: Pengembangan Model Simulasi untuk Menentukan Waktu Operasional Terbaik Angkutan Kontainer. *Jurnal Edukasi Dan Penelitian Informatika (JEPIN)* **10**(1), (2024).
12. Utomo, D.S., Mufti, D.: Perancangan Model Simulasi Arena Pada Kasus Sistem Transportasi. *Jurnal Teknik Industri Universitas Bung Hatta* **10**(01), 52–60 (2023).
13. Lindberg, T., Lindberg, T.: *Discrete Event Simulation of Bus Terminals of Bus Terminals* (Vol. 1841). Linköping University Electronic Press (2019).

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