# Best Route Search for Students Traveling from One State University to Another in Bandung Using the A-star Algorithm

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***Public transportation systems play a crucial role in urban mobility, especially in large cities like Bandung. For students who frequently travel between universities, choosing the most efficient transportation mode, considering both cost and time, becomes a challenge. This paper presents the development of a route planning system using the A star algorithm to assist students in selecting the best route. The system takes into account the bus fare and distance between bus stops to determine the optimal route. Using graphs as the underlying structure, the program determines which bus stop is the most efficient to reach and provides the best route alternatives based on the available data. The findings of this study show that the A-star algorithm is an effective method for finding the shortest route with the lowest cost and time.***

***Keywords: A-star algorithm, public transportation, graph, cost, travel time, bus stops.***

## I. Introduction

Public transportation systems are a critical component of urban infrastructure that support mobility, especially in large cities like Bandung. With multiple universities scattered across the city, students often need to travel between universities for academic and non-academic activities. However, selecting an efficient transportation route is challenging, both in terms of cost and travel time.

In the field of transportation, one of the ways to plan an efficient route is through the use of graph algorithms. A graph is a mathematical structure used to represent relationships between objects, in this case, between bus stops and universities. Each node in this graph will represent either a university or a bus stop, while the edges will represent the bus routes that connect these bus stops.

The A* algorithm, a widely known pathfinding algorithm, is well-suited for this problem. The A* algorithm allows us to compute the best route between two points (in this case, the starting university and the destination university), considering both cost and travel time. By using heuristics, this algorithm can efficiently find the best route.

The primary objectives of this research are:

1. Develop a system to help students select the best public transportation route between state universities (PTN) in Bandung.
2. Utilize the A* algorithm to find the optimal route by considering factors such as bus fare, distance from bus stops to universities, and travel time.
3. Assist students in making decisions regarding the most cost-effective and time-efficient transportation option.
4. Improve commuting experience for students by providing an efficient route selection system.

This paper aims to develop a route planning system that assists students in choosing the best bus and bus stop that is most efficient, using the A* algorithm. This system will take into account the bus fare**,** travel time, and distance between bus stops and universities in determining the optimal route.

## II. Theoretical Background

### *A. Graph*

Graph theory is a branch of discrete mathematics that studies structures called graphs. A graph consists of a set of vertices (nodes) connected by edges. In this context, graph theory is used to model the relationships between objects, such as universities and bus stops, as well as the bus routes connecting those bus stops.

Formally, a graph can be defined as G = (V, E), where:

- V is the set of vertices (nodes), representing objects or points, in this case, universities and bus stops.
- E is the set of edges that connect pairs of vertices. These edges represent bus routes that connect the bus stops.

Graphs can be categorized based on several criteria, such as whether they are directed or undirected, and whether the graph is simple or contains multiple edges. In this research, we are mainly concerned with weighted, undirected graphs. The edges in this graph represent bus routes, and the weights on the edges represent cost or distance.

Graphs are used extensively in optimization problems, such as finding the shortest path between two nodes. In transportation systems, graphs are commonly used to model the network of bus stops and routes. By applying graph algorithms, we can calculate the shortest route between two points (universities or bus stops), which is essential for route planning.

*B. Types of Graph*

Graphs can be classified based on several criteria, such as:

- Simple Graphs: A simple graph contains no multiple edges or loops. Each pair of vertices is connected by at most one edge.

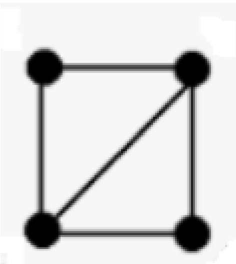

Fig 1. Simple Graph

https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/20-Graf-Bagian1-2024.pdf. Retrived on 20/06/2025

- Weighted Graphs: In a weighted graph, each edge has a weight or value, which can represent parameters such as cost, distance, or travel time.

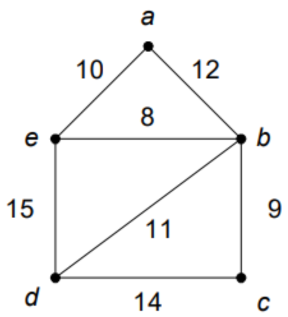


Fig 2. Weighted Graph

https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/20-Graf-Bagian1-2024.pdf. Retrived on 20/06/2025

- Directed Graphs (Digraphs): In a directed graph, each edge has a direction, indicating the direction of travel from one node to another. In the case of bus routes, a directed graph is typically used, as bus routes often only allow travel in one direction.

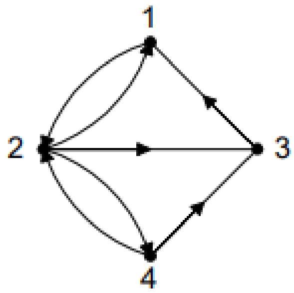


Fig 3. Directed Graphs

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- Undirected Graphs: In an undirected graph, edges do not have directions. The relationship is bidirectional, meaning you can travel in both directions along the edge.

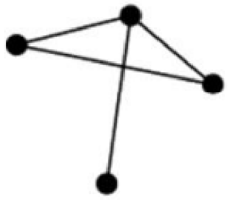

Fig 4. Undirected Graphs

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In public transportation systems, we generally use a weighted, undirected graph, where the nodes represent universities and bus stops, and the edges represent the bus routes. The weights of the edges represent the cost of using the bus route or the distance between two bus stops.

*C. A* (A-star) Algorithm*

A* is a widely used and highly efficient algorithm for pathfinding and graph traversal, commonly employed in transportation systems due to its ability to find optimal routes. It is a best-first search algorithm that determines the shortest path between a starting node (university or bus stop) and a goal node (destination university or bus stop) within a graph. A* uses a heuristic function to estimate the remaining cost from the current node to the goal, guiding its search towards the most promising paths.

The evaluation function for A* is expressed as: $f(n) = g(n) + h(n)$, where:

- $f(n)$ is the total estimated cost of traveling from the start node through node n to the goal.

- g(n) is the actual cost incurred to reach node n from the start node, which can represent the bus fare or time taken to reach a bus stop.
- h(n) is the heuristic estimate of the remaining cost, typically representing the distance from node n to the goal (university or bus stop).

For A* to guarantee finding the optimal path, the heuristic function h(n) must be admissible (it never overestimates the actual cost to the goal) and consistent (it maintains a monotonic property). In the context of public transportation, g(n) could represent the actual travel cost or time between bus stops, while h(n) is often calculated as the straight-line distance or estimated time from the current bus stop to the destination university.

Although A* is an effective algorithm for finding optimal routes, it can explore many nodes if the heuristic is not accurately estimated or if the transportation network is complex. In the case of public transportation systems, the heuristic must be carefully selected to ensure efficient routing while minimizing the exploration of unnecessary paths.

### *D. Transportation in Bandung*

Bandung, as the capital of West Java Province, Indonesia, has a growing urban population and a diverse range of transportation needs. Public transportation plays an important role in the mobility of the community, especially for students who frequently travel between universities for academic and non-academic purposes. The transportation system in Bandung consists of various modes, such as buses, angkots (minivans), taxis, and online ride-hailing services like Grab and Gojek.


Fig 5. Metro Jabar Trans

https://images.app.goo.gl/8xyiNhviDUcEhjeV8

Retrived on 20/06/2025

There are three types of buses in Bandung, namely Metro Jabar Trans and Trans Metro Bandung. Below are the routes available for each bus service:

- Metro Jabar Trans

Metro Jabar Trans has 6 main routes as follows:

1. Leuwipanjang - Soreang (via Tol Soroja)
2. Alun-Alun Bandung - Kota Baru Parahyangan (via Cimahi)
3. Baleendah - BEC
4. Leuwipanjang - Dipatiukur
5. Dipatiukur - Jatinangor (via Tol Moh. Toha)
6. Leuwipanjang - Majalaya

Fare: Rp 4.900

Discount: Seniors, students, and people with disabilities receive a discount of Rp 2.000.

- Trans Metro Bandung

Trans Metro Bandung has several main routes, including:

1. K1: Cibeureum - Cibiru
2. K2: Cibeureum - Cicahue
3. K3: Sarijadi - Cicaheum
4. K4: Antapani - Leuwipanjang
5. K5: Antapani - Stasiun Hall
6. F1: Stasiun Hall - Gunung Batu
7. F2: Cibeureum - Summarecon

Fare: Rp 4.000
Discount: Students receive a discount of Rp 2.000.

The diversity of routes offered by these three bus services provides many choices for the public, especially students, to select the most suitable transportation mode for their destination. However, despite the availability of these transportation options, various factors such as travel time, fare, and accessibility to bus stops influence the selection of the optimal route.

## III. METHODOLOGY

The method used in this research is divided into three main stages: (A) data collection (B) graph modeling (C) A-star Algorithm Implementation.

### *A. Data Collection*

The following are the route and stop data using Trans Metro Bandung.

| KORIDOR | JURUSAN | ARAH | JALAN YANG DILALUI | JAM OPERASIONAL |
|---|---|---|---|---|
| Koridor 1 | Cibiru - Cibeureum | Pergi | Soekarno Hatta - Jend. Sudirman - Rajawali Barat - Elang Raya | 05.00-15.30 WIB |
| Koridor 1 | Cibeureum - Cibiru | Pulang | Elang Raya - Soekarno Hatta | 05.00-17.30 WIB |
| Koridor 2 | Cicaheum - Cibeureum | Pergi | Jend. Ahmad Yani - H. Ibrahim Adjie - Jakarta - Jend. Ahmad Yani - Kembang Sapatu - Terate - Samoja - Malabar - Jend. Ahmad Yani - Asia Afrika - Jend. Sudirman - Rajawali Barat - Elang Raya | 05.00-18.00 WIB |
| Koridor 2 | Cibeureum - Cicaheum | Pulang | Elang Raya - Rajawali Barat - Rajawali Timur - Kebon Jati - Suniaraja - Otto Iskandardinata - Stasiun Timur - Perintis Kemerdekaan - Braga - Lembong - Veteran - Jend. Ahmad Yani | 05.00-18.00 WIB |
| Koridor 3 | Cicaheum - Sarijadi | Pergi | Jend. Ahmad Yani - P.H.H. Mustofa - Surapati - Prabudimuntur - Cikapayang - Layang Prof. Mochtar Kusumaatmadja - Dr. Djunjunan - Surya Sumantri - Lemahneundeut - Perintis - Sarimanah - Sariwangi | 05.00-17.00 WIB |
| Koridor 3 | Sarijadi - Cicaheum | Pulang | Sariwangi - Lemahneundeut - Terusan DR. Sutami - Surya Sumantri - Dr. Djunjunan - Layang Prof. Mochtar Kusumaatmadja - Cikapayang - Surapati - P.H.H. Mustofa - Jend. Ahmad Yani | 05.00-18.00 WIB |
| Koridor 4 | Simpang Antapani - Leuwipanjang | Pergi | Jakarta - Sukabumi - Laswi - Flyover Laswi - Pelajar Pejuang 45 - BKR - Peta - Raya Kopo - Soekarno Hatta - Leuwi Panjang | 05.30-15.00 WIB |
| Koridor 4 | Leuwipanjang - Simpang Antapani | Pulang | Raya Kopo - Peta - BKR - Pelajar Pejuang 45 - Flyover Laswi - Laswi - Jend. Ahmad Yani - H. Ibrahim Adjie - Jakarta | 06.00-17.00 WIB |
| Koridor 5 | Terminal Antapani - Stasiun Hall | Pergi | Terusan Jakarta - Jakarta - Sukabumi - Laswi - L.L.R.E. Martadinata - Merdeka - Lembong - Tamblong - Asia Afrika - Jend. Sudirman - Gardujati - Kebon Jati - Suniaraja | 05.30-15.00 WIB |
| Koridor 5 | Stasiun Hall - Terminal Antapani | Pulang | Suniaraja - Otto Iskandardinata - Stasiun Timur - Perintis Kemerdekaan - Braga - Lembong - Veteran - Jend. Ahmad Yani - H. Ibrahim Adjie - Terusan Jakarta - Cibatu Raya | 06.30-15.00 WIB |
| Feeder 1 | Stasiun Hall - Gunung Batu | Pergi | Suniaraja - Otto Iskandardinata - Stasiun Timur - Perintis Kemerdekaan - Wastukencana - Pajajaran - Cihampelas - DR. Abdul Rivai - Dr. Cipto - DR. Gunawan - Dr. Otten - Westhoff - Pasteur - Dr. Djunjunan - Sukaraja II - Dakota - Gunung Batu | 06.00-15.00 WIB |
| Feeder 1 | Gunung Batu - Stasiun Hall | Pulang | Gunung Batu - Dakota - Sukaraja II - Dr. Djunjunan - Pasteur - Cihampelas - Wastukencana - Pajajaran - Cicendo - Kebon Kawung - Pasir Kaliki - Kebon Jati - Suniaraja | 06.00-16.00 WIB |
| Feeder 2 | Summarecon Mall - Cibeureum | Pergi | Grand Bulevar - Bulevar Barat - Gedebage Raya - Gedebage Selatan - Soekarno Hatta - Jend. Sudirman - Rajawali Barat - Elang Raya | 06.30-15.00 WIB |
| Feeder 2 | Cibeureum - Summarecon Mall | Pulang | Elang Raya - Soekarno Hatta - Gedebage Selatan - Magna Raya - Bulevar Barat - Grand Bulevar | 06.30-17.00 WIB |

Fig 6. Table of route and stop data using Trans Metro Bandung.

[Trans Metro Bandung | BLUD UPTD Angkutan DISHUB Kota Bandung]

Retrieved on 20/06/2025

The following are the route and stop data using Metro Jabar Trans.






### *B. Graph Modelling*

The transportation system in Bandung, which includes bus routes and bus stops, is modeled as a graph. A graph consists of nodes (also called vertices) and edges (also called arcs), where:

- Nodes represent key locations such as universities and bus stops.
- Edges represent the bus routes connecting the bus stops.

In this study, the graph is weighted, where the edges have weights that correspond to the costs or distances of traveling between bus stops. The weight could represent either the bus fare (cost) or the distance (for estimating travel time). The objective of graph modeling is to map out the public transportation system in a way that allows us to apply optimization algorithms, such as **A***, to find the most efficient route between two nodes (universities).

## IV. Result and Discussion

This paper explores the application of the **A*** algorithm in optimizing the travel routes for students commuting between universities in Bandung. The graph model developed for this purpose represents the network of bus stops and universities as nodes and the bus routes as edges, with weights assigned based on either cost or distance.

The **A*** algorithm, which combines the actual cost (g(n)) and the heuristic estimate (h(n)), proved to be an effective method for finding the most efficient route between two points, considering both bus fare and travel time. The use of heuristics further enhanced the algorithm's efficiency, enabling faster route selection by focusing on the most promising paths. The heuristic function utilized in this study was based on the straight-line distance between bus stops and universities, which served as an estimate of the remaining travel distance or time.

Through the graph model, the algorithm was able to optimize the travel routes for students by:

- Minimizing the total cost of travel (bus fare).
- Reducing travel time based on the distance between bus stops and universities.
- Offering a feasible and efficient solution by identifying the most cost-effective and time-efficient routes.

Despite its effectiveness, the implementation of A* showed that the algorithm's performance can vary depending on the accuracy of the heuristic function and the complexity of the transportation network. In more **congested areas** or when **traffic data** is not factored into the model, the algorithm's ability to select the best route may be affected. Therefore, future improvements could involve incorporating **real-time traffic data** and **bus schedules** to make the system even more efficient and reliable.

This study demonstrates the power of **graph theory** and the **A*** algorithm in solving practical transportation problems and optimizing student commutes in urban settings like Bandung. By considering both **cost** and **distance** as key factors in route selection, students can make more informed decisions, resulting in

In conclusion, this research successfully applied the **A*** algorithm to optimize travel routes for students commuting between universities in Bandung. By modeling the transportation network as a graph, the algorithm was able to provide **optimal paths** based on both **cost** and **distance**, allowing for more efficient and cost-effective commuting.

The **graph model** used in this study effectively represented the key elements of the public transportation system, including **bus stops**, **universities**, and **bus routes**. The **A*** algorithm's use of **heuristics** to guide the search towards the most promising paths proved to be an essential feature in improving the algorithm's performance and finding the best routes.

However, further research is needed to incorporate **real-time data**, such as **traffic conditions** and **bus schedules**, which could enhance the **A*** algorithm's efficiency, especially in a dynamic and congested environment like Bandung. The integration of such data would likely improve the overall route selection process, leading to even more accurate and reliable recommendations for students.

Ultimately, this study highlights the potential of combining **graph theory** and **A*** for optimizing transportation systems, not only for students in Bandung but also for similar urban transportation challenges in other cities.

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## REFERENCES

[1] Munir, R. (2024). Graf - Bagian 1. Retrieved June 20, 2025, from https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/20-Graf-Bagian1-2024.pdf.

[2] Munir, R. (2024). Graf - Bagian 2. Retrieved June 20, 2025, from https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/21-Graf-Bagian2-2024.pdf.

[3] Munir, R. (2024). Graf - Bagian 3. Retrieved June 20, 2025, from https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/22-Graf-Bagian3-2024.pdf.

[4] Muzhaffar, R. (2022). Utilization of A* Algorithm to Determine the Best Route When Using Trans Metro Pasundan, from https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2022-2023/Makalah2022/Makalah-Matdis-2022%20%281%29.pdf

[5] "Trans Metro Bandung", from Trans Metro Bandung | BLUD UPTD Angkutan DISHUB Kota Bandung

[6] Bandung Metropolitan Area Transportation Map. (2022). Forum Diskusi Transportasi Bandung. Retrieved from https://425867b3-685a-437f-9bf8-c3411dd31873.usrfiles.com/ugd/425867 24c15d12aa444fdaab13e4660ede9db1.pdf

## PERNYATAAN

I hereby declare that the paper I wrote in my writing is not an adaptation, a translation of someone else's papers, or plagiarism.

Bandung, 10 Juni 2025

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