Jakarta's Transit System: Choosing the Best One Based on Your Preferences with Decision Tree

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Abstract—**Transit systems are the cheapest way to go from places to places when someone did not own a private vehicle. In big cities such as Jakarta where people from all around the metropolitan area swarmed into the capital city to do their activities everyday, public transportation are needed to reduce the number of traffic happening on the road. Jakarta is home to diverse public transportation facilities, which includes buses such as Transjakarta, trains like KRL Commuterline, MRT, and LRT, microbuses, and so on. Some times, it is hard to choose which one we want to use because there are so many alternatives given by the city. Passengers needs to sort out their preferences so they could use the best transportation according to their liking. This could be done by implementing the concept of Decision Tree in real life, which will be discussed by this paper.**

Keywords—**decision trees, Jakarta, preferences, transit system**

I. Introduction

Jakarta is the capital city of Indonesia. Officially known as the Special Capital Region of Jakarta, it also acts as its own province with a total population of 10,770,487 as of 2020 [1]. It is one of the most populated urban areas in the world, placing 2nd after Tokyo.

Recently, Jakarta was named the winner of the 2021 Sustainable Transport Award (STA), an annual award distributed by the Institute for Transportation and Development Policy (ITDP) and the STA community. The award acknowledges a city's effort on improving the mobility of its citizens, reducing air pollution, and the improvement of pedestrians' and cyclists' safety. Jakarta is the first among Southeast Asian cities to receive the award, especially for their effort in improving the city's integrated transportation system which includes Transjakarta, LRT, MRT, Commuterline, the airport rail link system, and numerous other available transportation means [2].

With all the available public transportation provided by the government, citizens might find themselves in confusion as they cannot decide which transportation they should be taking. There are numerous aspects which could affect their decisions before taking the public transportation of their choice.

The consideration process could be done by applying the concepts of Decision Tree, which can make the user specify which of the option presented satisfy their condition and brings them to the final answer, which is the method of transportation that they will be using.

This paper will discuss how public transportation users in Jakarta could determine which public transportation they should

use based on the implementation of the Decision Tree theory. The public transportations that will be discussed are limited to the rapid transit system in Jakarta which includes Transjakarta, LRT, MRT, Commuterline, and the airport rail link system.

II. Basic Theory

A. Tree

A tree is a connected undirected graph that does not contain any circuits [3]. It means that it cannot contain any multiple edges or loops, making it a simple graph.
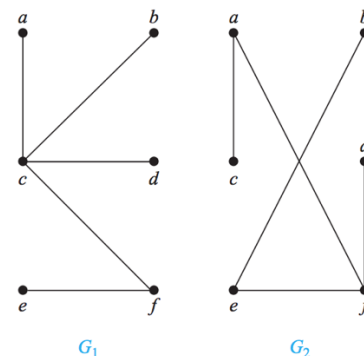

Figure 2.1 Examples of a Tree
Source: Discrete Mathematics And Its Applications 7th Edition by Kenneth H. Rosen

A graph G = (V, E) with n amount of vertex is considered a tree if it satisfies the following properties:
1. Every two vertices of G are connected by a single path
2. G is connected and has m = n - 1 edge(s)
3. G contains no cycles and has m = n-1 edge(s)
4. G contains no cycle, and an addition to the edge pf the graph would create exactly one cycle
5. G is connected and every edge is a cut-edge

Multiple trees that are unconnected with each other are called a *forest*. A forest can also be unconnected graphs that does not contain any circuits. Every component inside the graph is considered as a tree.
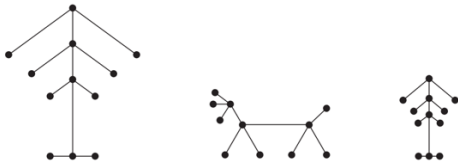
Figure 2.2 Example of a Forest
Source: Discrete Mathematics And Its Applications 7th
Edition by Kenneth H. Rosen

B. Rooted Tree

When a vertex on a tree is appointed as a *root* and every edge is directed away from that vertex, the tree is now considered as a directed graph called a *rooted tree*.
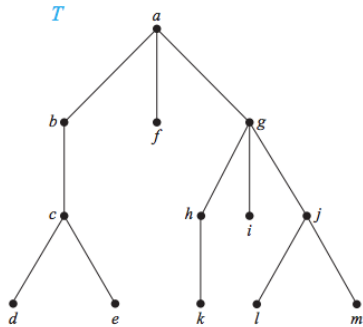

Figure 2.3 A Rooted Tree
Source: Discrete Mathematics And Its Applications 7th
Edition by Kenneth H. Rosen

Although it is a directed graph, arrows that are supposed to show the direction of the edges are disregarded since the root of a rooted tree can be randomly chosen from one of the available vertices. Every time a different root is chosen, the direction also changed.

There is a terminology that is used to describe the role of each vertices, which points a vertex as a *parent* and the vertex under it a *child*. If a v is a non-root vertex of a tree, u is the parent of v if there is a directed edge from u to v. A parent could have several children, making them *siblings*. Vertices that acts as a parent are called *internal vertices*. If a vertex does not have any children, they're called a *leaf*.

Fig. 2.3 shows a rooted tree with vertex a acts as the root. Vertex b, f and g are the children of a and are considered siblings. Vertex d, e, f, k, i, l, and m are leaves because they have no children.
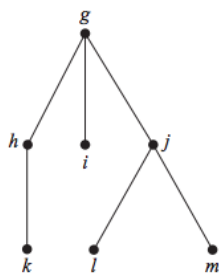

Figure 2.4 A Subtree of a Rooted Tree
Source: Discrete Mathematics And Its Applications 7th
Edition by Kenneth H. Rosen

Fig. 2.4 shows the subtree of the tree T from Fig. 2.3. When we take a part of a rooted tree, the topmost vertex acts as a root and a parent to the vertex below them. The vertex g in Fig. 2.4 is the root of that certain subtree, with h, i, j acts as its children.

Besides the role of parents and children, a vertex could have a degree, level, and depth. A vertex's degree is the amount of children a vertex parent has. The degree of vertex a on Fig. 2.3 is 3, while the degree of vertex j is 2.
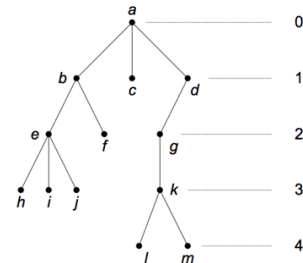

Figure 2.5 Rooted Tree Levels
Source:
http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2020-
2021/Pohon-2020-Bag2.pdf

We can determine a vertex's level by defining the root as the 0th level, while the children of a are dubbed as the 1st level. Fig. 2.5 shows a rooted tree with 4 levels, which ends when the last *descendants* of the main root a does not have any children. The depth of a rooted tree is shown by the number of levels they have. The tree in Fig. 2.5 has a depth of 4.

When every vertex in a rooted tree has no more than m children, the rooted tree is called a *m-ary tree*. If each vertices has exactly m amount of children, it is called a *full m-ary tree*. A tree with m = 2 is called a binary tree.

C. Decision Tree

Rooted trees can be used in daily life scenarios to decide which solution to take based on the decisions made prior to achieving the solution. When an internal vertex in a rooted tree corresponds to a decision and there is a subtree at these vertices available for each possible outcome of the decision, the tree is called a decision tree.
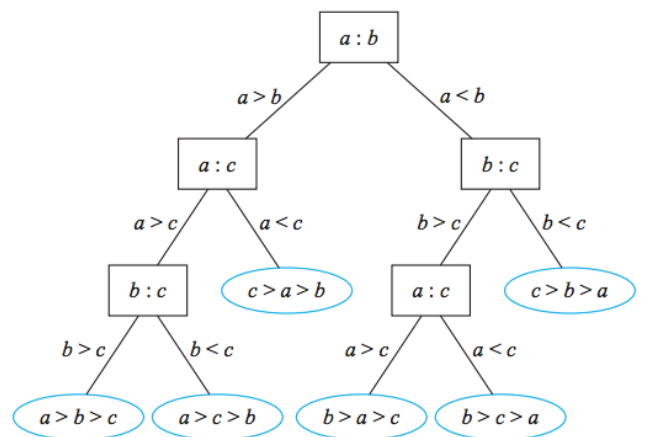

Figure 2.6 Example of a Decision Tree
Source: Discrete Mathematics And Its Applications 7th
Edition by Kenneth H. Rosen

The decision tree in Fig. 2.6 shows the process of sorting three integers a, b, and c from the largest value to the smallest value. The internal vertices (shown as rectangles on the figure) acts as a decision while the leaves (shown as the blue ovals on the figure) represent all the possible solutions for the intended problem.

D. Public Transportations in Jakarta

Since its founding in 1527, Jakarta has gone through many advancements in their public transportation facilities. Nowadays, people are free to choose their preferred transportation means based on their needs or contentment. The public transportations available in Jakarta are:

1. Transjakarta: Transjakarta is a bus rapid transit (BRT) system that provides a public transportation system to not only Jakarta, but also its metropolitan area (Jakarta, Bogor, Depok, Tangerang, and Bekasi, commonly called as *Jabodetabek*). Operating since January 2004, Transjakarta is the first BRT system in Southeast Asia and they have their own dedicated lanes, commonly called as 'busway'. These lanes are the longest BRT lanes in the world with 251.2 km total length [4].

2. Light Rail Transit (LRT): Light Rail Transit is one of Jakarta's main new transit system that began operating just a year ago on December 2019. Currently, it only serves one route only, from Pegangsaan Dua to Velodrome. All of the train stations along the route are integrated either with Transjakarta bus stations or microbuses such as Mikrotrans. The government are still working on adding more routes as they planned to add 6 more routes in the future [5].

3. Mass Rapid Transit (MRT): MRT started its construction in October 2013, building an underground and elevated lines along the path of Bundaran Hotel Indonesia and Lebak Bulus. It is the system's first route, and it started operating since March 2019 [6]. The first route harbors 13 stations in total, connecting the center of Jakarta to the southern parts of Jakarta. They planned to have 5 routes in total, connecting the northern, southern, east and west Jakarta with the same transit system. It is also integrated with numerous other transit systems such as the Transjakarta, KRL Commuterline, and the microbuses.

4. KRL Commuterline: KRL Commuterline system is perhaps one of the older generation of Jakarta rapid transit system, which began operating since the 1920s. However, after some declines throughout the years, they finally blossomed into a leading and dependable transportation system after they started to use the current form of electric train service we know now. The electrical system was first operated in 2008, with further modernization started from 2011. Serving Jakarta's metropolitan area, it has a total route of 418.5 km with 6 lines available and 80 stations scattered around Jabodetabek. KRL Commuterline is integrated with several other transit

system such as the Transjakarta, MRT, Airport rail link, and even the intercity electrical train system.

5. Soekarno–Hatta Airport Rail Link: The airport rail link system first operated 2 years ago, on December 2017. It serves the purpose of providing a fast, comfortable, and effective alternative for people who needs to go to Soekarno–Hatta International Airport. The route is 54.3 km long, with five stations which are connected to the KRL Commuterline stations and MRT stations. Unlike other transit systems, the airport rail link does not stop at every stations they pass, only several ones that allow passengers to enter from several sides of Jakarta. Since Soekarno–Hatta International Airport is located in Tangerang, its route also passes Tangerang's region.

6. Other public transportations that will not be discussed in this paper.

III. CONSIDERATIONS BEFORE TAKING THE TRANSPORTATION

There are a few considerations that can be made by a public transportation user before taking a certain transportation. These consideration are as follows.

1. Destination

The purpose of taking a transportation is to move from one place to another place. Therefore, it is the place where we are right now and our destination is the first thing we need to consider before taking any transportation means. Every transportation has different scopes of regions, so we need to be sure where we are headed to. Destination-based transportation such as the airport rail link will be an absolute answer for someone who is going to the airport. But with the other transit systems, we need to choose the closest one to our origin location and the closest one to our destination.

2. Integration between transit systems

Some transit systems are more integrated than the rest. The more integrated a transit system is, the more advantageous they are. When you are heading to a destination, sometimes your transportation of choice does not really bring you to the exact point you are heading to. However, you could continue your journey with a different transportation means if they are available at the place you are getting off from.

3. Price

Although most of Jakarta's transportation systems were subsidized by the government, some transportations costs more than the others.

Transjakarta and LRT has a flat rate of Rp 3.500 and Rp 5.000 respectively, while the cost of MRT and KRL Commuterline increased the further we go. The minimum price for a MRT pas is Rp 4.000 for a single trip to the nearest station, while the most expensive one is Rp 14.000 which could take you from Bundaran Hotel Indonesia station to Lebak Bulus Station. KRL Commuterline starts from Rp 3.000 for the first 2.5 km ride and adds another Rp 1.000 for every 10 km. The price for Airport

Rail Link ranges from Rp 10.000 to Rp 50.000, depending on where the passenger is getting in from.

4. Traffic

Although most of us would say we prefer traffic-free lanes, sometimes it needs some sacrifice to actually do it. With train transit systems such as the LRT, MRT, and KRL Commuterline, since the lane is used only for that specific type of transportation, we need to bore the consequences of not being able to sit, or not being able to stand properly because how jam-packed the corridors are. With Transjakarta, you may have a chance to sit or choose a less crowded bus, but the trip could take ages with you stuck in the middle of Jakarta's traffic jams. Of course, this does not happen all the time—they mostly happened during rush hours like in the morning or late afternoon—but sometimes a journey must be taken during unexpected hours, which could affect our choice of transportation.

Those are what the author thinks might be the considerations made by someone before choosing a public transportation.

IV. USING DECISION TREE TO CHOOSE

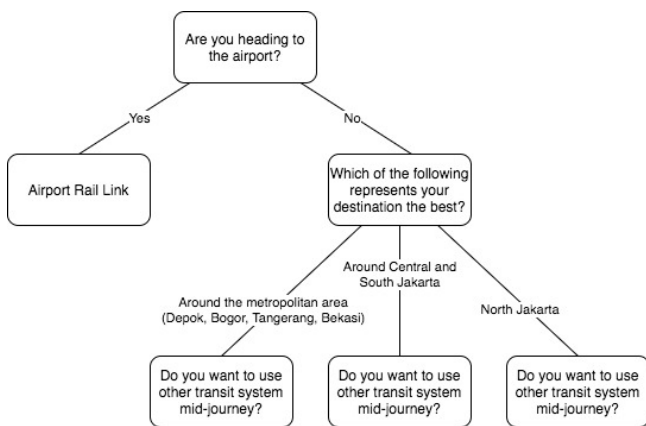The first thing we should consider is the location where the passenger is heading to.

Figure 4.1 Destination Preferences
Source: Author

If a passenger's destination is an airport, the best way to go to the airport is the Airport Rail Link. Since we consider destination first, Airport Rail Link automatically became the best solution, although in some cases people might prefer other transportation because of the price. It's cheaper to go by Airport Rail Link if you are traveling alone, because the price is reasonable comparing to traveling by car or bus (which sometimes costs more since you need to pay for toll roads or gas). However, you might want to reconsider if you are traveling in big groups, because alternative transportations like rented car or taxi can be a lot more cheaper. That, if you consider about the price. If the passenger is not going to the airport, they're given a choice which determine their destination.

At this point, if the passenger choose 'Around the metropolitan area', the available transportation choices are the KRL Commuterline and Transjakarta. If they choose 'Around

Central and south Jakarta', the available transportation choices are KRL Commuterline, Transjakarta, and MRT. If they chose North Jakarta, the the available transportation choices are KRL Commuterline, Transjakarta, and LRT. Airport rail link are not mentioned anymore as they only serve the routes to airport.

After the destination is set, the passenger can choose whether they want to use a transportation that is integrated with the other transit system or not.
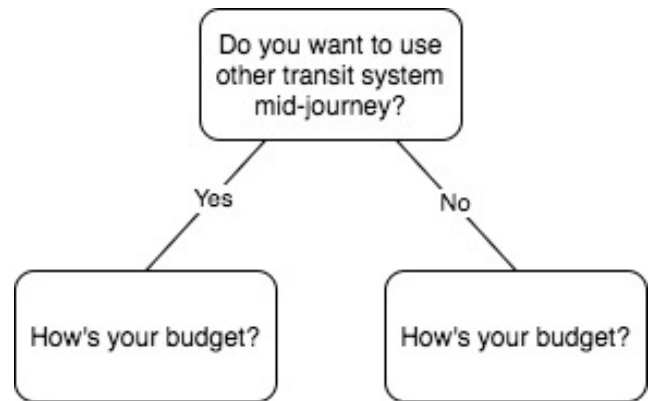

Figure 4.2 Integration Preferences
Source: Author

It's normal to have a change of heart midway, so some might prefer taking a transportation that could give them the ability to use other transportation as well. MRT, KRL Commuterline, and Transjakarta fell into the "Yes" category, while LRT fell to the "No" category as it contain very few integration choices.

After choosing the their integration preference, we need to determine the passenger's budget.
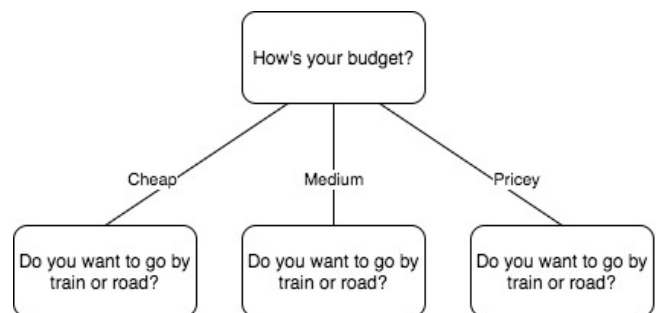

Figure 4.3 Budget Preferences
Source: Author

Based on the price written on the previous part, we divide the rates into three categories, which are cheap, medium, and pricey. The cheap price range includes Transjakarta and KRL Commuterline, the medium price range is for the LRT, and the pricey price range is for the MRT. However, with some restrictions made on the inner vertex before the parent vertex 'How's your budget', these choices may be reduced to the available transportation means. For example, if the passenger had previously chosen 'Around Central and South Jakarta', the decision for this part of the vertex would be restricted into the cheap and pricey categories only. The same procedures is applied to the other categories as well.

At last, the passengers needs to choose whether they want to go by train or by road, which represents the differences in traffic preferences.
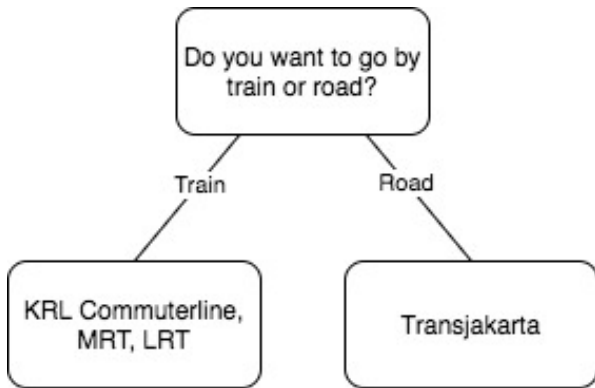

Figure 4.4 Traffic Preferences
Source: Author

With the last inner vertex, we had arrived to the final answers. These are the possible answer for the decision vertex, but answers may vary due to the decisions made beforehand. The full decision tree is as shown below.

There are some vertices that only have one *child*, which means that the options for that vertex is limited because of the decisions that has been made beforehand. There are 5 possible outcomes (5 possible choice of transportation) that is divided into 9 different solutions.

Figure 4.5 Full Decision Tree
Source: Author

V. CONCLUSION

A decision tree is a concept that can be widely used in many aspects of life, not only in science but also in our daily lives. Decisions in real life can be modeled through the things we learn at class and that shows how knowledge can impact the way we live our lives.

Jakarta is an enormous city with lots of facilities available for all people to use. They provide the citizens with several travel choices, which sometimes can make someone ponder which of the transportation they should use. By using decision tree that was taught by the Discrete Mathematics course, we could model the considerations that people have and reach the ultimate solution by following the decisions we made on the decision tree.

The things written in this paper are mostly from the author's own experiences with judgements made purely from the author's observation.

VI. ACKNOWLEDGMENT

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PERNYATAAN

Dengan ini saya menyatakan bahwa makalah yang saya tulis ini adalah tulisan saya sendiri, bukan saduran, atau terjemahan dari makalah orang lain, dan bukan plagiasi.

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