

Optimizing Zipline Routes for Daily Material Gathering in Valley IV of Arknights: Endfield Using Weighted Graphs

Natanael Chris Fabian Santoso - 13525083

Program Studi Teknik Informatika

Sekolah Teknik Elektro dan Informatika

Institut Teknologi Bandung, Jalan Ganesha 10 Bandung

E-mail: natanaelcfs1234@gmail.com , 13525083@std.stei.itb.ac.id

Abstract—Arknights: Endfield is an action RPG game with a unique base-building twist. It allows players to create facilities to help produce materials, automate production lines, and improve map traversal. Players can create ziplines, and by powering them, it allows players to traverse the map at great speed while ignoring hostile terrain and enemies. However, ziplines have limitations, such as a maximum range and a maximum amount allowed for every subregion on the map. This paper will analyze and optimize zipline routes in order to find the most optimized zipline route, using weighted graphs, Hamiltonian paths, and paths with the least total weight. An optimized zipline route would allow the player to traverse the map in the least amount of time possible, while spending the least amount of resources possible.

Keywords—Arknights: Endfield; Ziplines; Graph; Weighted Graph; Shortest Path; Optimal Path

I. INTRODUCTION

Arknights: Endfield is an action role-playing game developed and published by Hypergryph. Arknights: Endfield is a spinoff of Hypergryph's Arknights, which is a tower defense game released in 2019.

Arknights: Endfield differs from its predecessor by implementing a real-time action RPG with significant base-building and management elements. Players of Arknights: Endfield explore a vast open world, battling endemic monsters and hostile militias while surveying the land for resources, establishing outposts, and managing bases [1].

Arknights: Endfield has a feature that makes it stand out among the different action RPG games on the market, which is its base-building system, integrated with exploration and resource management. Players can build facilities to enhance and refine in-game materials, automate production of various in-game products, and improve exploration and traversal of the world by deploying ziplines and defense facilities.

The combat in the game is roughly similar to other action RPG games on the market, in which you have to assemble a party of up to 4 characters (also called "operators" in-game) maximum. However, the combat stands out, as the game allows for the participation of all party members (each party consists of 4 operators maximum) during combat, with

seamless transition when swapping operators. It also emphasizes precise skill aiming at enemies and dodging enemy attacks.

II. THEORETICAL BASIS

A. Graph

A graph is a data structure that can be used to represent complex, non-linear relationships. A graph consists of nodes that are connected by edges.

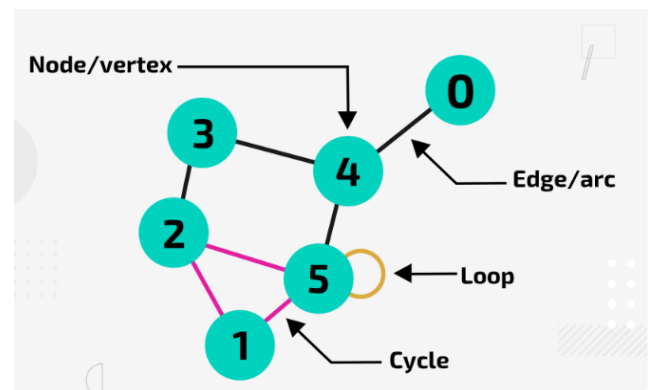


Figure 2.1. A graph's main components (Source: https://adacomputerscience.org/concepts/struct_graph)

Graphs come in multiple types. The most common type is a graph with at most one edge connecting two vertices, which are called simple graphs. A multigraph is a graph where multiple edges are allowed between two vertices. While loops (vertices that are connected to itself) are usually not allowed, there are graphs where this restriction doesn't hold. A graph that may contain multiple edges and graph loops is called a pseudograph.



Figure 2.2. Three kinds of graphs (Source: <https://mathworld.wolfram.com/Graph.html>)

B. Weighted Graph

A weighted graph is a graph in which each edge is assigned a numerical value, also known as the weight. The weight can also be thought of as the cost, distance, or quantification of the relationship between two nodes.

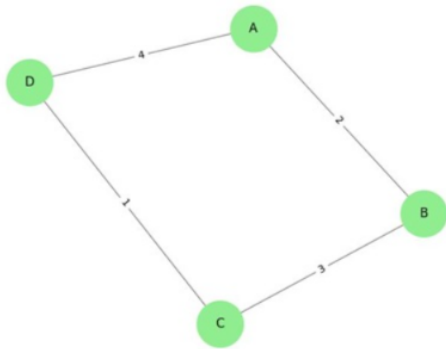


Figure 2.3. An example of a weighted graph (Source: https://www.tutorialspoint.com/graph_theory/graph_theory_weighted_graphs.htm)

C. Hamiltonian Path and Circuit

A Hamiltonian path is a graph path between two vertices of a graph that visits each vertex exactly once. If a Hamiltonian path exists whose endpoints are adjacent, then the resulting graph cycle is called a Hamiltonian cycle. A graph that possesses a Hamiltonian path is called a traceable graph.

III. ARKKNIGHTS: ENDFIELD'S MAP

There are many arguably important sites to visit on the map in the game, but this paper will be focusing on the material gathering sites which are the Recycling Stations, Rare Growths, and Rare Ores. These gathering sites refresh on each player's map daily and must be gathered to avoid wasting materials that would've otherwise been in the player's inventory.

Depending on the player's exploration level and type, Rare Growths and Rare Ores refresh by adding 1-2 of the corresponding material for the player to gather up to a max of 7-8. If a refresh causes the count of material for a specific Rare Growth or Rare Ore to be over the maximum, then the game will set the count to the maximum. Rare Growth and Rare Ore materials are crucial in Arkknights: Endfield, as they allow the player to increase the level of operators and weapons, significantly enhancing combat and exploration.

A Rare Growth site in Valley IV can hold either one of four materials, which are Pink Bolete, Red Bolete, Kalkodendra, and Chrysodendra. Pink Boletes are used to raise the level cap of an operator from level 20 to level 40. Red Boletes are used to raise the level cap of an operator from level 40 to level 60. Being able to raise the level cap of an operator means drastically improving the operator's combat capabilities, as raising an operator's level boosts the operator's base combat stats. Kalkodendras and Chrysodendras are used to improve an operator's Combat Nodes, which significantly boost the operator's combat capabilities, such as allowing an operator to output more damage when fighting enemies, boost

healing capabilities to other operators, and increase buffs towards other operators.

A Rare Ore site in Valley IV can hold either one of two materials, which are Kalkonyx and Aurnyx. Kalkonyxes are used to raise the level cap of a weapon from level 20 to level 40, and Aurnyxes are used to raise the level cap of a weapon from level 40 to level 60. Being able to raise the level cap of a weapon means significantly improving combat capabilities, as the operator who uses the weapon would have improved attacking stats, as well as other buffs that come when using the weapon.

Depending on its own level, a Recycling Station refreshes by allowing the player to collect 3 Aerospace Material I up to 6 Aerospace Material I and 6 Aerospace Material II. A refresh will always allow the player to collect materials that correspond to the specific Recycling Station's level. If a refresh happens while the player hasn't collected the rewards given by a Recycling Station, then nothing changes and the Recycling Station would still have the same amount of materials to be collected. Recycling Stations are important in Arkknights: Endfield, as they allow the player to level up the player's main space station in the game, called Dijiang. They allow the expansion of Dijiang's production output.

Arkknights: Endfield's map consists of two major regions, each with their own subregions. The two major regions in Arkknights: Endfield as of June 19th, 2026 are Valley IV and Wuling. Valley IV is made up of multiple subregions which are The Hub, Valley Pass, Aburrey Quarry, Originium Science Park, Origin Lodespring, and Power Plateau. Each of these subregions contain material gathering sites in which the player must gather daily.

A. Valley Pass

Valley Pass of Valley IV contains 1 Rare Ore site which holds Kalkonyx, 1 Rare Growth site which holds Pink Bolete, and 1 Recycling Station. It is important to note that Valley Pass's Rare Ore site is inside of a cave system, rendering it difficult to reach by traversal methods other than simply walking or running there.



Figure 3.1. Valley Pass subregion of Valley IV. (Source: Author's Collection)

B. The Hub

The Hub of Valley IV contains 3 Rare Ore sites, all of which hold Kalkonyx, and 6 Rare Growth sites, 3 of which hold Pink Bolete and the other 3 hold Kalkodendra. It also

contains 3 Recycling Stations. This subregion is the largest subregion in Valley IV and contains the largest number of gathering sites.

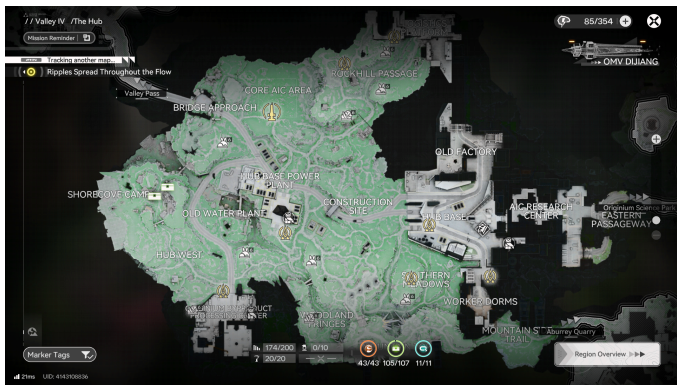


Figure 3.2. The Hub subregion of Valley IV. (Source: Author's Collection)

C. Aburrey Quarry

Aburrey Quarry of Valley IV contains 1 Rare Ore site which holds Kalkonyx, and 3 Rare Grow sites, 2 of which hold Kalkodendra and the other holds Pink Bolete. It also contains 1 Recycling Station. This subregion is notably steep, with lots of obstructions which increases the difficulty of traversing and exploring this subregion, whether it'd be by walking and running or by ziplines.

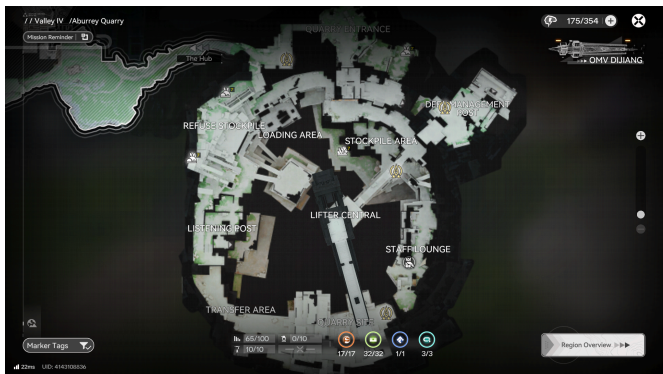


Figure 3.3. Aburrey Quarry subregion of Valley IV. (Source: Author's Collection)

D. Originium Science Park

Originium Science Park of Valley IV contains 2 Rare Ore sites both of which hold Kalkonyx, 3 Rare Growth sites, 2 of which hold Pink Bolete and the other holds Kalkodendra, and 2 Recycling Stations.

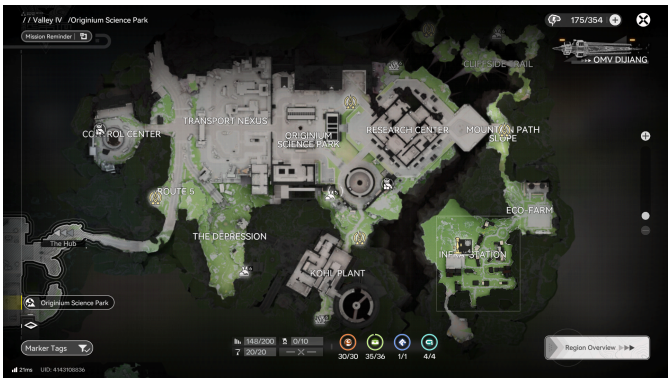


Figure 3.4. Originium Science Park subregion of Valley IV. (Source: Author's Collection)

E. Origin Lodespring

Origin Lodespring of Valley IV contains 3 Rare Ore sites all of which hold Auronyx, 5 Rare Growth sites, 3 of which hold Red Bolete and the other 2 hold Chrysodendra, and 2 Recycling Stations.



Figure 3.5. Origin Lodespring subregion of Valley IV. (Source: Author's Collection)

F. Power Plateau

Power Plateau of Valley IV contains 1 Rare Ore site which holds Auronyx, 3 Rare Growth sites, 2 of which hold Chrysodendra and the other holds Red Bolete, and 2 Recycling Stations. Power Plateau's Rare Ore site is inside of a small cave system, rendering it difficult to reach by other traversal methods than walking or running. Although, it is still possible to reach the mouth of the cave by zipline.



Figure 3.6. Power Plateau subregion of Valley IV. (Source: Author's Collection)

IV. ZIPLINE ROUTE ANALYSIS

Zipline Pylons and Zipline Towers in Arknights: Endfield allow players to traverse the map much more quickly compared to the standard map traversal method of walking or running with an operator. Using a zipline allows the player to traverse the map at 15 m/s in-game. Other than its fast speed, using a zipline also allows the player to skip obstacles that would've otherwise been a huge issue when walking. These obstacles include the terrain, where a player might have to go around certain parts of the map to reach the destination on the map rather than going directly to the destination. Enemies on the map are also obstacles that the player has to deal with when walking or running. The player must fight and defeat the enemies, or find another route that avoids them altogether.

Each subregion on the map has a limit to how many ziplines can be placed within it. For subregions in Valley IV, Valley Pass can have up to 10 ziplines, The Hub can have up to 20 ziplines, Aburrey Quarry can have up to 10 ziplines, Originium Science Park can have up to 20 ziplines, Origin Lodespring can have up to 25 ziplines, and Power Plateau can have up to 20 ziplines. This means a region cannot hold more ziplines than its zipline limit, as the game prevents the player from placing more ziplines.

Ziplines must be powered by either Pylons or Relay Towers, which also must be connected to the AIC Core in The Hub or any of the Sub-PAC units in Valley Pass, Originium Science Park, or Power Plateau. Once a zipline is powered, Zipline Pylons will automatically connect to another zipline within 80 meters in-game, and Zipline Towers will automatically connect to another zipline within 110 meters in-game.

An ideal zipline route would be a route that visits every material gathering site in a subregion at least once, uses as few ziplines as possible, and takes the least amount of time possible. This can be done by attempting to find a Hamiltonian Path or a path with the least amount of time taken once a representative graph of a subregion is built.

A. Methodology

There are an endless number of possible combinations of ziplines and zipline routes on each subregion of Valley IV despite the existence of a zipline limit on the map, and the existence of a distance limit for every zipline. In order to search a narrower pool of possible zipline routes, the following methods are to be followed.

1. Consider every TP Point, and gathering site (Rare Growths, Rare Ores, and Recycling Stations) to be nodes on a graph.
2. Consider every TP Point as starting nodes from which the optimal path will be built. All starting points must start from a starting node.
3. Inspect every node in-game and see which ones form a connection. If two nodes form a zipline route in the game, connect them with an edge on the graph. Edges

represent two ziplines that are connected and form a route.

4. Nodes that are considered to be impossible to reach by the current constraint (such as requiring too many ziplines to reach or impossible to reach with ziplines) are discarded.
5. If the resulting graph is disconnected, add new nodes to connect every component of the graph. Adding new nodes must be done by adding the least amount of nodes possible to connect any two or more components of the graph, and must comply with the game's 110 meter zipline distance limit.
6. Measure the distance between two nodes on the game's map. Then, use the following formula to assign a weight (traversal time) to every edge on the graph.

$$\text{Traversal Time} = \frac{\text{Distance Between 2 Nodes}}{\text{Zipline Speed}}$$

With Zipline Speed = 15 m/s

7. Attempt to find a Hamiltonian Path from a given starting node to an end node. Nodes that must be visited are the nodes that represent a Recycling Station or a gathering site. Other nodes such as starting nodes and connecting nodes aren't required to be visited. If a Hamiltonian Path is impossible, then find a path that reaches all nodes and has the smallest total weight. If a path that isn't a Hamiltonian Path exists that has a smaller total weight, use that path instead of the Hamiltonian Path.
8. Once the optimal path is found, discard all unused nodes and edges from the graph in order to comply with the game's zipline limit for every subregion on the map. An unused node means a node isn't part of the optimal path found.

B. Valley Pass' Zipline Route

Using the methods described above, an optimal zipline route for Valley Pass can be constructed as follows.

First, consider every TP Point, Rare Growths, Rare Ores, and Recycling Stations to be nodes. Then, consider every TP Point to be a starting node. Figure 4.1 is the resulting graph after completing steps 1 and 2.

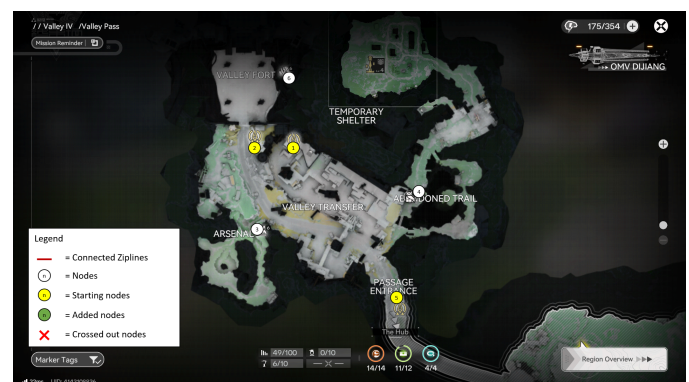


Figure 4.1. Graph that represents Valley Pass after steps 1 and 2. (Source: Author's Collection)

After completing steps 1 and 2, connect the existing nodes with edges. Only nodes that actually form a zipline route in the game are connected with edges on the graph. Then, nodes that are practically impossible to reach with the current constraints are discarded. In Valley Pass, it's the node that represents the Rare Ore site, as it isn't possible to reach the site using ziplines to begin with. The resulting graph is disconnected, which means new nodes must be added in order to connect all the separated components of the graph. Figure 4.2 is the resulting graph after completing steps 3, 4, and 5.



Figure 4.2. Graph that represents Valley Pass after steps 3, 4, and 5. (Source: Author's Collection)

Then, assign a weight to every valid edge that exists on the graph using the formula in step 6. Figure 4.3 is the resulting graph after completing step 6.



Figure 4.3. Graph that represents Valley Pass after step 6. (Source: Author's Collection)

Finally, attempt to find a Hamiltonian Path from a given starting node to an end node on the graph, while connecting every node that represents a Recycling Station or a gathering site. In the graph that represents Valley Pass, both a Hamiltonian Path and nonhamiltonian paths exist, but the path with the least total weight is a nonhamiltonian path. Then, every node that isn't connected to the optimal path is discarded. Figure 4.4 is the resulting graph after completing steps 7 and 8, while also serving as the final resulting graph that represents the zipline route for Valley Pass.



Figure 4.4. The resulting zipline route for Valley Pass. (Source: Author's Collection)

The resulting zipline route uses 6 ziplines, well below the limit of 10 ziplines for Valley Pass.

C. The Hub's Zipline Route

The steps taken to create a zipline route for Valley Pass can be iterated for every other subregion in Valley IV. Figure 4.5 is the resulting zipline route for The Hub.

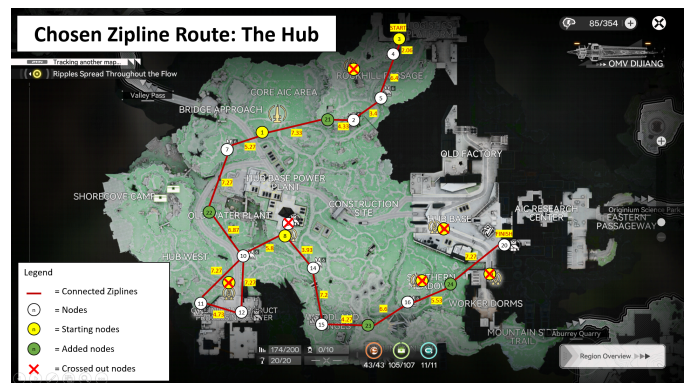


Figure 4.5. The resulting zipline route for The Hub. (Source: Author's Collection)

There are a total of 6 nodes that are discarded, as they either aren't connected to the zipline route (like nodes 6, 13, 17, 18, and 19), or aren't necessary due to already existing notes (like node 9). The resulting zipline route uses 18 ziplines out of the allowed 20.

D. Aburrey Quarry's Zipline Route

Aburrey Quarry represents a unique challenge compared to other subregions in Valley IV, due to its extreme terrain that makes it difficult to reach certain areas of the map. Such is the case for one of Aburrey Quarry's Rare Growth site which is unreachable by zipline, and so requires the player to get off the zipline, walk over to the site and then go back to continue the zipline route. Figure 4.6 is the resulting zipline route for Aburrey Quarry.



Figure 4.6. The resulting zipline route for Aburrey Quarry. (Source: Author's Collection)

There are a total of 2 discarded nodes as they either aren't connected to the zipline route (like node 5), or take too many ziplines to reach (like node 1). It is important to note that node 1 is a node that represents a Rare Growth, but since there aren't enough ziplines to reach it, the node is discarded and a player using this route simply needs to walk to the site after getting off the zipline at node 11. The resulting zipline route uses 10 ziplines, which is exactly the limit for Aburrey Quarry.

E. Originium Science Park's Zipline Route

Originium Science Park is expansive with lots of open terrain, allowing a number of ziplines to stretch right up to the 110 meter distance limit. Figure 4.7 is the resulting zipline route for Originium Science Park.

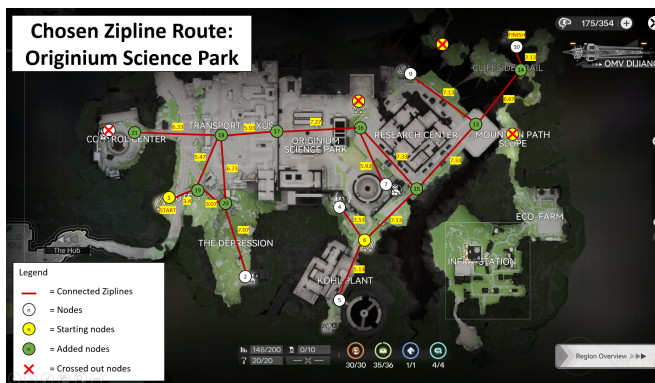


Figure 4.7. The resulting zipline route for Originium Science Park. (Source: Author's Collection)

There are a total of 4 discarded nodes as they either aren't connected to the zipline route (like nodes 8, 11, and 12), or aren't cost effective (like node 3). It is important to note that node 3 is a node that represents a Recycling Station, but since there aren't enough ziplines to reach it, the node is discarded and a player using this route simply needs to walk to the Recycling Station after getting off the zipline at node 21. Nodes 4 and 9 are represented as only 1 zipline when in practice it requires 2 ziplines, since the terrain on both nodes renders it impossible to reach the nodes with only 1 zipline. The resulting zipline route uses 19 ziplines out of the allowed 20.

F. Origin Lodespring's Zipline Route

Origin Lodespring allows for the largest number of ziplines at 25, as the subregion is large with lots of terrain and obstructions that require shorter zipline routes. Figure 4.8 is the resulting zipline route for Origin Lodespring.

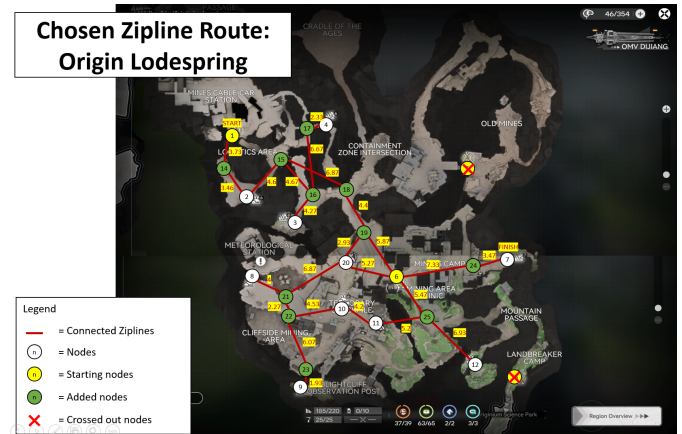


Figure 4.8. The resulting zipline route for Origin Lodespring. (Source: Author's Collection).

There are a total of 2 discarded nodes, which are nodes 5 and 13, as they both aren't connected to the zipline route and are impossible to reach. The resulting zipline route uses 22 ziplines out of the allowed 25.

G. Power Plateau's Zipline Route

Power Plateau doesn't have a lot of Recycling Stations and gathering sites compared to the amount of ziplines allowed for it, especially compared to other subregions like The Hub and Originium Science Park. This allows the construction of a route that is well below the subregion's zipline limit of 20 ziplines. Figure 4.9 is the resulting zipline route for Power Plateau.

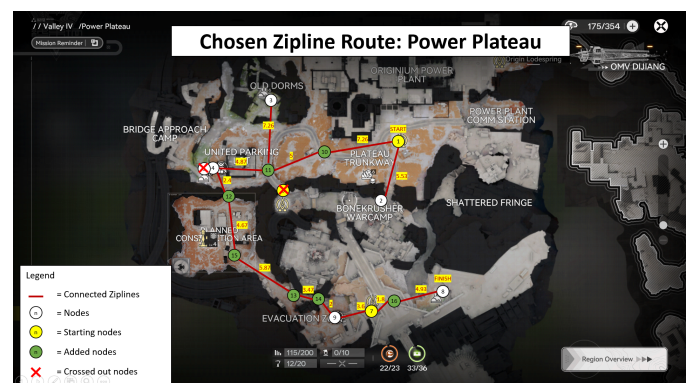


Figure 4.9. The resulting zipline route for Power Plateau. (Source: Author's Collection)

There are a total of 2 discarded nodes, as they either aren't connected to the zipline route (like node 6), or aren't necessary due to already existing nodes (like node 5). It is important to note that node 2 is a node that represents a Rare Ore site, but since the site is inside of a small cave system, players have to get off the zipline at node 2 and walk inside the cave before going back on the zipline at node 2. The resulting zipline route uses 14 ziplines out of the allowed 20.

V. CONCLUSION

Ziplines are an excellent method of traversing the map in Arknights: Endfield, as they allow for faster travel times. Constructing a zipline route allows the player to traverse the map at 15 m/s in-game, skip having to traverse through rough terrain, and skip having to fight enemies or finding an alternative route to avoid enemies.

Weighted graphs, Hamiltonian paths, and finding the path with the least weight is an effective way to create an optimized zipline route in Arknights: Endfield. Assuming that the sites that must be visited are Recycling Stations, Rare Growth sites, and Rare Ore sites, Valley Pass uses 6 of the 10 maximum ziplines allowed, The Hub uses 18 of the 20 maximum ziplines allowed, Aburrey Quarry uses 10 of the 10 maximum ziplines allowed, Originium Science Park uses 20 of the 20 maximum ziplines allowed, Origin Lodespring uses 22 of the 25 maximum ziplines allowed, and Power Plateau uses 14 of the 20 maximum ziplines allowed.

The resulting zipline routes for every subregion on Valley IV in this paper is most likely not the most optimized route for gathering daily materials from Recycling Stations, Rare Growth sites, and Rare Ore sites, as there are an endless number of combinations of zipline routes, and endless possibilities of an even more optimized route. It also doesn't consider other sites on the map, in which case the resulting zipline route would be different. However, using weighted graphs, finding Hamiltonian paths, and finding paths with the least weight is an effective method in order to formulate a zipline route that visits every site at least once, and takes a relatively short amount of time.

ACKNOWLEDGMENT

I would like to thank God Almighty for blessing me so that the work on this paper went smoothly. I would also like to thank Dr. Rinaldi Munir for being an excellent lecturer of IF1220 Discrete Mathematics class, and allowing me to have the opportunity to learn and work on this fun field of mathematics. And lastly, I would like to thank my friends and family for supporting me in my journey in ITB.

REFERENCES

- [1] Majarucon, Alfonso. "Arknights: Endfield". game8.co. April 16, 2026. [Online]. Available: <https://game8.co/articles/games/arknights-endfield>. Accessed: Jun 19, 2026.
- [2] Majarucon, Alfonso. "Arknights: Endfield Gameplay & Story". game8.co. April 16, 2026. [Online]. Available: <https://game8.co/articles/reviews/arknights-endfield-gameplay-and-story>. Accessed: Jun 19, 2026.
- [3] Ada Computer Science. "Graphs". adacomputerscience.org. [Online]. Available: https://adacomputerscience.org/concepts/struct_graph. Accessed: Jun 19, 2026.
- [4] Tutorials Point. "Graph Theory – Weighted Graphs". tutorialspoint.com. [Online]. Available: https://www.tutorialspoint.com/graph_theory/graph_theory_weighted_graphs.htm. Accessed: Jun 19, 2026.
- [5] Weisstein, Eric W. "Hamiltonian Path". mathworld.wolfram.com. [Online]. Available: <https://mathworld.wolfram.com/HamiltonianPath.html>. Accessed: Jun 19, 2026.
- [6] Weisstein, Erin W. "Graph". mathworld.wolfram.com. [Online]. Available: <https://mathworld.wolfram.com/Graph.html>. Accessed: Jun 19, 2026.

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.

Bandung, 19 Juni 2028



Natanael Chris Fabian Santoso – 13525083