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Hamilton Circuits of Top Tourist Spots in Pangasinan

Gina May R. Natividad[1], Norman C. Escaño[2], Jormalyn I. Quillopas[3], Hazel Mae R. Diza[4]
Pangasinan State University, Lingayen Campus[1,2,3,4]

Abstract *– Most of the people love to travel around places that have good scenery and exciting activities. Pangasinan has many tourist attractions that can be visited. There is always a need to plan your expenses. Travelling requires consuming time and money. This study will help to minimize your expenses by finding the optimum Hamilton circuit. The study will find an optimal route in the graph with top tourist spots in Pangasinan will be the vertices to be visited.*

In this research, the weighted graph of the top tourist spot in Pangasinan will be given finding its Hamilton circuit. On the list of the top tourist spots in Pangasinan the Veteran's Park in Lingayen one, Lucap Wharf in Alaminos, Wonderful Cave in Bolinao, Minor Basilica of Our Lady of the Rosary of Manaoag and Balungao Hilltop Adventure. The combinations of the tourist spots should be arranged to count the number of possible circuits. The Brute Force Algorithm, using its methods, finding the optimal solution is possible. Through this, it was found out that Brute Force is the best method to use and the best circuit to follow to optimize the expenses.

Keywords *– Hamilton Circuit, Brute Force Algorithm.*

INTRODUCTION

Pangasinan, derived its name from the word panag-asinan, which means where salt is made, owing to the rich and fine salt beds which were the prior source of livelihood of the province's coastal towns. There are several tourist attractions in Pangasinan wherein you can have the best vacation ever. The Department of Tourism has the list of the top 5 tourist spots in Pangasinan that most people visited. Pangasinan is decorated with the most beautiful tourist spots and untouched landscapes in this province. (Thomas, 2018)

For the first list, Veteran's Park is located in Lingayen, Pangasinan. It was built in 1995 to help commemorate Lingayen Gulf Landing's 50th Anniversary. The small circular open space made a huge impact on the tourist, as a little gallery showcased an attention-grabbing display of raw relics, such as actual airplanes and tanks. (Flores,2016)

Minor Basilica of Our Lady of the Rosary of Manaoag is located in Manaoag, Pangasinan. This is a famous pilgrimage site of the North. The church had withstood bombing during World War II and an earthquake in 1982. After all renovations, you will now see the rosary park, spacious candle gallery, and a Museum of the Minor Basilica. (Malicdem, 2017)

Balungao Hilltop Adventure is located in Balungao, Pangasinan. This is a nice place and blessed with hot springs. The Balungao Hilltop Adventure Resort offers zipline experience, all-terrain vehicle driving, bungee trampoline, hiking or trail walking, trust fall, and mountain biking. (Hernandez, 2018)

Lucap Wharf is located at the heart of this bustling seaside municipality. The Wharf serves a jumping point for a Hundred Island boat tour, you can see in this area are the welcome sign of Hundred Island, a small but neat lighthouse stands modestly in this wharf and there's a souvenir shop nearby the wharf. (Guia, 2016)

Wonderful Cave in Bolinao, Pangasinan is one famous tourist attraction in Bolinao which is a refreshing Underground Natural Spring pool. As the name itself portrays its mystical beauty, it is one of its kind caves which holds an emerald green and fresh pool water within its womb. (Villareal, 2014)

A Hamilton circuit is a path that begins and ends at the same vertex and passes through all other vertices of the graph exactly one time. It might seem that there should be an easy way to determine whether a graph has a Hamilton circuit. Surprisingly, there are no known simple necessary and sufficient criteria for the existence of Hamilton Circuit. However, many theorems are known to give sufficient conditions for the existence of Hamilton Circuit. (Pearson, 2010)

Informing a circuit there will be needed to do a graph and find its edges' weights. A graph is a set of vertices connected by edges. They are found on road maps, constellations when constructing schemes and drawings. Graphs underlie many computer programs

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that make modern communication and technological processes possible. They contribute to the development of thinking, both logical and abstract. (Pearson, 2010)

OBJECTIVES OF THE STUDY

Determine the optimal solution of all Hamilton Circuit presented. To count how many ways or paths they can make or choose when visiting the different tourist spots in the Pangasinan. The researchers then will make use of the Brute Force Algorithm to find the optimal Hamilton circuits.

MATERIALS AND METHODS

Brute Force Algorithm

Brute force is a type of algorithm that tries a large number of patterns to solve a problem. In some cases, they are extremely simple and rely on raw computing power to achieve results.

Brute Force Algorithm is a system that involves testing every single possible solution to a problem to find the right one.

These are the steps in determining the optimal solution by using Brute Force Algorithm.

1. Represent the problem with a complete, weighted graph.
2. List all possible Hamilton circuits for this graph.
3. Determine the cost (or distance) associated with each of these Hamilton circuits.
4. The Hamilton circuit with the lowest cost (or shortest distance) is the optimal solution.

RESULTS AND DISCUSSION

To the possible number of Hamilton circuits, it will use the equation $N = 1/2\ (n-1)!$ Where n is the number of points. The graph has six points, the Lingayen as the starting point, the Veteran's Park in Lingayen, Lucap Wharf in Alaminos, Wonderful Cave in Bolinao, Minor Basilica of Our Lady of the Rosary of Manaoag and Balungao Hilltop Adventure. Therefore,

$$N = 1/2\ (n-1)!$$
$$N = 1/2\ (6-1)!$$
$$N = 1/2\ (5)!$$
$$N = 1/2(5 \cdot 4 \cdot 3 \cdot 2 \cdot 1)$$
$$N = 1/2\ (120)$$
$$N = 60$$

Hence, the number of possible different Hamilton circuits is 60.

It only has half of the combinations of the circuits because the other half is the reverse of the circuit.

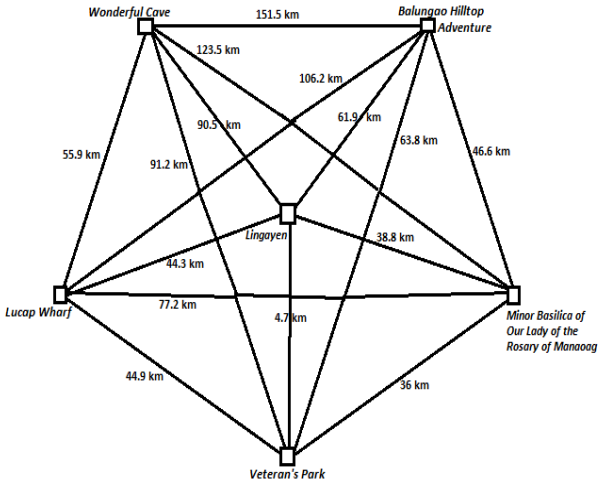
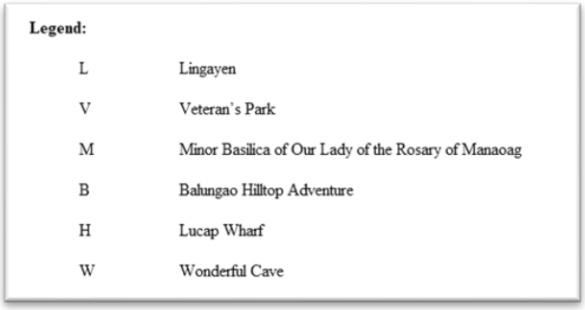


Figure 2. A completed weighted graph of Top Tourist Spots



Legend:

L	Lingayen
V	Veteran's Park
M	Minor Basilica of Our Lady of the Rosary of Manaoag
B	Balungao Hilltop Adventure
H	Lucap Wharf
W	Wonderful Cave

Figure 3. Variables representing the tourist's spots

Figure 3 shows the variables equal to the spots and will be used in solving the total weight of the circuit.

Table 1. List of the 60 possible unique circuits.

Circuits	Total Weights (km)
1. $L — V — M — B — W — H — L$	4.7+36+46.6+151.5+55.9+44.3=339
2. $L — V — M — B — H — W — L$	4.7+36+46.6+106.2+55.9+90.5=339.9
3. $L — V — M — H — B — W — L$	4.7+36+46.6+77.2+106.2+90.5=361.2
4. $L — V — H — M — B — W — L$	4.7+44.9+77.2+46.6+151.5+90.5=415.4
5. $L — H — V — M — B — W — L$	44.3+44.9+36+46.6+151.5+90.5=

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	413.8
6. $L — H — V — M — W — B — L$	44.3+44.9+36+123.5+151.5+61.9 =462.1
7. $L — H — V — W — M — B — L$	44.3+44.9+91.2+123.5+46.6+61.9 =412.4
8. $L — H — W — V — M — B — L$	44.3+55.9+91.2+36+46.6+61.9=3 35.9
9. $L — W — H — V — M — B — L$	90.5+55.9+44.9+36+46.6+61.9=3 35.8
10. $L — W — H — V — B — M — L$	90.5+55.9+44.9+63.8+46.6+38.8= 340.5
11. $L — W — H — B — V — M — L$	90.5+55.9+106.2+63.8+36+38.8= 391.2
12. $L — W — B — H — V — M — L$	90.5+151.5+106.2+44.9+36+38.8 =467.9
13. $L — B — W — H — V — M — L$	61.9+151.5+55.9+44.9+36+38.8= 389
14. $L — B — W — H — M — V — L$	61.9+151.5+55.9+77.2+36+4.7=3 87.2
15. $L — B — W — M — H — V — L$	61.9+151.5+123.5+77.2+44.9+4.7 =463.7
16. $L — B — M — W — H — V — L$	61.9+46.6+123.5+55.9+44.9+4.7= 337.5
17. $L — M — B — W — H — V — L$	38.8+46.6+151.5+55.9+44.9+4.7= 342.4
18. $L — M — B — W — V — H — L$	38.8+46.6+151.5+91.2+44.9+44.3 =417.3
19. $L — M — B — V — W — H — L$	38.8+46.6+63.8+91.2+55.9+44.3= 340.6
20. $L — M — V — B — W — H — L$	38.8+36+63.8+151.5+55.9+44.3= 390.3
21. $L — V — B — M — W — H — L$	4.7+63.8+46.6+123.5+55.9+44.3= 338.8
22. $L — V — B — W — M — H — L$	4.7+63.8+151.5+123.5+77.2+44.3 =465
23. $L — V — B — W — H — M — L$	4.7+63.8+151.5+55.9+77.2+38.8= 391.9
24 $L — V — W — B — H — M — L$	4.7+91.2+151.5+106.2+77.2+38.8 =469.6
25. . $L — V — W — H — B — M — L$	4.7+91.2+55.9+106.2+46.6+38.8= 343.4
26. $L — V — W — H — M — B — L$	4.7+91.2+55.9+77.2+46.6+61.9=3 37.5
27. $L — V — M — W — H — B — L$	4.7+91.2+123.5+77.2+106.2+61.9 =402.8
28. $L — V — W — M — H — B — L$	4.7+36+123.5+55.9+106.2+61.9= 388.2
29 $L — H — M — V — B — W — L$	44.3+77.2+36+63.8+151.5+90.5= 463.3
30. $L — H — M — B — V — W — L$	44.3+77.2+46.6+63.8+91.2+90.5= 413.6
31. $L — H — M — B — W — V — L$	44.3+77.2+46.6+151.5+91.2+4.7= 415.5
32. $L — H — B — M — W — V — L$	44.3+106.2+46.6+123.5+91.2+4.7 =416.5
33. $L — H — B — W — M — V — L$	44.3+106.2+151.5+123.5+36+4.7 =466.2
34. $L — H — B — W — V — M — L$	44.3+106.2+151.5+91.2+36+38.8 =468
35. $L — H — V — B — W — M — L$	44.3+44.9+63.8+151.5+123.5+38. 8=466.8
36. $L — H — B — V — W — M — L$	44.3+106.2+63.8+91.2+123.5+38. 8=467.8
37. $L — W — V — H — M — B — L$	90.5+91.2+44.9+77.2+46.6+61.9= 412.3
38. $L — W — V — M — H — B — L$	90.5+91.2+36+77.2+106.2+61.9= 463
39. $L — W — V — M — B — H — L$	90.5+91.2+36+46.6+106.2+44.3= 414.8
40. $L — W — M — V — B — H — L$	90.5+123.5+36+63.8+106.2+44.3 =464
41. $L — W — M — V — B — H — L$	90.5+123.5+46.6+63.8+44.9+44.3 =413.6
42. $L — W — M — B — H — V — L$	90.5+123.5+46.6+106.2+44.9+4.7 =416.4
43. $L — W — H — M — B — V — L$	90.5+55.9+77.2+46.6+63.8+4.7=3 38.7
44. $L — W — M — H — B — V — L$	90.5+123.5+77.2+106.2+63.8+4.7 =465.9
45. $L — B — H — W — V — M — L$	61.9+106.2+55.9+91.2+36+38.8= 390
46. $L — B — H — V — W — M — L$	61.9+106.2+44.9+91.2+123.5+38. 8=466.5
47. $L — B — H — V — M — W — L$	61.9+106.2+44.9+36+123.5+90.5 =463
48 $L — B — V — H — M — W — L$	61.9+63.8+44.9+77.2+123.5+90.5 =461.8
49. $L — B — V — M — H — W — L$	61.9+63.8+36+77.2+55.9+90.5=3 85.3
50. $L — B — V — M — W — H — L$	61.9+63.8+36+123.5+55.9+44.3= 385.4
51. $L — B — V — W — M — H — L$	61.9+63.8+91.2+123.5+77.2+44.3 =461.9
52. $L — B — W — V — M — H — L$	61.9+151.5+91.2+36+77.2+44.3= 462.1
53. $L — M — W — B — H — V — L$	38.8+123.5+151.5+106.2+44.9+4. 7=469.6
54. $L — M — W — H — B — V — L$	38.8+123.5+55.9+106.2+63.8+4.7

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58. $L — M — H — V — B — W — L$	38.8+77.2+44.9+63.8+151.5+90.5 =466.7
59. $L — M — B — H — V — W — L$	38.8+46.6+106.2+44.9+91.2+90.5 =418.2
60. $L — M — H — B — V — W — L$	38.8+77.2+106.2+63.8+91.2+90.5 =467.7

Table 1 shows the list of all the possible circuits where the starting point is L with its total weight. The letters used in the table was shown its meaning in Figure 2.

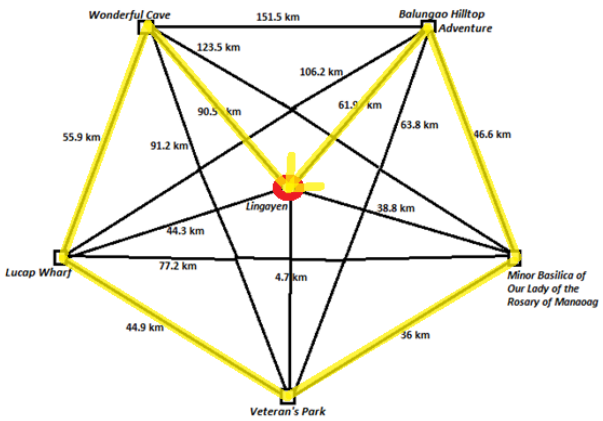

Figure 4. Circuit L-W-H-V-M-B-L

Figure 4 shows that the graph's circuit started at Lingayen goes to Wonderful Cave to Lucap Wharf to Veteran's Park to Minor Basilica of Our Lady of the Rosary of Manaoag to Balungao Hilltop Adventure going back to Lingayen which is the starting point.

$L - W - H - V - M - B - L = TOTALWEIGHT$

$90.5 + 55.9 + 44.9 + 36 + 46.6 + 61.9 = 335.8$

Therefore the total weight of this circuit is 335.8 kilometers.

Hence the hamilton circuit with the least total weight is the circuit $L - W - H - V - M - B - L$ which has 335.8 kilometers in a total of the edges it traverses. This is the optimal hamilton circuit but it is not efficient.

CONCLUSION AND RECOMMENDATION

In this study, the researchers showed that a 6-pointed graph has 60 unique circuits. Some of the unique Hamilton circuits can have the same total weight even if they have the same route. From *Lingayen* as the starting point going to *Wonderful Cave* to *Lucap Wharf* to *Veteran's Park* to *Minor Basilica of Our Lady of the Rosary of Manaoag* to *Balungao Hilltop Adventure* then going back to *Lingayen*, and derived as $L - W - H - V - M - B - L$was the best optimal circuit in distance. $L - W - H - V - M - B - L$has 335.8 kilometers as its total weight which is the lowest total weight among all the unique possible circuits.

The researchers highly recommend to the next researchers to expand the study by applying more than 6 vertices. The researchers also recommend exploring the Hamilton circuit to other problems like the route of the todas or tricycle drivers in a certain place. The researcher also recommends using the mathematical concept of Graph theory like Bottleneck traveling salesman problem to find a weighted graph that minimizes the weight of the most weighty edge of the cycle.

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PLEASE INCLUDE CONTACT INFORMATION

NAME: GINA MAY R. NATIVIDAD
CONTACT NO: 09163830268
EMAIL ADDRESS: GINAMAYNATIVIDAD@GMAIL.COM

NAME: HAZEL MAE R. DIZA
CONTACT NO: 09777537328
EMAIL ADDRESS: HMDIZA.LINGAYEN@PSU.EDU.PH