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ALGORITHM TO FIND TOURISM PLACE SHORTEST ROUTE: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Algorithm is very useful to find shortest route. Peoples need a map to find route from current location **to** destination location. For finding the shortest route, it needs a GPS for digital maps. Algorithm is very important for finding tourism place shortest route because peoples can know about the shortest route from their current location to tourism place location. Many people want to know about the shortest route to go to their tourism place destination. With this algorithm it can ease people to find tourism place, increase the number of tourism visits and gain profit for tourism place and accommodation business. There are some factors that influence for choose the best algorithm for find shortest route are cost, time, distance, values, nodes, parameters, vertex, and edges. It must find the best algorithm to find shortest route when we build an application about tourism place so that the shortest route can be found by maps accurately. Algorithm to find shortest route must have accuracy and tremendous usefulness. The aims of this paper are reviews algorithms that used to find shortest route, algorithm process runs, the used of algorithm, a factor that influence used algorithm to find shortest route especially tourism place. This paper will give benefits to ministry of tourism to understanding about algorithm to find tourism place shortest route and they could build an apps that can ease peoples for find shortest route to their tourism place. The content of this paper are algorithms definition, algorithm usability and algorithms run process.

Keywords: *Algorithm, Shortest Path, Shortest Route, Systematic Literature Review*

1. INTRODUCTION

From several years before, GPS (Global Positioning System) and digital maps had helped people to find the route from one place to another place. A lot of people use GPS and digital maps for finding nearest route and the best route when they go to some place. At the moment people who do not know the best route go to some place, they can find the best route with digital maps. After that, the digital maps run its algorithm for searching the route, nearest route, and best route. GPS and digital maps will have great benefits, usability, and ease people to find the place with their gadget. Therefore, algorithm to find tourism place shortest route is very interesting to discover, study, and applied with tourism sector.

From several research before states that algorithm to find tourism place shortest route are Djikstra Algorithm, Bellman Ford Algorithm, Fuzzy Floyd Algorithm, Ant Colony Algorithm, Genetic Algorithm, Breadth-first Algorithm, Shortest Path Searching Algorithm, GA Based Algorithm, A* Algorithm, K-Shortest Path Algorithm, Multimodal Shortest Path Algorithm, K-Nearest Neighbor Query, Floyd Warshall Algorithm, Heuristic Shortest Path Algorithm, Nearest Neighbor, and Transit Algorithm. These algorithms are used to find the best and nearest route by digital maps. Each algorithm has advantages dan disadvantages based on the purpose of digital maps.

Algorithms are an important formula to run GPS and digital maps. When they go to another place from their address, they input current location and destination. After that, digital maps will search the best and nearest route according to destination.

Positions anywhere on the earth can located and navigate by GPS satellite based system. Information which is transmitted from satellites are received by GPS and triangulation is used to calculate user's

exact location. The function of GPS are create digital maps, determine distance between two points, navigate from one location to another, and determine the position of locations. [1] Therefore we need a decision making system that is an interactive computer information system that can provide alternative solutions [2].

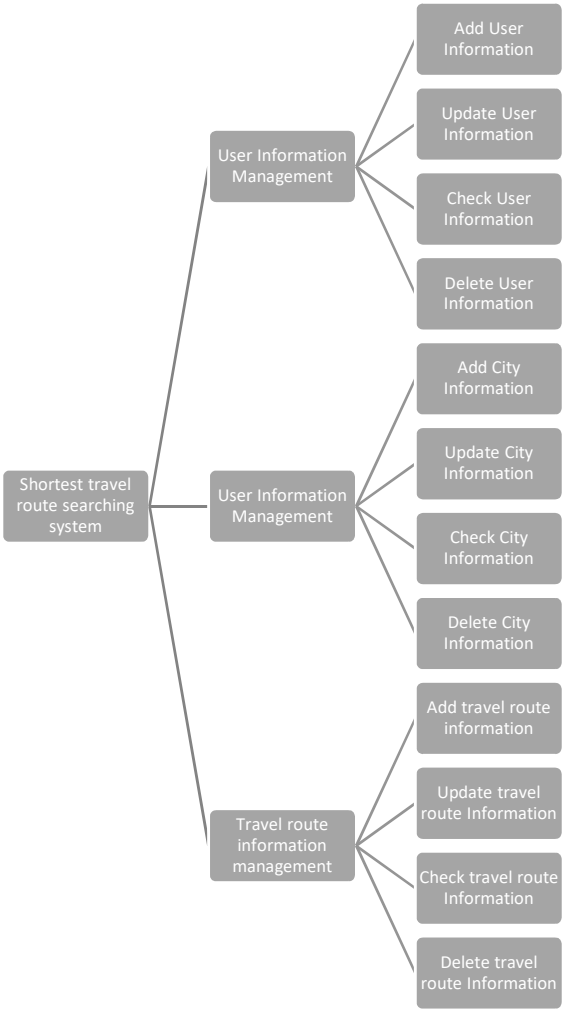

Figure 1: The function module of shortest travel route searching system [3].

The results of this SLR can be a reference for researchers and application developers in determining the shortest distance algorithm that is commonly used to find tourist objects. The aims of this Systematic Literature Review is to review various scientific publication about algorithm to find tourism place shortest route. The specifically purpose of this research to analyze various scientific publication and know about algorithms to find tourism place shortest route for ease programmer and system analyst develop new system to find the near route.

Another research that supports this research is finding the most effective shortest distance search algorithm. The research conducted is needed to become a reference for certain algorithms that are most widely used today.

2. LITERATURE REVIEW

2.1. Dijkstra Algorithm

A graph search algorithm that can be used to solve the one source shortest path problem for one graph that has non negative edge path cost is suggested by Dijkstra.[4] Optimum path is found by Dijkstra Method. This algorithm can find minimum-cost path by all paths in searching, beginning from the starting point, when it search region in particularly. Nevertheless, Dijkstra algorithm has weakness about inefficient and needs more time when the distance to destination is long[5]. The single source shortest path problem is solved by a Dijkstra graph based searching algorithm. It uses only on positive weight graphs. Routing nearest location is often use Dijkstra Algorithm. Finding the shortest path with minimum cost uses Dijkstra Algorithm[1]. The first find shortest distance from origin vertex to the nearest vertex after that it gets secondary shortest path.

Dijkstra Algorithm is used to track their vehicles and route monitoring by GPS. This routing system can tell the location and information that can be observed by another location. Dijkstra Algorithm is often used in car navigation frequently[6]. The most effective graph algorithms that can be modified in solving shortest path problem is Dijkstra Algorithm[7]. There are some improved Dijkstra Algorithm to find restricting search space. These algorithms are rectangle purpose of restricting search space, static hexagon purpose of restricting search space, and dynamic hexagon area[8].

2.2. A* Algorithm

A* Algorithm can reduce useless route search by estimate the distance to destination is based on approach of the Dijkstra Algorithm[5]. A* Algorithm is faster than Dijkstra Algorithm because A* Algorithm is a simple algorithm to find the nearest route. A* Algorithm can calculate the nearest route based on Dijkstra Algorithm[9]. A* Algorithm can get the best result in problem of route planning. A* Algorithm can get the best run time than other algorithm at the road network application. A* Algorithm is often used to find an effective route

especially travel distance and traffic condition. Usually, Finding the best route through a graph uses A* Algorithm and centralized path planning for robot[8]. A* Algorithm can solve robot path planning. Searching shortest distance from start nodes to end nodes is optimal way use A* Algorithm[9]. Dijkstra Algorithm improves method into A* Algorithm. It uses A* Algorithm to find a path between two destinations.[6]

2.3. Genetic Algorithm

Genetic Algorithm is adaptive individual search algorithms based on the theory evolutionary ideas of natural selection and gene types[9]. Simulate processes in natural system for evolution, specifically follow the principles of survival fittest by Charles Darwin is the basic concept of Genetic Algorithms. Essentially, the random sets of parameters are applied to an algorithm and a fitness value (optimization value) is calculated for each parameters. The best sets are mixed(this is combination of selection, Crossover and mutation) and sets again applied to algorithm until optimal parameter(s) are obtained[10].

Genetic Algorithm duplicate various processes that had happened in natural evolution. Based on case of path search, a path is selected and regarded as a gene and the solution path is obtained by performing calculation of duplicate genetic crossing, spontaneous mutations, etc. The number of genes that had produced determines the search time. Genetic Algorithm has advantage that is not too affected by the network size. A problem with Genetic Algorithm is some generations becomes large as the optimum solution is approached necessarily[5].

A search technique to identify estimates solutions to near optimal solutions uses Genetic Algorithm. It uses fitness function to find solution. The first estimate solution and merge fittest solution to create a new solution may better that previous solution is the basic idea behind fitness function[11].

When the optimal solution is hard to find, it can solve complex problem by Genetic Algorithm. It same process of natural selection. Each member of the populations is calculated by fitness function Genetic Algorithm. It is a natural genome which uses mutation to randomize the process. After that, the fitness function is selected individual solution[12].

Genetic Algorithm can be implemented using relation that chosen by decision maker, crip numbers, using defuzzification indices or with fuzzy numbers[13]. Genetic Algorithm can calculate many routes, so that user can select a desirable route from the returned routes[4].

2.4. Ant Colony Algorithm

Marco Dorigo has invented ant-colony algorithm in 1992. This invention based on experiment how the food is collected by ants. This process is ants go out from hive and forms direction randomly. When a food is founded, ants emits pheromone on the way back which is sign to other ants for a food resource. If the next ant will choose a direction, it will consider direction which is signed by pheromone vapor. If a food is nearest or the amount is bigger, many ants go on this route which indicates a stronger pheromone vapor and what is the reason for a number of ants. If ants is increase the pheromone concentration, it will higher for a number of ants. So, two effects help each other. This is the reason why ants going in route nature for food.[14]

2.5. Breadth-first Algorithm

A deep-first algorithm that can find the end nodes by transvers connected nodes from start node to end node is Breadth-first Algorithm. This advantage of this algorithm is high accuracy because all nodes are visited. The disadvantages of this algorithm is sometimes it is possible to find end node longer than another algorithms due to all nodes have been transfersed.[15]

It starts from start node and firstly marks all nodes as ‘not visited’. After that, the first node has been connected to the queque. The algorithm registers the distances by transfer the connected nodes. Then, it repeats same process for the other nodes.[15]

2.6. Bellman-Ford Algorithm

The popular shortest path algorithm is Bellman-Ford Algorithm. Bellman-Ford Algorithm moves paths between nodes one at a time to find the shortest path. The advantages of Bellman-Ford Algorithm is approach to the right conclusion because it transverses paths. Sometimes, it is slower than another short path algorithm because all path spend much time during transversal.[15] It can implement Bellman-Ford search Algorithm from current location to destination but it must calculate node needs between energy consumption.[16] For solving shortest route Bellman Ford Algorithm is used to calculate the cost of the cheapest paths from single source vertex or node to all other nodes in weight directed graph.[7]. Shortest path problem which there are edges of graph may negative weights as long as G contains without negatives cycle uses Bellman Ford Algorithm.

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2.7. Transit Algorithm

Transit algorithm is a method for finding shortest path on the largest road networks. The advantages of transit algorithm is the final query is indifferent to path length completely but only depends on the number of transit nodes and origin destination[17].

2.8. Heuristic Algorithm

Probability planning uses heuristic algorithm. Heuristic function can be used A* Algorithm behavior [17]. Heuristic Algorithm is used when the origin node is located at the center of city and the destination node is located far from center of city, it needs the optimal search technique would like to search minimum path route from origin path and destination nodes[18].

2.9. K- Shortest Path Algorithm

K-Shortest path Algorithm has a single label that assigned to each node j, when K shortest path problem it may has K labels for each node that can record K paths. The label of node j is formed by five K-tuple: πj, σj, ξj, ηj and θj. When πjk, σjk, ξjk, ηjk and θjk is K shortest path algorithm sequentially component. Sequentially, πjk and σjk point the travel time and transfer times of a path path from original node O to node j; ξjk and θjk means the node i before j in this path and its position in ξ^{i}. sequentially. H^{jk} is the bus line connecting node j and the previous node i.

To improve the efficiency of search algorithm, we set a maximum tolerant transfer times Y from the origin O to the destination D, such as σjk +wjD ≤ Y. It means that the sum of the transfer times from original node O to node j and the least transfer times from node j to destination D must be less or equal to the maximum tolerant transfer times[19].

2.10. Tabu Search Algorithm

A local search-based meta-heuristic that run with several iterations is tabu search algorithms. Each iteration is the best solution in neighbourhood of current situation that is chosen as new current solution although solution cost is increased. Tabu-list is a short-term memory that required to store attributes that have been visited recently. It can helps to avoid short term cycling. Searching stops after fixed number of iterations or numbers of sequential iterations has the best solution without several iterations[20].

2.11. Floyd Warshall Algorithm

Floyd's algorithm is used to determines shortest route between two nodes in the network. The algorithm represents an n - nodes network as a square matrix with n rows and n columns (i , j) with matrix gives the weights w_{ij} from nodes i to j which is finite i is linked directly to j and infinite otherwise. The Floyd Algorithm is straightforward. There are three nodes i,j,and k with the connecting weights on three edges,it is easy to reach j from i through k if $w_{ik} + w_{kj} < w_{ij}$.[21]

The advantages of Floyd Warshall Algorithms are overlapping problems, optimal structure, time usability to improve complexity of algorithm. The applications of Floyd Warshall Algorithms are Bipatriness, Minimax, Maximin, and Safest path[7].

2.12. Fuzzy Shortest Path Algorithm

There is a fuzzy graph G with type V fuziness

π is a set of all paths from vertex *va* to vertex *vb* and fuzzy length of path will be [22] :

l_p = length(P) = $\sum_{e_k} W_k$, where P ∈ π,

Where e_k ∈ p

The fuzzy set of shortest paths is a fuzzy set S on π with membership πS given by

$\pi_s(P) = \min\{\mu_{lp \leq lQ}\}$, where P ∈ π , $Q \in \pi$

The support consist all of the paths which potentially could have minimum length :

Supp(S) = $\{P \in \pi \mid \mu_{lp \leq lQ} > 0, \forall Q \in \pi\}$

Based on the fuzzy set of shortest paths that define above can be collapse into a *fuzzy shortest path* where each edge *ei* has a membership in the fuzzy set S':

$\mu_s(i) = \sum_{e_i \in P, P \in \pi} \max\{\pi_s(P)\}$, for I = 1,….$n_e$

The advantages of Fuzzy Shortest Path Algorithm are simple to implement,works fast for small training sets,it need not a priori knowledge about the structure of training data and it runs asymptotically approaches the performance of Bayes classifier[23].

3. RESEARCH METHODOLOGY

This research used systematic literature review method for analysing, identifying, and reviewing algorithm to find tourism place shortest route based several research before. The aim of this research is review algorithm to find shortest path.

There are 39 online research library have been chosen to search articles are ACM Digital Library, Global Journal of Computer Science, Google Scholar, IEEE Xplore, Taylor Francis Online, Scientific.net, InformPubs Online, Cornell University, Research Gate, Science Direct, Springer, SSRN, Nepal Journal Online, SIAM Journal, Wiley Online, Semantic Scholar, Blue Eyes Intelligence

Engineering, Inform Pubs Online, Transtellar, MDPI, ETH Zurich, IJSTR, Korea Science, SAGE Publication, Sciendo, Uni-Obuda, ASCE Library, CiteseerX, Static Usenix, Estudogreal, Academia,ceur-ws, Scitepress, SCS, Academic Journals, and smith.edu. IEEE Xplore has contain significant journals about algorithm to find shortest route. In order to increase accuracy of results, this review included articles from various scientific library, finding process is repeated use google scholar [24].

4. RESULT AND ANALYSIS

This research is looking for the shortest distance of a tourist object using a certain algorithm controlled by the programmer. This research shows that the algorithms that are often used can be known so that they can be a reference for the next researcher.

4.1. Study Found

The first finding was using keywords (algorithm for searching shortest path tourism place) was obtained 16 journals. The second finding was using keywords (bellman ford shortest path) was obtained seven journals. The third finding was using keywords (Keywords Dijkstra algorithm searching tourism place) was obtained 25 journals. The fourth finding was using keywords (graph shortest algorithm) was obtained 52 journals. The fifth finding was using keywords (travel salesman problem) was obtained 21 journals. The sixth finding was using keywords (Nearest hospital) was obtained five journals. The seventh finding was using keywords (nearest route transportation) was obtained 89 journals.

The total of papers are 215 papers. Then, each paper is collected and manually selected to determine its relevance to the topic.

4.2. Candidate Studies

There are 215 papers chosen by reading abstract and introduction based on tittle that will to study. As result,there are 88 papers is selected.

4.3. Selected Studies

The selected journal or paper fulfil the following criteria :

- This research focusses on algorithm to find shortest route.
- This research discusses the suitable algorithm for find tourism place shortest route.
- The article according to paper tittle
- These are articles published between the years 2000 – 2019
- The research paper is about algorithm to find shortest route began from 1967 – 2019

The results are 26 articles suitable criteria for review can be seen in Figure 2. Data output, which is a number of study from selected paper can be seen in Table 1. All data about Systematic Literature Review including study found, candidate studies, selected studies depict on venn diagram in Figure 3.

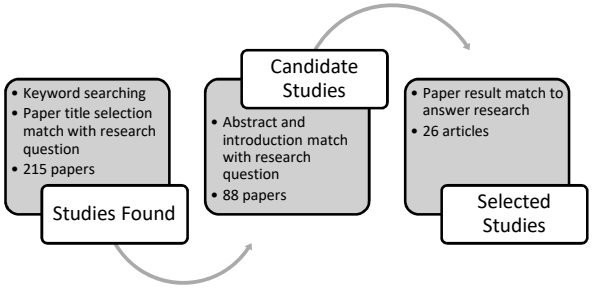

Figure 2: Searching for Systematic Literature Review

From 26 selected papers there are 71 authors who participated in 31 Universities, five institutes,two colleges,and three companies. Most of all each author only write one paper. There are one author who works in two departments in China. The institution location is in USA, India, Slovakia ,Malaysia, Iran, China, Pilipina, Hungary, Myanmar, Ireland, Canada, Singapore, Nigeria, Brazil, Spain, Iraq, Nepal, Japan, Sri Lanka, Turkey,Germany,and Lebanon. Author Demography can be seen in Figure 4.

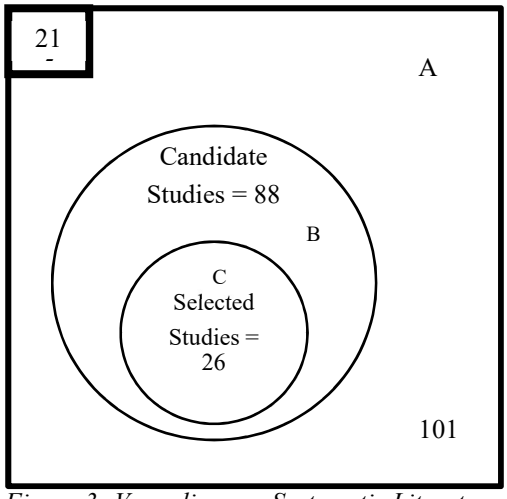

Figure 3: Venn diagram Systematic Literature review

- Sets C (Selected studies) is a subset from sets B (Candidate studies).
- B (Candidate studies) is a superset from sets A (Selected Studies).
- Notation $C \subseteq B$
- $(C \cap B) = 25$
- $A' = 109 - (44 + 25)\ A' = 40$
- A' is a journal that aren't candidate studies or selected studies.

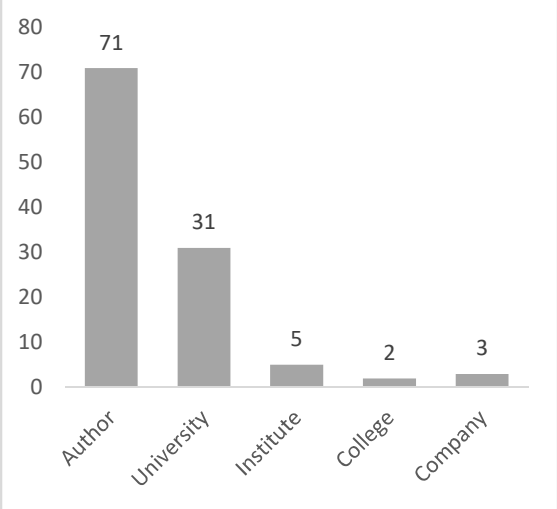

Figure 4: author Demography

All the author works in 25 departments and each positions in three companies which are : Electrical and Computer Engineering, Computer Science, Computer and Informatics, Computer and Mathematics Sciences, Computer Science, Industry Estates, Computer Engineering, Traffic and Transportation, Electrical Electronics and Computer Engineering, Transport Technology and Economics, Material Handling and Logistic System, Computer Studies, Mechanical and Control Engineering, Computer Science and Informatics, Civil Engineering, Automation, Transportation Center, Air Transportation Management, Mathematical Science, Mathematics and Computer Science, Mathematics and Statistics, Information Technology, Science and Technology, Transportation Engineering, Information Science, Fujitsu Laboratories, Computer Programming, Electronics Engineering, Communication and Signal Processing, and Transportation Center.

After that, it simplify into 9 departments and each positions in two companies namely : Electronic and Computer Engineering, Computer Mathematics and Statistics, Industry Estate, Traffic Transportation Technology and Economics, Material Handling and Logistic System, Mechanical and Control Engineering, Civil Engineering, Automation, Information Technology, Science and Technology, Fujitsu Laboratories and Transportation Center.

Author's academic background can be seen in Figure 5. Paper is selected by publication year between 2010 – 2019 as shown in Figure 6. University, institutes, colleges, and company can be seen in Figure 7.

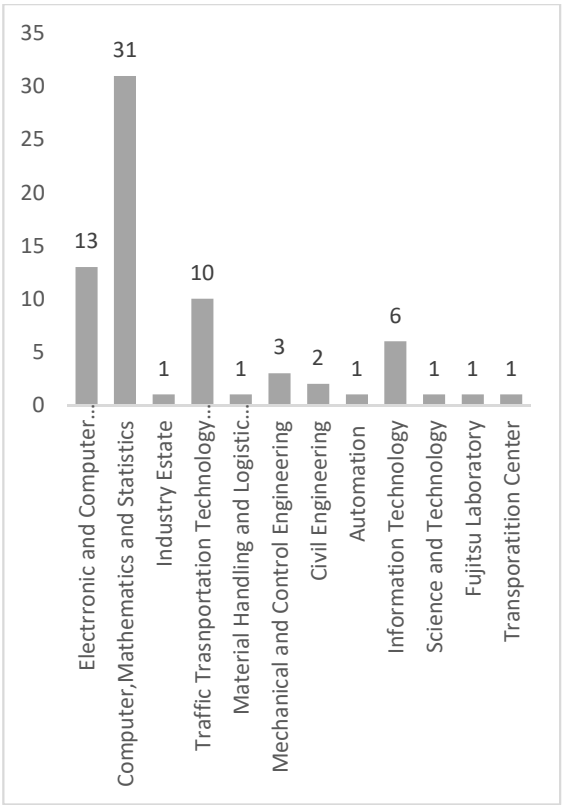

Figure 5: Author Academic Background

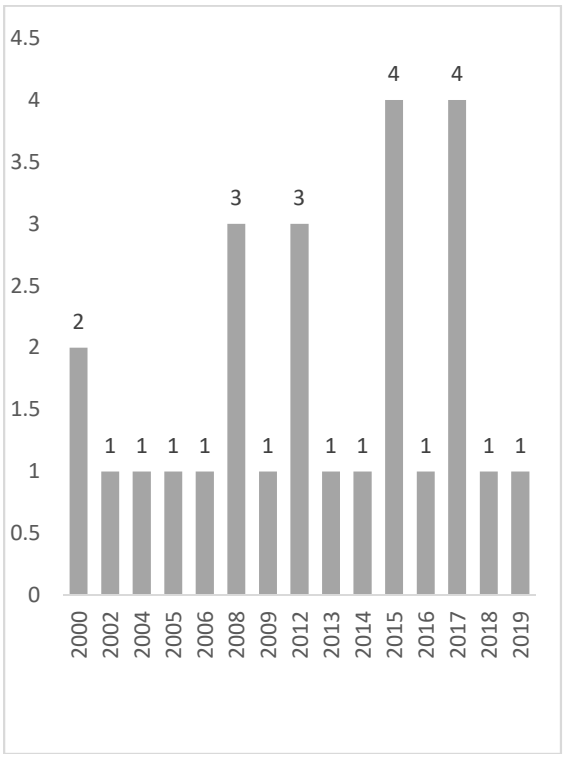

Figure 6: Publication Year

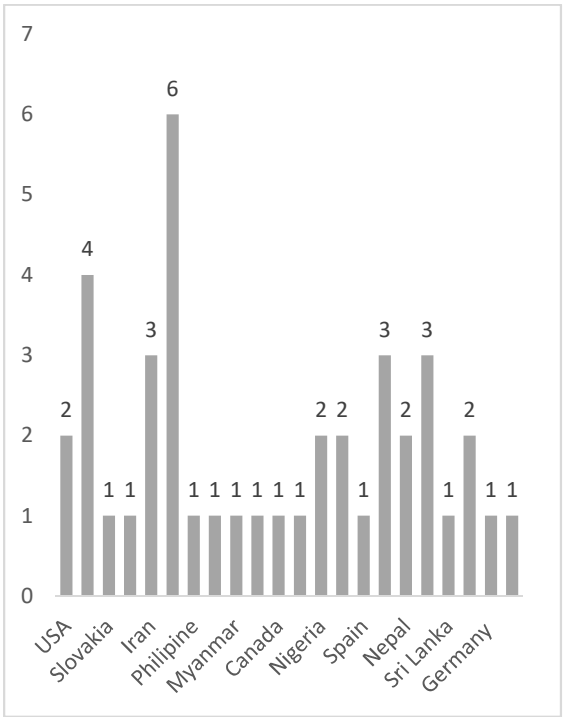

Figure 7: University, Institutes, College, and Company

4.4. Suitable Algorithm to Find Tourism Place Shortest Route

Reference [24] the most critical points to another places and how far is it from current location to destination location. So, tourist must know their location to be visited. The destinated place is located and how far is it from current location. From kind of case above, it needs an algorithm that can ease to find shortest route from current location. From current location to destination location is the most important data to find shortest route. When people is on current location, they choose destination location on maps. After that, the maps run it algorithm to find route and shortest route.

Determination of suitable data mining for kind of data above :

- Dijkstra Algorithm
  Dijkstra Algorithm can be used to create nearest route from current place to another place. Routing nearest location uses Dijkstra Algorithm and find shortest path with minimum cost. Dijkstra Algorithm has high efficiency with big cities[8]. Dijkstra algorithm can be collaborate with Genetic Algorithm.
- A* Algorithm
  Find and increase shortest distance from starting nodes to end nodes where end nodes is optimal way use A* Algorithm[9]. A* Algorithm can calculate shortest path followed by Dijkstra Algorithm.
- Genetic Algorithm
  Genetic Algorithm is perfect for multiple objective route planning. Genetic Algorithm uses parameters to create route planning. Genetic Algorithm is quite robust against failure and network errors if the paremeters set convergently.[14] For solving complex problem when optimal solution is hard to find it uses Genetic Algorithm.[12] Genetic Algorithm can find semi-optimal route in practical time.[6] Genetic Algorithm can collaborate with Djikstra Algorithm,Ant Colony Algorithm,and Fuzzy Shortest path algorithm.
- Ant Colony Algorithm
  Follow the route planning by used Ant Coloniy Algorithm. Ant Colony Algorithm is faster than Genetic Algorithm. Ant colony Algorithm is influenced by several factors are parameters and values. Ant Colony Algorithm can collaborate with Genetic Algorithm.
- Breadth First Algorithm

Breadth First Algorithm is too slow to give the shortest path and find end node. Breadth first algorithm guarantees to find shortest path algorithm but it is necessary to reach shortest path from possibilities path by look the node tree after find node.[15]

- Bellman Ford Algorithm
  Bellman Ford Algorithm provides efficient route path for GPS.[25] Bellman Ford Algorithm mostly used to solve problems with single source vertex that might include negative nodes if it cannot find the shortest path if a negative cycle is reachable from the source[16]. Bellman Ford Algorithm can be collaborate with Dijkstra Algorithm.
- Transit Algorithm
  Transit Algorithm is a method for find shortest paths in very large road networks. It only depends on number of transit nodes from origin and destination[18].
- Heuristic Algorithm
  Heuristic Algorithm can improve algorithms that was used in search process if the origin nodes and destination nodes was too far.[18]
- K-Shortest Path Algorithm
  K-Shortest Path Algorithm can provide the best choice under different traffic condition by setting reliability value to link travel time.[19] K-Shortest Path Algorithm is a subject to set several constraints such as sequences of used nodes, number of transfer, distance, fare, travel time, and so on.[26]
- Fuzzy Shortest Path Algorithm
  In Fuzzy KNN Algorithm, the importance of a neighbor is estimated based on relative distance between the neighbor and test pattern. If the neighbor is far away from the test pattern is also receives considerable importance, strictly speaking, the importance associated with zero should be close to zero matter what the other neighbors are[23].
- Tabu Search Algorithm
  Tabu Search Algorithm run through several iterations. Tabu-list is used to store attributes that has been visited solutions. During each iteration, the best solution in the neighborhood of the current solution is chosen as the new current solution, even it needs more solution cost[20]. Tabu Search Algorithm can collaborated with heuristic algorithm.
- Floyd Warshall Algorithm
  Floyd Warshall Algorithm is used to find shortest route between two nodes in a network model between edge weights are given as a new numbers. Floyd Warshall Algorithm can collaborate with Fuzzy Shortest Path Algorithm.

4.5. Determination Factors of Suitable Algorithm to Find Shortest Route

Reference[27] Users can search their optimal routes based on their own preferences such as shortest traveling time, least cost, least transfer, least walking distance or even preferred mode of transport. Shortest path problem is the problem of finding a path between two nodes in a graph likes the sum of weights of its constituent edge is minimized. The weights are costs, distance, travel time, and social economic values.

Factors that influence suitable algorithms are parameters, vertex, nodes, edge, values, cost, distance, and travel time.

5. CONCLUSION

There are 12 algorithms found in this literature review that frequently used to find shortest path. These algorithms are Dijkstra Algorithm, A* Algorithm, Genetic Algorithm, Ant Colony Algorithm, Breadth First Algorithm, Bellman Ford Algorithm, Transit Algorithm, Heuristic Algorithm, K-Shortest path Algorithm, Fuzzy Shortest Path Algorithm, Tabu Search Algorithm, and Floyd Warshall Algorithm. There are eight algorithms that frequently used to find tourism place are Dijkstra Algorithm, A* Algorithm, Fuzzy Shortest Path Algorithm, Bellman Ford Algorithm, Genetic Algorithm, Ant Colony Algorithm, Floyd Warshall Algorithm, Breadth First Algorithm. But there are only five algorithms that have been used based on this research are Dijkstra Algorithm, A* Algorithm, Bellman Ford Algorithm, Genetic Algorithm, and Ant Colony Algorithm. There are five factors that influence suitable algorithms are parameters, vertex, nodes, edge, and values.

The scope of this paper discusses the algorithm for determining the shortest distance to a tourist attraction. The weakness of this research is that it does not look for which algorithm is most effective to use to determine the shortest distance. Future research is expected to conduct literature studies to find the best algorithm to find the shortest distance. This research produces three big search algorithms for the shortest distance of a tourist attraction that has been regularly researched. The most widely used

algorithms are Dijkstra's algorithm, Genetic Algorithm, and Fuzzy Shortest Path Algorithm. Dijkstra's algorithm is in 11 papers, the genetic algorithm is in 5 papers, and the Fuzzy Shortest Path algorithm is in 4 papers.

Result of this study must give benefit with ministry of tourism to build application that can find shortest route from current location to tourism destination. Furthermore, it could build more appropriate system about tourism place and shortest path from current location. For future research, it prefers to understand new algorithm that may useful for finding tourism place to obtain interest frequency of tourism place visit.

Table 1: Algorithm to Find Tourism Place Shortest Route

Algorithm	Selected Journals
Dijkstra Algorithm	11
A* Algorithm	2
Ant Colony Algorithm	1
Breadth First Algorithm	1
Bellman Ford Algorithm	3
Transit Algorithm	1
Heuristic Algorithm	1
K-Shortest Path Algorithm	2
Fuzzy Shortest Path Algorithm	4
Tabu Search Algorithm	1
Floyd Warshall Algorithm	1
Genetic Algorithm	5
Total	26

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