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Concept of Decision Support System for Defining The Educational Tourist Attractions in Malang City using Decision Table and Genetic Algorithm

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Abstract: *The tourism sector is the backbone of the economy in Malang Regency, especially in Batu City. The development of tourism in the region initially is in the form of agro tourism, which includes apple orchards, strawberries, and various tubers.Many tourists, both outside the region and local residents, do not know the location of educational tourism in Malang. Previously, they know such information from the recommendation of friends or by verbal news. In addition, there is only tourist information on the location of the indicated area. Therefore, a system that can help to know the location of the tour that can be accessed anywhere and anytime based on economic ability and tourist location is required. Objects in this study include educational tours that are more aimed at children with early school age, namely when entering elementary school. One of the methods proposed by this research is using decision support system (DSS), which is expected to solve the difficulties faced by the tourists, especially in finding and conducting the management of visits to educational tours. This DSS will contain a data management subsystem that contains an educational catalog, then also supported by base model subsystem using genetic algorithm (GA) to perform best route search optimization, and knowledge base subsystem in a form of expert system using decision table (DT).*

Keywords: *educational tourist attraction, decision support system, decision table, genetic algorithm*.

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I. Introduction

Nowadays, agro tourism in Malang Regency is starting to develop from the beginning of the traditional nature tourism into educational tour. This is also supported by the development of several other types of educational tourism outside the agro sector. The tour uses a combination of agro and water with high-tech rides. Education became one of the emphasis on the tour, hence began to develop educational tourism in Malang Regency.

Many tourists, both outside the region and local residents, do not know the location of educational tourism in Malang Regency. Therefore, a system that can help to know the location of the tour that can be accessed anywhere and anytime based on economic ability and tourist location is required. One system that can be a solution to this problem is the merging of tourist destination search using decision support system (DSS), which consists of combination of decision table (DT) and genetic algorithm (GA). The objective is to help tourists to choose and plan several educational tourist attraction as their destination in sequence based on their interest and starting position, while optimizing the budget they have.

Due to the very diverse range of rides provided by educational tourist attractions, it is almost impossible that all attractions are visited in a short time. In addition, the diversity of the touristinterestis a big problem to combine with the rides provided by the educational tourist attractions. One of the methods proposed by this research is using DSS which is expected to be able to answer the difficulties faced by the tourists, especially in finding and conducting the management of visits to educational tours. This DSS will contain a data management subsystem that contains an educational catalog, then also supported by base model subsystem using genetic algorithm to perform best route search optimization, and knowledge base subsystem that is expert system using DT.

In this research, the topic of DSS is done on the basis that the decision-making is not a critical, absolute, and rigid. The determination of educational tourist attraction to be visited by tourists is a decision that can be violated without causing dangerous or critical circumstances. Therefore,DSS is chosen as a topic in this research.

The knowledge base subsystem is an expert system (ES) using the DT method. DT is a table describing a complex condition that can be used as a tool in decision-making. DT selection is aimed at obtaining the ease of implementation of IF-THEN structure that can be determined by the user of the system with an infinite combination[1]. DT is used to determine the list of educational tourist destinations based on tourists' location[2].

GA is a search technique within computer science to find an approximate solution for optimization and search problems. GA is a special class of evolutionary algorithms using techniques inspired by evolutionary biology such as inheritance, mutation, natural selection, and recombination (crossover)[3]. In this study, GA is used for the optimization of route determination of educational tourist destinations in accordance with its location and the criteria that have been given in the previous DT structure.

In this case, research and development is needed using DT and GA to assist tourists in determining the order of educational tour visits based on their wish, their location, and their budget.Given all the above factors, it is necessary to build a prototype of DSS development with knowledge base subsystem, data management subsystem, base model subsystem and user interface subsystem using DT and GA to provide educational tour decision support to travelers using web applications. The resulting application is expected to be accessible by tourists using both laptop and mobile (mobile phones and tablets) so it will be ideal applied in the form of web applications.

II. Theoretical Basis

Decision Support System

Decision support system (DSS) is a system based on interactive computer, which assists the decision makers to use data and several models to solve unstructured problems[4]. DSS combines human resources (experts) and computers to improve decision quality. DSS consists of several components:

1. Data Management, which includes database contains relevant data for various situations and is managed by RDBMS.
2. Model Management, which includes financial model, statistical, management of science, or other qualitative models, therefore can provide ability for analysis and software management to the system.
3. Communication, which user can communicate and request command to the DSS through this subsystem.
4. Knowledge Base, as an additional subsystem that supports other subsystems or acts as stand-alone component[5].

Decision Table

Decision tables (DT) are a concise visual representation for specifying which actions to perform depending on given conditions. They are algorithms whose output is a set of actions. The information expressed in decision tables could also be represented as decision trees or in a programming language as a series of if-then-else and switch-case statements[1].

DT, especially when coupled with the use of a domain-specific language, allow developers and policy experts to work from the same information, the DT themselves. Tools to render nested if statements from traditional programming languages into decision tables can also be used as a debugging tool. DT have proven to be easier to understand and review than code, and have been used extensively and successfully to produce specifications for complex systems[1].

Genetic Algorithm

In computer science and operations research, a genetic algorithm (GA) is a meta-heuristic inspired by the process of natural selection that belongs to the larger class of evolutionary algorithms. GA are commonly used to generate high-quality solutions to optimization and search problems by relying on bio-inspired operators such as mutation, crossover and selection[3].

In a GA, a population of candidate solutions (called individuals, creatures, or phenotypes) to an optimization problem is evolved toward better solutions. Each candidate solution has a set of properties (its chromosomes or genotype) which can be mutated and altered; traditionally, solutions are represented in binary as strings of 0s and 1s, but other encodings are also possible.Once the genetic representation and the fitness function are defined, a GA proceeds to initialize a population of solutions and then to improve it through repetitive application of the mutation, crossover, inversion and selection operators[3].

Relational Database Management System

A relational database management system (RDBMS) is a database management system (DBMS) based on the relational model invented by Edgar F. Codd at IBM's San Jose Research Laboratory. Most databases in widespread use today are based on his relational database model[6].

RDBMSs have been a common choice for the storage of information in databases used for financial records, manufacturing and logistical information, personnel data, and other applications since the 1980s. Relational databases have often replaced legacy hierarchical databases and network databases because they were easier to implement and administer. Nonetheless, relational databases received continued, unsuccessful challenges by object database management systems in the 1980s and 1990s, (which were introduced in an attempt to address the so-called object-relational impedance mismatch between relational databases and object-oriented application programs), as well as by XML database management systems in the 1990s. However, due to the expanse of technologies, such as horizontal scaling of computer clusters, NoSQL databases have recently begun to peck away at the market share of RDBMSs[6].

III. Method of Research

Method of research used in this study is design and development of an application prototype. The concept of problem solving, algorithms, and data structures have been discussed previously, as the discussion is focused on prototype development. Figure 1 describes the flowchart of this prototype development.

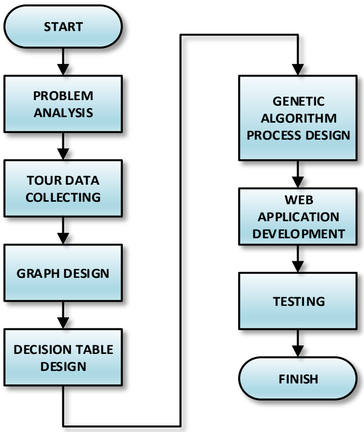

Fig. 1. The step sequences of the research methodology.

This research begins with problem analysis, followed by the collecting of the tour data, which focused on educational tourist attractions. The next step is to design the study framework, consisting of graph model, decision table model, and genetic algorithm. Based on the designed framework, as shown in Figure 2, a web application is then developed. Finally, this study is finished by testing the application into various parameters.

Problem Analysis

As variables of this research defined in advance, analysis to the variables will be done, i.e.:

1. The tourists' budget;
2. Current location of the tourists;
3. Database of educational touristattraction; and
4. Database of rules for educational tourist destinations based on budget and current location, in the form of decision table.

Meanwhile, the tourists have several parameters, which sent by their mobile devices, such as:

1. Personal details;
2. Wish list;
3. Financial budget; and
4. Current location provided by GNSS receiver onboard.

The system in this study will be build using decision table and genetic algorithm. Decision table will be used for storing expert data, while genetic algorithm will optimize the permutation generation of educational touristattraction visitation sequence.

Tour Data Retrieval

At this stage, the educational touristattraction data will be retrieved with several key components, including tour costs, tourist rides, tourist attraction locations, paths between tourist attractions,and transportation costs.

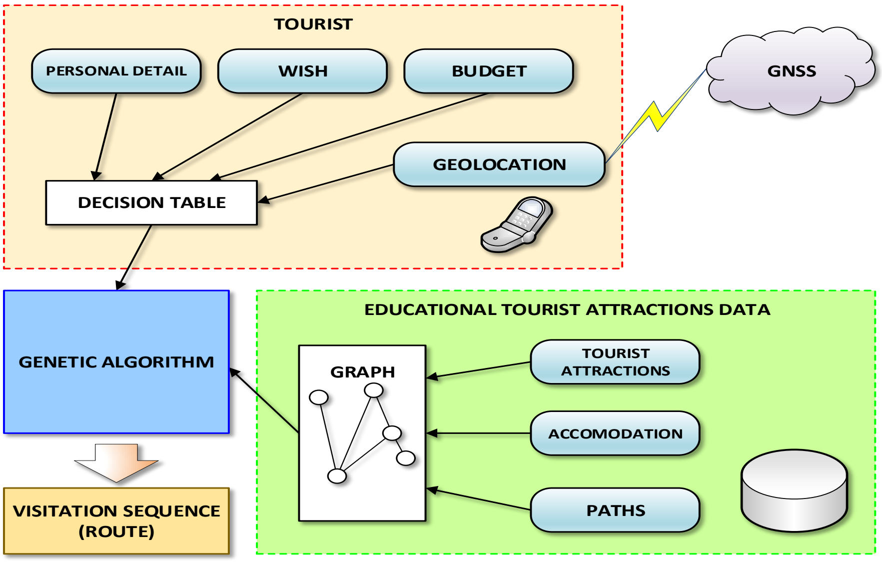

Fig. 2. The overall system framework.

Design of Decision Table, Graph, and Genetic Algorithm

The concept of designing DSS for providing educational tour of Malang tourism to tourists consists of data management subsystem, base model, and knowledge base. In the data management subsystem, presented metadata used for data storage of educational tourism in Malang. In addition to the storage of educational data master data, there is also a data storage details of the list of rides contained in the educational tourists attractions.

The section designed in this knowledge base subsystem is DT to receive data in the form of a list of rules that include:

1. Identity rules;
2. Rule name;
3. List conditions and operators between existing conditions (can be AND or OR); and
4. List of decisions, which are the most relevant educational tourism location for tourists.

In the knowledge base subsystem, the structure of the DT will be established. This structure uses four entity tables that use relational databases.

The section designed on the base model subsystem is the design of the representation of the tourist object and the path that is formed. In this design, there are two main types of data that are filled in:

1. Data node, as the point of educational tourist attraction. This data is identification of educational tourist point, followed by some related information, such as description of educational object, geographical coordinates, vehicle accessibility, related images, and ticket price (cost or rate).
2. Path data, which is the path formed between two vertices, and there are related information, such as description of the road, distance, the name of the road, the type of road, the type of vehicle that can pass through it, the related images, and the direction of the road.

Development of Web Application

The development of prototype programs will be performed using desktop-based application programs and using locally accessed MySQL database. A series of timers and watch variables will be placed in each process to determine the performance of the process performed and will be displayed at test time.

Testing

The last stage of the research is to conduct a series of useful tests to observe the outcome of the route and the timing of the tourist visit when the input given is changed by sampling 10 kinds of tourist data. This testing stage is performed using actual mobile devices. In the mobile device, the location is determined using GNSS emulation so that there is no need to move physically when tested. The testing process will be done by displaying the results of the timer and watch variables in each process. Figure 2 shows the system framework to test.

Test results will show how much the alternative route and time of tourist visit in accordance with existing tourist data. The suitability of the tourists, the total time of visit, the number of attractions visited, and the rest of the budget is a parameter that will appear on the test to be compared with the level of customer satisfaction. In addition, the test will show the result of space state and time calculation.

IV. Results And Discussions

Educational Tourist Attractions Data Filling

In this phase, a composite of educational tourist attraction data would be filled, which consists of tourist attraction sites data, tourist rides, and path between sites. The tourist attraction sites must be filled first, followed by tourist rides as their facilities inside. The path between sites would be filled the last, complete with the distance and charge for various transportation modes.

Decision Table Rules Setups

Map of Malang Regency[7]with sectored outline is shown in Figure 3, where the limitation is done by approximation (approach) to reduce the complexity of the drawing area formed. From these restrictions, ultimately formed the division of sectors represented in rectangles to simplify the conditions on DT.

Figure 3 is a map of Malang Regency that has been divided into nine sectors. Due to having to follow improper geographical shapes split into rectangular sectors, it is specific to sector 4 and sector 6 taken each with two rectangles. Here is the division of areas by sector that has been determined:

1. Sector 1, covering Ngantang, Kasembon, and part of Pujon.
2. Sector 2, an area of Batu City, which includes: Bumiaji at its center; Junrejo, Dau, and Karangploso in the east-south; Songgoriti and part of Pujon to the west; to Cangar area in the north.
3. Sector 3, is a Singosari area, which includes Malang City to the north, Singosari, and Lawang.
4. Sector 4, which is the area of Gunung Kawi, includes Wagir and Wonosari.
5. Sector 5, the main area of Malang City, including some Wagir, some Tajina, and Pakisaji.
6. Sector 6, which is East Malang area, includes Pakis, Tumpang, Poncokusumo, and Jabung.
7. Sector 7, namely Southwest Malang area, covering Kepanjen, Sumber Pucung, Kalipare, Pagak, and Bantul.
8. Sector 8 is the area of South Malang, covering Gondanglegi, Pagelaran, Gedangan, until Sumbermanjing.
9. Sector 9, which covers the areas of Wajak, Dampit, Tirtoyudo, and Ampel Gading.

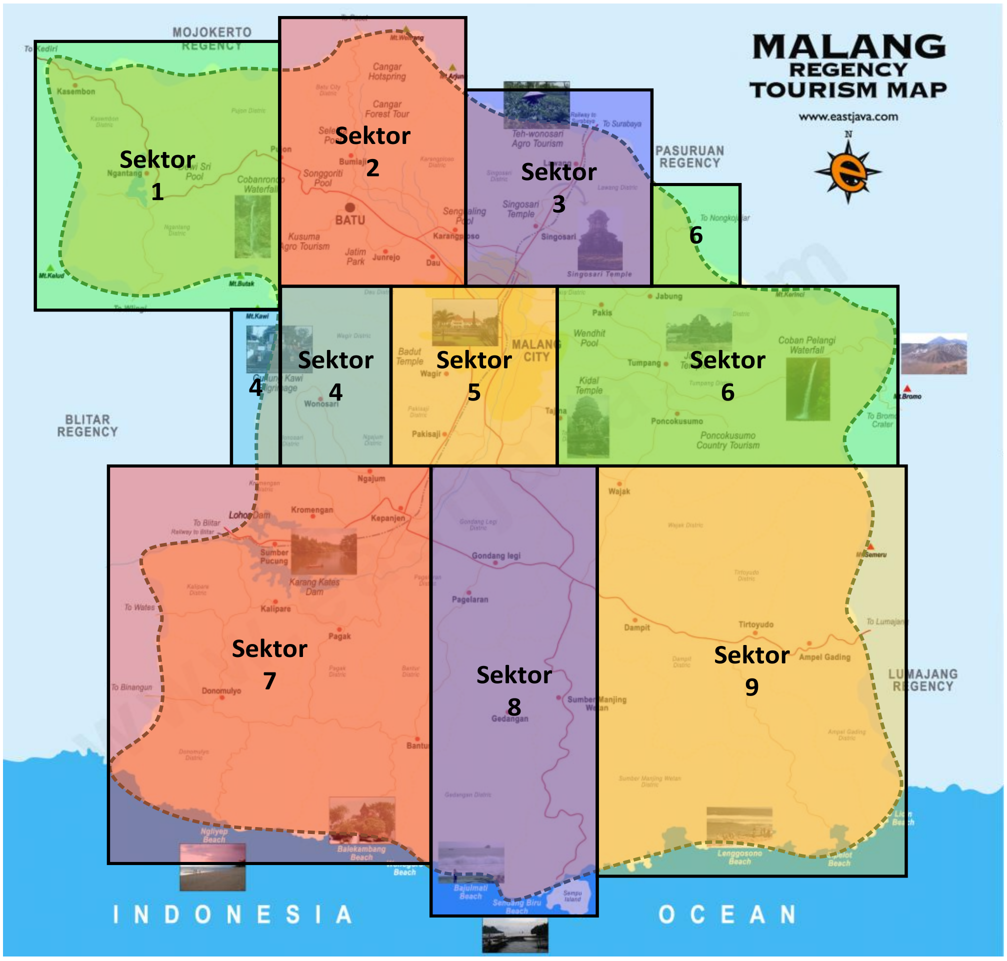

Fig. 3. The sector partition of Malang Regency, based on Malang Regency Map[7].

Model Base Design Process

In this study, the base model is designed with details such as:

1. Selection of rules on DT according to the location of tourists on GNSS recipients.
2. Selection of DT decision result, that is list of educational tourism destination, by cutting the list of educational attractions that will be visited based on the desire of the type of rides from tourists, then based on tourism budget.
3. Sequence of route of educational tourism destination with lowest transportation cost, complete (generation using permutation based on lexicograph) if the number of educational attractions is less than eight, or done using GA optimization (generation with random way) if the number of tourist attraction education is more than equal to eight. The number of routes formed is limited to 10,000 routes (9,010 routes to be precised). The best route will be cut if the budget of tourist transportation is not sufficient.

The first model base is the algorithm for obtaining decision support on the list of educational attractions that can be visited based on the geographical location of current tourists. The main input provided is the geographical location of the travelers obtained from GNSS recipients on their devices.

The second model base is an algorithm to perform the selection of decision results that have been obtained from the previous DT. Decisions that have been obtained are all educational attractions that can be visited and have been sorted based on the cost of visits ranging from the cheapest to the most expensive, which must be selected based on:

1. The desire of tourists to the type of rides that are available in the tourist attraction of education.
2. Budget tours are available on tourists.

The third model base is an algorithm for arranging the route sequence of educational tour visits after a list of educational attractions has been established. The order of visits is formed in one of two ways:

1. Route sequence search with complete permutation, using algorithm based on lexicographic order. This is done when the number of educational attractions that formed previously ranging from two to seven points. For seven points, the number of route sequences is 5,040 permutations.
2. Route sequence searching and optimization assisted using genetic algorithm, with the maximum permutation requirement of route sequence is 9,010. This is done when the number of educational attractions that formed previously is seven points or more. For seven points, the number of route sequences is 5,040 permutations.

User Interfaces

As a medium for access, an interface (user interface) is used for administrators and users (travelers).

Administrators access the system on multiple user interfaces, among which are:

1. Filling the data management, which is a list of educational attractions, a list of rides available in every tourist attraction, and a list of roads between educational attractions.
2. Filling the knowledge base, i.e. the rules on the DT each containing a set of conditions and the set of decisions.

All user interfaces are web-based, and optimized for charging using a desktop or laptop computer.

Tourists as users access the system on multiple user interfaces, among them are:

1. Fill in registration (registration) that aims to get data about the name, number of family members included, and initial wish list.
2. Make a request to the system to find the route of educational tour, while recharging the family members included (if not filled it will be used initial data), wish list (if not filled it will be used initial data), budget tour, transportation budget, and mode of transportation. Tourist positions will be automatically extracted from GNSS recipients.

Testing Result

The system test is performed with a combination of scenarios as follows:

1. The starting point of tourists (simulated as obtained from GNSS receiver) varies from nine sectors.
2. The wish list of rides varies from two to fifteen kinds.
3. The mode of transportation varies between regular public transport, motorcycle taxi, online car, motorcycle taxi, and private vehicles.
4. The budget of tourists for the cost of visits educational attractions, which vary between IDR 500,000 to IDR 5,000,000 (assuming carrying two adults and two children).
5. The tourist budget for transportation costs varies from IDR 500,000 to IDR 5,000,000 (assuming two adults and two children and various modes of transportation).

Table 1 shows the test scenarios performed, with the result parameters being the number of iterations and the time required by the server to perform calculations until an educational route decision is made. In addition, it will also show the number of educational attractions visited and the number of deductions based on budget tours and budget transport. The maximum number of maximal iterations tolerated on the server is 9,010 times; while the maximum time for each calculation until the decision is made to tourists is 500 milliseconds.

After obtaining the test results, it can be concluded that the use of restrictions based on iterations does not automatically limit the time of calculation. This is because every time an iteration process takes varying calculations, especially in a crossover process involving random numbers. While in the process of data retrieval on DT (decisions based on sector) has a fairly high performance, which is caused by the number of rules, conditions, and decisions are relatively small when compared with the search for the sequence of educational tourist visit routes.

Table 1 shows the testing scenario for the system developed.

Table 1: Systemtesting scenario.

No.	Starting Point (Sector)	Wishlist	Mode of Transport	Tour Budget	Transport Budget
1	5	2	Taxibike	500,000	500,000
2	5	5	Online Taxibike	1,000,000	1,000,000
3	5	10	Public Tranportation	2,500,000	1,500,000
4	5	15	Online Taxi	3,000,000	3,000,000
5	5	15	Online Taxi	5,000,000	5,000,000
6	5	15	Private Car	5,000,000	0
7	2	2	Taxibike	500,000	500,000
8	2	5	Online Taxibike	1,000,000	1,000,000
9	2	10	Public Tranportation	2,500,000	1,500,000
10	2	15	Online Taxi	3,000,000	3,000,000
11	2	15	Online Taxi	5,000,000	5,000,000
12	2	15	Private Car	5,000,000	0
13	3	2	Taxibike	500,000	500,000
14	3	5	Online Taxibike	1,000,000	1,000,000
15	3	10	Public Tranportation	2,500,000	1,500,000
16	3	15	Online Taxi	3,000,000	3,000,000
17	3	15	Online Taxi	5,000,000	5,000,000
18	3	15	Private Car	5,000,000	0
19	6	2	Taxibike	500,000	500,000
20	6	5	Online Taxibike	1,000,000	1,000,000
21	6	10	Public Tranportation	2,500,000	1,500,000
22	6	15	Online Taxi	3,000,000	3,000,000
23	6	15	Online Taxi	5,000,000	5,000,000
24	6	15	Private Car	5,000,000	0
25	1	15	Private Car	5,000,000	0
26	4	15	Private Car	5,000,000	0
27	7	15	Private Car	5,000,000	0
28	8	15	Private Car	5,000,000	0
29	9	15	Private Car	5,000,000	0

The test was performed with real server connected to internet, laptops, and real mobile devices. The internet connection of the mobile devices can be interchangeable between data packet and public hot spots. The internet connection of mobile devices will not affect the testing result as long as the stabile connection occurs. Table 2 shows the testing result under the above scenario.

Table 2: Systemtesting result.

No.	Starting Point (Sector)	Wishlist	Mode of Transport	Tour Budget	Transport Budget	Number Of Iterations	Calculation Time (ms)
1	5	2	Taxibike	500,000	500,000	6	0
2	5	5	Online Taxibike	1,000,000	1,000,000	9010	218
3	5	10	Public Tranportation	2,500,000	1,500,000	9010	266
4	5	15	Online Taxi	3,000,000	3,000,000	9010	265
5	5	15	Online Taxi	5,000,000	5,000,000	9010	281
6	5	15	Private Car	5,000,000	0	9010	249
7	2	2	Taxibike	500,000	500,000	6	16
8	2	5	Online Taxibike	1,000,000	1,000,000	9010	219
9	2	10	Public Tranportation	2,500,000	1,500,000	9010	312
10	2	15	Online Taxi	3,000,000	3,000,000	9010	343
11	2	15	Online Taxi	5,000,000	5,000,000	9010	375
12	2	15	Private Car	5,000,000	0	9010	358
13	3	2	Taxibike	500,000	500,000	6	0
14	3	5	Online Taxibike	1,000,000	1,000,000	720	16
15	3	10	Public Tranportation	2,500,000	1,500,000	9010	156
16	3	15	Online Taxi	3,000,000	3,000,000	9010	187
17	3	15	Online Taxi	5,000,000	5,000,000	9010	187
18	3	15	Private Car	5,000,000	0	9010	187
19	6	2	Taxibike	500,000	500,000	24	0
20	6	5	Online Taxibike	1,000,000	1,000,000	120	16
21	6	10	Public Tranportation	2,500,000	1,500,000	9010	172
22	6	15	Online Taxi	3,000,000	3,000,000	9010	156
23	6	15	Online Taxi	5,000,000	5,000,000	9010	187
24	6	15	Private Car	5,000,000	0	9010	172
25	1	15	Private Car	5,000,000	0	9010	203
26	4	15	Private Car	5,000,000	0	9010	203
27	7	15	Private Car	5,000,000	0	9010	93
28	8	15	Private Car	5,000,000	0	5040	281
29	9	15	Private Car	5,000,000	0	5040	250

Testing Analysis

As shown in Table 2, the testing suggests that in increasing of the wishes result in increasing number of iterations. The calculation time is also proportional to the tourist wishes. However, the same number of iteration results a slightly different in calculation time. It shows that the constant genetic algorithm process requires various time, since the acquisition of chromosomes between parents involves random variables. Generally, the number of iterations can be limited at exactly 9,010 times, while the calculation time can only be limited by time-out constraint. In the testing above, maximum calculation time of 375 milliseconds can be achieved.

V. Conclusion

Three conclusions have been obtained from this research. First, the several components of DSS have been constructed and composed into single prototype, i.e. data of educational tourist attractions as data management, geographical sector selections as knowledge base, and permutation for route generation with assistance of genetic algorithm. Second, the prototype has been developed in the form of web application;hence, it can be easily accessed from desktop, laptop, or mobile platform. Third, the prototype shows a good testing result, thanks to maximum iteration limit to make a consistent performance.

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