A Development of a Decision Support System for Transporting Goods in the Eastern Region of Thailand by DRG Algorithm and Weight Value Technique

Natthachai Plenwijan[1], Prapai Sridama[1], Sombat Theekasab[1], Nutdanai Singkleewon[1]

[1]Faculty of Science and Technology
Bansomdej Chaopraya Rajabhat University
1061 Issaraphab Rd., Hiranruchi, Dhonburi, Bangkok, 10600 Thailand
e-mail: prapaibsru1234@gmail.com

Abstract— The objective of this research is to develop a decision support system for transporting goods in the Eastern region of Thailand by DRG algorithm and Weight Value technique which it is designed in model planning and decision for customers who would like to send their product to anywhere in the Eastern region of Thailand, theory used decision tree, rule base, greedy algorithm, weight value and heuristic to find suitable solution for decision. The system is developed by using PHP language and MySQL on web application. The score is 4.8 of 5 to be evaluated by five expert persons proved that it could help to reduce time. The score is 4.6 of 5 is evaluated to satisfy by users.

Keywords- **Decision tree; Rule Base; Greedy Algorithm; Heuristic; Weight Value**

I. INTRODUCTION

From the growth of today' s economy with the potential of an e-Commerce system that is expanding. The above cause creates convenience in dealing between buyers and sellers. Therefore, transportation of goods is considered important. Currently, freight can be divided into many forms, including water transport, air, rail, pipeline, and road. The form of road transport has the highest volume of services than any other form of transport, which accounts for 81.1 percent of all forms of transport in Thailand. From the statistical data of the logistics data development working group office of the national economic and social development Board, as of April 2017, found that the cost of road freight has steadily increased. In 2009, it was found that the statistical cos of road freight was valued at 432 billion baht. In 2016, it was found that the statistic of the cost of road freight increased to 621. 8 billion baht] 1[. The transportation service business operators have been affected by the increase in the number of customers using the pick-up service. Therefore, it is necessary to manage the quality transportation business, both in service and management. One of the strategies used by the freight forwarding business operators is to implement a decision support system to manage the organization to increase work efficiency and services. The necessary information, both inside and outside the organization, is stored in a database system using computer technology. Information that is relevant and relevant to user needs is retrieved for analysis and results are displayed in various formats.

From the preliminary study on the current problems of small freight business in Thailand Encountered a problem transportation route planning, including operations on transportation route planning. Currently, the duty is assigned to the transportation supervisor, a position that requires experience and expertise in analyzing, planning, and arranging transportation routes. If there is a cause causing the transportation supervisor to not be able to work, such as an illness or personal mission, it is necessary to leave immediately, which may affect the daily route planning. In addition, it is not possible for customers to decide on the type of vehicle to provide their own transportation. As a result of these problems, customers have no choice in using the service, the form of transportation that is most suitable for their customers, and directly affects the satisfaction of customers from receiving the service. The researchers have already foreseen that such problems may have an impact on the overhead of shipping the goods. In the old model of transportation there was no clear reference to the route that was most appropriate. Therefore, the arrangement of good transportation routes will help the organization to save the transportation cost. The researchers will develop a decision support system to solve the problem using the DRG algorithm and weight. This algorithm compares results with current routing values and maximizes customer satisfaction, and increases performance metrics such as accuracy and processing time.

II. LITERATURE REVIEW

A. *Transportation Route Problems*

A well-organized and efficient rout can result in reduced transport distances, and sometimes the number of vehicles used for transportation can also be reduced. If the distance and the number of vehicles used for transportation is reduced, the resulting pollution from transportation decreases, and also reduces the cost of transportation of the company]1[.

B. *Heuristics*

Heuristics is a solution used to find the closest answer. The problem-solving and searching-for-answers model is a logical way of thinking that uses certain rules. This method is used to find a good answer and to a certain extent. Although, it may not be the best answer but it will be answered quickly. The answer must be an answer that is good enough and acceptable, and the solution will develop according to the difficulty of the problem. The method is to divide the area into groups and then arrange the route by using the nearest point selection method]1[.

C. *Decision Support System*

Decision support system is a method to help the decision maker to synthesize the information for the best decision by using computer as a tool to gathering information for making the decision in problem solving and be able to make decision on the complicate matters to get the best solution. The decision support system has evolution from two main studies which are "The study of the hypothesis for organization decision" at Carnegi Institute of Technology during 1950 to 1960 and " The study of techniques using for work" in 1960. This beginning points lead to the construction and development of many application programs. The format of decision support system will be filling with reliable information into the database. The information system of other enterprises that relates to decision will compose of models for decision making, process of analysis on the present working condition by experience expert, decision by rule-based, and communication system in term of " what if" analysis. However, what have been received from the system will help to classify the choices of selection by deleting the unsuitable choices of selection.

The decision making process is to define the steps for decision making to solve problems that occur within the organization with the rules by defining the steps from the first step to the last step to get the desired result. Step1: using ideas, step 2: design is the process of creating and analyzing decision-making options. Step 3: choosing the best alternatives. It is the process of finding and evaluating the different options that are obtained from the design process. And selected to have only one choice. The end result from step 3 is an alternative to the practical implementation of the solution]2[. The decision support system is an information system that can interact with users, which the system analyzes and considers all possible options]3[.

D. *Decision Support System*

A tree decision diagram is a tool that helps define the scope of a problem and helps to make possible solutions. The characteristics of the tree decision diagram are as 1(clearly showing the connection of the problem using graphic guidelines, 2(helping to deal with various complex situations in a more concise, 3(structure to tell the potential outcomes of various selections for decision making, 4(to help analysis order of decision making to solve various problems as well as analyze results from decision making in various ways, 5(to help to balance the risk in decision making, selecting solutions to problems, and 6(suitable for problems with not many options]2[.

E. *Rule Base*

The rule base is one method of expert systems. The rule base is the containment of information obtained from knowledgeable humans and instead of various information in the form of various rules. These rules can be used to work with different data operations in order to get appropriate conclusions or results.

F. *Greedy Algorithm*

The greedy algorithm is a type of algorithm that has concepts in each step to decide what looks like the best at that time. Algorithm for many types of optimization problems often consist of many steps. For some problems, the Greedy algorithm gives the best possible answer. But many other problems using Greedy algorithm will not get the best answer, but it may be a good answer for some cases.

G. *Relate Researches*

The problems of routing transportation are solved as bi-objective problems, integer programming and heuristic methods]4-8[. The most multi-objective approach to the problem is based on the weighted sum method. All criterion functions)those related to cost and risk(are multiplied by the appropriate weight coefficient and summed in an aggregated objective function. The multi-objective problem of route selection is decreased to a single-objective, which can be solved by some of the shortest path algorithms. Na, Shi, Liu Xumin, and Guan Yong in 2010]9[uses clustering analysis method for the main analytical methods in data mining. This paper presents an improved k-means algorithm in order to solve this question, requiring a simple data structure to store some information in every iteration, which is to be used in the next interaction. The experimental results show that this method can improve the speed of clustering and accuracy. The paper of Li, Kai, Lan Wang, and Lifeng Hao in 2009]10[presents a new hierarchical clustering algorithm. The experimental results are compared with those of some single runs of well-known clustering algorithms.

III. RESEARCH METHODOLOGY

This research studied the current situation problems in the transportation schedule planning of a cargo transportation establishment in the eastern region of Thailand. In order to deliver products to different locations, the carrier must consider how to deliver products that are appropriate and cost-effective in the process. The researchers designed a decision support system for the transportation of goods in the eastern region of Thailand using the DRG algorithm and weight values. The decision support system architecture for the transportation of goods in the eastern region of Thailand

using the DRG algorithm and weighting method as shown in figure 1.

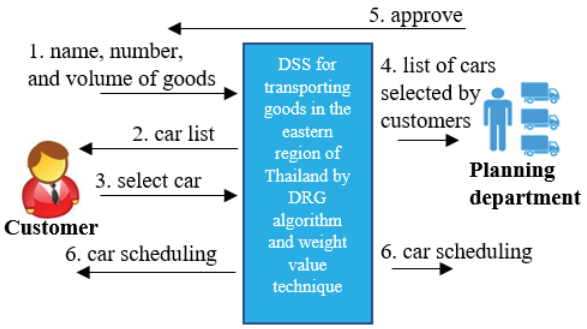

Figure 1. The architecture of DSS for transpoting goods in the eastern region of Thailand by DRG algorithm and weight value technique

From figure 1 shows a diagram of the decision support system architecture for the transportation of goods in the eastern region of Thailand using the DRG algorithm and weighting technique. The process is from the customer specifying the product name, amount of product, product volume)width x length x height(in centimeters, the place of delivery, and the date of delivery. Then, the decision support system for the transportation of goods in the eastern region of Thailand using the DRG algorithm and weighting technique processes according to the developed algorithm and sends the results as a returnable item to the customers. After that, customers can choose the item they want. In the next step, the decision support system for the transportation of goods in the eastern region of Thailand using the DRG algorithm and weighting technique will show the list of items that customers have chosen to ship to a shipping service company and if the plan is approved by the customer then the decision support system for the transportation of goods in the eastern region of Thailand using the DRG algorithm and weighting technique will send the confirmation statement back to the customer. The researches have designed an algorithm for selecting the list of cost and choosing the used car for delivery, as shown in figure 2.

Figure 2 contains the process of choosing a table for shipping. The first step is the process of checking the route, checking the vehicle status system and after that the system will get the number of vehicles that can deliver the product. The method for finding the answer is the method of finding the right path using the heuristics using the greedy algorithm to find the possible answer. Next, check the capacity of each truck selected by the system. The customer will enter data such as product, product quantity, product volume, specified in size per piece)width x length x height(in centimeters, which are sent to the DSS for the transportation of goods in the eastern region of Thailand using the DRG algorithm and weight values. Then, the DSS calculates the total volume of goods and car routes using equation 1. The volume calculation and weighting calculations, importance of decision making by using equation 2 to decide the car that is capable of transporting goods.

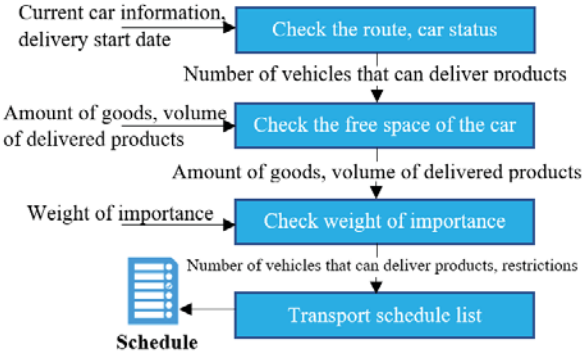

Figure 2. The algorithm for selecting items, costs, expenses and choosing the used car to deliver the product

$$NetV = (w \times l \times h) \times n \qquad)1($$

Let $NetV$ is net volume per 1 shipping item. w is product width per 1 piece. l is product length per 1 piece. h is product height per 1 piece. n is total number of products.

$$DRG = (W1 \times Cost) + (W2 * Remaining\ time) \qquad)2($$

Let *DRG* is *DRG* algorithm and weight vale. *W1* is level 1 of weigh value. *W2* is level 2 of weigh value. *Cost* is the transaction cost, which is calculated from the DSS. *Remaining* time is the time of before to transfer.

System performance evaluation was conducted by testing with 50 users in order to measure the efficiency of the system and the original system.

IV. Results of Experiment

From the development of a decision support system for the transportation of goods in the eastern region of Thailand using DRG algorithm and weight method, the researchers have experimented with NCR co., ltd. The researchers have compared the example of the scheduling data of the company with the results displayed to the customer before confirming the selection of the program. The data provided for testing include the shipping location, free space on the car, all areas on the car, delivery start date, delivery end date as in table 1. The table 2 is the result of the report processed by the decision support system for the transportation of goods in the eastern region of Thailand using the DRG algorithm and weighting technique. This system can process quickly and order results according to the importance of the company.

TABLE I. EXAMPLE OF COMPNAY SCHEDULING DATA

No.	Location	Free space of car	All space of car	Start date	Stop date
1	1,4,3	2.3*2.9*2.7	2.3*5.9*2.7	20/5/19	22/5/19
2	1,4,3	2.3*3.9*2.7	2.3*5.9*2.7	19/5/19	21/5/19
3	1,2,3	2.3*2.9*2.7	2.3*5.9*2.7	19/5/19	21/5/19
4	1,2,4,3	2.3*2.9*2.7	2.3*5.9*2.7	20/5/19	22/5/19
5	1,4,2,3	2.3*3.9*2.7	2.3*5.9*2.7	18/5/19	20/5/19
6	1,2,4,3	2.3*4.9*2.7	2.3*5.9*2.7	20/5/19	22/5/19
7	1,4,2,3	2.3*4.9*2.7	2.3*5.9*2.7	17/5/19	19/5/19
8	1,2,3,5	2.3*4.9*2.7	2.3*5.9*2.7	16/5/19	18/5/19
9	1,5,2,4,3	2.3*4.9*2.7	2.3*5.9*2.7	18/5/19	20/5/19
10	1,4,3	2.3*4.9*2.7	2.3*5.9*2.7	20/5/19	22/5/19
11	1,4,5,2	2.3*1.9*2.7	2.3*5.9*2.7	18/5/19	20/5/19
12	1,2,3	2.3*3.9*2.7	2.3*5.9*2.7	19/5/19	21/5/19
13	1,4,3	2.3*4.9*2.7	2.3*5.9*2.7	18/5/19	20/5/19
14	1,2,3	2.3*1.9*2.7	2.3*5.9*2.7	21/5/19	23/5/19
15	1,2,4,3	2.3*1.9*2.7	2.3*5.9*2.7	17/5/19	20/5/19

TABLE II. THE RESULS OF THE PROCESSED REPORT OF THE DECISION SUPPORT SYSTEM FOR THE TRANSPORTATION OF GOODS IN THE EASTERN REGION OF THAILAND USING THE DRG ALGORITHM AND WEIGHTING TECHNIQUE

No.	Location	Free area of car	All area of car	Start date	Stop date	Status
1	1,4,3	2.3*2.9*2.7	2.3*5.9*2.7	20/5/19	22/5/19	Pass
4	1,2,3,4	2.3*2.9*2.7	2.3*5.9*2.7	20/5/19	22/5/19	Pass
6	1,2,3,4	2.3*4.9*2.7	2.3*5.9*2.7	20/5/19	22/5/19	Pass
10	1,4,3	2.3*4.9*2.7	2.3*5.9*2.7	20/5/19	22/5/19	Pass
14	1,2,3	2.3*1.9*2.7	2.3*5.9*2.7	21/5/19	23/5/19	Not

TABLE III. THE AVERAGE CUSTOMER SATISFACTION

Title	Avg.
1. The assessment of design input	
1.1 Design of data import is easier to use, not complicated	4.55
1.2 The design of the data import is accurate.	4.37
1.3 The design of the import data is not consistent behavior change.	4.73
1.4 The form of letters, and characters that is easy to read.	4.23
The total average	4.47
2. The results of the evaluation process in the system	
2.1 In the process, the system has a process to follow the correct order.	4.53
2.2 Speed data access is on the appropriate level.	4.28
2.3 This system designed to reduce duplication of data import.	4.81
2.4 Each page of this application can present quickly.	4.56
2.5 The system is designed with redundancy process to work less.	4.51
The total average	4.54
3. The assessment of design results	
3.1The application has to format the partition of the screen to the right.	4.66
3.2 The information is accurate, clear, easy to understand.	4.85
3.3 The application option is the use of color. And letters to be displayed properly.	4.37
3.4 The application contains information to educate and interest.	4.42
3.5 The application offers a convenient and fast.	4.42
The total average	4.54
The total average net	4.52

Table 3 shows the average satisfaction of 50 customers. The highest satisfaction rating is at 5 points and the average satisfaction for this survey is 4.52 points. Then the satisfaction rating is at the highest level. In addition, the topic gives the highest level is the design of the import data is not consistent behavior change that is equal 4.73. However, the assessment of design input is high level while the results of the evaluation process in the system and the assessment of design results are highest levels.

V. CONCLUSIONS

The objective of this research is to develop a decision support system for transportation of goods in the eastern region of Thailand using DRG algorithm and weight method. There is a mock design for planning and decision making for customers who want to deliver products to various locations in the eastern region of Thailand. There is an opportunity for customers to decide which vehicle to use on their own. This system helps to consider the transportation schedule of the establishment instead of the transportation schedule planner. In addition, the system can reduce transaction scheduling time and can arrange the results sequentially according to the importance of the company.

REFERENCES

[1] National statistical office, " Logistics costs and the ratio of logistics cost to GDP of Thailand between 2009-2016", 2017.

]2[P. Kiti, "Scripture decision support system and exprt system", 2nd edtion, Bangkok : KTP, 2007.

]3[C. Yanipa, " Design of decision support system for continuous route routing with product transfer and suspension" , Master of Science thesis industrial engineering program, Chulalongkorn University, 2012.

[4] K. Kuhn, A. Raith, M. Schmidt, and A. Schöbel, "Bi-objective robust optimization." Trans. European Journal of Operational Research, vol. 252, no. 2, pp. 418-431.

[5] A. W. Siddiqui, and M. Verma, "A bi-objective approach to routing and scheduling matitime transportation of crude oil." Trans. Elsevier Transportation Research Part D, vol. 37, pp. 65-78,

2015.

[6] K. N. Andtroutsopoulos, and K. G. Zografos, "Solving the bicriterion routing and scheduling problem for hazardous materials distribution." Trans. Elsevier Transportation Research Part C, vol. 18, no. 15, pp. 713-726, 2010.

[7] A. Bronfman, V. Marianov, G. Paredes-Belmar, and A. Lüer-Villagra, "The maximin HAZMAT routing problem, Trans. European Journal of Operational Research, vol. 241, no. 1, pp. 15-27, 2015.

]8[T. Fan, W. Chiang, and R. Russell, " Modeling urban hazmat transportation with road closure consideration." Trans. Elsevier Transportation Research Part D, vol. 35, pp. 104-115, 2015.

[9] N., Shi, L. Xumin, and G. Yong, "Research on K-Means Clustering Algorithm: An Improved K-Means Clustering Algorithm," in Proc. Third International Symposium on Intelligent Information Technology and Security Informatics (IITSI), 2010, pp. 62-67.

[10] K. Li, W. Lan, and H. Lifeng, "Comparison of Cluster Ensembles Methods Based on Hierarchical Clustering," in Proc. International Conference on Computational Intelligence and Natural Computing, 2009 (CINC '09), pp. 499-502, 2009.