Information System for Deciding the Route to Transport Goods Between Bangkok and Mukdahan Province in Thailand

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Abstract— **The objective of this research is to develop an information system for deciding the route to transport goods between Bangkok and Mukdahan province in Thailand. Many techniques are used in this system, such as the risk analysis, analytic hierarchy process and zero-one goal programming. This system is tested by 50 customers from a shipping company in Bangkok, Thailand. The results showed that the system offers shipping cars for customers, and reduces time and errors in finding the transportation routing from staff. Furthermore, the system decreases the time of transaction documents and reduces the time to decide from customer. Staff have not over skill but they can use this program. This research surveys satisfaction of 50 customers. This survey finds the average score of satisfaction is 4.67 from 5. In addition, the number of customers increases by 25.37 percent.**

Index Terms—**Optimization; Risk Analysis; Analytic Hierarchy Process; Zero-One Goal Programming.**

I. INTRODUCTION

Transportation is an important activity in the business today. There are various forms of transport, such as road transport, water transport, rail transport and air transport. The type of transport with the highest proportion is road transport, which is 82.47 percent. Road transport is more expensive than other forms of transport, but other forms of transport cannot manage to meet the needs of service users. Transport by truck to respond to users thus it has a better advantage and a higher proportion of transport other modes of transport. The road transport by truck can be divided according to the ownership of two categories: 1) the manufacturer of the product has to transport its own and 2) hiring transportation operators. The company produces a large volume of product is very popular, the company employed entrepreneurs, cargo agents, freight themselves. Because of it can ease the process, reduce costs and improve performance better than the action itself. In addition, the transport of goods by truck can also be divided into two categories: operation characteristics. Full transport vehicles and transport vehicles are not full. The style transport vehicle that would normally be full freight from origin to destination without the acquisition of goods and there is no pick up or delivery routes.

The expansion of the economy and society that resulted in a number of vehicles on the roads in metropolitan areas increased dramatically. Each trip takes more time. The probe extends the time it takes to do away with most of being stuck on the road is inevitable. The expansion of the cargo that is often used for road transport is key. It has been affected by this issue. In addition, the number of consumers has grown and the demand for such products is increasing. Moreover, the cost of transport is increasing due to traffic congestion has increased. Companies involved in the transport of goods for consumption must be adapted. They must decrease the minimum costs of travel and customer satisfaction is in providing the transportation.

From the research it was found that the selection of routes and modes of transport, multimodal forms. The research abroad to focus on the choice of routes, multimodal transport model with the lowest cost of transportation or transported at minimal time. Then the developing and information system for deciding the route to transport goods between Bangkok and Mukdahan province in Thailand is used to analyze the route path. This system can be obtained from the information system used to help make decision. The concept of the problems of freight routes is the optimization of the freight route planning which knows the expenditure of freight route, the capacity of vehicle, and the routes to send goods of customer. The limits of freight route planning are all products of a customer to use one vehicle and the quantity not exceed the capacity of the vehicle.

The objective of this research is to develop the decision support system by optimization and dynamic analysis for consumer goods transportation routing between Bangkok and Mukdahan province in Thailand. This system can calculate and analyze transport routes for customers. Transport routes and vehicles appropriate are introduced for customers before they will determine by this system. In addition, they can know the timing to deliver goods or products. Furthermore, they can know the delivery costs too. Many algorithms are used to create the decision support system by optimization and dynamic analysis for consumer goods transportation routing, such as transportation theories, the decision support system theories, analytic hierarchy process (AHP) process and zero-one goal programming (ZOGP).

From this point, this paper is divided into four main sections. Theories and related researches are presented in the first section. Secondly, the information system for deciding the route to transport goods between Bangkok and Mukdahan province in Thailand is shown, and then the results of this system are presented. Lastly, the conclusion of this research is presented.

II. Theories and Related Researches

Theories and related researches are presented in this section. The principle to develop the information system for deciding the route to transport goods between Bangkok and Mukdahan province in Thailand is a principle of the decision to choose transportation routing. Therefore, only related researches are presented. However, some techniques or some principles can give higher popularity because these principles are easy to manage, but these principles do not process data fast.

A. Shipment by Truck

The nature of the truck by type of cargo can be classified into two that are full truckload and less than truckload. The design depends on several parameters such as size, density and distance on demand, and the value of the product. The transportation by distribution goods or Milk Run is used by the manufacturer of the product to deliver more cargo in one round. The benefits of this method include lower cost for the transportation manufacturer and shorter time moving from one point to another [1-3].

B. The Transport Routes

Proper arrangement of the transport routes can decrease the distance of transportation. Sometimes, it can reduce the number of vehicles used to transport them. Variations in the transit can be classified into 13 types: shortest path, traveling salesman problem, vehicle routing problem, transportation problem, minimum cost flow, minimum spanning tree, facility location, bin packing, parallel machine scheduling, crew scheduling, aircraft load planning, container handling at ports and heuristics [4].

C. Risk Analysis

The research of Banomyong (2011) is on the selection of shipping routes due to many manufacturing companies in the country of Laos. The decision criteria of choosing the right path is transportation costs. This research focuses on the risk of routes, which a determining factor for transport costs. Equation of risk is shown as:

$$Risk\_score = \frac{Rating\_probability\_of\_risk}{2\alpha The\_severity\_of\_the\_impact\_risk} \quad (1)$$

From Equation 1, if the risk score is 1, the risk probability is very small. But if the risk score is 5, the risk probability is very large.

D. Analytic Hierarchy Process (AHP)

The analytic hierarchy process is developed by Thomas L. Saaty in 1980. This process is used to solve the problem, which has multiple decision-making criteria. It can be used for the multiple attribute decision making. This process has many methods such as electre approach, promethee method, analytic hierarchy process and analytic network process. According to the principle of AHP by Saaty, it begins with the decision to issue the demand in the form of hierarchy, whose goal is to create a sample issue. This method is a model example of the hierarchy generally consists of goal, decision criteria and alternative structures of hierarchy [5]. AHP is used for the actual experience and forecasting models under each link in the path hierarchy.

E. Zero-one Goal Programming (ZOGP)

Programming target center is a tool developed by the goal programming. This technique expands from the linear programming. ZOGP has the ability to select the right answer. The variable is the only one of the two answers (0 or 1) [6].

F. Related Researches

This section presents comprehensive overview of different proposals for this system. Sequencing pickup and delivery (PD) tasks to be handled by a single vehicle is often referred to as vehicle routing or job sequencing [7]. The problem is NP-hard in general due to a complex combinatorial nature, and it includes the considered problem as a sophisticated case. Indeed our problem is further complicated by dynamic arrivals of PD requests. So far, there are a variety of research investigations on static and dynamic vehicle routing problems (VRPs) for different applications [8-10].

The hybrid vehicle routing problem concentrates on minimizing the total cost incurred by utilizing hybrid vehicles. Then, the Hybrid Vehicle Routing Problem (HVRP) is classified into the G-VRP group by Lin, et al. [11] as it also takes into account the environmental impact.

III. The Decision Support System by Optimization and Dynamic Analysis for Consumer Goods Transportation Routing between Bangkok and Mukdahan province in Thailand

The decision support system by optimization and dynamic analysis for consumer goods transportation routing between Bangkok and Mukdahan province in Thailand has development system processes as follows: education freight route possible between the points of departure and destination, criteria affecting the decision to choose the shipping route, and system structure. These processes are presented in Figure 1.
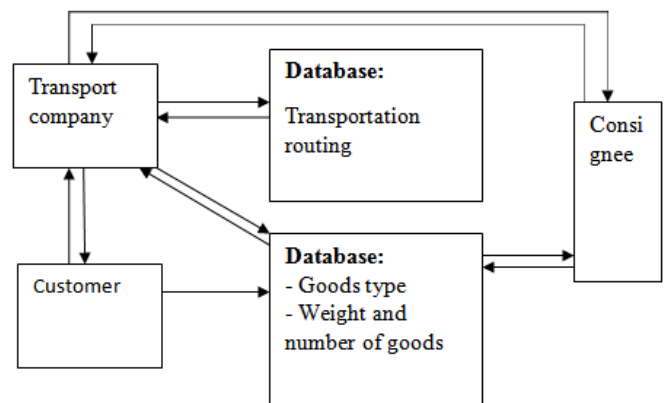

Figure 1: Processes of transportation routing system

Figure 1 presents processes of transportation routing system. These processes are concept of the system, which is developed in this research. The transport company can calculate and find the route paths to transfer goods. However, the system shows route paths by mapping with the google map, and the system finds well route paths only. For selecting the route paths to transfer goods, the system calculates by techniques, which are explained in this section.
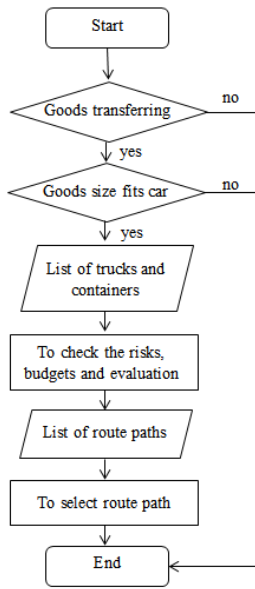
Figure 2: Various stages of transportation routing

Figure 2 shows various stages of transportation routing. The first stage starts when the system is requested by a customer. Next, the system checks number of trucks and containers, which are empty. In addition, these trucks and containers should fit the size for the goods. After that, the system checks the risks, budgets and evaluation in each route paths. Then, the system gives the list of route paths, which are well selected, and these selections are presented to the customer.

The system has three main components as follows: 1) to study route paths, 2) to analyse the decision criteria affecting the decision to route path and 3) to decide the route of delivery.

A. To Study Route Paths

By studying the route paths, this research found that there are four route paths for transportation by trucks and containers. However, these route paths have different advantages and disadvantages. This research finds route paths data by interviewing the Thailand government and experts for transportation between Bangkok and Mukdahan province.

B. Decision Criteria Affecting the Decision to Route Path

The decision criteria used statistical principles in this research. There are five decision criteria: 1) budgets, time, risk of product, risk of basic structure and equipment facilities and other risks. However, equation 1 is used for the calculation in this section.

C. Deciding the route of deliver

The objective of deciding the route is to select the route path for goods transportation between Bangkok and Mukdahan province under limitations such as budgets and risks. This research designs the decision system, which are three parts.

The database of decision system is the first part. The components of this part are route paths, criterions for quantitative decision (budgets, time for transportation), and qualitative decision (risks in each route path).

The second part is the information needs of the decision or users. The data of this part are the start point and stop point, budgets, facilities in the path, and other risks. This research

defines the weight in each data by expert from logistic company.

The last part is calculating and finding paths with appropriability and limitations. Zero-one goal programming (ZOGP) is used for the calculation in this part. It can be shown in Equation 2 to 8.

$$Minimize\_z = \sum_{i=1}^{n}(w_i d_i^- + w_i d_i^+),$$

$$z = w_1(d_1^+) + w_2(d_2^+) + w_3(d_3^+) + ... + w_m(d_m^+) \quad (2)$$

subject to:

$$\text{Budget: } c_1 X_1 + c_2 X_2 + ... + c_n X_n - d_i^+ + d_i^- = C \quad (3)$$

$$\text{Time: } t_1 X_1 + t_2 X_2 + ... + t_n X_n - d_i^+ + d_i^- = T \quad (4)$$

Risk of freight damaged:

$$f_1 X_1 + f_2 X_2 + ... + f_n X_n - d_i^+ + d_i^- = F \quad (5)$$

Risk of infrastructure:

$$r_1 X_1 + r_2 X_2 + ... + r_n X_n - d_i^+ + d_i^- = R \quad (6)$$

Risk of other factors:

$$l_1 X_1 + l_2 X_2 + ... + l_n X_n - d_i^+ + d_i^- = L \quad (7)$$

$$X_1 + X_2 + ... + X_n = l$$

$$W_i d_1^+ \ge 0; i = 1, 2, ..., m \quad (8)$$

$$X_i = 0 or 1; j = 1, 2, ..., n$$

where:
- z = deviation from the target set by the decision
- n_i = the weight of the decision criteria
- d_i^+ = deviation of each of the above target criteria
- d_i^- = deviation below the target of each criterion
- X_j = each of the decision variables path
- C_j = coefficients of X_j (the budget of the transit routes)
- t_j = coefficients of X_j (the time of transit transport routes)
- f_j = coefficients of X_j (the risk of goods)
- r_j = coefficients of X_j (the infrastructure of the transit routes)
- l_j = coefficients of X_j (other risks)
- C = the percentage of the difference between the budget and the cost of the lowest
- T = the percentage of time each transport route to the designated decision maker
- F = percent of the variance of the risk of the goods in transit as low as possible
- R = percent of the variance of the risk infrastructure and equipment, facilitating of the transit at the lowest
- L = percent of the other risks

The goal equation (Equation 2) and equation restrictions (3) to (7) found the limitations of the size difference. Then,

this research creates the conversion ratio for all targets ZOGP.

IV. RESULTS

The decision support system by optimization and dynamic analysis for consumer goods transportation routing between Bangkok and Mukdahan province in Thailand is developed and tested by 50 users. Some pages of this system are shown in Figure 3 to 5.
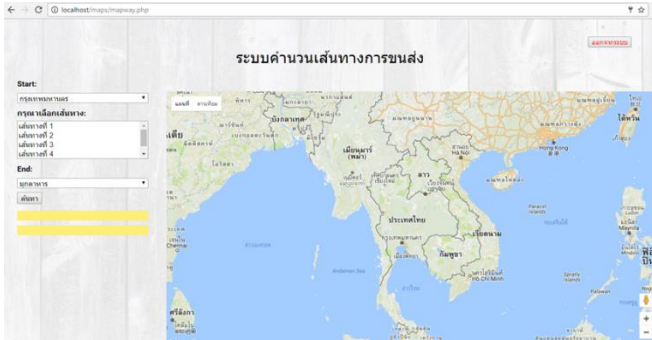

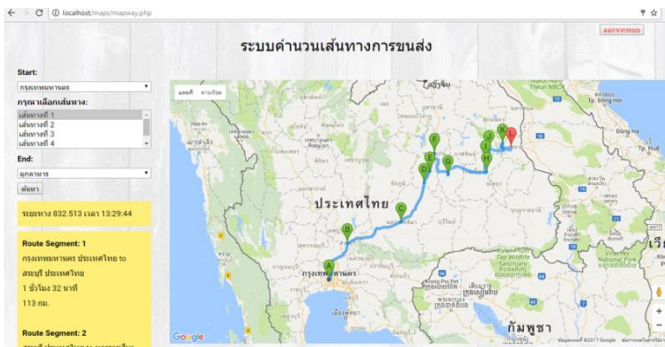Figure 3: To select and calculate route paths

Figure 4: Example of selecting a route path by the system
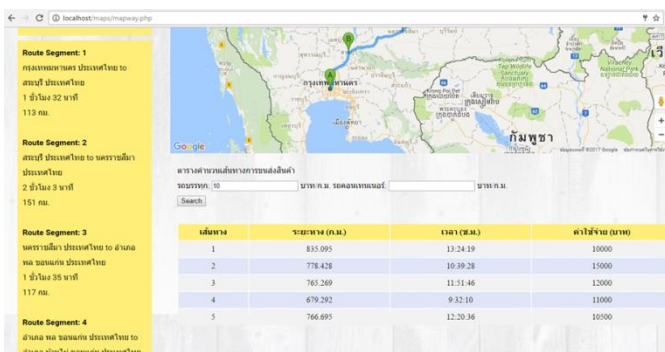

Figure 5: Calculating the cost of transportation in each route paths

Figure 3 presents the input the start point and the stop point screen. The system calculates and finds points that the truck or container is passing. If the system finds the best route path then the system shows the data and picture. It is shown in figure 4. However, the system can support limitations. Figure 5 presents the example of the cost limitation. The route paths are calculated in each path, which is limited by cost limitation. Lastly, the system shows the cost of transportation in each path. The advantage of this section is to help users in selecting the best route path.

The satisfaction survey of 50 customers is prepared in this research. The tool of satisfaction survey is questionnaire.

Features of the respondents are shown in Table 1, and Table 2 presents the average customer satisfaction.

Table 2 presents the average satisfaction of 50 customers. The highest satisfaction rating is at 5 points and the average satisfaction for this survey is 4.67 points. Then the satisfaction rating is at the highest level. In addition, the topic that gives the highest rating is the application that contains information to educate and interest, with 4.94 points . 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.

Table 1
Feature of the 50 respondents

Features		Number
Sex	Male	23
	Female	27
Education	High school	10
	Bachelor	23
	Ascended Master	17
The duration of customer (year)	1-3	7
	4-6	15
	7-10	22
	More than 10 years	6

Table 2
The average customer satisfaction

Title	Average
1. The assessment of design input	
1.1 Design of data import is easier to use, not complicated	4.68
1.2 The design of the data import is accurate.	4.62
1.3 The design of the import data is not consistent behavior change.	4.88
1.4 The form of letters, and characters that is easy to read.	4.20
The total average	**4.60**
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.	4.69
2.2 Speed data access is on the appropriate level.	4.57
2.3 This system designed to reduce duplication of data import.	4.92
2.4 Each page of this application can present quickly.	4.66
2.5 The system is designed with redundancy process to work less.	4.55
The total average	**4.68**
3. The assessment of design results	
3.1 The application has to format the partition of the screen to the right.	4.88
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.	4.39
3.4 The application contains information to educate and interest.	4.94
3.5 The application offers a convenient and fast.	4.67
The total average	**4.75**
The total average net	**4.67**

V. CONCLUSION

The development of the decision support system by optimization and dynamic analysis for consumer goods transportation routing between Bangkok and Mukdahan province in Thailand is developed in this research. This system can calculate and analyze transport routes for customers. The most appropriate transport routes and vehicles are introduced to customers after determined by this system. This system can give the best route path for transportation by optimization technique. In addition, the

optimization technique uses the statistical principles, such as Zero-one goal programming (ZOGP) and risk analysis. This system is tested by 50 customers from a shipping company from Bangkok, Thailand. The results present that the system offers transportation for customers, and reduces time and errors in finding the transportation routing from staff. This research surveys satisfaction of 50 customers by the questionnaire. This survey finds the average of satisfaction score is 4.67.

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