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# Geographical Information Systems Approach for Transportation Planning Management

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**Abstract**
This paper presents the implementation of Geographical Information Systems (GIS) concept in transportation planning. The purpose of this study is to describe alternative strategies for planning support system of the traveling salesman problems. In case study of lubricant oil sector, the use of GIS tools and techniques is to determine the shortest paths between points and set the path of multiple points in the optimum sequence with vehicle reschedule in Khonkhan Province, Thailand. The outcome from this study is to demonstrate that vehicle routing planning has a maximum benefit considering as a cost-effectiveness of fuel consumption reduction about 4.9% per month.
**Keywords:** GIS, transportation planning, lubricant oil, Khonkhan Province, Thailand

## 1. Introduction

Geographic information systems (GIS) are widely used in transportation planning, especially to reduce traffic impacts. The role of GIS in regional transportation planning is evaluated, including data integration issues, the configuration of transportation networks for use with GIS, and the linkage of transportation models to GIS.

Transportation Location Analyses in term of Vehicle Routing Problems (VRPs) seems like a relatively simple problem, especially with the use of computer technology. In general, a VRP consists of a set of customers that must be served via a fleet of vehicles, each of which leaves from and returns to a central depot. The type of VRP determines whether customers have goods delivered to them, are transported from one location to another, or are served in some other way. The classic routing problem (Travel Salesman Problem) minimizes the distance visiting customers tied to several restrictions (satisfy all customers' requirements, vehicle capacity cannot be exceeded, all routes start and end at the central site, etc).

All routing software products have the same basic capability to sequence stops on a route, and most are capable of assigning stops to routes and to terminal facilities. Most vendors claim that their routing software uses actual street distances, but some approximation of street distances can reduce computation time and thereby create routes more quickly. However, the use of GIS for optimization in transportation planning was applied in dealing with the development of a decision support system for transportation with the number of routing locations. Moreover, almost logistics software applications using GIS that describe the logistics tools, explore the problem of routing, comparing the features and limitations .

The main objective of this study is to do GIS-based Planning Support System for routing decisions and send out revised routing schedules to field vehicles of the lubricant oil sector in Khonkhan Province, Thailand.

## 2. Routing problem description

Currently, this company in Khonkhan Province has only one distribution center that the distribution area is 7,375.8 $km^2$ as shown in Figure 1.

 

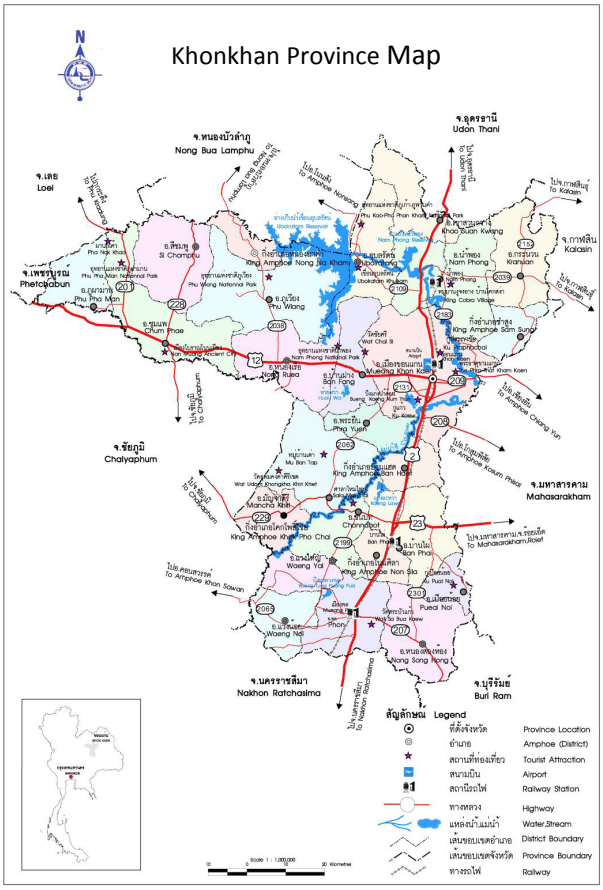


Figure 1: Study area in Khonkhan Province, Thailand

There are only 3 staffs to do lubricant oil distribution to 80 shops every week. The driving route based on the salesman experience. No one has yet found the most efficient route. Consequence, the most expense is the fuel consumption. This is because of the lack of routing planning.

### 3. Transportation plans and data

The first ideas were oriented to investigate all details of the logistics involved and the main functionalities the application should deliver. The following transportation related information, including plans and data, is managed by the salesman. Although not all inclusive of available information, the researchers are working to deliver as much information as possible during October-December, 2010 and January, 2011. The salesman provided the reports about cost of fuel consumption as shown sample in table 1, number of stops as shown as an example in table 2, hours and miles driven, profitability per stop or route, wait time and late time, and deviation from projections or averages.

Table 1: Example of Fuel consumption from salesman C during Oct.-Dec., 2010

| | Oct. | Nov. | Dec. | average |
|---|---|---|---|---|
| Fuel consumption (baht) | 5,900 | 5,600 | 5,700 | 5,733.3 |

From table 1, the average fuel consumption is about 5,733.3 baht per month per salesman C.

Table 2: Vehicle routing from experience of salesman C during Jan. 3-13, 2011

| Date | Location | Number of stops |
|---|---|---|
| Jan. 3, 2011 | Ban Phai district | 13 |
| Jan. 4, 2011 | Ban Phai, Wang Noy, Chonnabon district | 14 |
| Jan. 5, 2011 | Phiey Noy, Nongsonghong, Phon district | 13 |
| Jan. 6, 2011 | Wang Yai, Phon district | 14 |
| Jan. 10, 2011 | Khao Suan kwang, Numpong, Kranun district | 15 |
| Jan. 11, 2011 | Khok Pho Chai, Monjakiri, Phra Yung district | 14 |
| Jan. 12, 2011 | Ban Phai district | 13 |
| Jan. 13, 2011 | Ban Phai, Wang Noy, Chonnabon district | 14 |

 

The average shops for salesman C are 14 shops per day as shown in table 2. The salesman C reports the total distance during Jan. 3-13, 2010 that is 44,264.0 meters.

## 4. Transportation mapping

There are more than 80 shops in Khonkhan Province as shown in Figure 2.

From Figure 2, the boundary of Khonkhan Province is covered by green color and the blue dots are represented as the shops.

Transportation mapping using ArcGIS as a tool is to determine the routes must be designed in such a way that each point is visited only once by exactly one vehicle. All routes start and end at the depot, and the total demands of all points on one particular route cannot exceed the capacity of the vehicle.

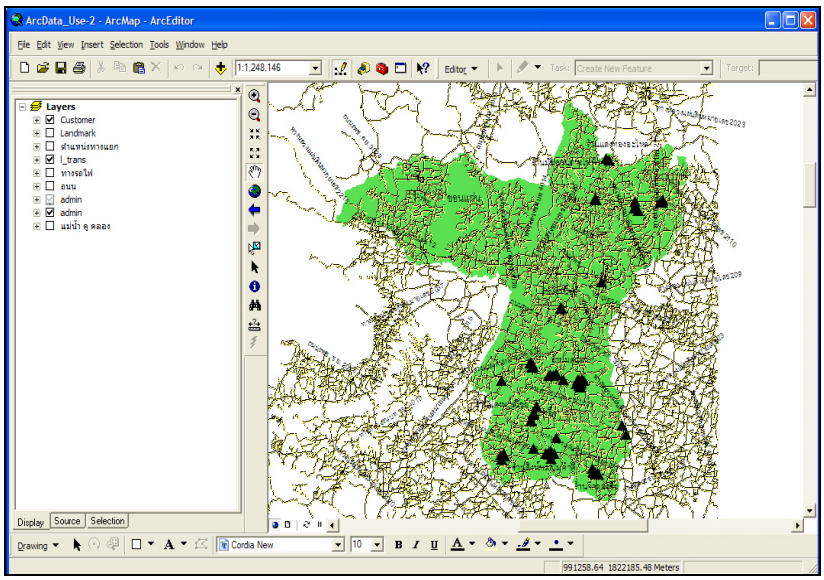


Figure 2: Eighty shops in Khonkhan Province, Thailand

From Figure 2, to get the distance information from transportation mapping, the vehicle routing is changed as shown in Table 3.

Table 3: Vehicle routing from GIS of salesman C during Jan. 17-27, 2011

| Date | Location | Number of stops |
|---|---|---|
| Jan. 17, 2007 | Ban Phai district | 13 |
| Jan. 18, 2007 | Wang Yai, Phon district | 14 |
| Jan. 19, 2007 | Khao Suan kwang, Numpong, Kranun district | 15 |
| Jan. 20, 2007 | Khok Pho Chai, Monjakiri, Phra Yung district | 14 |
| Jan. 24, 2007 | Ban Phai district | 13 |
| Jan. 25, 2007 | Ban Phai, Wang Noy, Chonnabon district | 14 |
| Jan. 26, 2007 | Phiey Noy, Nongsonghong, Phon district | 13 |
| Jan. 27, 2007 | Wang Yai, Phon district | 14 |

From table 3, the average shops for salesman C still the same as previous one that are 14 shops per day. The shortest paths between points and set the path of multiple points in the optimum sequence, the salesman did this route during Jan. 17-27, 2011 that save time about 45 minutes per day. Moreover, the total distance is 42,786.0 meters that less than the previous route 1,478.0 meters as shown in Figure 3.

From Figure 3, the green line is the salesman distance that equal to 44,264.0 meters. The planned route contains information concerning all the relevant logistic parameters of the transport process. The red line is to determine the shortest paths between points using GIS as a tool and set the path of multiple points in the optimum sequence. The distance of red line is 42,786.0 meters that less than the previous one 1,478.0 meters.

 

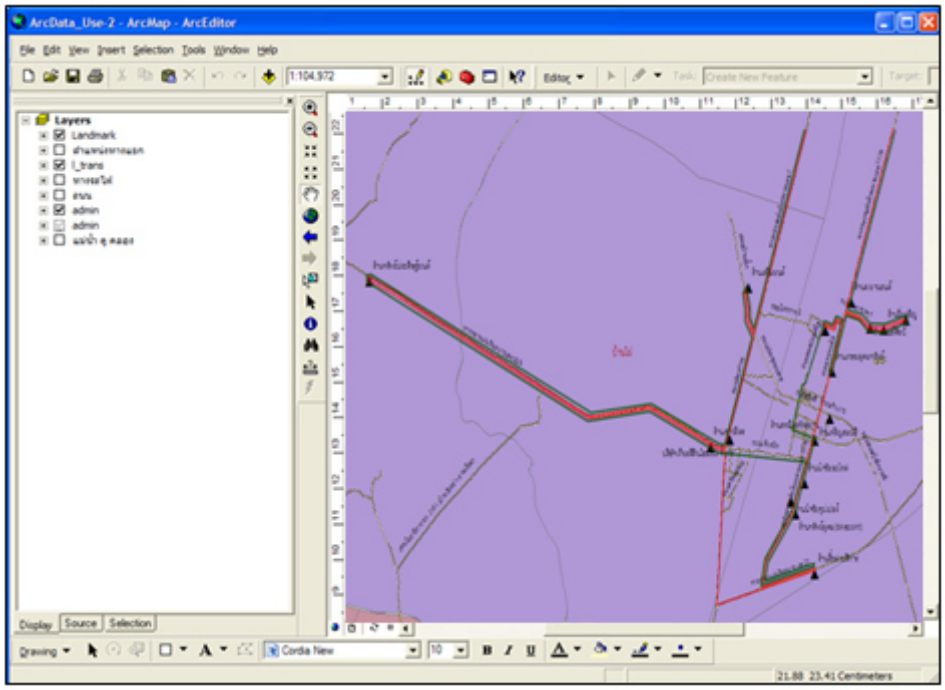

Figure 3: The paths of multiple points in the optimum sequence

## 5. Conclusion and recommendation

In this manner the planning process is significantly faster and the quality of the transport rises to a much higher level. The results of transport routes planning are optimal, within the constraints and routing parameters. Whereas, vehicle routing planning has a maximum benefit considering as a cost-effectiveness of fuel consumption reduction is about 4.9% per month.

Two key functionalities - the strategic level of planning: simulations of different transport scenarios and delivery profitability analysis. Geographic Information Systems (GIS) have been in use for presentation, analysis, distribution and the store of spatial data all making for easier and more efficient supported solutions for transport and logistics. In this study, to get distance information of sufficient quality, the most detailed street network commercially available for the considered province should be used.

Today a number of GIS applications for transport and logistics exist - and the number is rising. GIS has been use daily and worldwide for the efficient connection, harmonization and management of all transport processes in an ever rising number of companies. Solutions, such as intelligent routing plan, satellite fleet management, distribution area planning and management of infrastructure resources. However, unfortunately static distance information from a digital road network does not correlate directly with real travel times because of dynamic influences like traffic jams, road works and weather conditions. Travel times also depend on parameters such as driving style and vehicle type, which are particularly hard to quantify.

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