APPLICATION OF GIS FOR ANALYSIS CURRENT WASTE COLLECTION ROUTES AND FIND POTENTIALITY ROUTES OF THAPHO SUB-DISTRICT, MUEANG PHITSANULOK DISTRICT, PHITSANULOK PROVINCE

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ABSTRACT

At present, Thapho sub-district has rapidly grown because of the increase of urbanization, especially, around the university that causes expansion of business and service sector in this area. The growth of these sectors produces excessive garbage that becomes more crucial problem in the area. It found that the route planning of waste collection and logistic is not efficient. This research aims to evaluate the current waste collection routes and to propose the efficient waste collection routes in Thapho sub-district, Phitsanulok, Thailand. The data used in this study was road network, the points of garbage bin location, numbers of garbage bin, types of garbage bin, and current waste collection routes and schedule. This study found that there are 20 routes of current waste collection routes that cover 673 kilometers with some overlap routes. Total traveling time of the waste collection vehicles is about 83 hours. This study applied a GIS network analysis function called Vehicle Routing Problem (VRP) to construct waste collection routes with three different scenarios: Scenario 1, this model cannot reduce the number of routes and the routes have increased 100% (Full bin). Scenario 2, this model can reduce routes of garbage collection 5% (Half bin). And scenario 3 can recrease routes of garbage collection 10% (Average). All the three scenarios can reduce the collection distance approximately 11%, 46%, and 45%, respectively. The time of waste collection can also be reduced by 12%, 25%, and 25%, respectively. Thus, the results of this study can be used to optimize the efficient waste collection route planning for Thapho sub-district.

Keywords: *vehicle routing problem, geographic information system, waste collection route*

1. INTRODUCTION

Nowadays, Thailand has rapidly increased amount of waste and become important problem. In year 2015, the amount of waste is approximately 26.85 million tons or 93,560 tons per day, which is higher than year 2014 approximately0.89 percent. (Pollution Control Department, 2558). The increasing of solid waste causes great impacts on organisms and environment. According to the statistics, the quantity of waste in 2015 in Thailand has increased and without systematic waste management has been operated. In 2015, only 8.34 million tons of waste was disposed properly in the land field, whereas, 7.15 million tons of waste was disposed improperly and the amount of 6.22 million tons of waste was left over in the environment. Business and service sectors in Thapho sub-district have being expanded. This causes increasing more and more daily garbage. Thapho sub-district Administrative Organization is responsible for collecting and deliver garbage to the dump site. Increasing of solid waste consequently affects to the delay of garbage collection which affects directly to the operation cost. As inspected in years 2011 to 2015, the operation cost for garbage collection increased up to58.11percent.

For this reason, the researchers attempted to evaluate and analyze the efficiency of garbage collection using network analysis in GIS.This study aims to increase the efficiency of waste collection routes in Thapho sub-district, Phitsanulok, Thailand. The vehicle routing problem in network analysis was used to find optimal routes for travelling to collect the garbage in order to reduce travel distance and operation time.

2. STUDY AREA

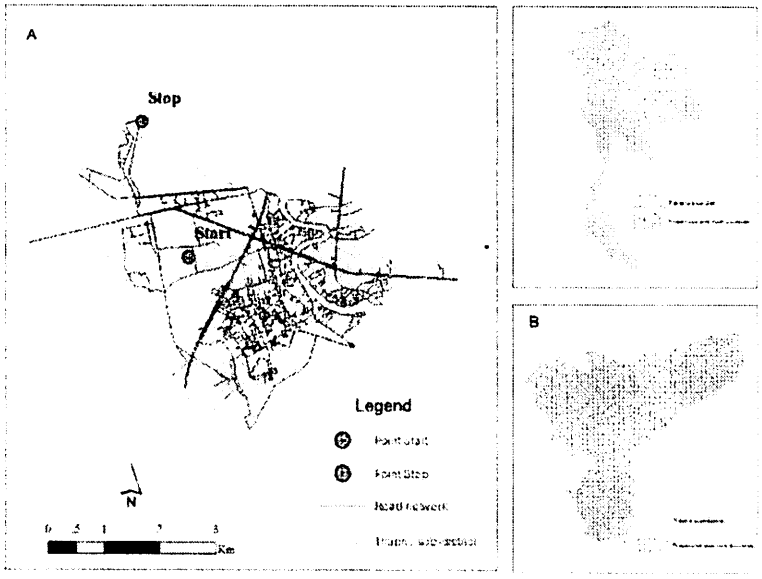

Figure. 1. Study area (A) Thapho sub-district. (B) Phitsanulok province boundary.

Thapho sub-district, Muang Phitsanulok, Phitsanulok, Thailand has total area approximately50.7 square kilometerswith 11villages and total population of 22,733 and 8,826 households. The major roads in this area including:

Road 1. Highway 117 (Phitsanulok - Nakhon Sawan).
Road 2. Highway 1065 (Phitsanulok - Bang Rakam).
Road 3. Phitsanulok - Kamphaeng Din.
Road 4. Highway 1063 (Phitsanulok - Bang Krathum).
Road 5. Highway 12 (Uttaradit - Uttaradit).

3. OBJECTIVES

1. To evaluate the current waste collection routes.
2. To propose efficient waste collection routes in the study area using Vehicle Routing Problem (VRP).

4. DATA AND METHOD

4.1 Data

- Garbage points

Thapho sub-district Administrative Organization has serviced garbage trashes to the community in public space. There are 2,726 garbage bins in 1,365 positions distributed in 11 villages in the study area.

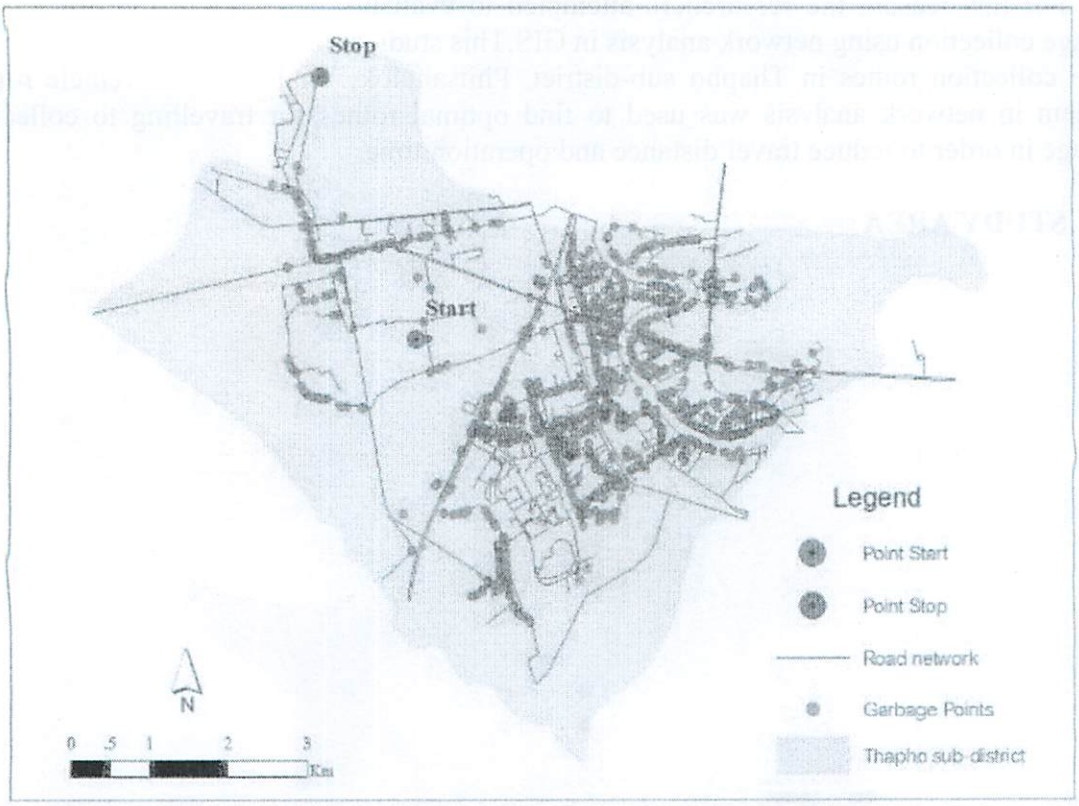

Figure.2. Map of garbage bin locations

- Current waste collection routes.

Currently, there are 20 waste collection routes which are operated by 4 trucks as shown in Table 1 below.

***Table 1. Routes* of a current waste collection 20 route to consist of 4 Cars.**

	1. Truck ID 81-0607	2. Truck ID 82-5426	3. Truck ID 82-3634	4. Truck ID 81-7207
Monday	Route1	Route7	Route11	Route17
Tuesday	Route2	Route8	Route12	Route18
Wednesday	Route3	Route9	Route13	Route19
Thursday	Route4	Route7	Route14	Route17
Friday	Route5	Route8	Route15	Route18
Saturday	Route6	Route10	No service	No service
Sunday	No service	No service	Route16	Route 20

4.2 Methodology

The concept of network analysis for efficient travel route can be used in many types of *research, such as* public health and tourism. Figure 2 represents the conceptual framework of this study. The data used in this study were including road network, points of garbage bin, numbers of garbage bin, types of garbage bin, and current waste collection routes and their schedules. The vehicle routing problem (VRP), a function in network analysis, was used to analyze the data to find the optimal routes for collecting waste. The result from VRP analysis was compared with the current waste collection routes to evaluate the efficiency.

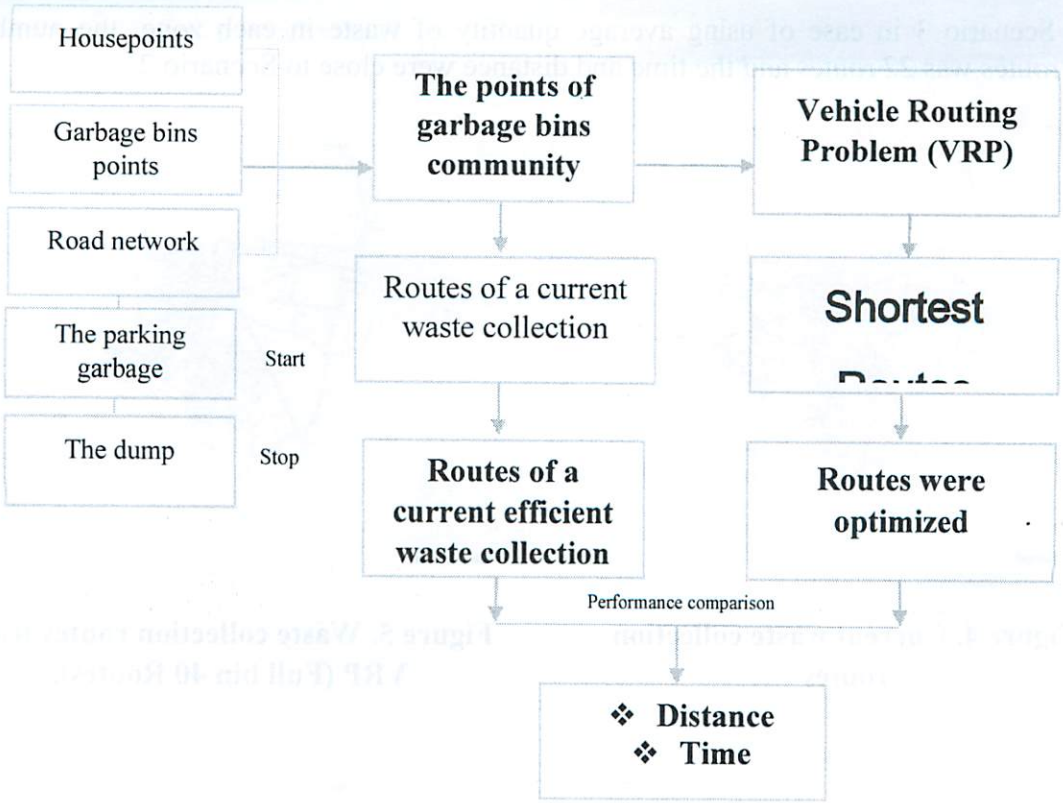

Figure 3. Conceptual framework

5. RESULTS

This study found that there are 20 routes of current waste collection routes that cover 673 kilometers with some overlap routes. Total traveling time of the waste collection vehicles is about 83 hours.

Table 2. Routes of a current waste collection and Routes waste collection calculated from the program.

data	Current waste collection routes	Waste collection routes from VRP			Percent change		
		Full bin	Half bin	Average	Full bin	Half bin	Average
Number of Route	20	40	21	22	+100%	+5%	+10%
Time/Hour	85	75	64	64	-12%	-25%	-25%
Kilometers	673	600	362	372	-11%	-46%	-45%

Table 2 shows that currently there are 20 routes of waste collection. This study simulated garbage collection routes using three different scenarios:

- Scenario 1 in case of all trashes are fully filled, the number of routes became increasing from 20 to 40 routes but covered only 600 kilometers. However, the operation time was reduced about 12%

- Scenario 2 in case of all trashes are only half filled, the number of routes generated was close to the current routes but it reduced operation time almost 50%.

- Scenario 3 in case of using average quantity of waste in each zone, the number of routes was 22 routes and the time and distance were close to Scenario 2.

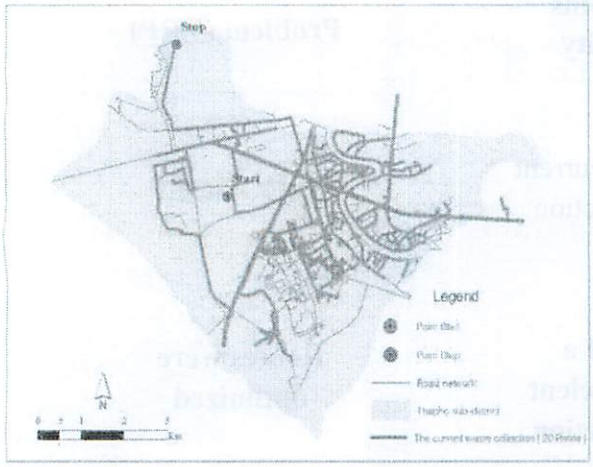

***Figure 4. Current* waste collection routes**

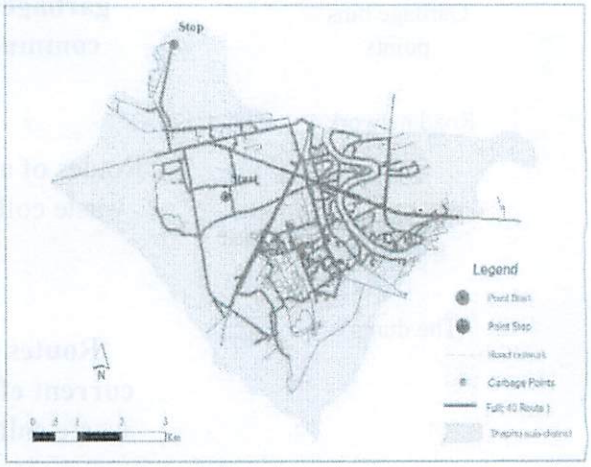

Figure 5. Waste collection routes from VRP (Full bin 40 Routes).

Figure 6. Waste collection routesfrom VRP(Half bin 21 Routes).

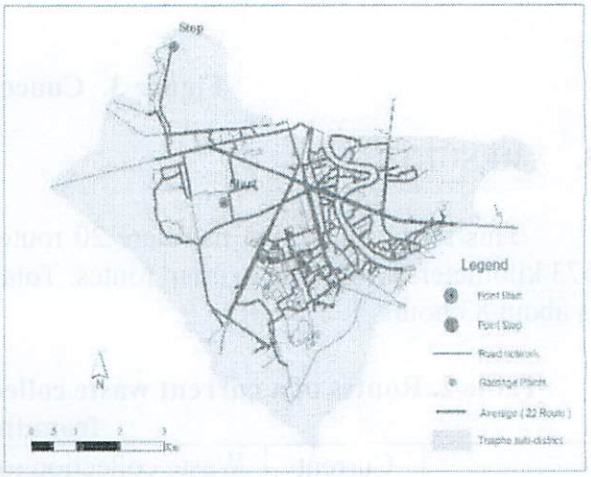

Figure 7. Waste collection routes from VRP. (Average bin 21 Routes).

Figure 4 shows the current 20 garbage collection routes. Figure 5, Figure 6, and Figure 7 show waste collection routes that were calculated from the network analysis. This study applied a GIS network analysis function called Vehicle Routing Problem (VRP) to construct waste collection routes with three different scenarios: quantity of garbage bin scenarios. The results showed that all three scenarios can reduce distance approximately 11%, 46%, and 45%, respectively. And the time of waste collection can be reduced by 12%, 25%, and 25%, respectively. Thus, the results of this study can be used to optimize the efficient waste collection route planning for Thapho sub-district.

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ESTABLISHING AND EXPLOITING THE GIS DATABASE FOR THE MANAGEMENT OF URBAN WATER DRAINAGE INFRASTRUCTURE

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ABSTRACT

Flooding state often occurs in rainy season or high tide in urban areas in Vietnam recently, impeding daily life activities of the society, causing damages to people and property in flooded areas. Ho Chi Minh City is a leading economic city in the country. However the city frequently faces up with severe floods when rain storms or high tides happen. Therefore, in order to address the problem of flooding in the process of urban development today, the paper has studied the design of the framework database for the management of urban drainage infrastructure, including basic geographic data layers and thematic data layers. Based on the designed framework database, experiments were conducted for the database for District 1 of Ho Chi Minh City. From the results of the experiments, the paper explores how data mining which involves the exploitation of attribute data and spatial data mining; then, calculates, extracts and edits maps in service of drainage network infrastructure management. From the results of data mining, solutions and recommendations are drawn to improve the quality of management of drainage infrastructure in District 1, Ho Chi Minh city.

Keywords: *Drainage network infrastructure, urban, Database, Data mining.*

1. INTRODUCTION

Urbanization is essential trend in all countries. Along with the economic development, a lot of problems incurred in urban areas, especially infrastructure development did not catch up urbanization process. In urban areas, especially in special urban area such as Ho Chi Minh City, infrastructure of drainage network can not satisfy drainage requirements so water-logged phenomena usually happens, causes the much damage to property, prevent the social activities and can even endanger to the lives of people.

In order to resolve the water-logged problem in the urban development process, the establishment of GIS database about infrastructure of drainage system is extremely necessary, it helps to analyze the technical conflicting of sewer system, then overcome, evaluate the causes, propose the solutions to reduce floods; study on planning the drainage system in the future; assessment the quality of construction, defects of sewer system, the state of encroachment on canals and at the same time actively repair, replace the old degraded sewers, build the optimal operation process.

The current short comings in Ho Chi Minh city is that the drainage system on the same basin is managed by too many offices such as Department of Transportation, Flood Protection Center, District People's Committee and Urban Water Supply One Member Limited Liability Company... therefore scope of management of the offices overlaps thus storage database is dispersed, asynchronous and there is no coordination between