GEOGRAPHIC INFORMATION SYSTEM BASED PROTOTYPE FOR TOURIST PLANNING APPLICATION : CASE STUDY IN BANGKOK PROVINCE

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ABSTRACT

Bangkok is a city of attraction in Thailand. However, the complexity of the routes in the area may cause a loss of time in travelling around the city.

This work studied and developed a prototype of a tourist planning application in the area of Bangkok province by using Geographic Information System (GIS) technology. The purpose of this work was to develop a program that could help tourists make appropriate travel plans within a limited time. Tourists can use this program to make their own plans by themselves. Network analysis was used to find the shortest route or the route requiring the least amount of time. The results display in the form of a route map with details to travel by car. This prototype was developed by using ArcGIS Engine with VB.Net used as a desktop program.

KEYWORDS: GEOGRAPHIC INFORMATION SYSTEM / GIS / ARCGIS / TOURIST PLANNING / NETWORK ANALYSIS

53 pages

ต้นแบบโปรแกรมระบบสารสนเทศทางภูมิศาสตร์ สำหรับวางแผนการท่องเที่ยวในพื้นที่จังหวัดกรุงเทพมหานคร

GEOGRAPHIC INFORMATION SYSTEM BASED PROTOTYPE FOR TOURIST PLANNING APPLICATION : CASE STUDY IN BANGKOK PROVINCE

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บทคัดย่อ

จังหวัดกรุงเทพเป็นเมืองท่องเที่ยวที่น่าสนใจเมืองหนึ่งของประเทศไทย แต่ด้วยความซับซ้อนของเส้นทางในพื้นที่ อาจทำให้นักท่องเที่ยวเกิดการสูญเสียเวลาจากการหลงทาง

การศึกษาและพัฒนาโปรแกรมต้นแบบสำหรับวางแผนการท่องเที่ยวในพื้นที่จังหวัดกรุงเทพมหานครนี้ได้นำระบบสารสนเทศทางภูมิศาสตร์มาประยุกต์ใช้ โดยมีวัตถุประสงค์เพื่อพัฒนาโปรแกรมที่ช่วยในการจัดทำแผนการท่องเที่ยวที่เหมาะสมกับเวลาให้กับนักท่องเที่ยว เพื่อให้นักท่องเที่ยวสามารถใช้โปรแกรมจัดทำแผนการท่องเที่ยวด้วยตนเอง โดยนำการวิเคราะห์แบบโครงข่ายเข้ามาใช้ในการค้นหาเส้นทางที่มีระยะทางสั้นที่สุด หรือค้นหาเส้นทางที่ใช้ระยะเวลาน้อยที่สุด แสดงผลลัพธ์ในรูปแบบแผนที่ที่แสดงเส้นทางพร้อมกับรายละเอียดในการเดินทางด้วยรถยนต์ โปรแกรมต้นแบบถูกพัฒนาโดย ArcGIS Engine ร่วมกับ VB.NET และใช้งานโปรแกรมอยู่ในรูปแบบเดสก์ท็อป

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CHAPTER I
INTRODUCTION

1.1 Background and Statement of Problem

Nowadays, Thailand faces with economic slowdown and insecure domestic political problems. That reflect tourists lose confidence in their safety. The Number of tourists who come to pay for travel had reduced. It is not affect only tourist industry but also less massive of money in economic too. Therefore, we should accelerate the supporting and promotion of tourism within the country, to restore and recovery the revenues of tourist business in Thailand. Supporting tourism will help Thai economy back to the active business as before.

Bangkok is a city attraction of Thailand. Since Bangkok has various tourist attractions spread around the province. So that tourists do not waste much time to travel. They can travel to a wide variety of interests in the same province. It causes, each year many tourists come to visit Bangkok. As shown in Table 1.1

Table 1.1 Number of tourists at Suvarnabhumi International Airport Year 2007-2008 [1]

Tourists by nationality	**2008**	**2007**	**%Δ 2008/2007**
East Asia	4,447,703	4,792,955	-7.20
Europe	3,128,694	3,072,113	+1.84
America	761,610	778,565	-2.18
South Asia	665,146	663,889	+0.19
Oceania	563,446	550,376	+2.37
Middle East	444,909	415,303	+7.13
Africa	97,180	97,285	-0.11
Total	10,108,688	10,370,486	-2.52

Bangkok has various types of tourist attractions such as tourism for learning, park, shopping, temple, history and art culture. Tourists can choose the type of tourism as their satisfaction within a single province. Especially foreign tourists or people whose have limited time. They can travel to multiple types of tourist attractions without spending much time to travel. However, transportation routes in Bangkok are also complex. Roads within the province include many lane roads. These could be cause of difficulty for tourists who are not skillfully in area, but need to travel to various tourist destinations themselves. Besides the travelling direction foreign tourists might have problem with language barriers to use in communication. That would be the cause of unexpected tourist plans.

To develop the prototype of tourist planning application, all relate data of tourism in Bangkok collected such as information of any attractions, road, location of restaurants and hotels, etc. Users can choose their interested destinations and create the appropriate tourist plans (with limited travel time) base on their demands. The results displayed in the form of tourist plans, that having information of distance and time to travel, and display the appropriate routes along with information user defined. From tourist plans, tourists can travel with their own plans, within the appropriate routes and within the limited time to tourist attractions in Bangkok province.

Geographic Information System (GIS) is used in developing a prototype of this application. This Application will generate the useful information base on conditions users defined. From tourist plans, users can make their own plans and travel by themselves within the appropriate time. Even they are not known those areas previously before. The results will be shown in the form of maps, showing the path of travel to tourist attractions in Bangkok province. And tourists can print their tourist plans.

1.2 Objective

The objectives of this work are as following;

1.2.1 To analyze and design prototype of tourist planning application to facilitate tourists in providing appropriate travel plans base on tourist requirements.

1.2.2 To provide information of tourist attractions in Bangkok province.

1.3 Scope of study

1.3.1 Any tourists can create and display their travel plans by using prototype of this application.

1.3.2 GIS is used to store map data and set the coordinates of tourist attractions and other locations in Bangkok province.

1.3.3 To display travel plan's result, network analysis is used to calculate and generate appropriate travel plan base on tourist's requirements.

CHAPTER II
LITERATURE REVIEW

2.1 Type of domestic tourism [2]

Travel in the country is classified into 2 groups as domestic tourism and inbound tourism. The domestic tourists can choose the appropriate type of travel base on their need and satisfaction. The patterns of travel in the country are divided into 2 types.

2.1.1 Travel group

Travel group is a form of tourism that tourists purchase package from travel agency. In this type of tourism, tour companies will be responsible for accommodation, food and travel route plans to all tourists. Thus travel group is fitting for tourists who unfamiliar with the area of located tourist attractions or the tourists who travel to the places at the first time.

Advantages of Travel group

- **Having companion** Travel group will be travel together as a group. So tourists can make known each others. That cause of security and comfort for tourists.
- **Agility** Tour guide will manage and guide all tour plans to tourists. The travel agency is a specialist. And having an advance plan prepared. That mean tourists do not waste much times in learning and searching any information. And Tourists do not solve any problems that arise during the trip.
- **Communications** In the case of foreign tourists, there will be problems with different languages and cultures. A travel group will solve this problem.

Disadvantages of Travel group

- **Lack of privacy** In travel group, tourists can not choose tourist attractions by their own. Travel plans are subject to the company's tour schedule such as list of attractions, order of attractions and time to use in each attraction.

2.1.2 Independent Travel

Independent travel is a type of tourism that tourists travel with their own plans. The tourists will have to learn and search all of information by themselves such as detail of attractions, travel routes and booking accommodates. From this, if tourists are not familiar with the area of attractions, it will cause difficulties. Especially foreign tourists whose have limited time. Lacking or insufficient information may cause of delays in travel and make travel plan not be as planed.

Advantages of Independent Travel

- **Having privacy** Because travel plans are directly depended on tourists needs. Tourists do not follow the schedule of any tour. They will create their own plans. That means tourists can make a break at any attractions or they can visit and learn each place in detail. Independent travel is actually based on the needs of tourists.
- **Quality of tourism** As travel group, the majority of plans take tourists visit a number of tourist attractions. But not take much time to learn each place in detail. Tourists will not know much just superficial. Other point is tourists cannot choose attractions to visit by themselves. Because travel agency already plan all of tourist attractions to visit. Different from independent travel, tourists can make their own plans. So that tourists can visit any attractions as long as they need.

Disadvantages of Independent Travel

- **Worthlessness time** Because tourists have no expertise in the path. They require more time to travel. This all waste their time and may be cause of unexpected scheduled plans.

2.2 Geographic Information System (GIS)

GIS refers to computer systems for data management which comprise many steps as gathering data, storage, analyst, display the result and evaluation of complex information needs of users. All of these steps are based on geography relationships.

GIS data is in layer format which divided by characteristics of each data type as road, water, etc. Each layer can be overlapping to process and analyze base on user demand. [3]

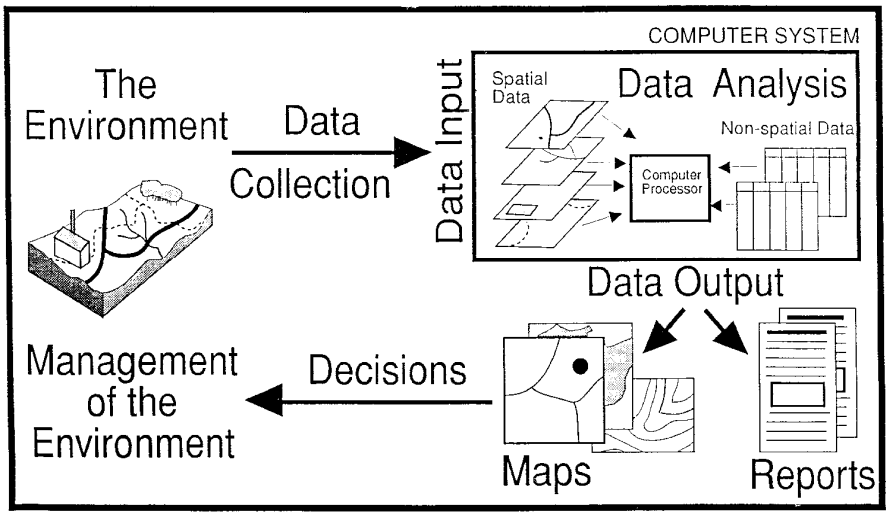

Figure 2.1 Functionality of geographic information system [4]

Information in GIS is divided into 2 types.

2.2.1 Spatial Characteristics Information

Spatial data characteristics presented in point line and closed area forms. For examples: Point displays the location of tourist attractions, restaurants and hotels,

Line displays path of transport, Closed area or Polygon shows the boundaries of Bangkok province, etc. All these spatial information may be stored in vector or raster.

2.2.2 Attribute Characteristics Information

Attribute information is used for data characterizing identity. It is stored only non-spatial data entities and form the database called geodatabase. Attribute information can present in number format, symbols or letters. For examples, name of the street, length of the road, number of traffic lanes, vehicle speed, etc.

Using GIS to create travel plans will help tourists who want to travel by their own plans and have limited time. Especially foreigners who are not intimate with travel route and may be have some problems with the different of cultural and language barrier. With this tourist plan by map application, tourists can travel to the attractions they want. The program will display the route of tourist plans in a sequence of visit attractions, time in travel and distance of travel routes. Concept of this application is to make a suitable tourist plan that meets the need of tourists. This plan supports the tourists to travel with their own plan and travel with the most efficient usage of time.

2.3 ArcGIS Desktop

ArcGIS Desktop is a program of information systems that effective in create, display and analyst spatial data. ArcGIS Desktop has many functions that can support the work of users. Users can easily use ArcGIS Desktop because it is a license product that produced by ESRI and developed in supporting format of user usage.

This program vary run according to the level of use. Some commands can be set to retrieve only at some level of use so that users should choose the suitable level of use for their works. ArcGIS Desktop is divided into 3 levels of use as ArcView, ArcEditor and ArcInfo as shown in figure 2.2. Each level of this program will consist of 3 sub-programs as ArcCatalog, ArcMap and ArcToolbox.

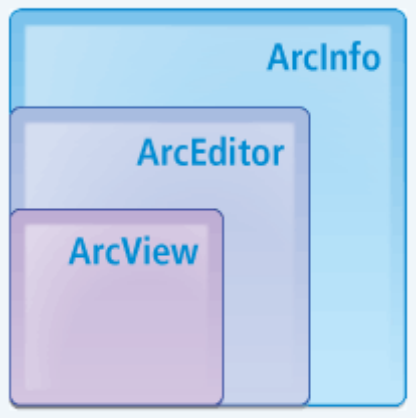

Figure 2.2 Level of use of the ArcGIS Desktop [5]

ArcGIS Desktop has many extensions that support users to run the analysis in various forms [6] for example,

- ArcGIS 3D Analyst
- ArcGIS Spatial Analyst
- ArcGIS Network Analyst
- ArcGIS Publisher
- ArcGIS Geostatistical Analyst
- ArcScan for ArcGIS
- ArcGIS Tracking Analyst
- Maplex for ArcGIS
- ArcGIS Survey Analyst

2.4 ArcGIS Network Analysis

ArcGIS Network Analysis is the extension of ArcGIS Desktop program used to analyze spatial data in network dataset format. ArcGIS Network use to solve the problems of transportation routes. By defining details of routes and locations into the database as data for analysis and use these data to analyze and create the appropriate route for tourist plans. [7-9]

2.5 Types of Network Analysis

In Network Analysis, users can solve wide variety of network problems base on their need of use. [7-9]

2.5.1 Finding the best route

Users can define any started point by defining a started point to a point or multiple points for finding the appropriate route. Users can set the priority of interested places. And then system will analyst and show the appropriate route sequence by order. The appropriate route maybe cost of shortest path or minimal time usage.

2.5.2 Finding the closet facility

To find facilities that stand nearest the interest point or area. For example, Search tourist information points that stand near the tourist accommodations etc.

2.5.3 Finding service areas

An analysis of the distribution of service areas that how is it coverage. Beginning with setting the interested area and then enter the conditions. System will search and match the results that meet the conditions.

2.5.4 Creating an Origin-Destination (OD) cost matrix

It is a matrix that shows the cost of travel from the beginning points to any multiple points in a sequence of travel.

2.6 ArcGIS Engine

ArcGIS Engine is a program for developers to develop an application. It consists of instruction set of GIS such as user interface and tools for developing applications based on the needs of users. ArcGIS Engine support multiple languages for development such as .NET, Java, C + +, etc.

Component of ArcGIS Engine

- **Controls** are user interface in ArcGIS Engine. It includes page layout, map, reader, table of contents and toolbars. All of this been run in development of applications.
- **Toolbars and Tools** Toolbars are set of tools in ArcGIS that use to operate with map and data. Example of tools: reader, layout, selection, map navigation and graphics.
- **Object libraries** are set of instructions for developing applications.

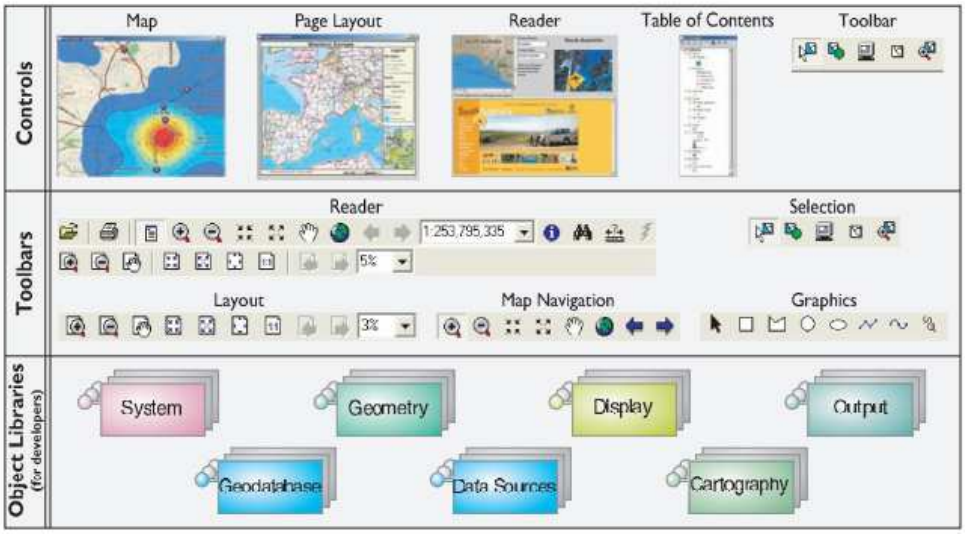

Figure 2.3 Component of ArcGIS Engine [10]

2.7 Related Research

Piyanuch Rattanakul [11] studies the application of GIS in designing the university shuttle bus routes for energy saving. Use network analysis extension of ArcGIS version 9.2 to design shuttle bus routes. Routes from this program should meet the demand of employees in the university and save energy from the other travel by vehicles. From this study can design in 23 routes and found that if employees change their behaviors from private vehicles to travel by shuttle bus of university. It can save up to 252,400 liters of oil per month as expenses 12,563.48 baht per month.

Sopit Soisodsri [12] study and develop decision support system for development of tourism at Ko Si Chang, Chonburi province. Various sources of tourist

information are gathered such as detail of attractions, local, population, administrative district, transportation of Ko Si Chang, etc. This system is designed and developed base on GIS technique by arcview3.2 with MS access program. Then develop a decision support system with MS Visual Basic program. Information displayed in map, images and text format that base on users query to the system.

Arnat Chakkaew [13] study and develop GIS base system for travel management database of Prachuap Khiri Khan Province. System developed to collect information of tourist attractions, accommodation, map, information about travel, etc. All data collected into database and developed an application by using arcview 3.1 in avenue language. This application displays all of GIS information such as map, images and other information that ranking the potential of attractions (in high, medium and low level) with weighting technique. The result used to consider developing of tourist attraction respectively to the budget and appropriate personnel use. Users can get all information need through the screen. And use information for developing plan in the future.

Wilairat Yathongchai [14] study distribution of tourist attractions in the southern of northeast province base on GIS. This work study distribution of tourist attractions, for provide a strategy to manage tourism in northeast province. From this study found that there are the most significant of historical attractions. So that it should be promote and develop tourism routes. There are also has natural, arts and culture attractions, that distribute without direction and located in a distance. If there is the proper route plan and accommodate, it would be promote the tourism.

Supadej Kaewsrichuang [15] study and develop GIS base system for supporting travel of Koh Tao. All data about travel collected such as detail of tourist attractions and important places, etc. All these spatial and attribute data are collected into database by arcview. Users can use this system to query attractions base on their conditions. The Results display in text, image and map format via web browser. Users will use this result for their decision making travel plan.

CHAPTER III
RESEARCH METHODOLOGY

3.1 Development process of tourist planning application

From problem of independence tourists who not have expertise in areas, so that they may be waste their time in losing way. That is the cause of delay travel plan. This problem is the motivation of this work to develop a supporting tourist planning application. This application will support and help tourists to guide their own plans. The development process of this application is shown in the figure 3.1 below.

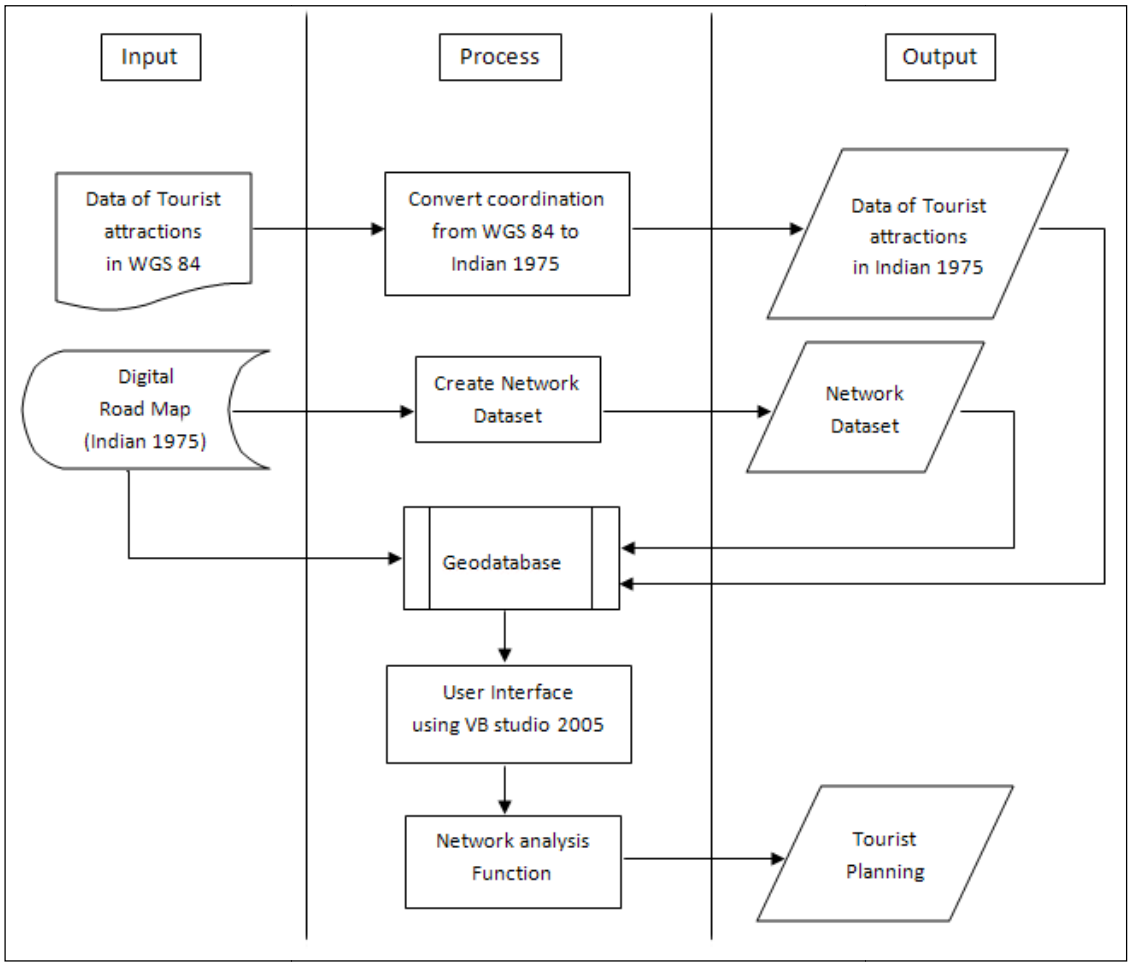

Figure 3.1 Development process of tourist planning application

From figure 3.1, Input data collected from 2 sources. First is from collection of tourist attractions in Bangkok province. Second is from digital road map of Ministry of Transport called MOT Transport FGDS (Detail of data collection is in the next heading). All collected data are stored into geodatabase. Only road data is set into network dataset for using in network analysis function. Next step is design user interface by Visual studio 2005 in .NET language. After design user interface, network analysis is used to analyze and create a travel plan base on user conditions.

3.2 Data collection

In this work all data collected in multiple layers of spatial data called shapefile. All layers are analyzed by overlay technique and displayed in ArcGIS Desktop program. Data collection in this work showed below:

3.2.1 Road, River and District of Bangkok province layers are using MOT Transport FGDS and MOT Transport Thematic Map. All layers are in shapefile format and use Indian Thai 1975 UTM Zone 47N coordination base on requirements of the Department of military maps.

3.2.2 Tourist attractions layer refer UTM WGS84 coordination from Googlemap [16], Wikipedia [17] and TAT [18]. Tourist attractions in this work include 68 attractions in Bangkok province are divided into 7 categories. Please see list name in appendix A.

3.2.3 Other places layers are in 5 layers: restaurant, hotel, hospital, police and fuel. All these layers base on MOT Transport FGDS and MOT Transport Thematic Map.

3.3 Prepared data before analysis

After collect data of locations and road, those data used as primary source to create network dataset. Network dataset used for analysis the appropriate route in network analysis. The steps of prepare data before analysis as follow:

3.3.1 Convert point coordination Input coordinate points values of tourist attractions into ArcGIS Desktop program. Then convert coordinates from UTM WGS 84 to Indian Thai 1975 47N. Save all data as shapefile layer. This shapefile used to locate stop location in network analysis.

3.3.2 Provide network data set Data prepared in the appropriate format before performing network analysis. Appropriate format means interested data is set into network dataset as steps below:

3.3.2.1 Create network dataset Network dataset is data structure created by ArcGIS Desktop Program. Create network dataset by input interested data into the program. Program will make network dataset that consist of edges, junctions and lines to use in network analysis.

3.3.2.2 Set properties of network dataset This step defines the detail of network dataset. The properties should be set like the real situation to perform the realistic result. In this work properties are set as figure 3.2

	Name	Usage	Units	Data Type
	Meters	Cost	Meters	Double
	Minutes	Cost	Minutes	Double
	Oneway	Restriction	Unknown	Boolean

Figure 3.2 Properties of network dataset

This network dataset includes 3 parameters

Meters Indicate distance of each road

Minutes Indicate time usage in each road

Oneway Indicate restrictions on road lane

CHAPTER IV
RESULTS

The data flow diagram, geodatabase, user interface and the result for network analysis of GIS based prototype for tourist planning application in Bangkok province has been designed and developed as shown below:

4.1 Data Flow Diagram

The data flow diagram of GIS based prototype for tourist planning application comprises two levels. The diagram shows how the data flow, where the data transformed and where the data stored. The figure of data flow diagram is written into two levels as shown in figure 4.1 and 4.2.

4.1.1 Context Diagram

This level represents the overall element of the GIS based application.

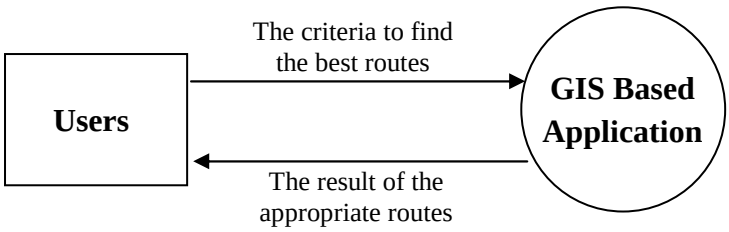

Figure 4.1 Context diagram of GIS based application

Users: input their conditions to find the best routes of travel and receive the result of the appropriate routes from GIS based application.

4.1.2 Level 0 of GIS based application

This application consists of 4 processes.

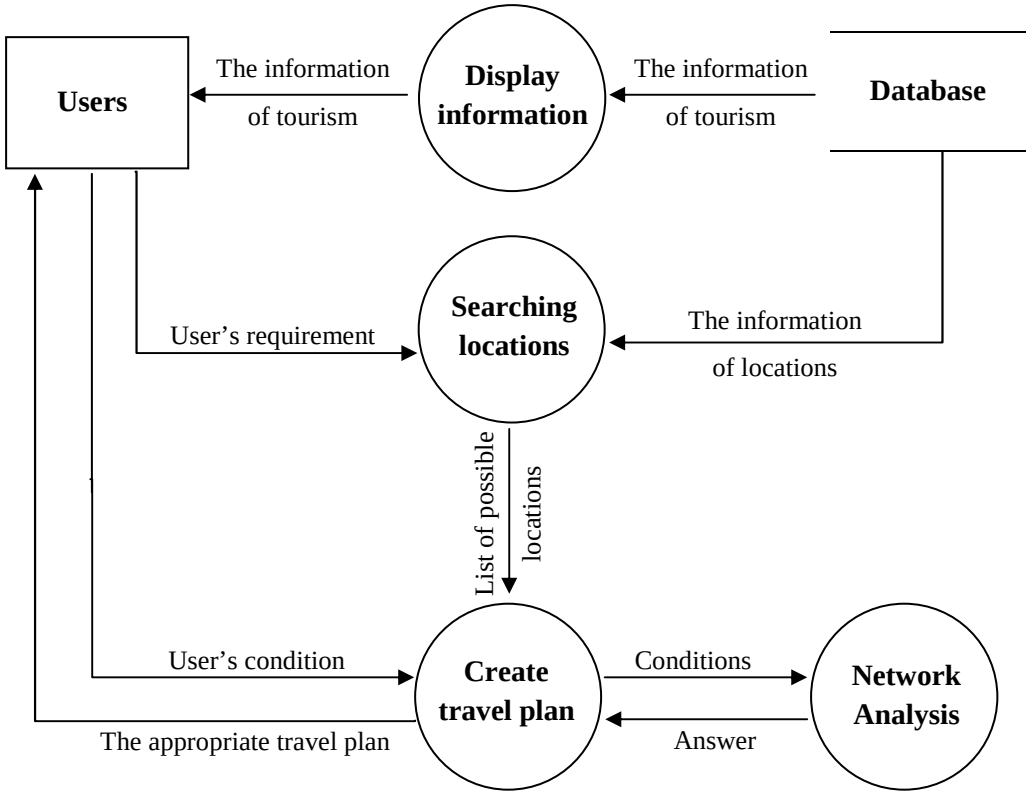

Figure 4.2 Level 0 of GIS based application

- **Display information:** This process show all information of tourism. User can get information of each location in detail**.**
- **Searching locations:** This process receive requirement from user then it find the possible locations from database and send the possible list of locations that match user's requirement.
- **Network Analysis:** This process calculate the answer and send it to the create travel plan process.
- **Create travel plan:** This process handles data from searching locations process and user's condition. It use network analysis function to analyst and create the appropriate travel plan to user.

4.2 GeoDatabase

All data in this work stored in a database called geodatabase. Geodatabase is a database that stores data in special format by making each storage data as a layer. Data in each layer will be used to display information in the map. All list name of layers in geodatabase as shown in table 4.1.

Table 4.1 Name of GIS layers in geodatabase for tourist planning application

Order	Name of layer	Detail
1	Travel Attractions	Information of tourist attractions layer
1	Restaurant	Information of restaurant layer
2	Hotel	Information of hotel layer
4	Hospital	Information of hospital layer
5	Police	Information of police layer
6	Fuel	Information of fuel layer
7	Road_bkk	Information of road in Bangkok province layer
8	Road_bkk_ND_Junctions	Information of junction of each road in Bangkok province layer
9	River	Information of river in Bangkok layer
10	Bkk	Information of Bangkok province layer

In each layer consists of details of that layer. For more information, user can see data dictionary for metadata and descriptive data of any layers at appendix C.

4.3 User Interface

User interface is screen that users can use to run application. For this application users can use user interface to connect the application and set their conditions to make their own plans. Interface of this application has shown as follows:

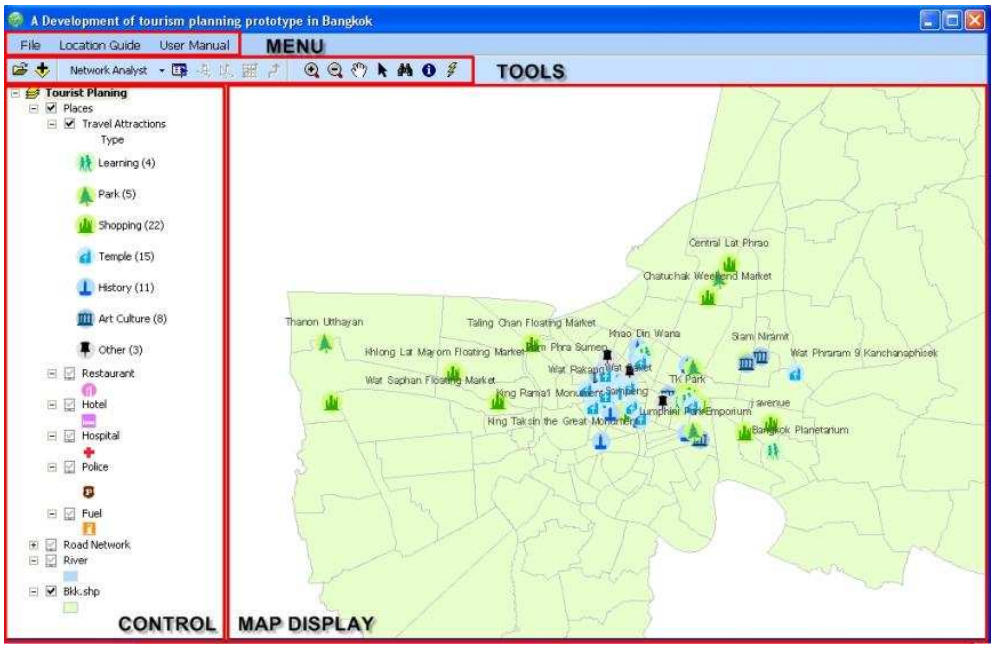

Figure 4.3 Interface screen of tourist planning application

User interface divided into 4 parts; Menu, Tools, Control and Map Display.

4.3.1 Menu This part contains 3 groups;

- **File:** This group has exit command. This command use to exit this application. The other way to close the application is clicking on the red-cross button on the upper right corner.

- **Location Guide:** This group use to detail information of tourist attractions. Tourist attractions are divided into 7 categories by their types of tourism as learning, park, shopping, temple, history, art/culture and other. Users can click at each type of tourism to display more information of any attractions.

- **User Manual:** This group contain user manual for guiding the beginning users to understand the steps of use for this application.

4.3.2 Tools This part is the set of tools to use in network analysis and create travel plan. Tools are grouped into 3 groups;

- Generic: This group including open and add data commands. Open is for opening project file. Add data is for adding shapefile layer into the application.

- Network Analyst: This group is used for network analyst. It include show/hide network analyst window, create network location tool, select/move network locations tool, solve and directions window.

- Map Navigation: This group include zoom in, zoom out, pan, select elements, find, identify and hyperlinks command.

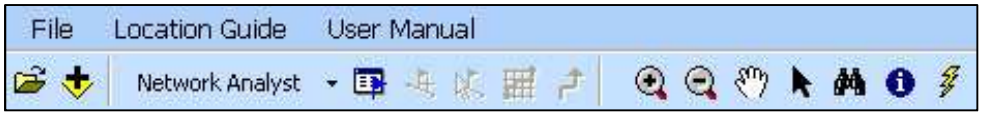

Figure 4.4 Menu and tools screen of tourist planning application

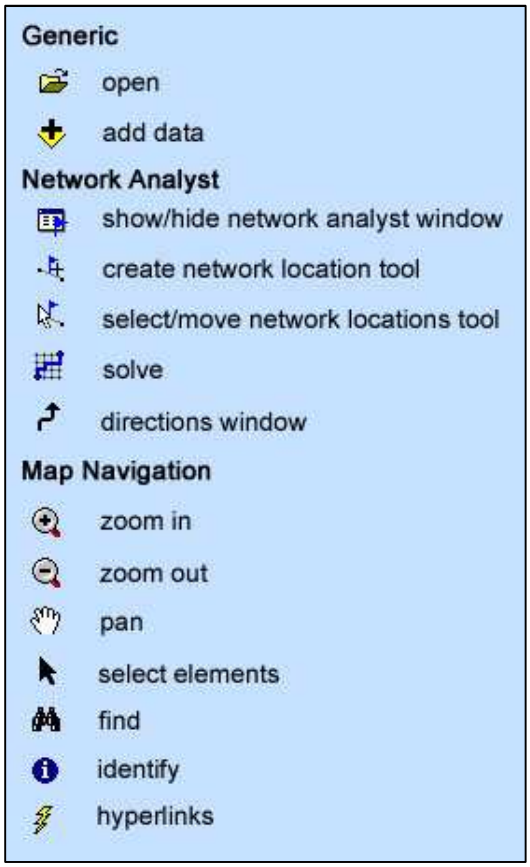

Figure 4.5 All tools button in tourist planning application

4.3.3 Control This part show all layers to use in analysis. Each layer is overlay on each other and displays the result on the map display. The result show top layer overlay on under layer. And user can hide any layer they do not need to show by uncheck the check box of that layer.

4.3.4 Map Display This part display map data and analysis result.

4.4 The Result of GIS for network analysis

In this work, finding the best route is to find the appropriate route base on condition set by tourists. The appropriate route is the path that tourists can travel within limited time. In this work the application made by ArcGIS Engine with MS Visual Studio 2005. Travel plan will be made after designing user interface by VB.NET language. Using steps of tourist planning application can be explained as follow:

4.4.1 Choosing tourist attractions Tourists can choose desire tourist attractions that stored in geodatabase of this application. This application has 68 tourist attractions in Bangkok province that divided into 7 categories as learning, park, shopping, temple, history, art and culture and other attractions. Furthermore, this application also has other location layers such as hotel, restaurant, hospital, police and fuel. All of these layers can be selected as stop location to use in network analysis. Users can view more information of any tourist attractions by clicking at Location Guide in menu bar that group any tourist attractions into 7 categories as shown in figure 4.6

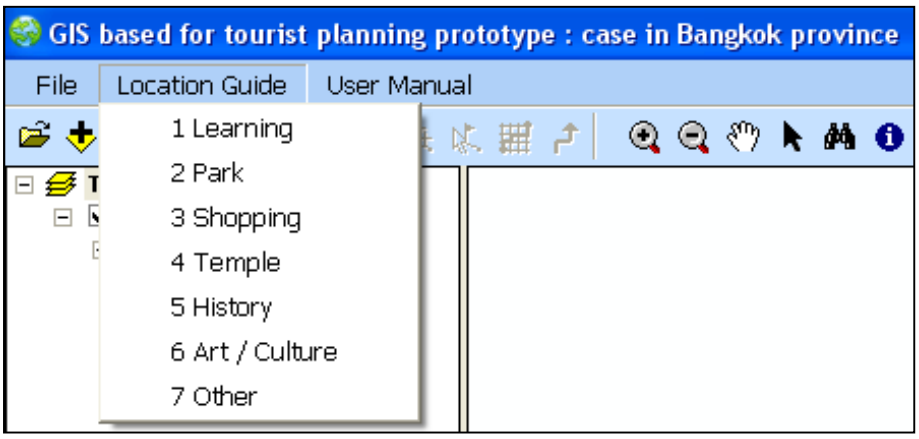

Figure 4.6 Location Guide menu display tourist attractions grouped by type of places

In addition, tourists can view information of each places by clicking identify button.  User just click on identify button and then click at any places displayed on the map control. It will open up new popup page to show information of that place as shown in figure 4.7.

According to the result, identify window show only short information of each tourist attraction. But when users click on hyperlink or click on Location Guide in menu bar. It will show more information of each tourist attractions in details as shown in figure 4.8. Users can learn and bring all of these information to use as informed decision to make a properly travel plan in the future.

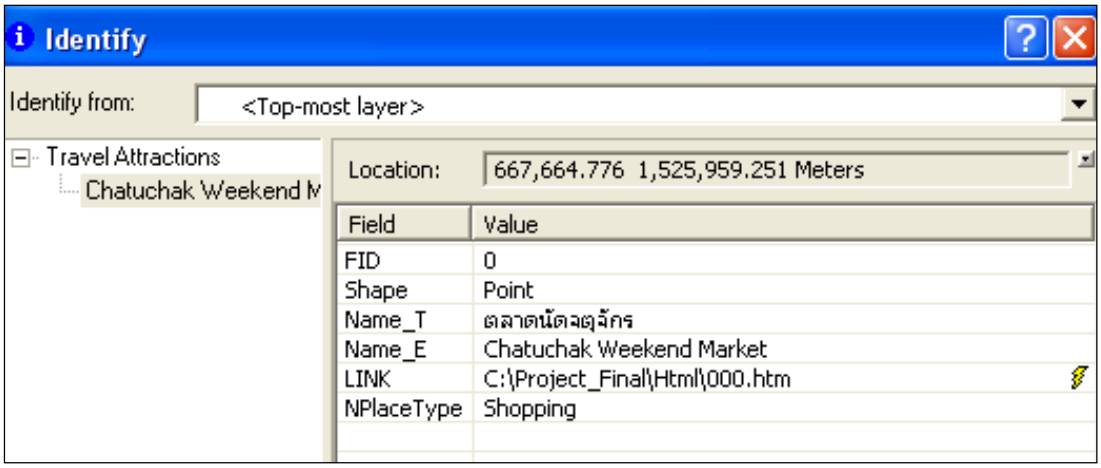

Figure 4.7 Information of tourist attractions by clicking on identify button

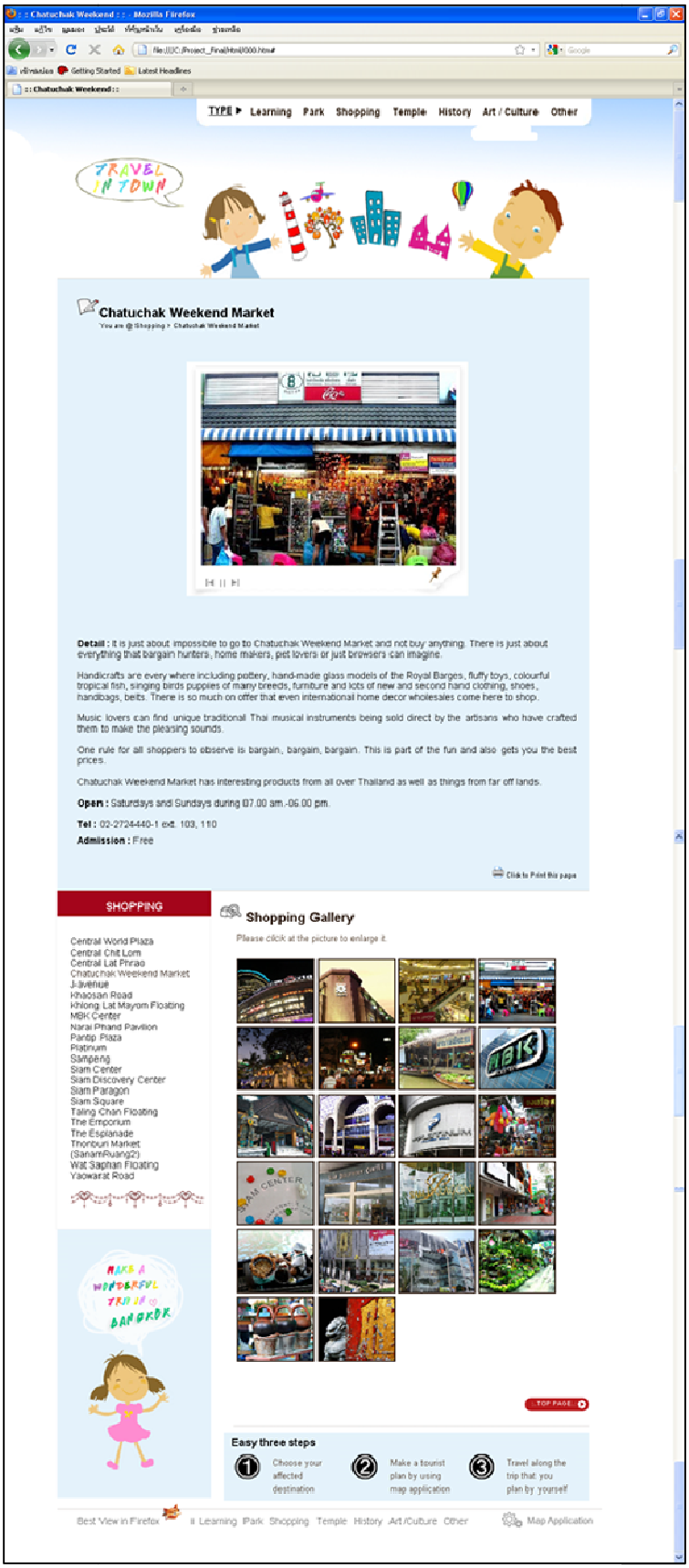

Figure 4.8 Screen display information of tourist attractions in shopping category

4.4.2 Travel plan creation After tourists already get sufficient details of tourist attractions and have choose their desire destinations, then go back to the map display page and click start new route to begin the tourist planning.

4.4.2.1 Defining Location is chosen visiting locations by tourists. There are 2 methods to define location as follow:

First Method setting location by Find button

- Click at Find  and type the name of tourist attraction.
- Set layer as travel attractions.
- Matching tourist attractions will appear. Then right-click the desire name and choose Add as Network Location.
- Visiting Location will display on the map.
- Tourists can add visiting location as much as they need.

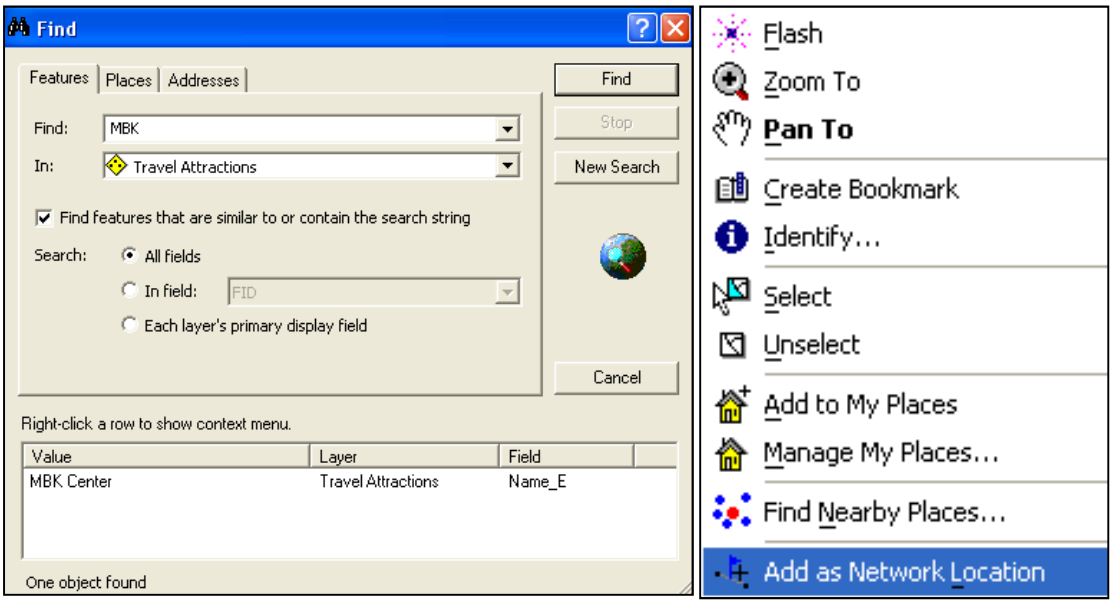

Figure 4.9 Defining visiting location by clicking on Find button

Second Method setting location by network tools

- Select create network location Tool  from toolbar. And pan cursor to the desire tourist attraction.
- Left-click, location will display on the map.
- Tourists can add visiting location as much as they need.

4.4.2.2 Attraction information this process is about how to set usage time at each visiting location. Start by opening network analyst window and then double click at any location, Type amount of time at Attr_Minutes (in minute unit). This is the time usage set base on information of time suggestion in geodatabase. From this, users can plus or minus time that they feel it appropriate. The example result as shown in figure 4.10

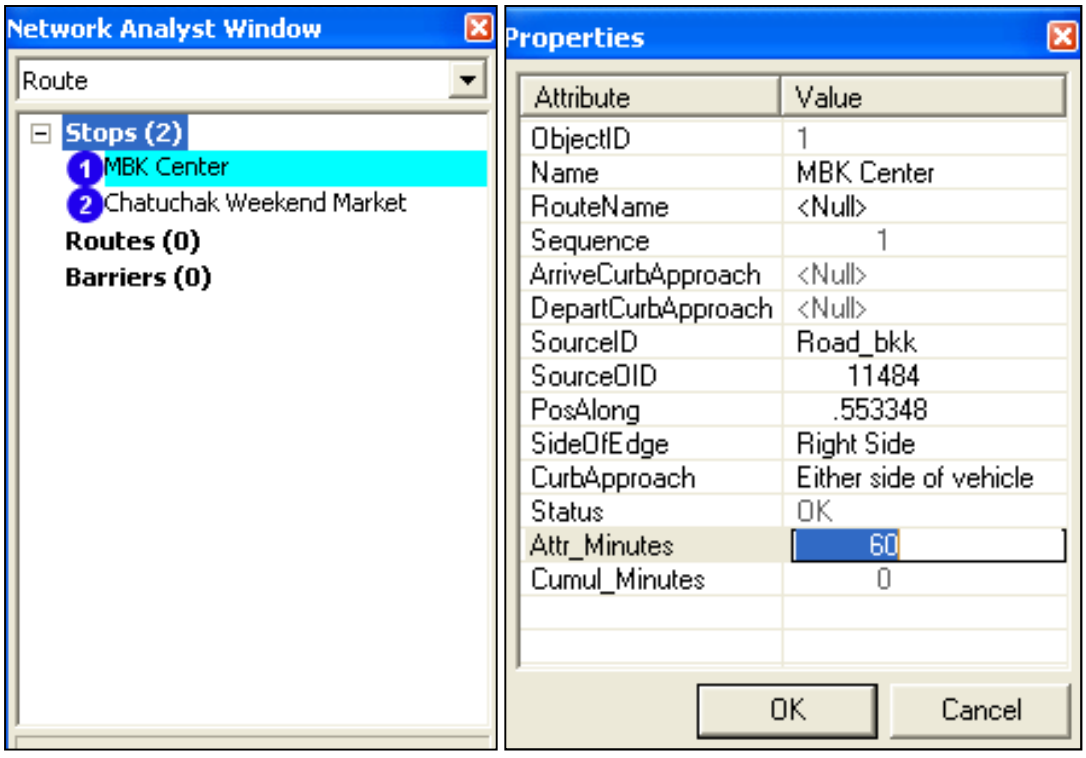

Figure 4.10 Network Analyst Window and Properties page to set time usage of each location

As the result, process to set time usage in this program is manual method. This may cause of user difficulty usage. If it can set time spend in each location by extracting data from geodatabase and appearing in automatic. Then users can use this application more easily.

4.4.2.3 Route properties this process is to set conditions of network analyst route. Started by right-click at created rout layer for network analysis and then select properties. Tourists can define the properties of route base on the shortest distance or the minimal time usage by setting at Impedance (in minutes / meters units). Not only set impedance, user can set the started time of travel plan or the best sequence of visiting location that auto generated by application as figure 4.11

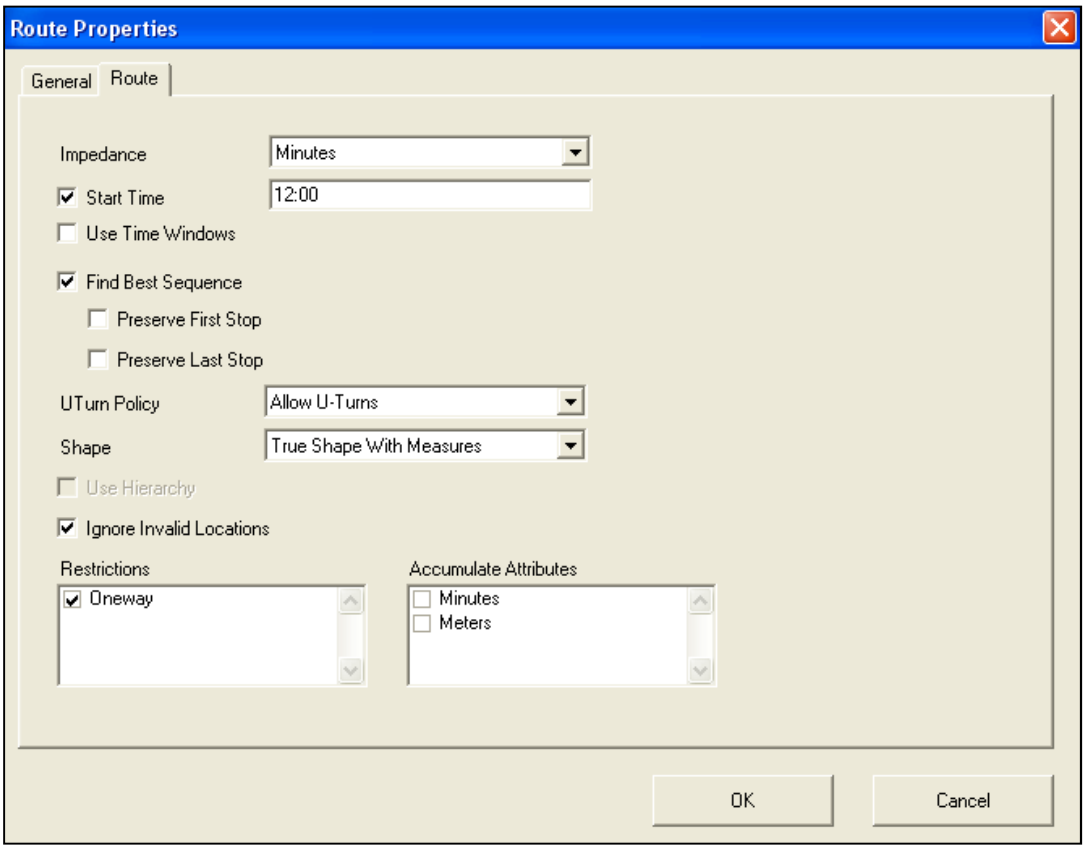

Figure 4.11 Properties of route

4.4.2.4 Running Program After defining all related properties, click solve button  to start network analysis. Program will proceed and analyze. The appropriate route will be shown when finish. The appropriate route is base on user condition set as step before.

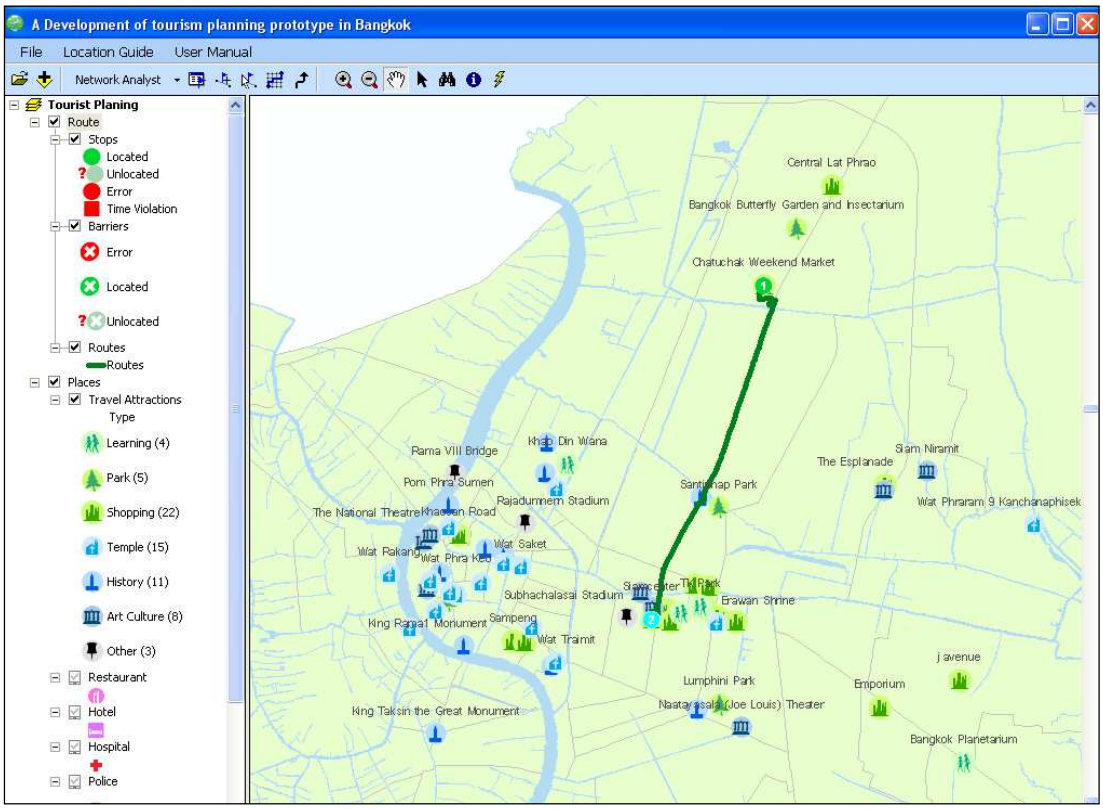

Figure 4.12 Appropriate route recommended by application

From route displayed, tourists can zoom in to enlarge map and have more detail along the path. When users click zoom in the map at zoom level, it appears other places, including hotel, restaurant, hospital etc. Not only other places appeared, the name of each line of roads appeared too. So tourists can keep travel plan in their mind such as which attractions to visit in a sequence, which restaurant chosen to be a stopover by the way etc. Moreover, they can apply this plan to choose a place to stay in the radial center of tourist attractions they plan to visit.

4.4.2.5 Printing travel plan User can click on direction button  to get the direction route of travel plan. In this plan consists of information such as total distances and time usage along the trip, started travel time, time usage at any place, travel time at any road line and finish travel time. This travel plan can print out by clicking on Print Preview button to preview before printing. Form of travel plan as shown in figure 4.13

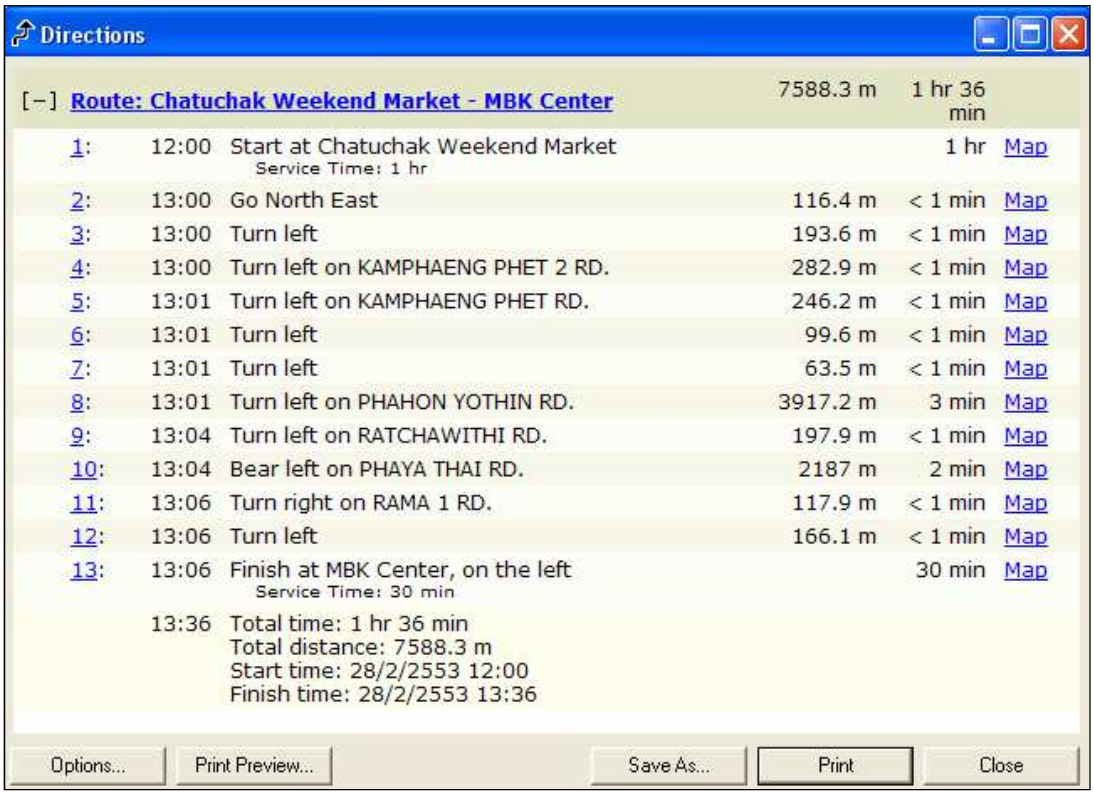

Figure 4.13 Appropriate travel plan recommended by application

CHAPTER V
DISCUSSION

The tourist planning application had been developed to support tourist planning in Bangkok province. This application use network analysis to guide the appropriate route that meet user requirement within the limited time.

The application composes of 4 important features as follow:

5.1 Defining Location

This feature allows users to search the visiting location via name of the locations or define position on the map. However, it is require users to add known location or browse through all attractions on interactive map, which could take longer time for the visitors to find an appropriate traveling plan for them. The usage of this program still be manual process so that users need to learn steps of use before using. Thus, this application would be better if a decision support system (DSS) is added in order to provide alternative suggestions for each individual user preference. This system may involve in 5 more steps as follows:

- **Gathering user information;** to collect data and behavior of users, such as age, salary, nationality, travel preference such as learning, park, shopping, temple, history, art/culture and other, etc. Moreover, collaborative featuring should be interested. This is used to collect the same users' preference as a group, and receive suggestion location from this group as information to consider for the next time analysis. And then bringing all this information to be made a database to use in analysis and recommend the appropriate choice for users.
- **Attraction classification;** In this process, all attractions in database must be classified according to various types of the attractions such as

shopping, temple, history, etc. as mentioned previously. Moreover, each attraction is also classified according to 5-stars rating from '5' to '1' base on place of interest. For example, five stars for the most interested place, three stars for average place, one star for the least interested place, etc.

- **Customizing attraction for individual travelers;** After database has been provided to the application, the DSS will display the appropriate attractions for users.
- **Adding budget expenses along the travel plans;** Program can manage the appropriate routes that meet the budget. Budget calculated from fuel usage or fee of each types of transportation, to conclude as the costs of travel**.** For more options, program may suggest restaurant or accommodation that close to tourist attractions and fit with the user's budget.
- **Adding some assessment of evaluation;** To listen feedback comments from users. This is used as information for developing program to meet the needs of users in the future.

Adding these things will facilitate users to get more corrected information and meet user requirement.

5.2 Attraction information

This feature is used to indicate time spent on each visiting location by adding time (in minute unit) for each location. According to figure 4.10 all users must define the spending period for each attraction by themselves leading to the difficulty to define spending time on each place, if user do not familiar with this place. Moreover, the estimate of traveling time could be improved by bringing real traffic conditions to consider within the system and implement an Artificial Intelligence (AI) system. Because traffic in each time period and in each road has different time spent traveling. Calculation times that reference the real-time traffic will make the result more accuracy and can be used more precisely.

However, this application could be improved using DSS as mentioned in 5.1 by estimate spending time using traveler preference. For example, the Grand Palace has been defined as 5 stars attraction in Art and Culture with the maximum visiting period for 60 minutes, if a traveler ranked his/her preference in Art and Culture as 4 of 5 stars, the estimate time for visiting Grand Palace will be approximately 50 minutes.

5.3 Route properties

According to figure 4.11, the transportation system in this application for traveling time estimation is evaluated based on car with speed limit of each road. Therefore, it could be much different than the real traveling time due to the traffic problems and different transportation used. Each transportation take different time to travel. Some has certain time to travel, such as BTS, MRT, this will be assessed accurately time. But travel by boat and bus are depended on traffic conditions in each period. This may require the appropriate adjustments of time delay to allow the results be more accurate and close to the real situation as possible. Thus this application could be improved by adding a different transportation system for users to choose such as boat, bus, BTS, MRT, etc.

The results display from this application is shown in window format which has limited of use. Accordingly, it should be developed a web application to extend the usage and facilitate the users. Moreover, this development could be done in the form of web portal; to collect all relate necessary information of tourism as the tourist information. In addition to this development, the system may be developed under the mobile application so that it can support the actual position and provide directions in various forms of travel to users.

5.4 The Application Evaluation

This application was tested by 30 people, in age range 19-38 years, 12 people used GIS and 18 not used GIS. The result of questionnaires is shown in Table 5.1.

Table 5.1 Result of the questionnaires

Title	% (Person)				
	Excellent	**Good**	**Average**	**Fair**	**Poor**
1. USER INTERFACE					
- Usability	20.0 (6)	66.7 (20)	13.3 (4)	0(0)	0(0)
- Speed of Usability	40.0 (12)	56.7 (17)	3.3 (1)	0(0)	0(0)
- The overall look	33.3 (10)	60.0 (18)	6.7 (2)	0(0)	0(0)
2. RESULT					
- Speed of the result	53.3 (16)	46.7 (14)	0.0 (0)	0(0)	0(0)
- Accuracy of the result	46.7 (14)	46.7 (14)	6.7 (2)	0(0)	0(0)
- Satisfaction with the result	50.0 (15)	46.7 (14)	3.3 (1)	0(0)	0(0)

From the table, it is seen that most of users are satisfied with this application. Common users can use this application at good level; the speed and accuracy of the result are at excellent level.

However, some users had suggestions to improve this application as follow:

- Adding more boundary areas to cover all parts of Thailand or maybe it should extend more area like vicinity rather than cover only Bangkok province.
- Adding more attractions to cover user's requirements.
- Adding more transportation systems such as BUS Route, BTS or MRT, as an alternative form of travel.
- Adding more location type such as bank.

CHAPTER VI
CONCLUSION AND RECOMMENDATIONS

GIS based prototype for tourist planning application case study in Bangkok province is a program developed to help tourists in searching attractions and planning a travel plan. Users or tourists can set conditions to use as criteria in making travel plans by themselves. This program will reduce the process and duration of data collection, and allow tourists to travel with their own plans. After development and usage of this program, the conclusion and recommendations can be described as below;

6.1 Conclusion

GIS based prototype for tourist planning application developed to be a prototype program that use GIS technology to support searching attractions and make a travel plan according to requirement of tourists.

The prototype use ArcGIS Desktop 9.2 for database management. This database stores all details about tourism such as attractions, transportation routes, accommodation, restaurant, hospital, police station and fuel in Bangkok province. Then develop an application by ArcGIS Engine with VB.NET and use this application in the form of desktop program.

This application has some point that should be adjusted for more accurate result. And should be reviewed and updated information in this program continuously. So that the result of searching and travel plan, be reliability and close to the real situation as possible. However, this GIS based application can be completed and supported the need of use as follow;

1. This program can search and give information of each attractions base on the requirement of users.

2. This program can help users to plan a travel plan base on user requirement such as to plan travel routes within shortest distance or to plan travel routes with minimal time. Travel plan which is made here can specify started time and time spent at each location of this plan.

6.2 Recommendations

As a result of GIS based prototype, recommendations are divided into 2 areas; recommendations for using this application and recommendations for future study.

6.2.1 Recommendations for using this application

- User should set screen resolution at 1024 x 768 for accurate display. This program can use on desktop computer and laptop that use Microsoft window XP as operating system.
- To use this program, that computer must install .Net Framework and have ArcGIS Engine Runtime License. So that it can process and analyst data.

6.2.2 Recommendations for future study

- For information, more information may be updated for example;
  - Adding more transportation routes such as bus, BTS, MRT and other form of travel.
  - Adding more categories of locations such as bank, government places, etc.
  - Expanding interested area, from Bangkok province to other areas around the country. To cover all information need of tourists.
- For developing program, it should be more user friendly interface to facilitate user to use this program. In addition, this program

should be implemented by adding DSS to cover the usage and support the decision of users.

- For analysis data, if there is the real time traffic information in each path of road as a factor to decide in analysis, it will display more accurate results.
- Program should be developed as a web base application. So that it can process and display information on internet network to facilitate the use of users. From the study found that it is possible to do. But it must use ArcGIS MIS with ArcGIS Server program to develop. These programs are protected by copyright and so expensive. To use all of those, require specialized expertise and time-consuming to learn. Moreover, if this application developed as mobile application, it will more flexible the usage.
- For program usage, this program can be applied as a model for planning and operating other plans by using this program for a path planning trip to various destinations and change the initial data set into the system.
- For display result, it should have more languages to communicate with foreign tourists. Because Chinese and Japanese tourists become a focus visitors that travel to Thailand a lot in every year.

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APPENDICES

APPENDIX A
LIST NAME OF TOURIST ATTRACTIONS

Table A1 Tourist attractions in Bangkok province divided by type of travel.

Type of Tourist Attractions	Name of Tourist attractions
Learning (4 places)	Bangkok Planetarium Khao Din Wana Siam Ocean World TK park
Park (5 places)	Bangkok Butterfly Garden and Insectarium Lumphini Park Santiphap Park Saranrom Park Thanon Utthayan
Temple (15 places)	Erawan Shrine Wat Arun (Temple of Dawn) Wat Benchambophit Dusitwanaram / (Marble Temple) Wat Chana Songkhram Wat Mangkorn Kammalawat Wat Phra Chetuphon Vimolmangklararm Rajwaramahaviharn / (Wat Pho) Wat Phra Keo Wat Phraram9 Kanchanaphisek

Table A1 Tourist attractions in Bangkok province divided by type of travel. (cont.)

Type of Tourist Attractions	**Name of Tourist attractions**
Temple (15 places) (cont.)	Wat Rakang Wat Ratchabophit Sathitmahasimaram Wat Ratchanadda Wat Ratchapradit Sathitmahasimaram Wat Saket (The Golden Mount) Wat Suthat and Giant Swing Wat Traimit
History (11 places)	City Pillar Shrine Commemoration Gate honouring HM the King's Sixth Cycle Birthday Democracy Monument King Rama I Monument King Rama III Monument King Rama V Monument King Rama VI Monument King Taksin the Great Monument Pom Phra Sumen Victory Monument Vimanmek Mansion

Table A1 Tourist attractions in Bangkok province divided by type of travel. (cont.)

Type of Tourist Attractions	Name of Tourist attractions
Art and Culture (8 places)	Bangkok Art and Culture Centre Bangkok National Museum Grand Palace Jim Thompson House Naatayasala (Joe Louis Theater) Rachadalai Theatre Siam Niramit The National Theatre
Other (3 places)	Rajadumnern Stadium Rama VIII Bridge Subhachalasai Stadium

APPENDIX B
NETWORK DATASET

Network dataset is a data structure that consists of edges, junctions and lines to use in network analysis. To create a network dataset, it is an easy way to do from wizard in ArcCatalog. The step to do as follow:

1. Start ArcCatalog then right mouse click at shapefile that you want to create a new dataset and choose “New Network Dataset…” as figure B1

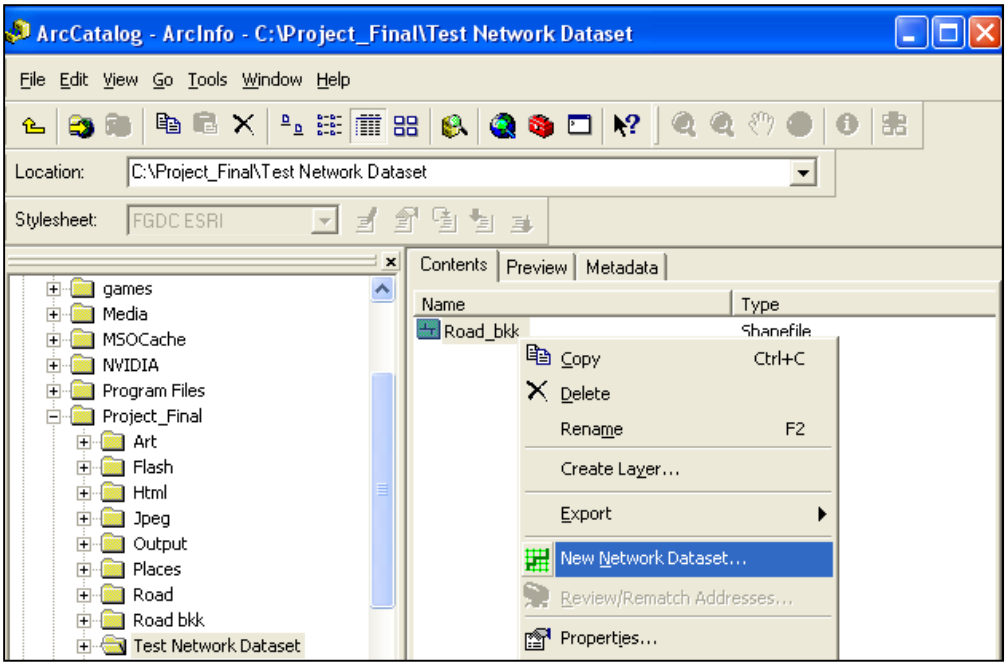

Figure B1 Create Network Dataset

2. Type a name for your network dataset.

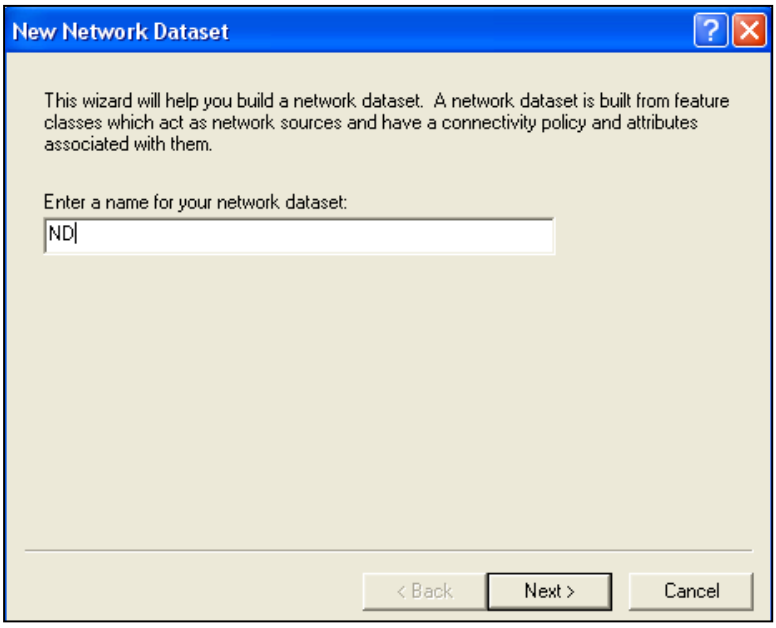

Figure B2 Name your network dataset

3. Set Connectivity for your network dataset

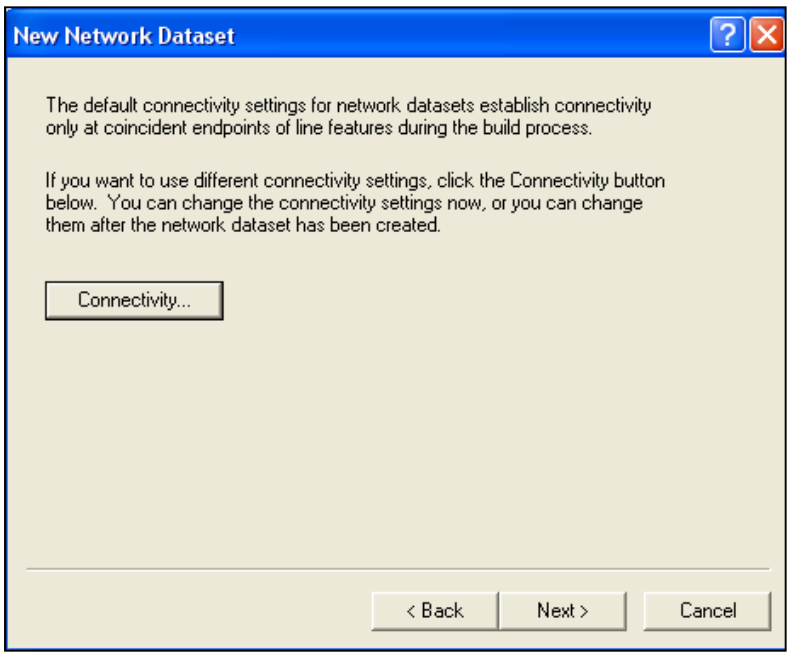

Figure B3 Set connectivity of network dataset

4. Choose “No” because this network dataset is not define route’s height.

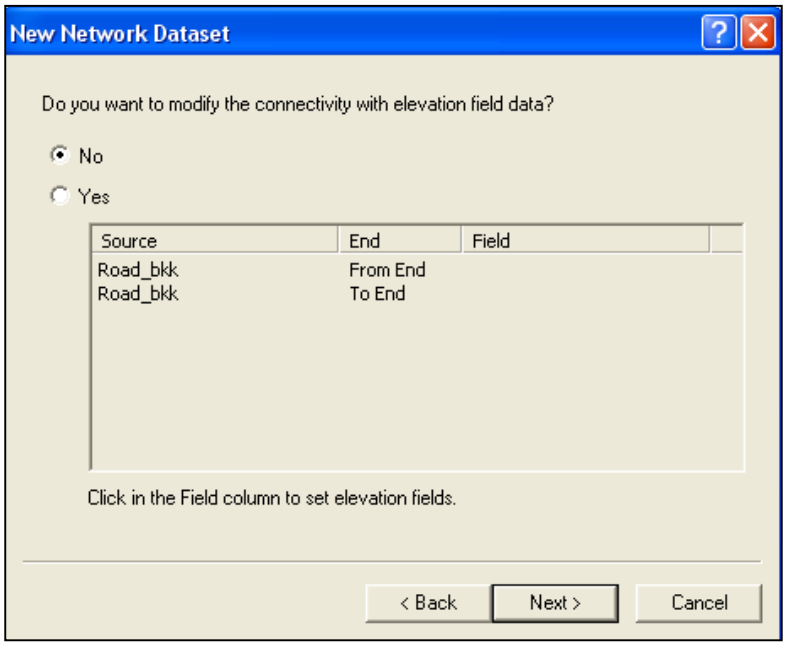

Figure B4 Window of route’s height

5. This window is for setting turn function. Choose global turns and then click Next to define properties of network dataset.

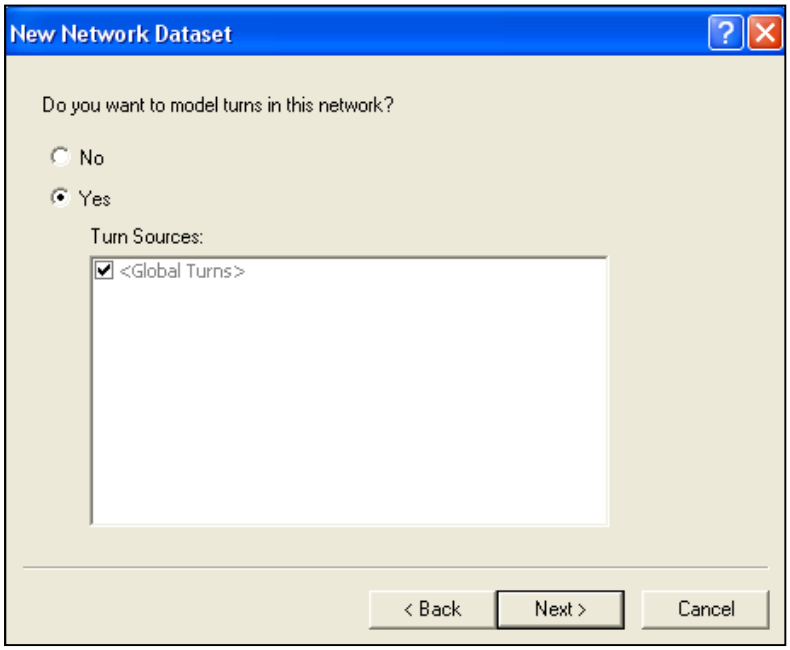

Figure B5 Turn function of network dataset

6. Properties of network dataset can be defined as follow:

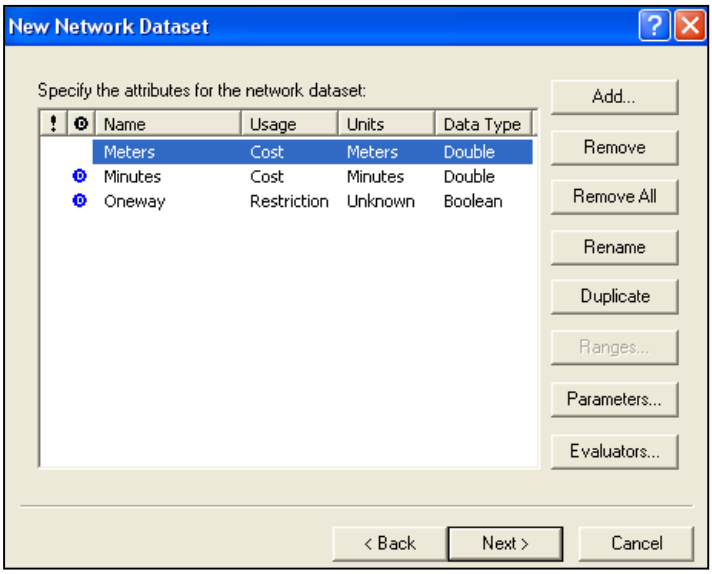

Figure B6 Properties of network dataset

- Cost : This is used to set as impedances in network analyst. You can choose Meters to analyst the shortest distance or choose Minutes to analyst the minimal time usage in any routes.
- Restriction : This is the limitation elements such as one-way streets, terms of turn, etc.

Click Eveluators button to defined and checked properties.

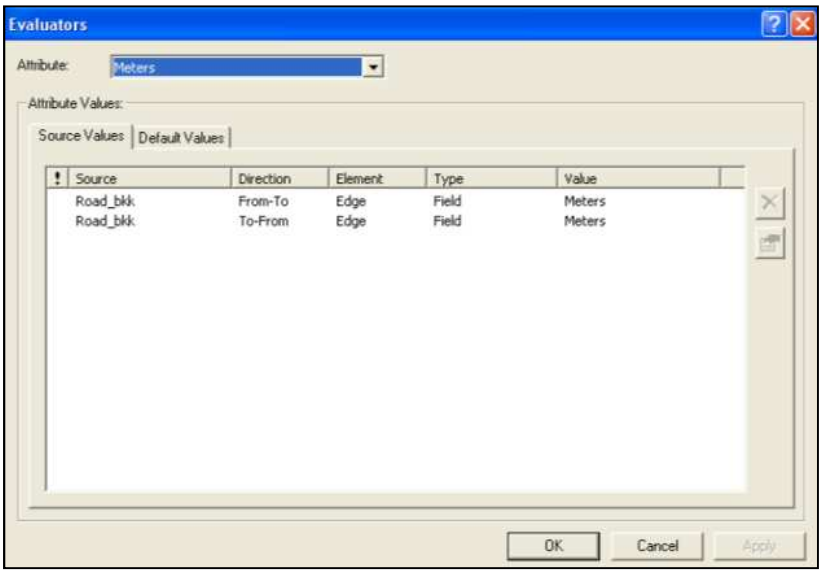

Figure B7 Eveluators window

7. Choose “Yes” to set driving directions.

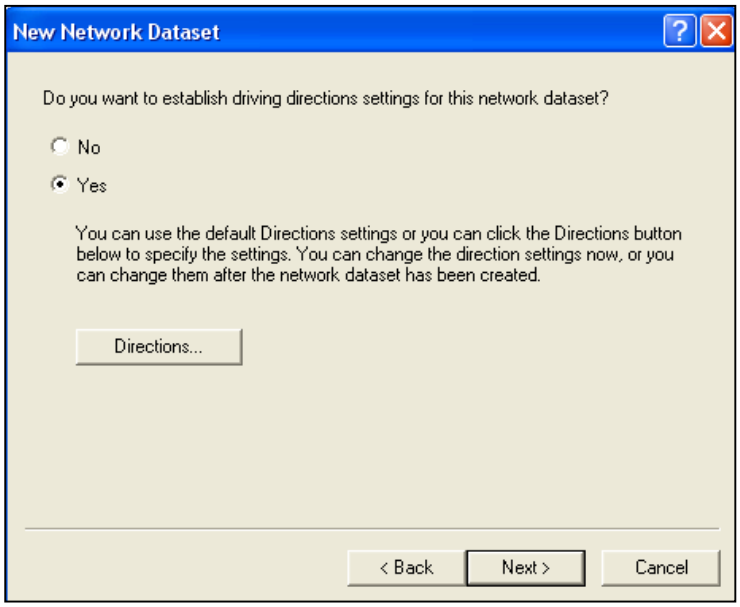

Figure B8 Driving directions window

8. When you click Directions button, it will appear network directions properties window as figure B9.

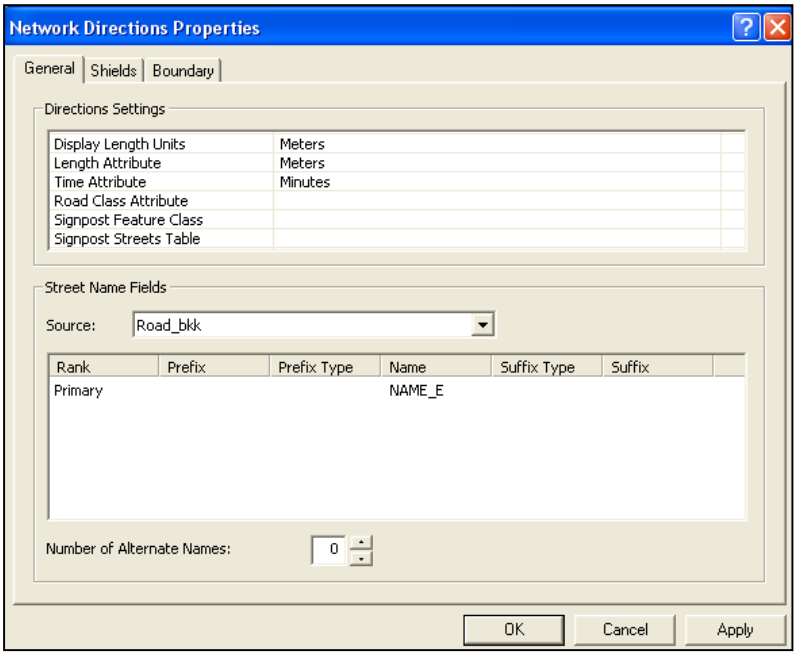

Figure B9 Network directions properties window

At General Tab, you can set display units of network dataset and attribute to show name of each road.

9. When all network dataset values are set, it show network dataset summary output as shown in figure B10.

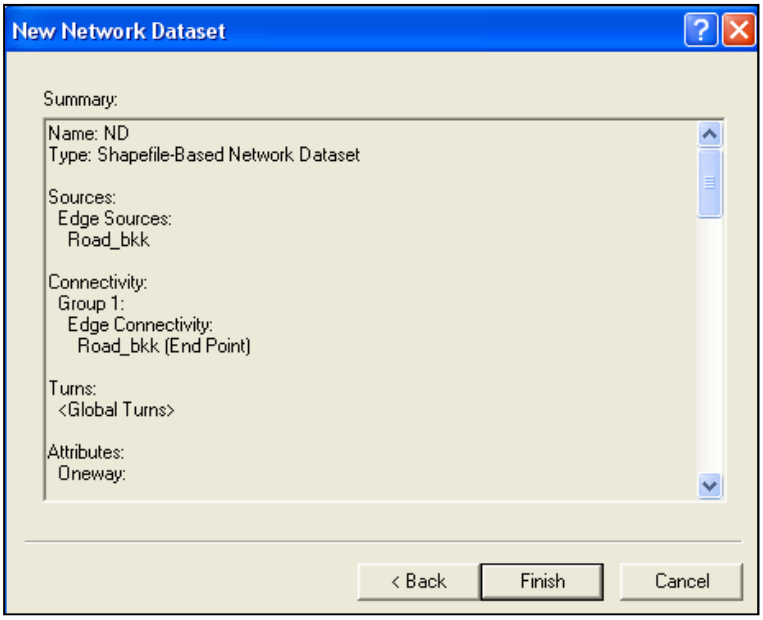

Figure B10 Network dataset summary window

10. Click “Finish” to start creating network dataset. Program will generate and show new network dataset popup to confirm. Click “Yes” to build network dataset.

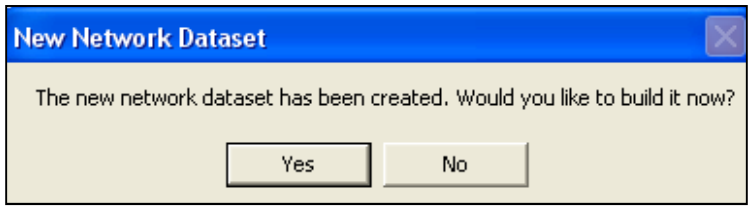

Figure B11 New network dataset popup

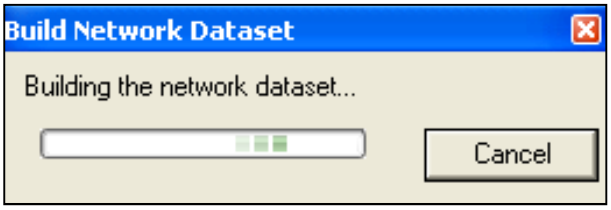

Figure B12 In process of building network dataset

11. New network dataset consists of icon  and has point feature that connect junction of each road lines.

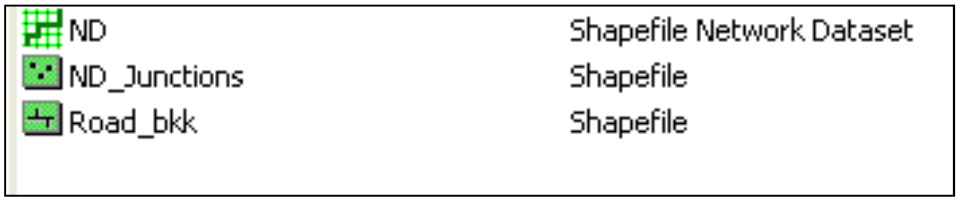

Figure B13 Show all network dataset features

APPENDIX C
DATA DICTIONARY

1.PLACE TABLE

1.1 Travel Attractions

Name	Alias	Type	Length	Detail
FID	FID	Object ID	4	
Shape	Shape	Point	-	
Name_T	Name (Thai)	Text	254	Name of Places in Thai
Name_E	Name (English)	Text	254	Name of Places in English
Place_type	Place_type	Text	2	Type of Places (Number)
LINK	Details of Place	Text	150	Htm pages with details
NPlaceType	Type of Place	Text	50	Type of Places (in Text)
TIME	Suggestion Time	Text	20	Time usage in each places

1.2 Restaurant

Name	Alias	Type	Length	Detail
FID	FID	Object ID	4	
Shape	Shape	Point	-	
NAME_T	Name (Thai)	Text	70	Name in Thai
NAME_E	Name (English)	Text	70	Name in English
TEL	Telephone	Text	20	Telephone Number
OPEN_TIME	Open	Text	20	Open time
COST_BAHT	Cost (Baht)	Text	15	Estimated budget
WEBSITE	Website	Text	50	URL address

1.3 Hotel

Name	Alias	Type	Length	Detail
FID	FID	Object ID	4	
Shape	Shape	Point	-	
NAME_T	Name (Thai)	Text	70	Name in Thai
NAME_E	Name (English)	Text	70	Name in English
TEL	Telephone	Text	20	Telephone Number
WEBSITE	Website	Text	50	URL address

1.4 Hospital

Name	Alias	Type	Length	Detail
FID	FID	Object ID	4	
Shape	Shape	Point	-	
NAME_T	Name (Thai)	Text	70	Name in Thai
NAME_E	Name (English)	Text	70	Name in English
TEL	Telephone	Text	20	Telephone Number
WEBSITE	Website	Text	50	URL address

1.5 Police

Name	Alias	Type	Length	Detail
FID	FID	Object ID	4	
Shape	Shape	Point	-	
NAME_T	Name (Thai)	Text	70	Name in Thai
NAME_E	Name (English)	Text	70	Name in English
TEL	Telephone	Text	20	Telephone Number

1.6 Fuel

Name	Alias	Type	Length	Detail
FID	FID	Object ID	4	
Shape	Shape	Point	-	
NAME_T	Name (Thai)	Text	70	Name in Thai
NAME_E	Name (English)	Text	70	Name in English

2. ROAD NETWORK TABLE

2.1 Road_bkk

Name	Alias	Type	Length	Detail
FID	FID	Object ID	4	
Shape	Shape	Point	-	
OBJECTID	OBJECTID	Long	9	
ROAD_TYPE	Type of Road	Short	4	Type of Road
ROAD_NUM	Num of Road	Text	8	Number of road
NAME_T	Name (Thai)	Text	70	Name in Thai
NAME_E	Name (English)	Text	70	Name in English
SURFACE	Surface	Short	4	Surface of road
WIDTH	Width	Short	4	Road width
LANE	Lane	Short	4	Number of road lane
ONEWAY	Oneway	Text	2	
LENGTH	Length	Double	19	Road length (kilometer)
SPEED	Speed	Short	4	Speed in each road line
Minutes	Minutes	Double	19	Time usage in each road
Meters	Meters	Double	19	Road length (meter)
FT_Minutes	FT_Minutes	Double	19	
TF_Minutes	TF_Minutes	Double	19	

2.2 Road_bkk_ND_Junctions

Name	Alias	Type	Length	Detail
FID	FID	Object ID	4	
Shape	Shape	Point	-	
Id	Id	Long	6	

3. RIVER TABLE

Name	Alias	Type	Length	Detail
FID	FID	Object ID	4	
Shape	Shape	Polygon	-	
OBJECTID	OBJECTID	Long	9	
TYPE	Type	Short	4	River type
NAME_T	Name (Thai)	Text	70	Name in Thai
NAME_E	Name (English)	Text	70	Name in English
SHAPE_Leng	Length	Double	19	River length
SHAPE_Area	Area	Double	19	River area

4. BKK TABLE

Name	Alias	Type	Length	Detail
FID	FID	Object ID	4	
Shape	Shape	Polygon	-	
P_NAME_T	Province (T)	Text	70	Province name in Thai
P_NAME_E	Province (E)	Text	70	Province name in English
A_NAME_T	Amphoe (T)	Text	70	Amphoe name in Thai
A_NAME_E	Amphoe (E)	Text	70	Amphoe name in English
T_NAME_T	Tambon (T)	Text	70	Tambon name in Thai
T_NAME_E	Tambon (E)	Text	70	Tambon name in English
SHAPE_LENG	Length	Double	19	Bangkok province length
SHAPE_AREA	Area	Double	19	Bangkok province area

APPENDIX D
QUESTIONNAIRE

แบบสอบถามความคิดเห็นเพื่อประเมินผลการใช้โปรแกรม

GEOGRAPHIC INFORMATION SYSTEM BASED PROTOTYPE FOR TOURIST PLANNING APPLICATION : CASE STUDY IN BANGKOK PROVINCE

ตอนที่1 : ข้อมูลส่วนตัวของผู้ตอบแบบสอบถาม

1. เพศ ชาย หญิง
2. อายุ ..... ปี
3. อาชีพ ..... นักศึกษา คณะ .....
4. ท่านชื่นชอบการท่องเที่ยวหรือไม่ ชื่นชอบ เฉยๆ ไม่ชื่นชอบ
5. ท่านเคยใช้โปรแกรมทางด้านGISหรือไม่ เคยใช้ ไม่เคยใช้

ตอนที่2 : ความคิดเห็นในการใช้งานโปรแกรม

คำถาม	ดีมาก	ดี	ปานกลาง	น้อย	ควรปรับปรุง
1. ส่วนติดต่อกับผู้ใช้					
ความยากง่ายในการใช้งาน					
ความรวดเร็วในการเรียกใช้งาน					
ความสวยงามของหน้าจอใช้งาน					
2. ส่วนแสดงผลลัพธ์					
ความรวดเร็วในการแสดงผลลัพธ์					
ความถูกต้องของผลลัพธ์ที่ได้					
ความพึงพอใจในผลลัพธ์					

ความคิดเห็นเพิ่มเติมและข้อเสนอแนะอื่นๆ .....

.....

BIOGRAPHY

NAME	Miss Vorapan Chinchalongporn
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INSTITUTIONS ATTENDED	King Mongkut's Institute of Technology Ladkrabang, 2001-2005 Bachelor of Science (Environmental Resource Chemistry) Mahidol University, 2007-2010 Master of Science (Technology of Information System Management)
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