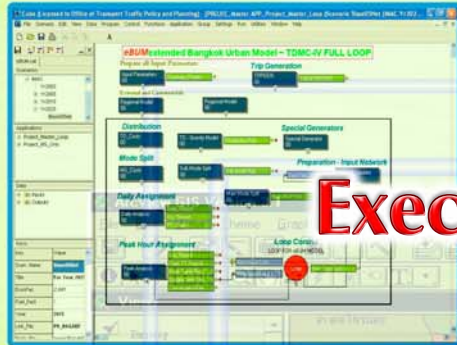




**Office of Transport and Traffic Policy and Planning
(OTP)**



Executive Summary Report

Transport Data and Model Center V (TDMC V)



By



TransConsult Co., Ltd.



Sea Consult Engineering Co., Ltd.



**Pacific Consultants International
(Thailand) Co., Ltd.**

February 2007

TABLE OF CONTENTS

	Page
CHAPTER 1 : INTRODUCTION	
1.1 Background	1-1
1.2 Project Objectives	1-2
1.3 Executive Summary Report Objectives	1-2
CHAPTER 2 : STUDY SCOPE	
2.1 Transportation & Traffic Database System Improvement and Maintenance	2-1
2.2 Transportation & Traffic Model Improvement and Maintenance	2-2
2.3 Transportation & Traffic Database, Information System, and Model Application and OTP Human Resource Capacity Strengthening	2-2
2.4 Project Period	2-3
CHAPTER 3 : TRAFFIC AND TRANSPORTATION DATABASE INFORMATION SYSTEM MAINTENANCE AND IMPROVEMENT	
3.1 Database Management and Website Development (MIS)	3-2
3.2 Development of Geographical Information System (GIS)	3-7
CHAPTER 4 : TRANSPORTATION AND TRAFFIC MODEL AND IMPROVEMENTS MAINTENANCES	
4.1 Review of the transport model developments	4-1
4.2 The National Model (NAM)	4-4
4.3 Extended Bangkok Urban Model (eBUM)	4-12
CHAPTER 5 : DATABASE SYSTEM AND TRANSPORT MODEL APPLICATION AND HUMAN RESOURCE CAPACITY DEVELOPMENT	
5.1 Database System and Model Application	5-1
5.2 Technical Consultation	5-1
5.3 Seminars	5-2
5.4 GIS and MIS Training	5-2
5.5 GIS Technical Tour	5-2

CHAPTER 1 Introduction

- Background
 - Project Objectives
 - Bangkok Transport Model Development and Maintenance
-

1.1 Background

Office of Transportation and Traffic Policy and Planning (OTP) performs as the center in stipulating nation traffic and transportation policies, including ground, water, and air transportations. OTP is also coordinating with other institutes or organizations to manage policies, plans, projects, and measures in the most effective way.

OTP has been continually developing the information system and transportation & traffic models to be used as a tool assisting the management and decision related to transportation & traffic policies in the nation since 1998 under the Urban Transport Database and Model Development Project: UTDM. Later in 2005, Transport Data and Model Center IV: TDMC IV has developed Geographic Information System: GIS to cover BMR, Chiang Mai, Chonburi, Nakhon Ratchasima and Songkla for ground, water, and air transportations to be used as a tool supporting for strategic planning and decision making related to transportation and traffic policies and plans.

However, the most important issue is to make sure that the information system and transportation & traffic models have been continually implemented to the most current available data and ready to be used whenever it is needed. This is a primary component in stipulating effective transportation and traffic policies, plans, projects, or measures. On the other hand, currently, traffic and transportation models have to be continually developed to respond short term implementation plans in order to mitigate traffic problems in responding to government policies and OTP assignments.

To improve and maintenance the OTP information system, transportation & traffic models and GIS to conform with Infrastructure Development Strategy of Strategy formulation 2005-2008. It is necessary to develop the information system, transportation & traffic models and GIS continually in order to be more widely used and timely respond to the Government and Ministry of Transport policies for the more efficient management.

1.2 Project Objectives

OTP had hired the consultant for the Transport Data and Model Center (TDMC) project. The project has the following objectives:

- 1.2.1 To improve and maintenance transportation & traffic database and information system necessary for planning and implementing the transportation related projects in any provinces and travel modes (ground, water, and air transportation). However the goal of this objective is aimed at making the database available at any times and ready to support decision makings in transportation and traffic planning processes.
- 1.2.2 To improve and implement OTP's transportation & traffic models for National model, Bangkok Metropolitan Region model, Local Area Model and Regional City model to be used as a tool for planning, managing transportation & traffic projects and to support the development of Logistic for the Nation.
- 1.2.3 To encourage the application of transportation & traffic information system and model for stipulating policies, plans, projects, or measures. This objective also includes OTP human resource capacity strengthening for using these information systems and models.

1.3 Executive Summary Report Objectives

The objectives of this report is to summarize all the works have been done during 12 months of the project period.

CHAPTER 2 Study Scope

- Transportation & Traffic Database System Improvement and Maintenance
 - Transportation & Traffic Model Improvement and Maintenance
 - Transportation & Traffic Database, Information System, and Model Application and OTP Human Resource Capacity Strengthening
 - Project Period
-

Study scope is one of the most important aspect for the project in order to direct work plans and project organizations. It is aiming the project to reach its goals in analyses, data collections, database developments, and project final products. Study scope for this project is divided into 3 topics including 1.) Transportation & Traffic Database System Improvement and Maintenance, 2.) Transportation & Traffic Model Improvement and Maintenance, 3.) Transportation & Traffic Database and Information System, and Model Application and OTP Human Resource Capacity Strengthening.

2.1 Transportation & Traffic Database System Improvement and Maintenance

Works includes the followings.

2.1.1 Study and review the OTP's existing Database and Information System in order to recommend and develop the appropriate Database and Information System. The Database and Information System has to work seamlessly with the GIS System. Where as the GIS System has to have these features: input, store, edit, manage, analyze and display map data.

2.1.2 Improve and maintain the Database and Information System to cover the basic design of the system, statistically data check, data processing procedures, publicize the data and publish the data in other forms such as document, other media etc.

2.1.3 Develop and integrate transportation and traffic data such as transportation networks using the existing Information Technology: GPS, GIS and MIS to support planning and strategic decision making.

2.1.4 Procure computer and necessary equipments:

- Computer Notebook 1 set
- Plotter A0 size 1 set resolution more than 500x500 DPI the consultant has replaced, according to the Steering Committee resolution 4/2549, with:

1. Increased hard disk capacity from 72 GB to 146 GB: HP 146 GB 10K U320 Pluggable Hard Drive 1 set
 2. Computer: HP PC Pavilion a1588L 2 sets
 3. Tables and chairs 2 tables and 4 Chairs
 4. Printer: HP Printer LaserJet 2420 1 set
 5. MP3 Player: Apacer (AU523) 2 sets
- Scanner A4 size 1 set resolution more than 1200x1200 DPI
 - Video DVD Camcorder 1 set
 - Handy Drive 5 sets

2.2 Transportation & Traffic Model Improvement and Maintenance

2.2.1 Study and Review OTP's Traffic and Transportation Models

2.2.2 Improve National Model (NAM) for the base year (2006) and the future year (2011, 2016, 2021, 2026 and 2031) and incorporate Cube Cargo into the model.

2.2.3 Improve Extended Bangkok Urban Model (eBUM) for AM and PM peak period and Daily travel for the base year (2006) and the future year (2011, 2016, 2021, 2026 and 2031). Collect addition traffic data to calibrate the model, especially the Voyager Module, to ensure the model robustness. Also incorporate a GIS map cover BMR area and a Satellite image cover Bangkok area into the model to make the model more realistic.

2.3 Transportation & Traffic Database, Information System, and Model Application and OTP Human Resource Capacity Strengthening

2.3.1 The consultant has to use the database, information and model developed in this project to analyze and evaluate plans, projects and measures assigning by OTP with no lesser than 5 subjects.

2.3.2 The consultant has to provide technical consulting and attending conferences or meetings which are assigned by the OTP along the project period.

2.3.3 The consultant has to arrange technical seminar/workshop for the OTP and other concerned agencies to understand the usage of database, information and models in the transportation and traffic related project two times in Bangkok and other province.

2.3.4 The consultant has to arrange technical training for OTP's officials in GIS and MIS technology concerning transportation and traffic using aerial photos and/or satellite images to develop prototype and to make a PowerPoint presentation at an accredited or a certified institute.

2.3.5 The consultant has to provide the GIS Fly Through Technical Tour for OTP's officials, at least 10 persons, in the country which has highly accomplished their works in these technologies.

2.4 Project Period

The overall project period is 12 months which start from February 16, 2006 to February 15, 2007.

CHAPTER 3 Traffic and Transportation Database Information System Maintenance and Improvement

- Database Management and Website Development (MIS)
 - Development of Geographical Information System (GIS)
-

To assist OTP in dealing with planning and coordinating transportation/traffic related projects for all travel modes (ground, water, and air transportation) in the nation, OTP's Transportation and Traffic Information System has to have a decent and up-to-date database that cover all relevant data. It has to have appropriate and easy to use applications to be used as a tool for managing, searching, processing and analyzing data. The system also has to present the processed information in a useful form in order to enable the more efficient utilization of the information.

Spatial data is the information represents location of object. It is important data and very useful for understanding the relationship of factors concerning the planning of transportation and traffic project. Geographic Information System (GIS), which is one of the Information technology, designs to deal with spatial data is considered as a very important feature to be included in OTP's Transportation and Traffic Information System.

OTP has realized the importance of the information which includes spatial data to fulfill its missions. OTP, OCMLT at the time, has started the development of the transportation database system since 1995. At present, OTP has relied more on the transportation/traffic database for planning all modes of travel (ground, water, and air transportation) then it is an appropriate time to review, improve and maintenance the database to cover an ever increasing demand of new usage of data.

This chapter summarizes all works in Transportation & Traffic Database and Information System Maintenances and Improvements. The subject is divided into 2 main issues including Database System and Management Information System (MIS) Design and Development, and Geographic Information System (GIS) Design and Development.

3.1 Database Management and Website Development (MIS)

In the TDMC V project, the consultant has split the work into small subtasks to enable OTP to understand the MIS improvement and maintenance plan and easily track all subtasks. The brief details of all subtasks are as follows:

3.1.1 Study and Review of Database Management System Development process for all data groups

The first task the consultant has performed was the study and review of Database Management System development process for all data groups. The consultant realized that the database design, software development process and the generated reports were very important. So, the information from the reviewing of the development process can be used as a basis of the work in TDMC V. This task was completed since March 2006.

3.1.2 Check database status, prepare data update and maintenance plan

This subtask is one of the most important works in TDMC V project because the database of TDMC V is very big, which consists of 20 data groups. Each group also has a number of subgroups; 128 subgroups altogether. This subtask is divided into the following steps:

3.1.2-1 Check database status

The consultant has prepared a checklist of data. Which include all 128 subgroups, to assist in defining the status of data. The consultant has used the following criteria to define the status of data:

- Data readiness of external sources;
- Data completeness of external sources;
- Data availability;
- Data necessity.

The result shows that only 50 subgroups or 56 excel sheets in the database have met the above criteria, which can be seen in Table 3.1-1.

3.1.2-2 Prepare data update and maintenance plan

After the consultant has finished checking the database status, the consultant has developed a plan for data update and maintenance. The data for updating normally are in the form that cannot directly be imported into the database such as excel files, hardcopy documents and information on any related websites. These data need to be transformed into a format that can be uploaded to the database using the database management software's functions. The plan has completed since the Interim Report.

3.1.2-3 Develop data maintenance method

Database maintenance is the other important work. In TDMC IV project, the consultant has provided the DVD-Writer to be a device for backing up the data. In case of emergency, OTP can recover the data in a short time even though the data are from many sources. In TDMC V, the consultant has developed a more appropriate way to improve the maintenance process, which summarized in the database maintenance manual.

3.1.2-4 Develop database maintenance manual

The consultant has submitted database maintenance manual to OTP. The manual has also included an Appendix of a Thai translated oracle database manual, which can be applied to use with OTP database environment. The content of the manual are consist of:

- Back up process;
- Oracle database installation on a new operating system.

3.1.2-5 Prepare plan for data update

After the consultant checked the data status in the database, the consultant has concluded the plan for data update including the source that cannot be imported into the database directly such as excel file, document and information on the related website. This kind of raw data needs to be transformed into the format that can be uploaded using the database management software functions. The plan was ready and informed to OTP since the Interim period.

3.1.2-6 Study data maintenance methodology

Database maintenance is one of the important parts that the consultant concerns. In TDMC IV project, the consultant provided the necessary devices, DVD-Writer, for OTP to back up the data in a suitable medium. In case of emergency, OTP can recover the data in a short time even though the data are from many sources. In TDMC V, the consultant already analyzed and got an appropriate way to improve the maintenance process which will be transformed into the database maintenance manual.

3.1.2-7 Develop database maintenance manual

The consultant has provided database maintenance manual to OTP already. Moreover, the consultant translated the oracle database manual into Thai language and apply it to use with OTP database environment. The complete version is sent to OTP to determine already and will be officially published when OTP needs. The contents will consist of

- Back up process
- Oracle database installation on UNIX which will be used for new installation of operating system

3.1.3 Data maintenance and update

After the consultant has finished checking the database status, the consult has also studied the data, to be updated, from external sources, which can be summarized as follow:

- From 128 subgroups, only 50 subgroups are available.

The consultant has already updated all 50 subgroups.

3.1.4 Design and develop MIS website for internet and intranet

The consultant has developed the MIS website in TDMC IV. In TDMC V project, the consultant has prepared a development team and a plan for website's functionalities improvement.

The consultant has reviewed the MIS website development process to identify additional functionalities which could improve the performance of the website.

The existing website has a problem; the website does not allow uploading multiple files (chapters of a report). In TDMC V project, the consultant has solved the problem by modifying the software to support multiple files uploading so that each file will be smaller and use less time to upload. The system has 2 input panes: the first is for the administrator and the second is for general user.

3.1.5 MIS, GIS and Model Integration

The MIS, GIS and Model integration is the most important task in TDMC V project. Since the new system can be utilized for making a more efficient decision in many transportation related projects. The consultant has studied the OTP needs then developed the database and software to fulfill those needs. This task consists of the following steps:

3.1.5-1 Develop the integrated database concept

During June to July 2006, the consultant has developed the integrated database concept to be a basis for the new system as shown in Figure 3.1-1

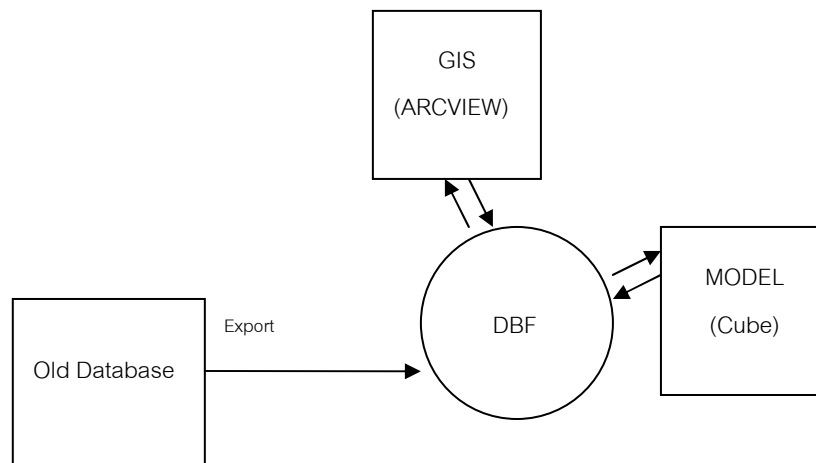


Figure 3.1-1 The integrated database concept

3.1.5-2 Study of the imported and exported data among GIS, MIS and Model

Since June 2006, the consultant has studied some inputs and outputs among GIS, MIS and Model, which are DBF files from GIS and Model, in order to make sure that the files can be imported and exported to and from the system. The consultant has also defined the file formats to be used in the system. The design tasks are as follows:

- Design and develop database
- Design and develop application for data export from MIS
- Design and develop application for data update in GIS and Model

The design tasks have already finished since January 2007. These tasks are done in parallel with the study of the imported and exported data among GIS, MIS and Model. Since the consultant has to simultaneously study and design both database and application. Currently, the consultant has finished this integration system among MIS GIS and Model.

3.1.6 Upgrade equipments in computer room

During TDMC III and TDMC IV projects, the database has stored a large amount of data which makes hard disks cannot hold any more data. Then the consultant has decided to improve these devices in order to have a better performance. The tasks are as follows:

3.1.6-1 Study data storage devices and the improvement and maintenance method

Since June 2006, the consultant has studied the server which includes the installed software in TDMC server. The consultant has analyzed all software installed since TDMC II and found that there were a lot of difficulties to reinstall them again so the consultant chose to add a more bigger hard disk into the server and port applications from TDMC III, TDMC IV and TDMC V into this new hard disk.

3.1.6-2 Upgrade data storage and performance tuning

After the study of data storage and database maintenance method was completed in August 2006, the consultant has installed the new hard disk to the server which provides more space to support future data for many years to come.

3.2 Development of Geographical Information System (GIS)

The success of the TDMC V project is that the GIS database for transportation planning are developed in order to be the compatible database with the data in GIS, MIS and eBUM of the Office of Transportation and traffic Policy and Planning (OTP). Relative data in transport model that are developed by the OTP are linked together. The compatibility of data transfer is encouraged in terms of GIS system design in order to achieve the most efficiency for transportation planning.

After considering the principle of city planning and data structure, the data relevant to the transportation analysis by OTP's model are categorized and made available link for query and analysis. The database and the results of transportation model in many scenarios can be displayed through this GIS system. The results of the analysis and assessment of different scenarios are simultaneously displayed and compared with by select the group of database in the existing MIS system. In the initial stage of project, the data in GIS is divided up into the eight main categories followed by the importance of the data for analysis by the existing transportation model of OTP. The data categories include:

- Group 1 Fixed Infrastructure Inventory
- Group 2 Schedule of Services
- Group 5 Socio – Economics
- Group 6 Transport Economics
- Group 17 Trip Rate
- Group 18 Vehicle Count
- Group 19 Passenger Car Count
- Group 20 Travel Time / Delay

In the early stage of TDMC V, the integration of the database in MIS and GIS is the first priority task for data integration to ensure that the database is appropriate and compatible for transportation and traffic planning, the data in MIS, GIS and eBUM. After the previous study, four existing OTP databases that are unnecessary for transport analyst can be integrated to this GIS system of TDMC V. Consequently, the GIS system for transportation planning is integrated with:

- Group 7 Environmental Condition
- Group 8 Vehicle Inventory
- Group 11 Land Use
- Group 13 Transportation Programs and Projects

The GIS structure is completely executed and the details of each task are composed of:

3.2.1 Developing GIS database

The existing database and map included in TDMC V project, including the consideration to developing the GIS database are comprehensive studies. The BMA data in the previous GIS database, TDMC IV, are the out-of-date data and network collected by the other agencies. The OTP's GIS has reached the point where the GIS data update for transportation planning are urgently required. By remote sensing technology, the accuracy of the existing network shall be increased by overlaying with the satellite images and creating the network in the new transportation layer.

The BMA data around 2,000 km² from IKONOS satellite image are gathered in this project and then divided into 20 sections as shown in Fig 3.2-1. In addition, BMA area not included by the IKONOS image is integrated and overlaid by the completion of the remote sensing technology (see Fig 3.2-2)

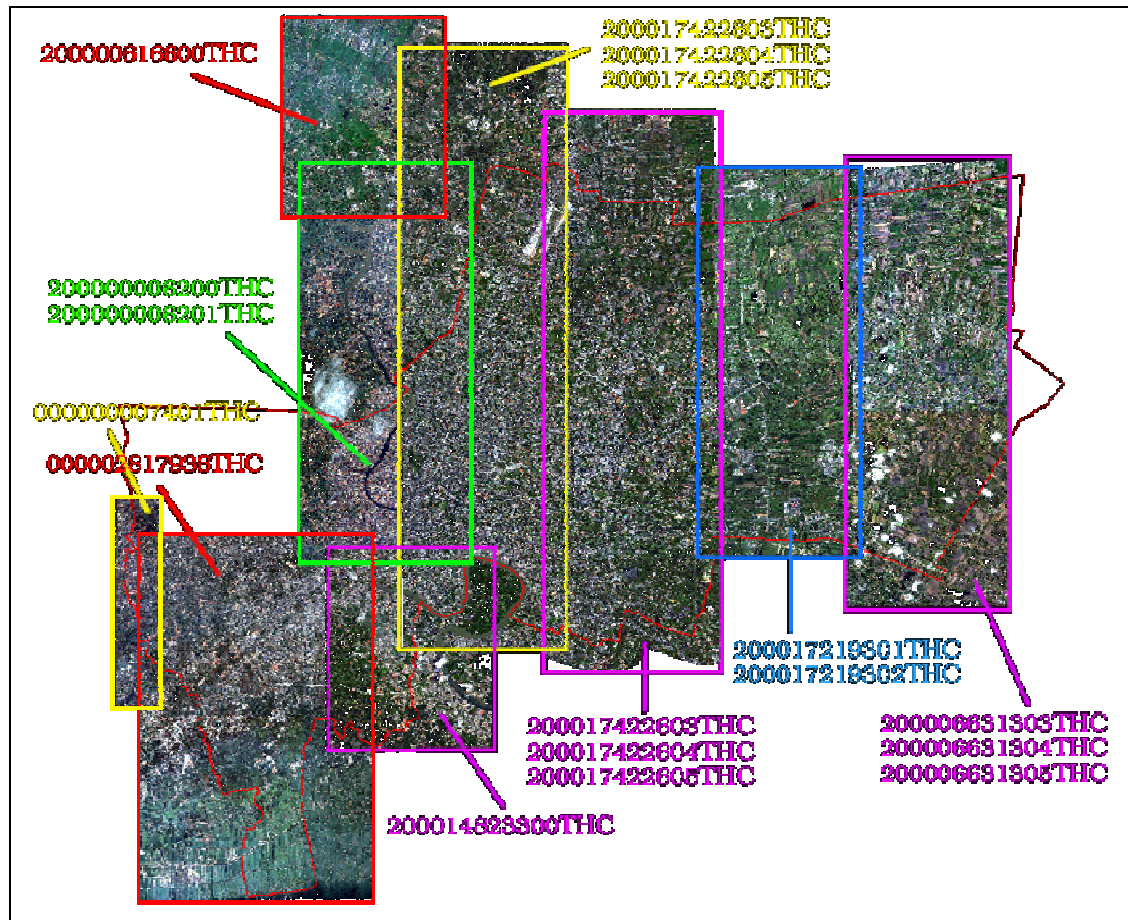


Figure 3.2-1 The satellite images from IKONOS which are used in TDMC V

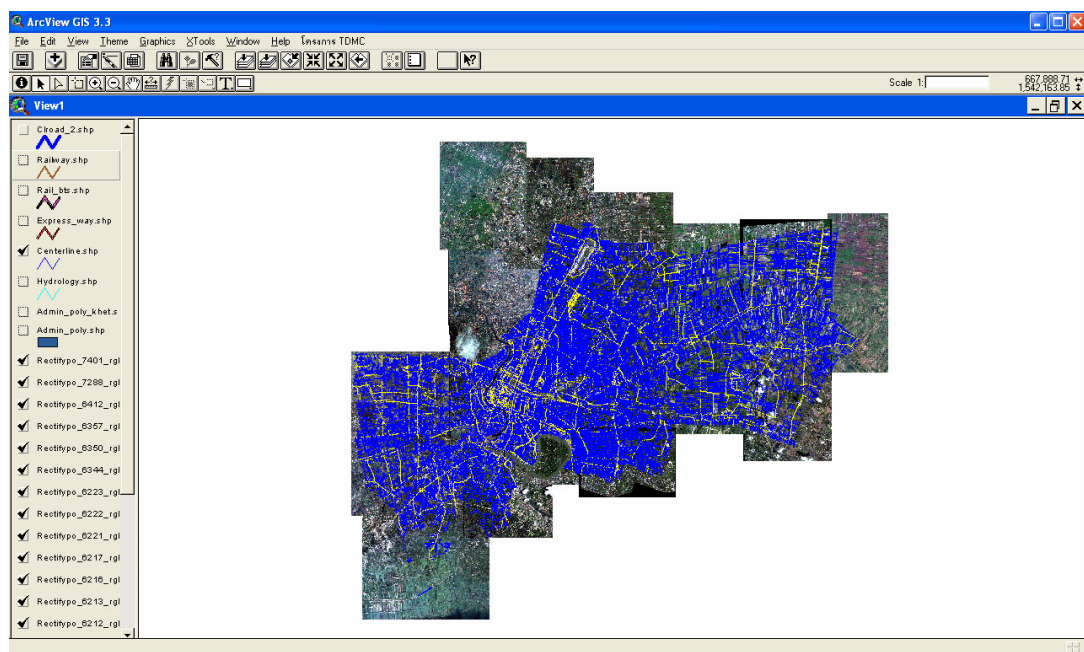


Figure 3.2-2 GIS layers which are overlaid on IKONOS satellite images after map rectification

3.2.2 The Data Linkage between GIS and MIS

The data contained in GIS and MIS system were linked together for planning and OTP Policy in BMR. The GIS is very useful for applying to many fields especially in Transportation. The GIS can be used to present road network, land use, land coverage, and so on that make transportation analysis more convenient and easily readable. The attribute data in MIS system can be linked to GIS and could present those data on the GIS map. Moreover, GIS is available for the user to make a query, search for the data and present various thematic maps.

In this project, four groups of data of GIS and MIS were integrated. They include Group No. 7: Environmental Conditions, Group No. 8: Vehicle Inventory, Group No. 11: Land Use, and Group No. 13 Transportation programs and Projects. The details of integration of these group data are as follows.

3.2.2-1 The MIS and GIS Data Linkage for Group No. 7: Environmental Conditions

There are two types of environmental data including air pollution and noise pollution in this group. These data are details of air pollution in traffic analysis zone and noise pollution in observation sites in several years. For the linkage of the GIS and MIS for this group data, it is necessary to create a new GIS point layer and join the noise observation locations to this point layer. For the air pollution, the data will be linked by using traffic analysis zone. The data are separated into layer by year. After data linkage, the maximum, the minimum, and the average of air and noise pollutions can be presented on GIS map as illustrated in Figure 3.2-3 to 3.2-6.

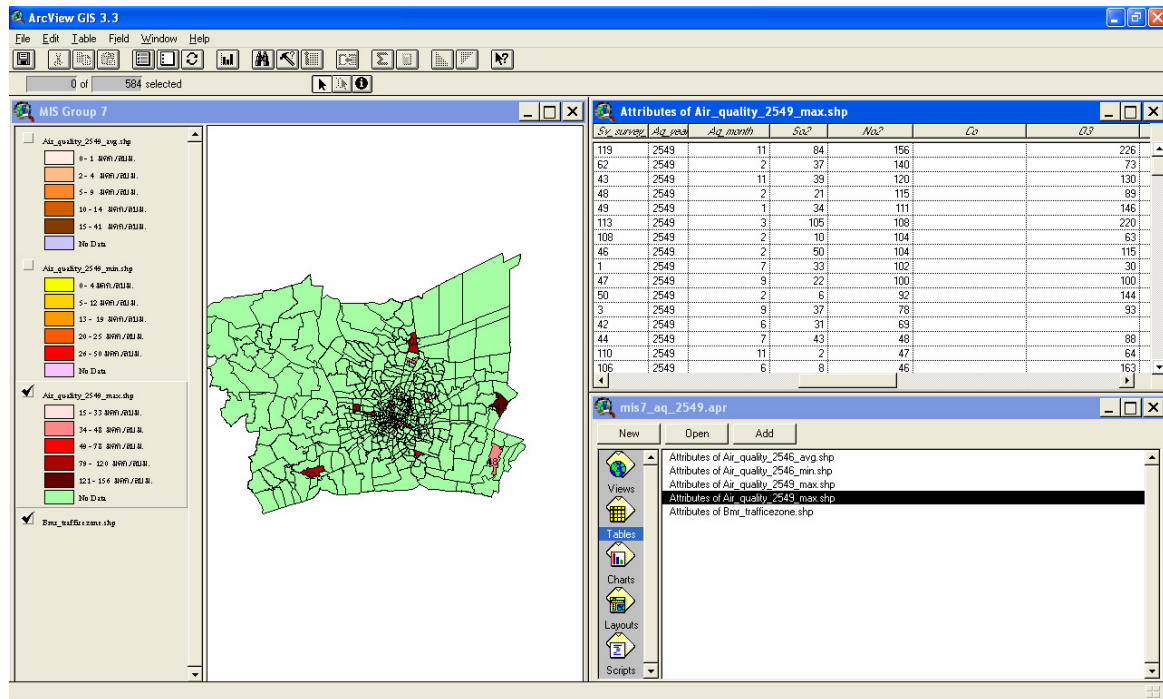


Figure 3.2-3 The maximum air pollution on GIS map in 2006

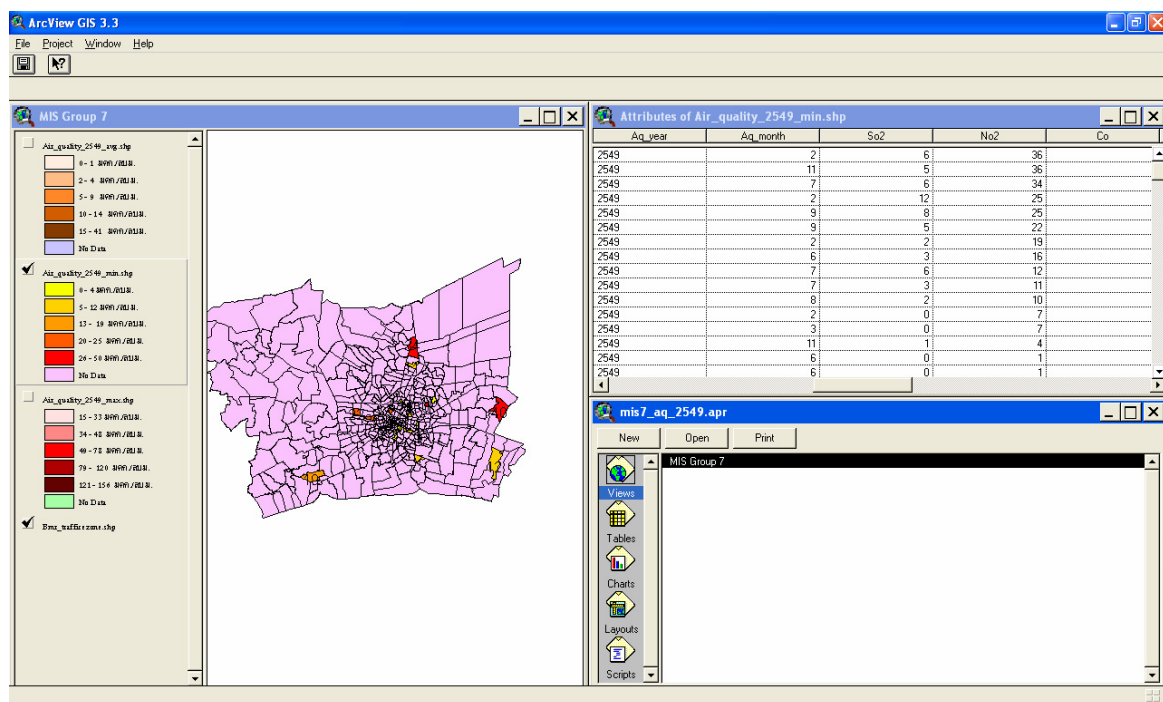


Figure 3.2-4 The minimum air pollution on GIS map in 2006

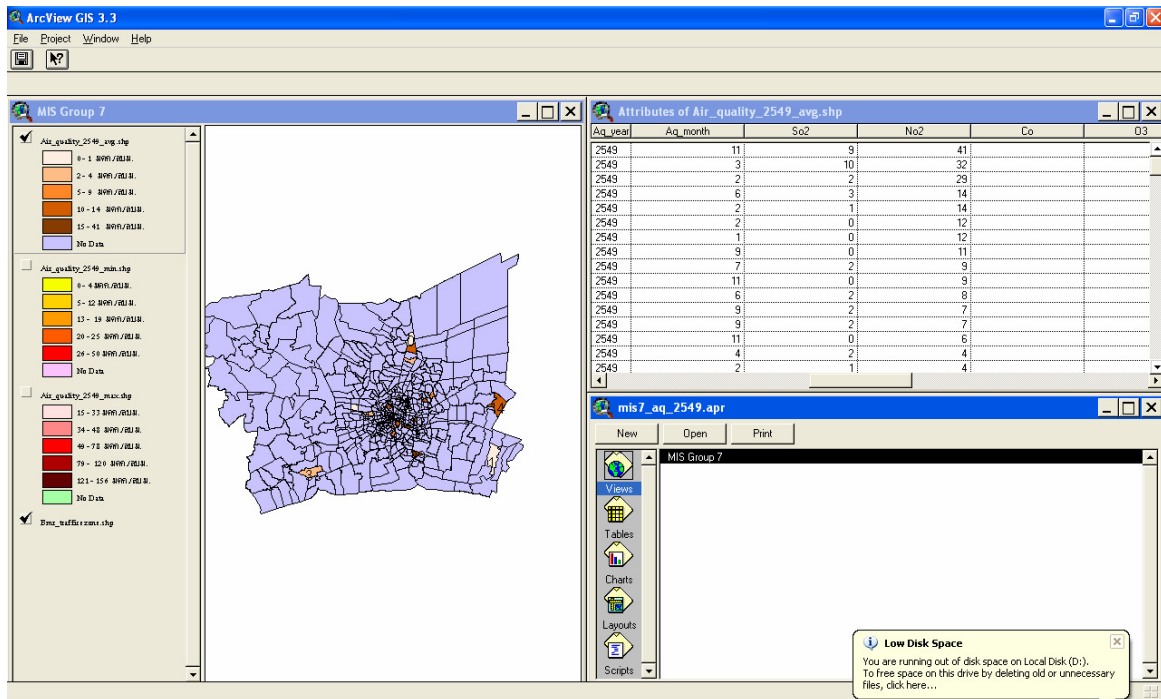


Figure 3.2-5 The average air pollution on GIS map in 2006

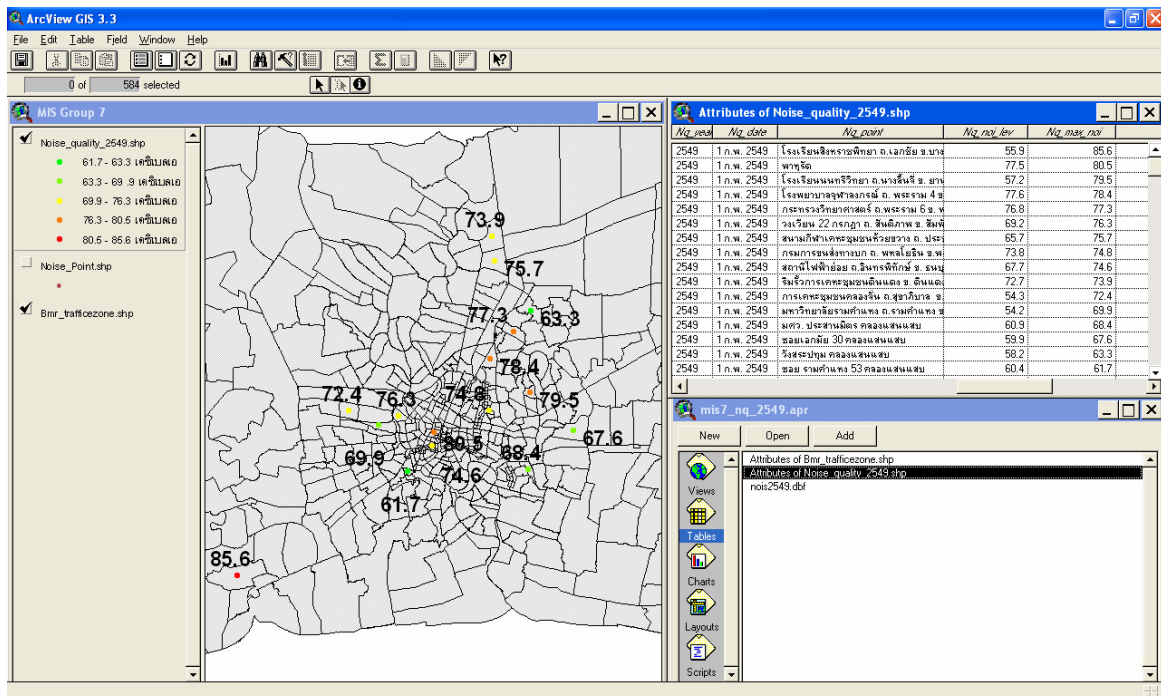


Figure 3.2-6 The noise pollution at observation locations on GIS map in 2006

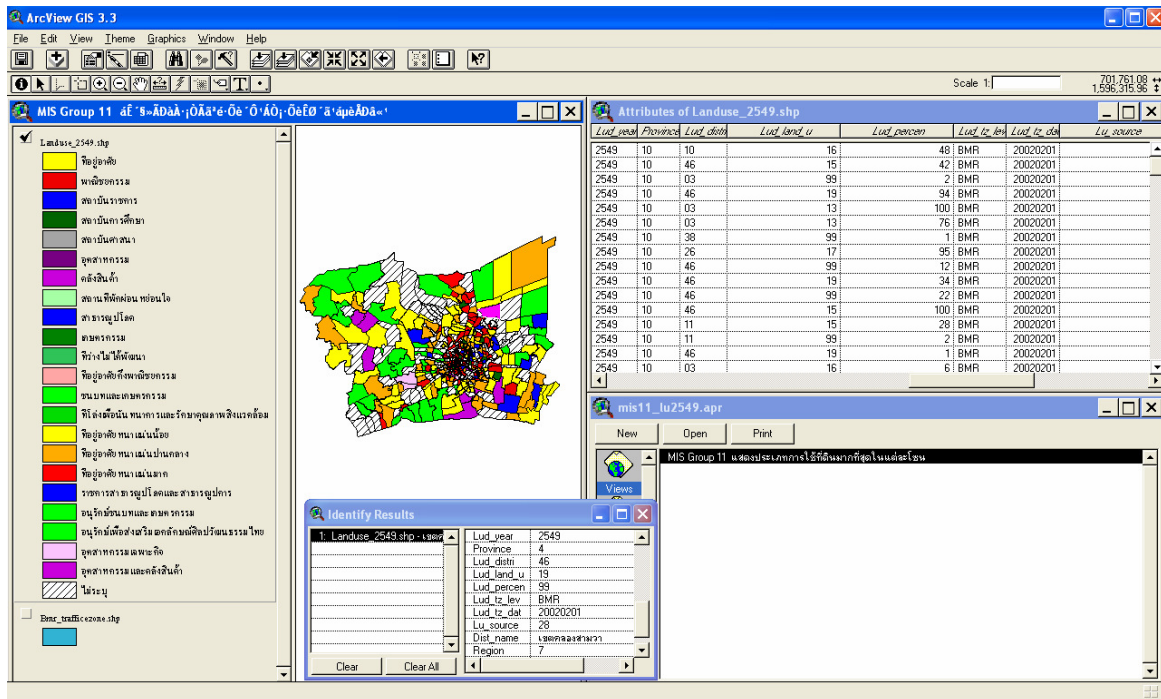
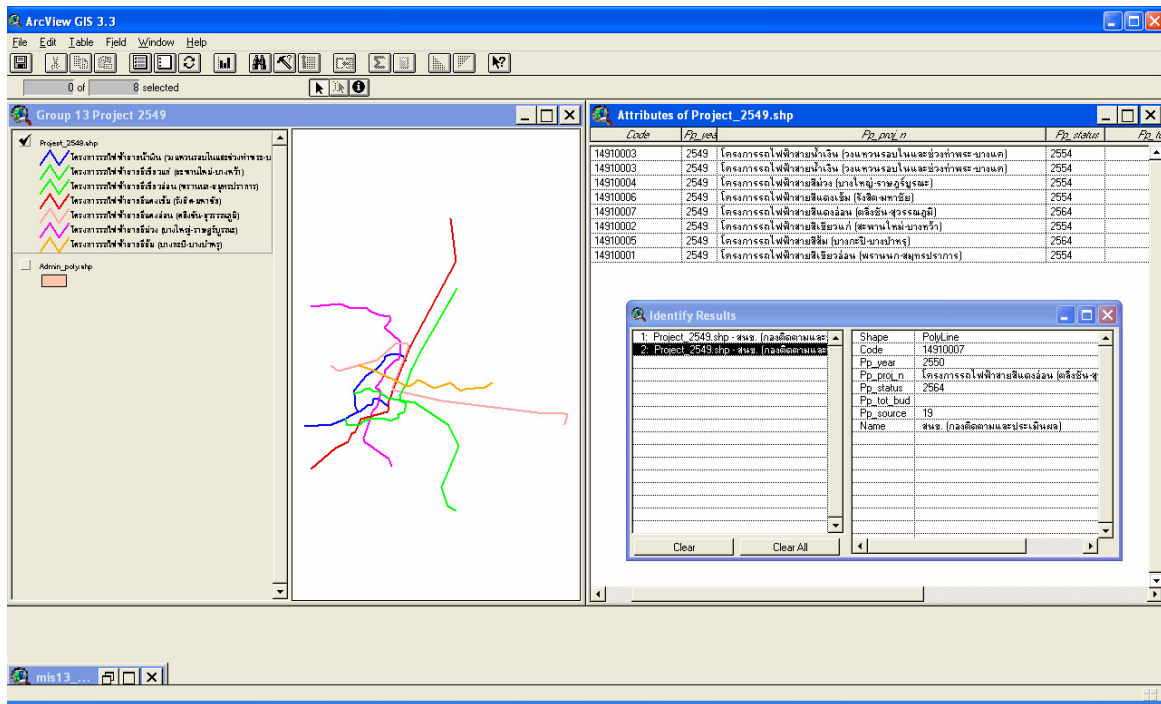


Figure 3.2-8 The land use at each traffic analysis zone in 2006 are showing on GIS map

3.2.2-4 The MIS and GIS Data Linkage for Group No. 13: Transportation Programs and Projects

The data of transportation programs and projects describe information of the transportation projects such as project name, time and cost, responsive organization. There are no data which can refer to the location so it can not be linked to GIS data. Therefore, it is necessary to create a new GIS line layer so that the transportation programs and projects can be linked to GIS. Figure 3.2-9 presents the transportation projects on GIS map.



3.2.3-1 The Adjustment of GIS Attribute Tables and eBUM Data Structure

Initially, the GIS data and data in eBUM model are adjusted in order to make them available to work each other. The integrated system can provide the users to easily correct the network on GIS. The jointed data can be managed by MIS system. From the study of the data used in eBUM, there are 4 main data required including OD matrix data, network data, economic factor, and external good matrix and external trip matrix data. It was found that only two of them, OD matrix and network data, can be linked to GIS. The details of data linkage are as follows.

- OD Matrix Data

OD matrix data of traffic analysis zones used in the model consists of population data and employment data for each traffic analysis zone. The data is in DBF format, so it needs to adjust the GIS data by adding the coding in traffic analysis zone field in GIS traffic analysis zone layer. After data adjustment, the coding of traffic analysis zones in both GIS and eBUM will be the same and can be matched together. The integrated system after matching the data is illustrated in Figure 3.2-10.

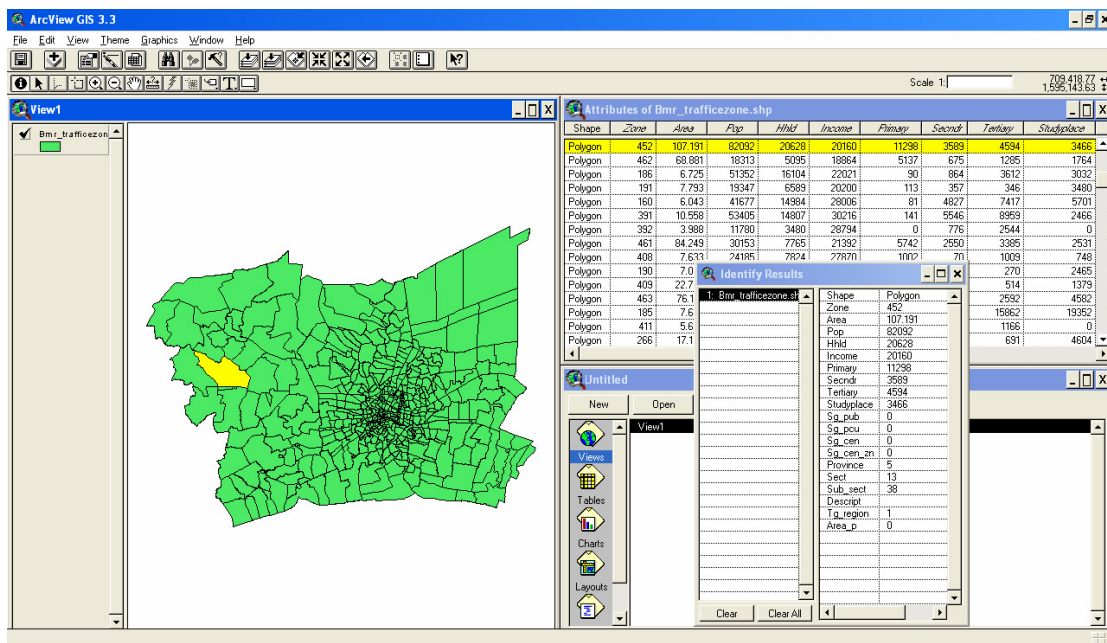


Figure 3.2-10 The traffic analysis zones layer and relating attribute data of OD matrix after GIS and eBUM system integration

- Network Data

The existing GIS system does not have the data which can be linked to network data in eBUM. It needs to be modified highway network by adding coding field. All polylines which represent roads in GIS will be added coding which is the same as eBUM. Moreover, the coordinate of end nodes of the link will also be adjusted to be the same as the stated and ended nodes in eBUM model as well. The integrated nodes and links of the system after matching the node-link data are illustrated in Figure 3.2-11 and 3.2-12.

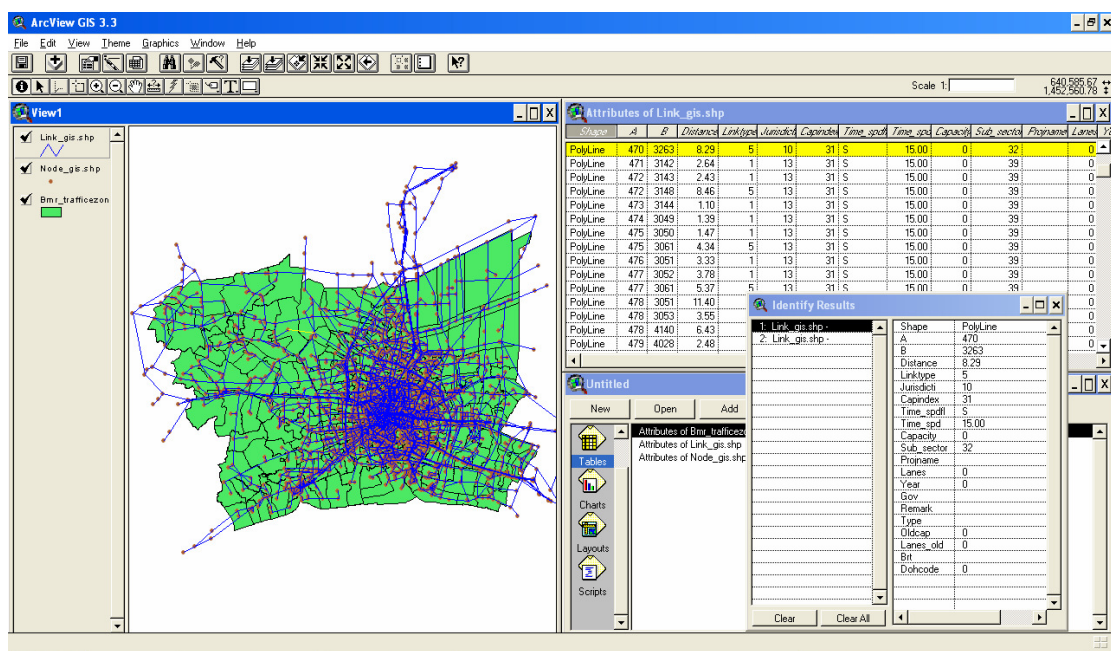


Figure 3.2-11 The road network layer and relating attribute data of nodes and links after GIS and eBUM system integration

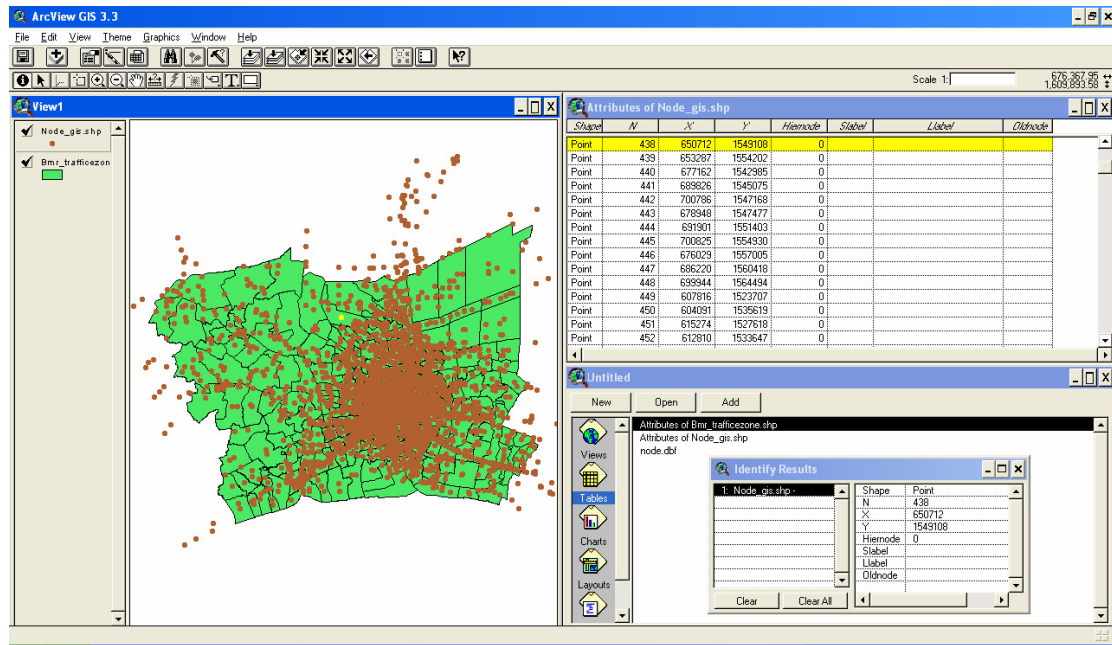


Figure 3.2-12 The coordination of nodes mapping on GIS map and related attribute node data

3.2.3-2 The Checking on GIS data after importing the coordinate data from eBUM

From GIS data checking, it was found that the coordinate of nodes and links from eBUM and GIS difference from IKONOS satellite images. Therefore, it needs to be rectified the coordination in GIS. Furthermore, the links which generated from the coordinate of nodes in eBUM are straight line and be different from such links in GIS. Therefore, the integration of GIS and eBUM can make the transportation analysis more realistic presenting. The concept of using the integration system is that users can develop links representing roads on GIS map. Then that data from GIS will be exported in the eBUM node-link format to eBUM for running 4 step model. The outputs from the model can be sent back to GIS for illustrating several thematic maps on GIS.

3.2.3-3 The adjustment of road network in eBUM

Since there are many roads in eBUM, the only main roads in the network were selected for network adjustment. The existing road networks in eBUM are double straight lines. It is different from a single line representing a road in GIS. Therefore, the road network of eBUM and GIS could not be linked directly. They must be added a field containing link code by referencing Node number. The road network from eBUM and GIS can be linked each other by using these coding

system. After linkage, the shape of road network in CUBE program could be the same as the real world actual road. The road network after adjustment is presented in Figure 3.2-13.

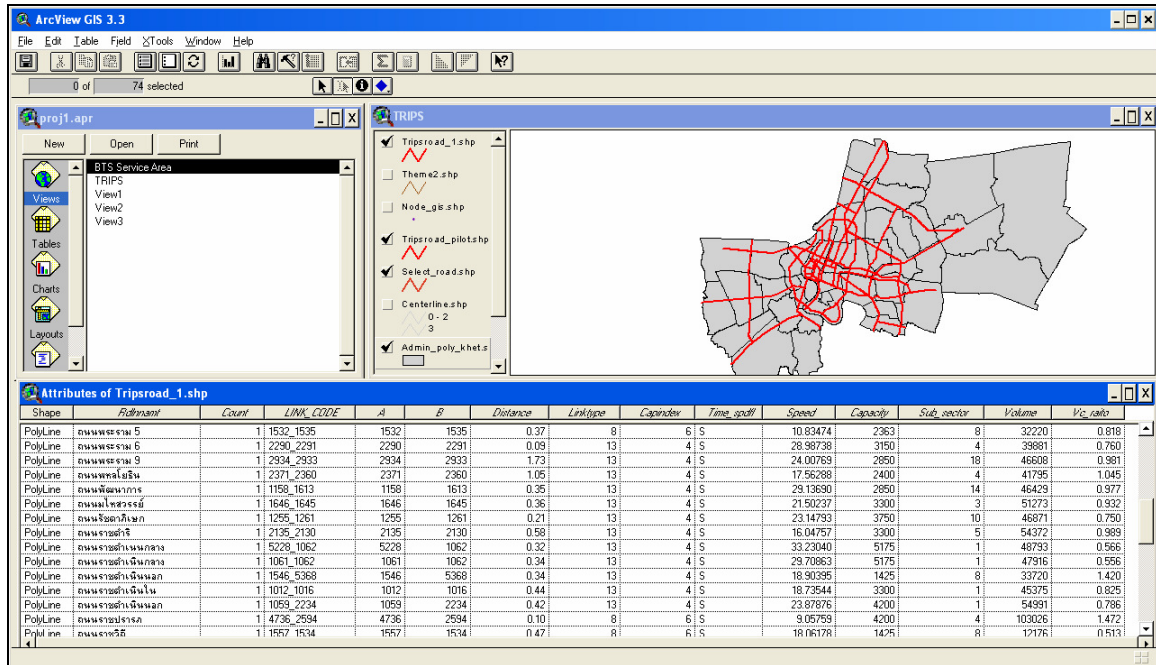


Figure 3.2-13 The road network in GIS in BMR after adjustment of road network of eBUM

CHAPTER 4 Transportation and Traffic Model Improvements and Maintenances

- Review of the transport model developments
 - The National Model (NAM)
 - Bangkok Transport Model Development and Maintenance
-

To complete the development of the transport model, the consultant has reviewed a series of steps in developing the existing transport model at detailed levels and assessed its efficiency coincidentally in order to lay an appropriate approach in developing and maintaining the transport model and also to give suggestions and recommendations in developing transport model structure. Figure 4.1 shows a series of steps in developing the transport model.

4.1 Review of the transport model developments

The consultant has reviewed the existing OTP transport model divided into two levels namely:

- The National Model (NAM), and
- The extended Bangkok Urban Model (eBUM).

The way to review the existing transport model at two levels can be explained in three steps namely:

- Reviewing the transport model application process;
- Review inputs, and
- Review parameters and mathematic relationship.

4.1.1 Review of Transport Model Application Processes

The consultant has thoroughly reviewed the application process of the existing transport model at all two levels.

Furthermore, the consultant has linked the transport model all levels together by which the outputs from the transport model at higher level can be used as boundary data for the transport model at lower level, for instance, the total number of trips traveling from/into BMR from the eBUM can be obtained from the NAM, as a consequence of an increase in the efficiency of the transport model at any analysis level. Moreover, reviewing the transport model application process has provided useful data in laying the appropriate approach in developing and maintaining the future transport model.

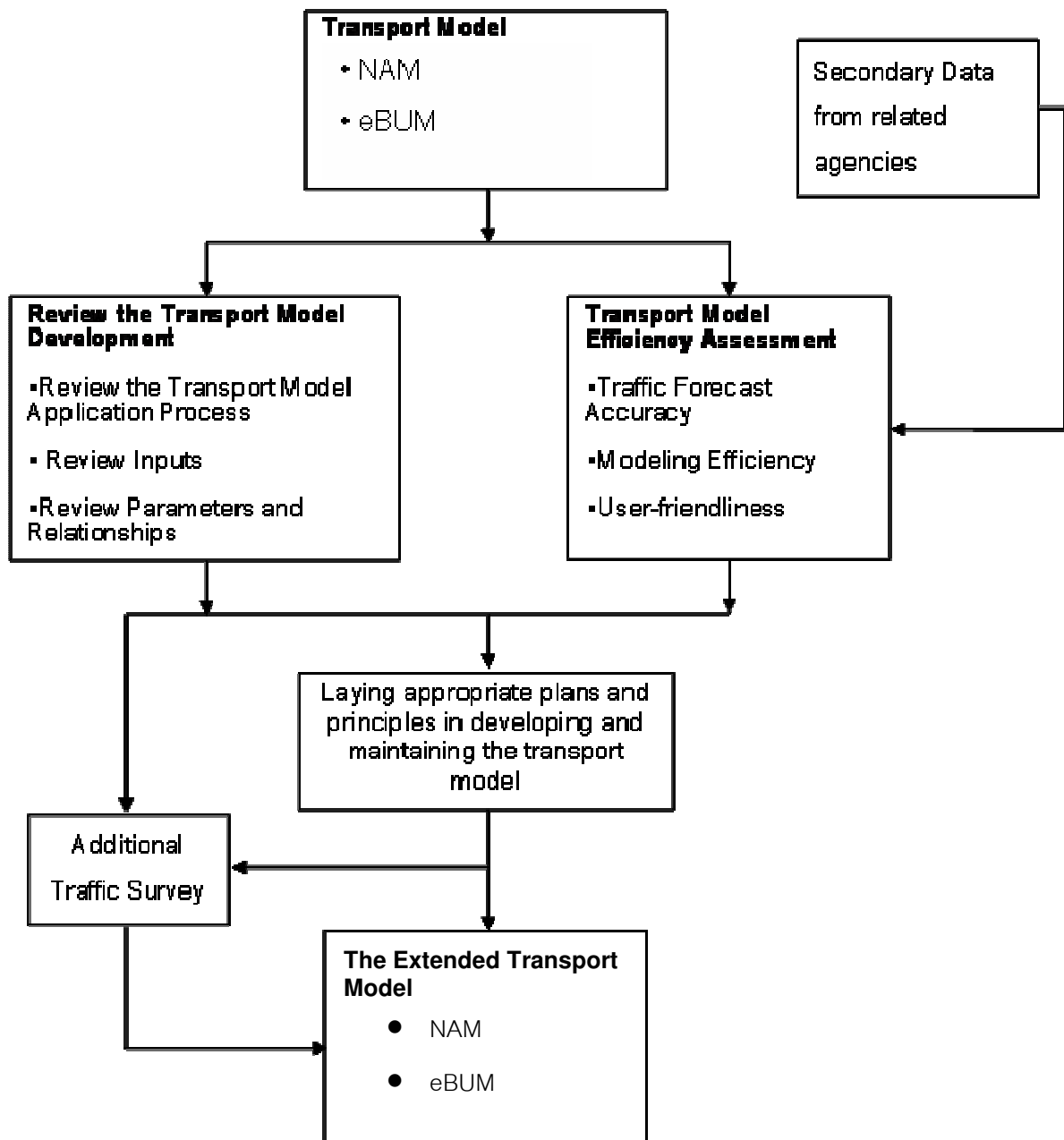


Figure 4.1 The Transport Model Development and Maintenance Process

4.1.2 Reviews of Inputs

The consultant has verified the accuracy of the coded input data used in the transport model at all two levels. With respect to traffic data such as traffic demand or socioeconomic data, the consultant has gathered the existing useful data together with the additional data from surveys and properly adapted them as a result of the most realistic final input data to produce reliable outputs.

In the previous versions of the transport model, input data at each level of the transport model were coded separately but input data (such as traffic demand network) at all levels of the transport model in the enhanced transport model has been gathered to a single database, as a result of time saving and the reduction of errors in editing input data.

4.1.3 Reviews of Parameters and Mathematical Relationships

The transport model developed by OTP comprises many mathematical equations in which each equation may consist of many parameters reflecting traveler behavior and network service characteristics. The consultant has revised and adapted parameters at two levels of the transport model to be more realistic and also reviewed the rationality of mathematical equations in the transport model in order to enhance the transport model as a consequence of more reliable outputs from the model.

The consultant has laid the principles to assess the transport model efficiency at two levels by which data for assessing the transport model has been gathered from properly related agencies. The principles consist of:

- Traffic Forecast Accuracy;
- Model Run Efficiency, and
- User-friendliness.

For the reason that the rate of socioeconomic change for Thailand has been so fluctuated over the years especially in BMR, the transport model needs a consistency with such the rate that may affect traffic forecast of the transport model by which the consultant has set the detailed approach in maintenance and development with respect to the modeling process and inputs (which portion of them needs to be maintained/developed once more and when is the appropriate time?). In addition, the manual explaining a series of steps in the transport model application for a specific task test in the future has been conducted.

Additionally, to set the detailed approach in maintenance and development, data from reviewing the transport model and assessing the model efficiency have been used as well. The advantages of the transport model after maintenance and development are as follows:

- Better user interface;
- Data such as model structure characteristics at each level are all in one single database as a result of the more efficacious transport model;

- Accurate modeled outputs, and
- Better connectivity between the transport model at levels.

Besides, the consultant has developed NAM for daily assignment and eBUM for AM peak, PM peak and daily assignment during the base year 2006 and the project year 2011, 2016, 2021, 2026 and 2031.

4.2 The National Transport Model (NAM)

The consultant has gathered and reviewed planning data (such as population, GDP, traffic counts, network and so on) from previous study projects particularly from TDMC IV projects and also updated and adjusted those data properly as a consequence of more accurate outputs from the transport model. The maintenance and development process of NAM can be explained this point onward.

4.2.1 Network and Transport Service Update

The consultant has updated the transport network for all transport modes including transport services by reviewing the existing database and then appropriately updated them from the obtained data. The transport network consists of passenger network and freight network. The data needed for updating the transport network are both primary and secondary. The primary data from OTP and related agencies are as outlined below:

- In course of travel
- Attitudinal survey
- Vehicle count
- Passenger count
- Trip rate
- Travel time/delay

The secondary data from both OTP and related agencies are as follows:

- Socioeconomic
- Land use
- Freight volume
- Fixed infrastructure

- Vehicle inventory
- Schedule of services
- Environment
- Transport economics
- Road accidents
- Tourist
- Traffic and Transport at regional city
- Programs and projects

Furthermore, data from related agencies such as Ministry of Transport or Nation Economic and Social Development Board have been obtained in order to review all project plans relating to the transport network, services and other useful aspects of the transport model.

4.2.2 The National Model (NAM) Improvement

TDMC V project has subdivided Thailand into 926 zones, according to Amphur boundary, including 11 external zones from adjacent counties accounting for 937 zones altogether. The consultant has gathered planning data and updated highway network among Amphurs in order to increase the accuracy of highway network in the transport model. Also, the consultant has developed the national model for the daily assignment during two periods of time. The first period is the base year 2006 and the second period is the project years consisting of the year 2011, 2016, 2021, 2026 and 2031.

4.2.2-1 Approach Used in Developing the National Model

Due to the fact that OTP has been undertaking The Development of Multimodal Transport and Logistics Supply Chain Management for Implementation of Action Plan at the same period of time as this project that is relevant to freight distribution by transport modes, the TDMC V consultant has cooperated closely with the consultant from that project in order to obtain useful data and use them for developing the National Model with respect to freight transportation.

4.2.2-2 NAM Structure

The new national model is essentially a classic four step transport model, nevertheless, there is a limitation when an analysis of logistics policy is required especially when low cost airlines or No Frill Airlines (NFA) system is taken into consideration. This is

because when NFA system is coded into the network, traffic demand will increase significantly not only from diverted demand but from generated demand also. Therefore, the consultant has developed the model structure by putting an automatic feedback loop into the national model structure as illustrated in Figure 4.2-1.

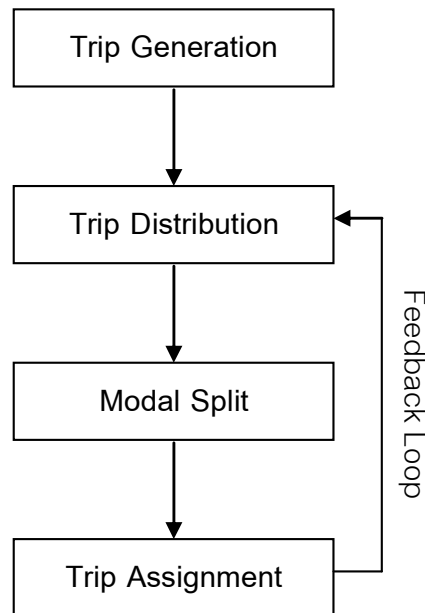


Figure 4.2-1 The Developed National Model Structure

4.2.2-3 NAM Model Validation

The consultant utilized traffic volume from 4 screenlines to validate NAM stability. These screenlines are presented in Figure 4.2-2. The processes of model validation are summarized in Figure 4.2-3 and the results of NAM validation are summarized in Figure 4.2-4 - 4.2-6. Furthermore, results from NAM model development and improvement can be summarized as shown in Table 4.1-4.2. From the summary tables, the results found that both person trips and freight transportation are increasing to 9.42 million-trips/day and 6.56 million-tons/day in year 2031 from 2.45 million-trips/day and 1.39 million-tons/day in present (year 2006) respectively. Hence, there could be summarized that, in year 2031, the number of both person trips and freight transportation will be increased about 5% and 6% per annum respectively.

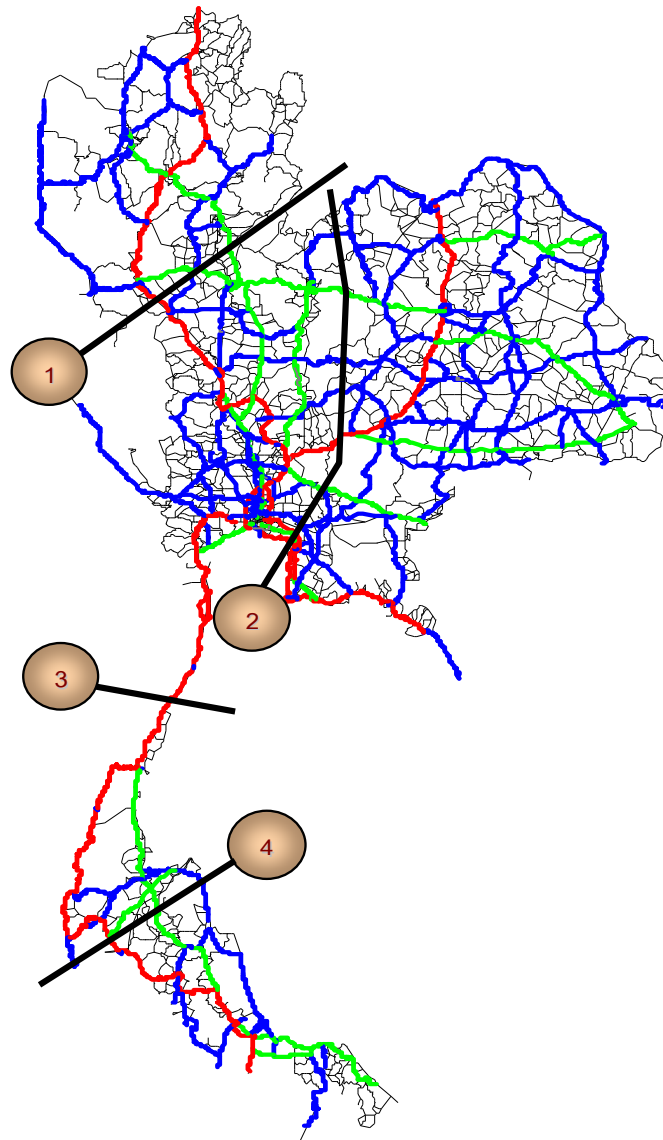


Figure 4.2-2 Screenline locations used for NAM model validation

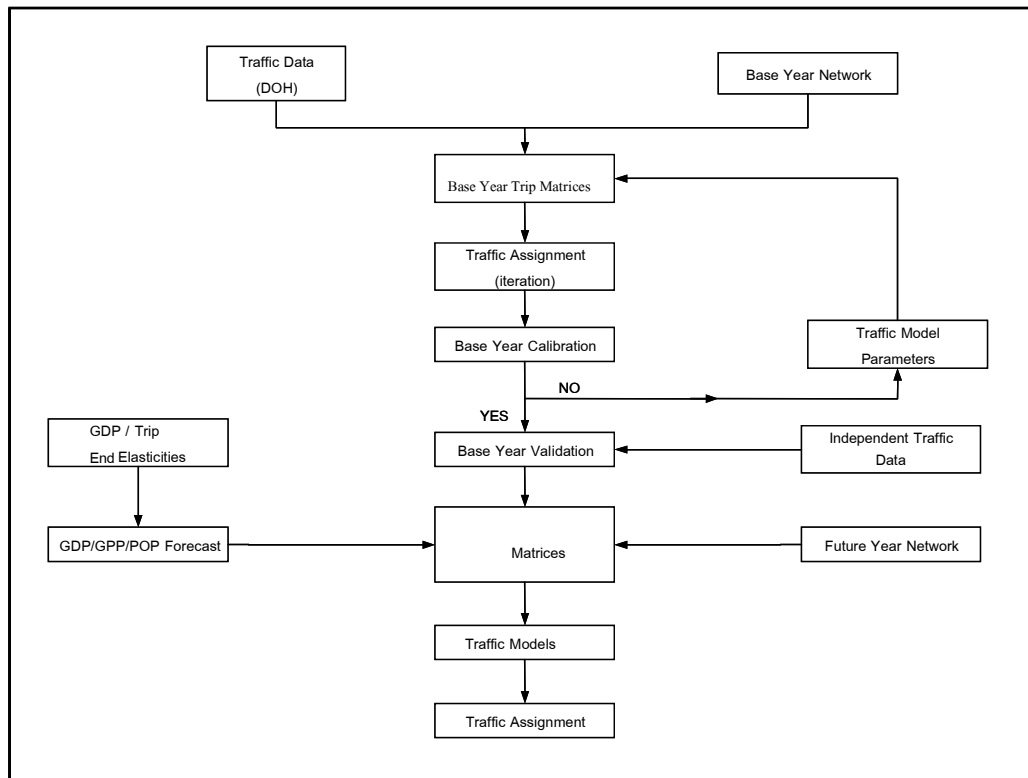


Figure 4.2-3 NAM model validation processes

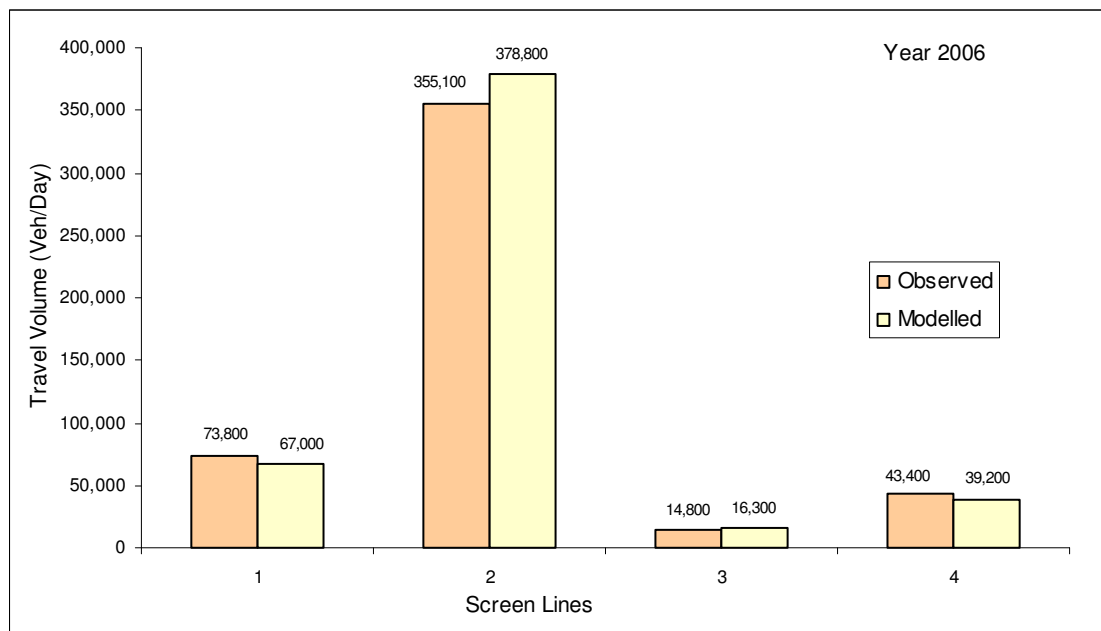


Figure 4.2-4 The number of passenger cars comparing between survey results and NAM results

(Unit: vehicles/day)

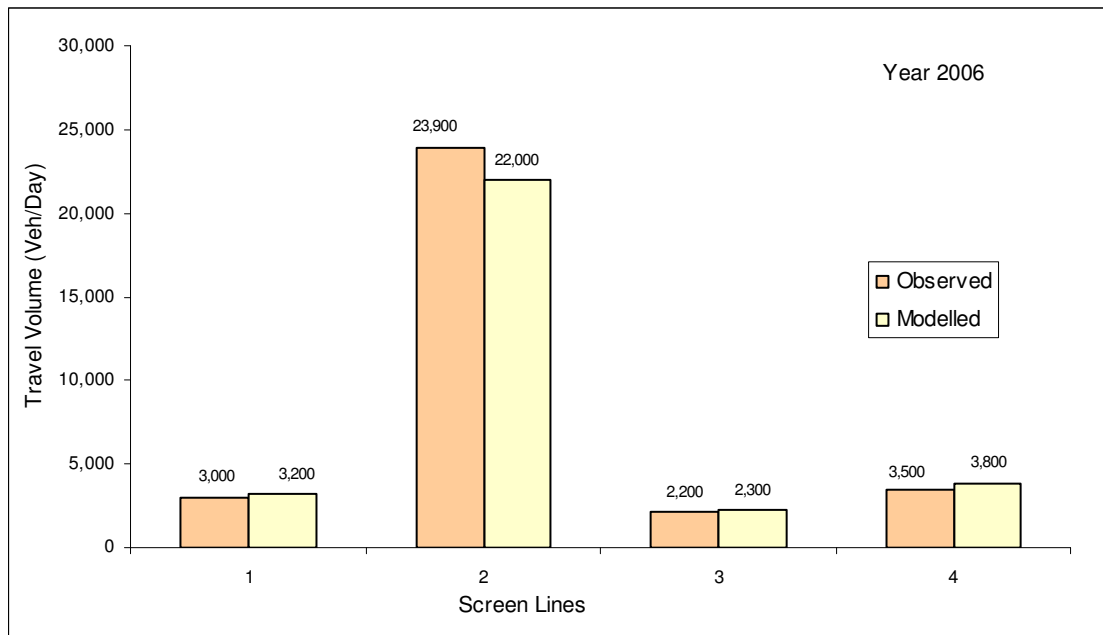


Figure 4.2-5 The number of buses comparing between survey results and NAM results

(Unit: vehicles/day)

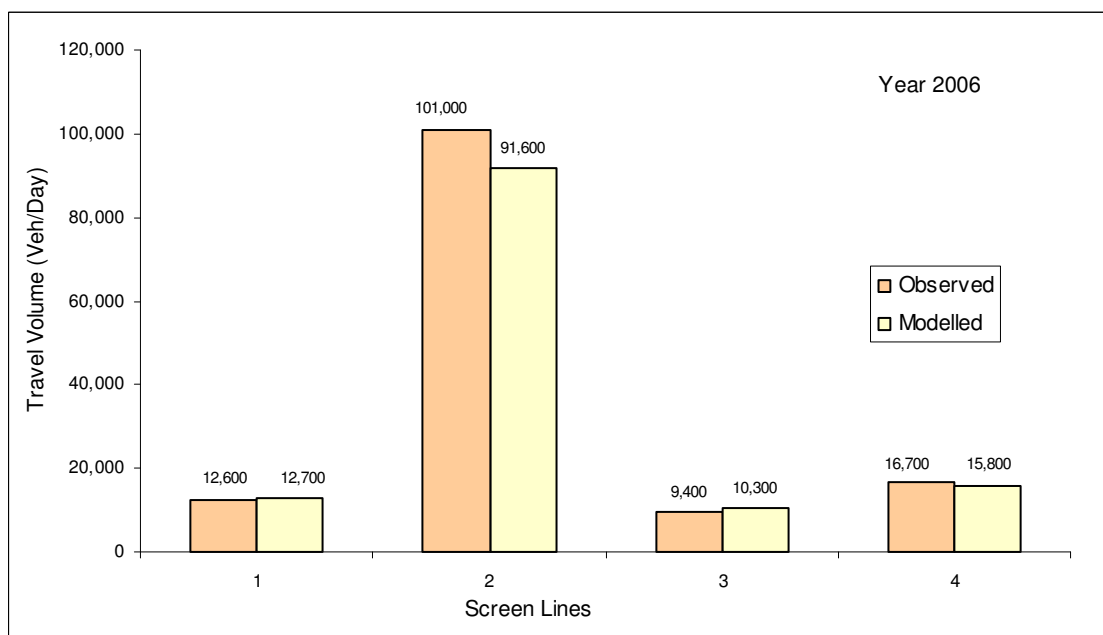


Figure 4.2-6 The number of trucks comparing between survey results and NAM results

(Unit: vehicles/day)

Table 4.2-1 Results of person trips from NAM (1,000 trips/day)

Travel Mode	2006	2011	2016	2021	2026	2031
Passenger Car	1,401	1,865	2,455	3,244	4,205	5,422
Bus	852	1,133	1,495	1,931	2,513	3,253
Train	172	229	300	386	501	646
Air Transportation	29	38	50	65	84	107
Total	2,454	3,265	4,300	5,626	7,303	9,428

Table 4.2-2 Results of freight transportation from NAM (tons/day)

Travel Mode	2006	2011	2016	2021	2026	2031
Road	1,180,272	1,777,793	2,389,820	3,111,248	4,153,617	5,546,039
Train	41,561	62,603	84,155	109,559	146,265	195,297
Water	174,720	263,174	353,775	460,571	614,877	821,003
Air	148	216	291	390	521	695
Total	1,396,701	2,103,786	2,828,041	3,681,768	4,915,280	6,563,034

4.2.2-4 NAM Details in TDMC V

In TDMC V project, the consultant has improved the freight part of the NAM model from the Development of Multimodal Transport and Logistics Supply Chain Management for Implementation of Action Plan project, which has used Cube Cargo for the export, import and cross border freight movement, to extend the model to include the freight consumed in Thailand. The structure of the improved model is shown Figure 4.2-7 and 4.2-8. Further more, the consultant has also incorporated the Multi-Class assignment as in the eBUM model into the NAM model as shown in Figure 4.2-9.

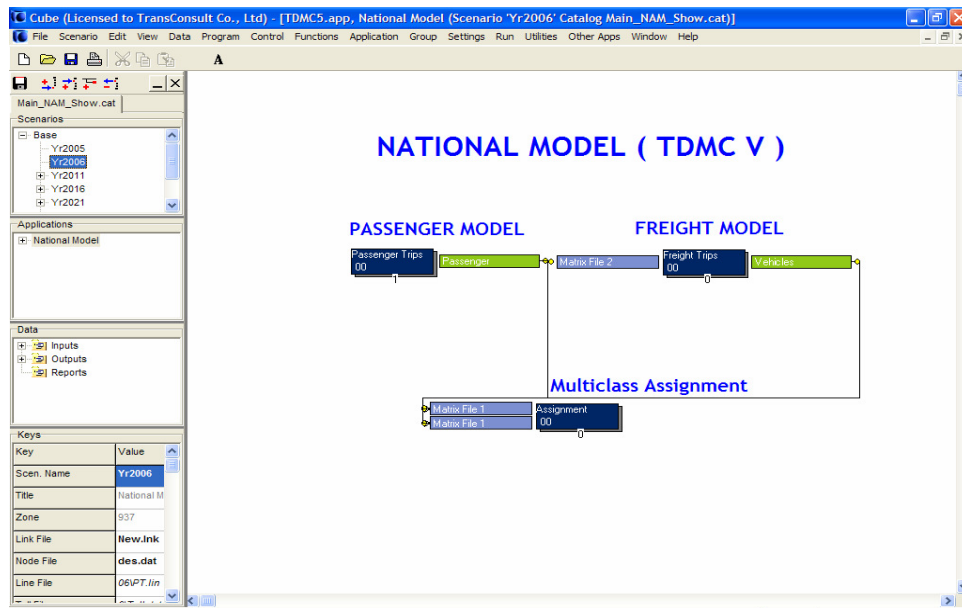


Figure 4.2-7 NAM Structure from TDMC V

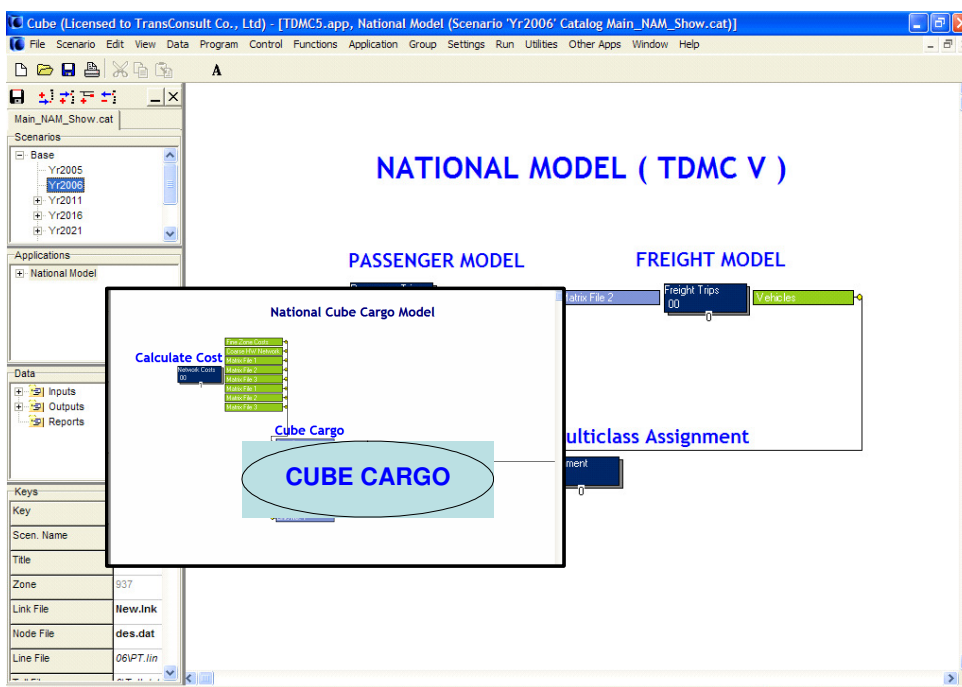


Figure 4.2-8 NAM Freight Model Structure for TDMC V

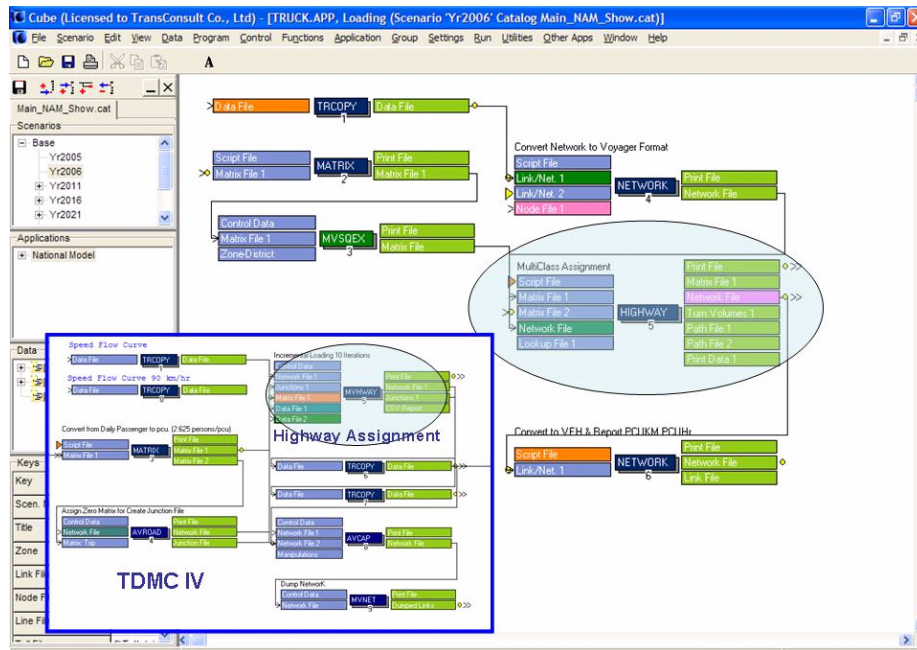


Figure 4.2-9 the NAM Multi-Class Assignment model

4.3 Extended Bangkok Urban Model (eBUM)

4.3.1 Bangkok Transport Model

During the previous project, TDMCIV the project team introduced the new enhanced model for the Bangkok transport model which is now described as eBUM or the extended Bangkok Transport Model. During this project further enhancements were added to the transport model.

The continued development of the transport model structure included three stages during this project namely:

- Stage 1 – Update of the Trip Distribution
- Stage 2 – Inclusion of PM Peak Analysis
- Stage 3 – Addition of External Vehicles as a Key

The trip distribution module of the transport model has now been fully converted into the Voyager structure. This also involved a simplification of the trip generation programs. Instead of having a very detailed set of control boxes for trip distribution, all of this is now included in one simple program.

The evening peak module has now been read incorporated in the transport model. All of the equations from the original new UTDm transport model were converted into Voyager structural format. However, it is the project team's opinion that for most scenarios there is no need to run the evening Peak module.

In the earlier version of the model it was necessary to manually link in every time some files from previous runs. In particular this was the case with the external trip tables. The external trip table is now linked in as a Voyager key. Now when running a new scenario there is no need to copy any files into the scenario sub directory before execution of that scenario.

In this project the model structure has been modified and continues to utilize the new catalogue feature of the Cube Voyager software but now incorporates additional features. As it is normal with these projects, this project incorporates two examples of the use of the model and a new validation for the year 2006. In addition during this project a user manual was developed for the Bangkok transport model. There is also significant enhancement to GIS features within the transport model.

The new generation model, eBUM incorporates not only the catalogue feature of Cube but also many of the transport modules are now written in Voyager software script. The opening Cube view of the new model is presented in Figure 4.3-1 whilst the input window for the keys is shown in Figure 4.3-2.

The second new feature is now the more of the transport modules have now been converted into the Cube Voyager script. Previously many of the reporting features of the model were developed in database software, these reporting programs will now all be written in Voyager Script.

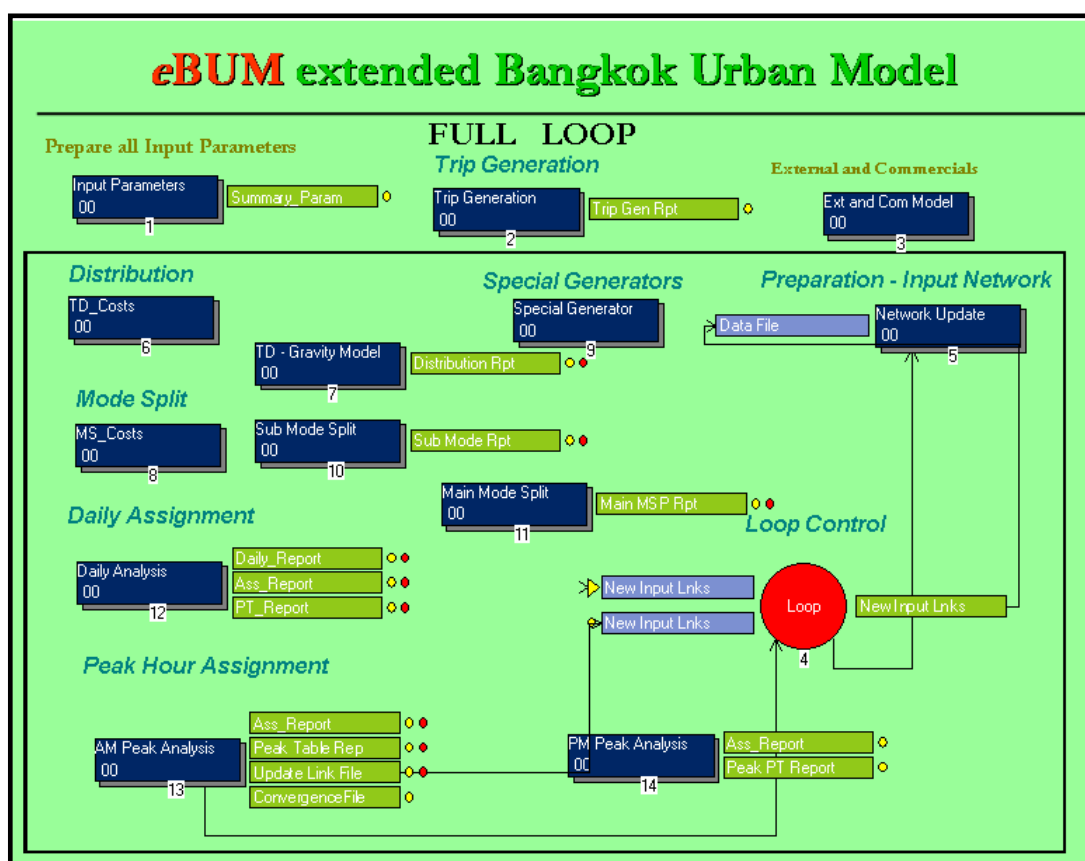


Figure 4.3-1 The New Bangkok Transport Model

Scenario - TDMC5.Yr2026 (Application Project_Master_Loop)

eBUM (extended Bangkok Urban Model)

Title (First 60 Characters Used in Some Reports) For Year 2026 TDMC-V project

Economic Factors 2.085

Fuel Cost Factor 2.1

Scenario Year 2026

Input network Link File C:\eBUM\Project\TDMC5\LNK25_TDMC.DBF Browse ...

Node File in Database Format C:\eBUM\Project\TDMC5\ND25_TDMC.DBF Browse ...

Input Transit Line File in TRIPS Format C:\eBUM\Project\TDMC5\PT_05.lin Browse ...

Database of Toll Files C:\eBUM\Project\TDMC5\Toll25NT.DBF Browse ...

Enter Turn Ban File C:\eBUM\Project\TDMC5\TRNPEN.DAT Browse ...

Number of Zones 625

Full Demographic Input File C:\eBUM\Planning\DEMO-26.DBF Browse ...

External and Internal Commercial Vehicles File C:\eBUM\INPUTS\Ext_Com\TDMC\EXT_COM26.MAT Browse ...

Set the maximum number of Loop Iterations 10

Percentage Peak Convergence Desired 10

Specify the BRT Route Number, NUMERIC ONLY-Reduces Capacity on Road 0

OK Cancel Run

Figure 4.3-2 The Input Menu Screen for the New Bangkok Transport Model

The New Bangkok Transport Model – Validation

Although *eBUM* was validated against available data in 2005, it was a requirement of this project to validate the Bangkok transport model in 2006. Thus from this point onwards, the base year for *eBUM* is 2006. In order for this validation to proceed, the consultant adopted as input into this procedure the planning data for year 2005 developed for OTP during the IMAC study.

In the earlier model validation there was only one mass transit line in operation in Bangkok. However now in 2006 there are two mass transit operations in Bangkok namely the Green Line or BTS and the Blue Line or the Underground system. The newly validated model estimates that the Green and Blue Lines in 2006 attract 431,000 and 237,000 passenger boardings per day respectively. This compares with an observed average ridership of 420,000¹ and 220,000 passengers per day respectively for the Green and Blue Lines. This is a difference of 3 and 8 for the Green and Blue Lines respectively, see Table 4.3-1.

¹ These ridership estimates are daily average provided by the two operators in 2006.

Table 4.3-1 Model validation for BTS passenger in 2005

BTS Line	Model (persons/day)	Survey (persons/day)	Differences (%)
Green	431,000	420,000	3
Blue	237,000	220,000	8

To ensure model stability the model loop was executed through several iterations for the year 2006. These iterations guaranteed the stability of the model after the inclusion of the impact of congestion. The model results were then compared across three screenlines for passenger movements where there was appropriate data. The screenlines are shown in Figure 4.3-3 and described in Table 4.3-2. The results from the vehicular screenlines are presented in Table 4.3-3. The traffic crossing the river included all bridges between the Western Outer Ring Road and the Rama IX bridge inclusive.

Table 4.3-3 also presents a Screenline comparison for vehicular movements across the river whilst Table 4.3-4 presents all passenger movements across three relevant Screenlines. In all cases the results are well within the benchmark of 15%².

² In the earlier Urban Transport Database and Model Development(UTDM) project for OTP, the maximum variation for road Screenlines was set at 15% and for public transport at 25%.

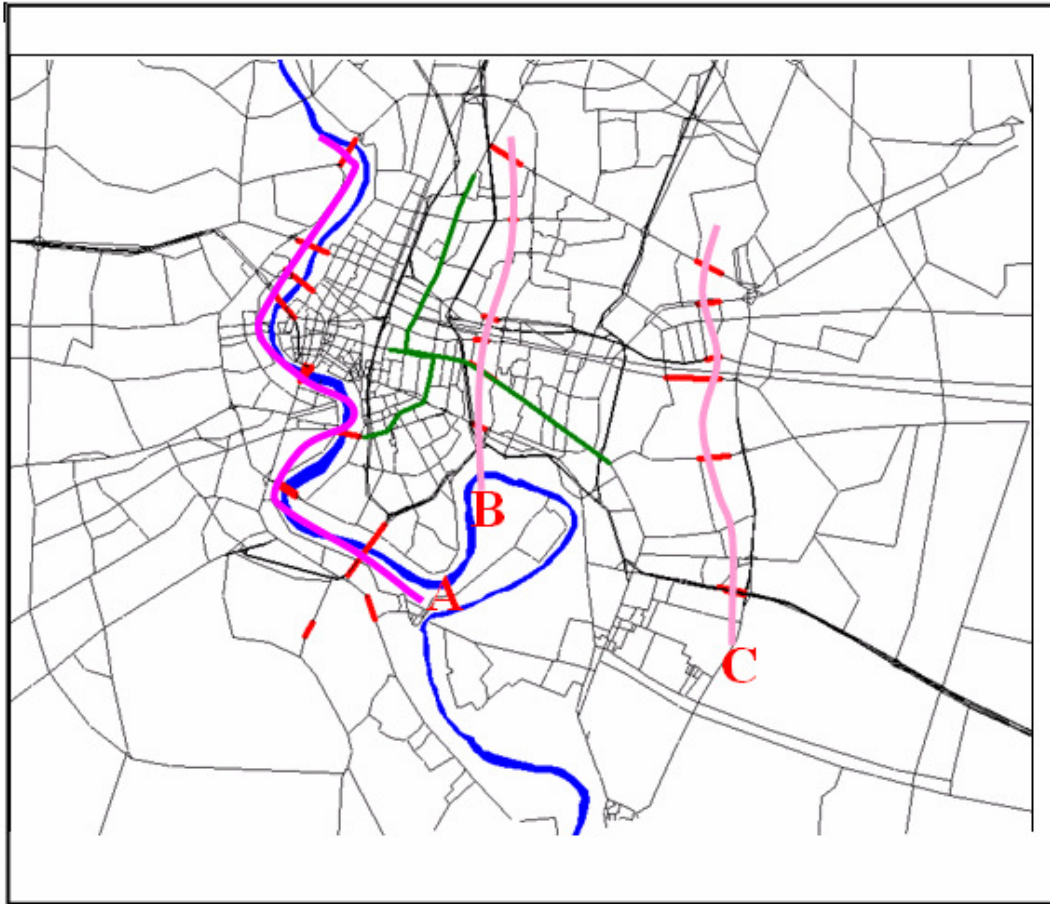


Figure 4.3-3 Locations of Person Screenlines

Table 4.3-2 Screenline Description

Screenline	Name	Description
A	City River Bridges	All Inner City Bridges from Rama VII Bridge South to Rama IX bridge
B	Inner East	Screenline from Lat Phrao in the North to Rama IV in the South.
C	Outer East	Screenline from Bang Kapi to Bang Na.

Table 4.3-3 Daily Vehicular Screenline Traffic (PCU)

Screenline	Assignment	Count (Observed)	% Difference
River Inbound	690,802	684,626	0.9
River Outbound	687,574	699,665	1.7
River Total	1,378,376	1,384,290	0.4

Source: 1. BMTA Route Planning and Scheduling Study and TID II, DoH Traffic Counts from the East-West Feasibility Study. (This project counted traffic across the central river bridges and also was used to estimate growth in traffic counts from 2003 to 2006.)

2. Traffic Assignment is an estimate of the Consultant

Table 4.3-4 Daily Passenger Screenline

Screenline	Assignment	Count	% Difference
A	1,082,124	985,273	10
B	546,905	575,186	5
C	455,115	463,365	2

Source: 1. BMTA Route Planning and Scheduling Study and TID II, Growth from 2003 to 2006 is derived from the DoH's East-West Feasibility Study

2. Traffic Assignment is an estimate of the Consultant

The above comparison of screenline data results and that of mass transit estimates results in the conclusion that the model was replicating the existing situation and producing stable results, thus the model was considered validated against the base year of 2006.

Model Results

After model improvement and validation processes, the results of eBUM trip estimation for 2006 can be summarized as the following

- Trips in Bangkok and its circumference area, excluded trips from trucks, is about 15.88 million persons-trips/day
- HBW is 6.31 million trips from total 15.88 million trips about 39.7 percent from over all trip purposes as present in Table 4.3-5
- Private trip in 2006 is taking about 57 percent from over all travel modes. These private trips are mostly family trips with one or multi vehicles. Table 4.3-6 presents the results
- Morning and afternoon peak hour in Bangkok and its circumference area has an average of travel speed at about 18.6 km/hr and 21.2 km/hr respectively.

- Results of passengers who use public transportations as present in Table 4.3-7 show that there are about 9.8 percent of persons who travel using the mass public transportations such as BTS green line and MTA.

Table 4.3-5 Trip plans in 2005 (Unit: million persons-trips/day)

Group	HBW	HBE	HBO	NHB	Total
0 Vehicle	1.92	1.1	0.7	0.21	3.92
1 Motorcycle	1.08	0.55	0.71	0.45	2.79
1 Car	1.39	1.04	1.18	0.75	4.36
Multi Veh.	1.92	0.93	1.07	0.89	4.81
Total	6.31	3.62	3.66	2.3	15.88

Table 4.3-6 Trips in 2006 classified by number of vehicle owned and trip purposes

Vehicle Group	Total Trips	Public Transport Trips	Private Trips	Public Transport Trips (%)	Private Trips (%)
0 Vehicle	3,917	3,267	650	83	17
1 Motorcycle	2,790	957	1,833	34	66
1 Car	4,360	1,483	2,877	34	66
Multi Vehicle	4,813	1,185	3,628	25	75
Total	15,880	6,892	8,988	43	57

Table 4.3-7 Public transportation users in 2006 (Unit: million persons-trips/day)

SRT Rail	52
Bus	6,125
BTS Green Line	431
MRT Blue Line	237

Trips in the Future

Traffic condition resulting from model evaluation can be classified into 2 characteristics which are non public transportation trips (motorcycle, tuk tuk, passenger car, taxi, pickup, and truck) and public transportation trips. Table 4.3-8 and 4.3-9 present these results. The results found that, approximately, number of trips will be increased from 17.2 million persons-trips/day in 2006 to 29.4 million persons-trips/day in 2031 or increased about 70 percent within 25 years. On the other hand, from trip purposes in Table 4.3-10, HBW will be approximately 40 percents from overall trip purposes of persons who use public transportation. Main public transportation networks are presented in Figure 4.3-4 - 4.3-8.

Table 4.3-8 Results from eBUM model

Year	AM Peak				PM Peak				Daily			
	Total Person Trips	Total PCU Trips	Veh-kms	Veh-hrs	Avg Speed (kph)	Total Person Trips	Total PCU Trips	Veh-kms	Veh-hrs	Avg Speed (kph)	Total Person Trips	Total PCU Trips
2006	1,845,000	543,000	11,171,000	599,000	18.64	1,699,000	500,000	10,981,000	519,000	21.15	17,258,000	8,792,000
2011	2,023,000	622,000	12,995,000	787,000	16.51	1,864,000	573,000	12,725,000	658,000	19.33	19,292,000	10,001,000
2016	2,222,000	721,000	15,269,000	1,074,000	14.21	2,046,000	664,000	14,951,000	856,000	17.47	21,569,000	11,545,000
2021	2,416,000	780,000	15,541,000	887,000	17.51	2,243,000	724,000	15,631,000	802,000	19.48	23,805,000	12,602,000
2026	2,640,000	865,000	17,261,000	974,000	17.73	2,457,000	805,000	17,321,000	876,000	19.76	26,385,000	13,907,000
2031	2,904,000	955,000	19,136,000	1,194,000	16.02	2,719,000	894,000	19,276,000	1,077,000	17.89	29,446,000	15,383,000

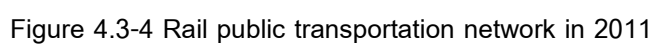
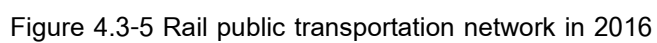
Table 4.3-9 The number of passengers who use main public transportation system

	Passengers (1,000 persons-trips/day)					
	2006	2011	2016	2021	2026	2031
Red	-	637	983	1,592	2,095	2,508
Green	431	721	1,430	1,727	1,859	2,161
Blue	237	882	1,256	1,479	1,666	1,998
Orange	-	-	-	316	402	476
Yellow	-	-	-	-	179	229
Purple	-	124	192	898	1,001	1,181
Pink	-	-	-	-	130	170
Train	52	66	68	73	78	83
Bus	6,125	5,906	5,897	5,873	5,936	6,422

Table 4.3-10

Trip proportions classified by trip purposes and vehicle category Check with new results
(1,000 persons-trips/day)

Objective	2006			2011			2016			2021			2026			2031		
	PC	MC	PT	PC	MC	PT	PC	MC	PT	PC	MC	PT	PC	MC	PT	PC	MC	PT
HBW	2,353	1,077	2,875	2,772	1,127	2,994	3,255	1,201	3,061	3,475	1,216	3,427	3,900	1,293	3,650	4,303	1,367	3,977
HBE	636	225	2,754	721	237	2,828	813	255	2,937	861	262	3,090	945	280	3,261	1,041	301	3,515
HBO	1,966	742	953	2,335	789	1,058	2,784	865	1,125	3,085	907	1,385	3,574	995	1,511	4,095	1,093	1,717
NHB	1,521	469	310	1,822	481	415	2,153	499	465	2,324	498	674	2,662	527	735	2,996	557	851



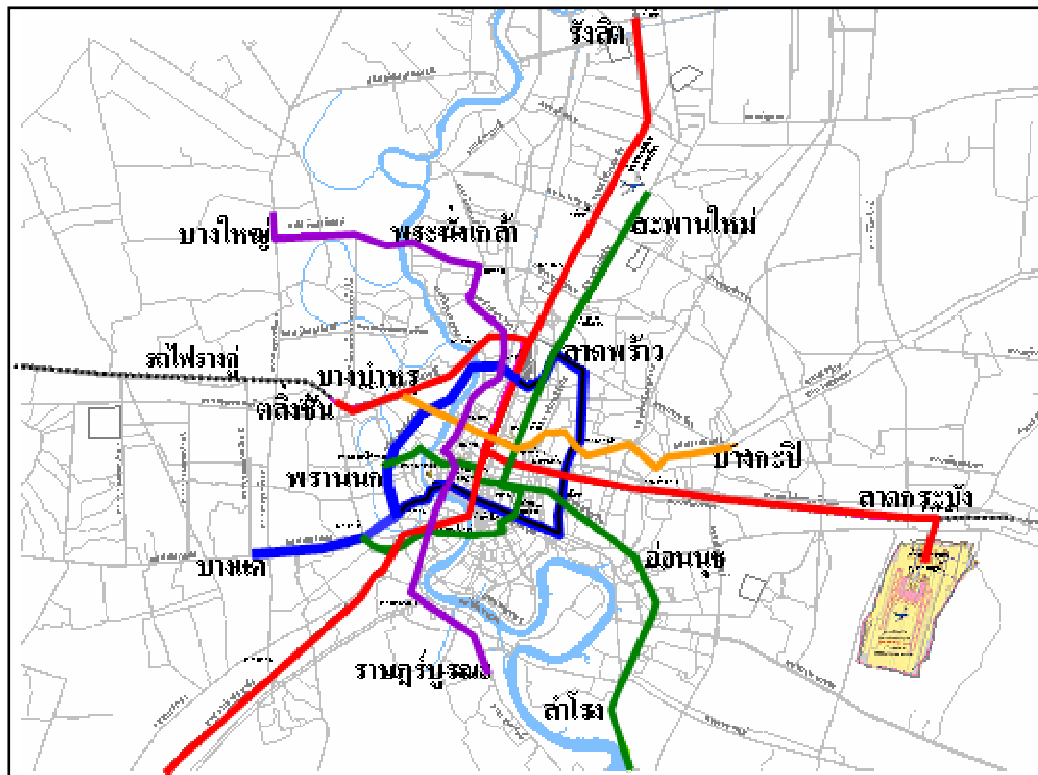


Figure 4.3-6 Rail public transportation network in 2021

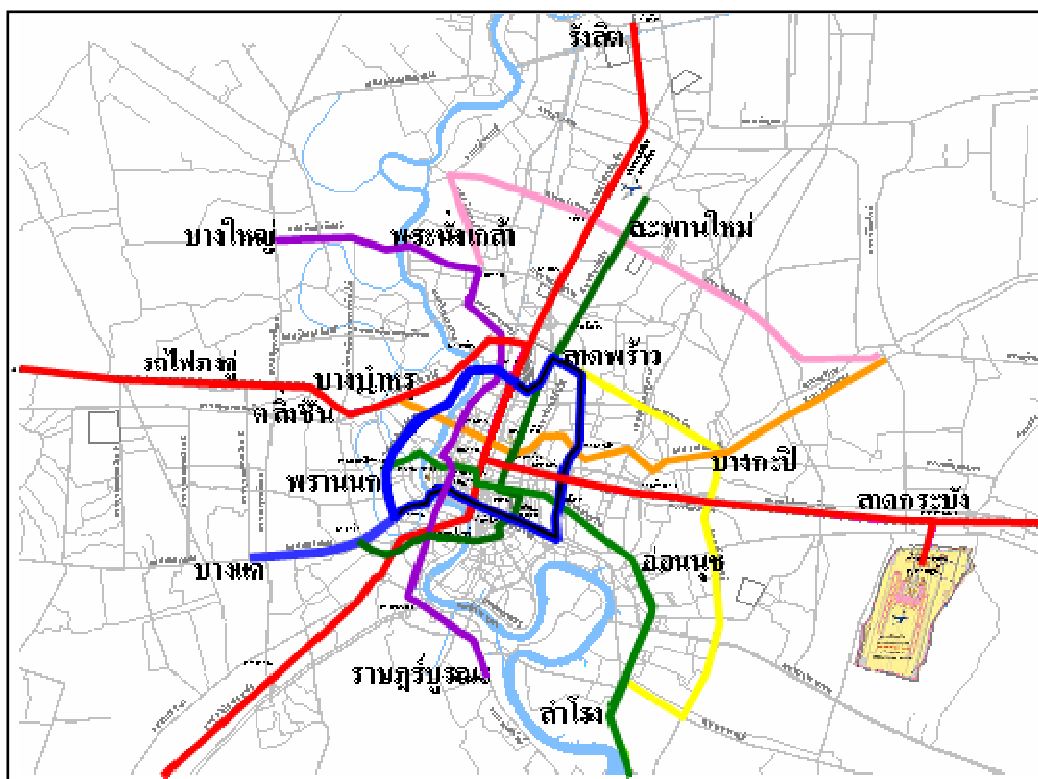


Figure 4.3-7 Rail public transportation network in 2026

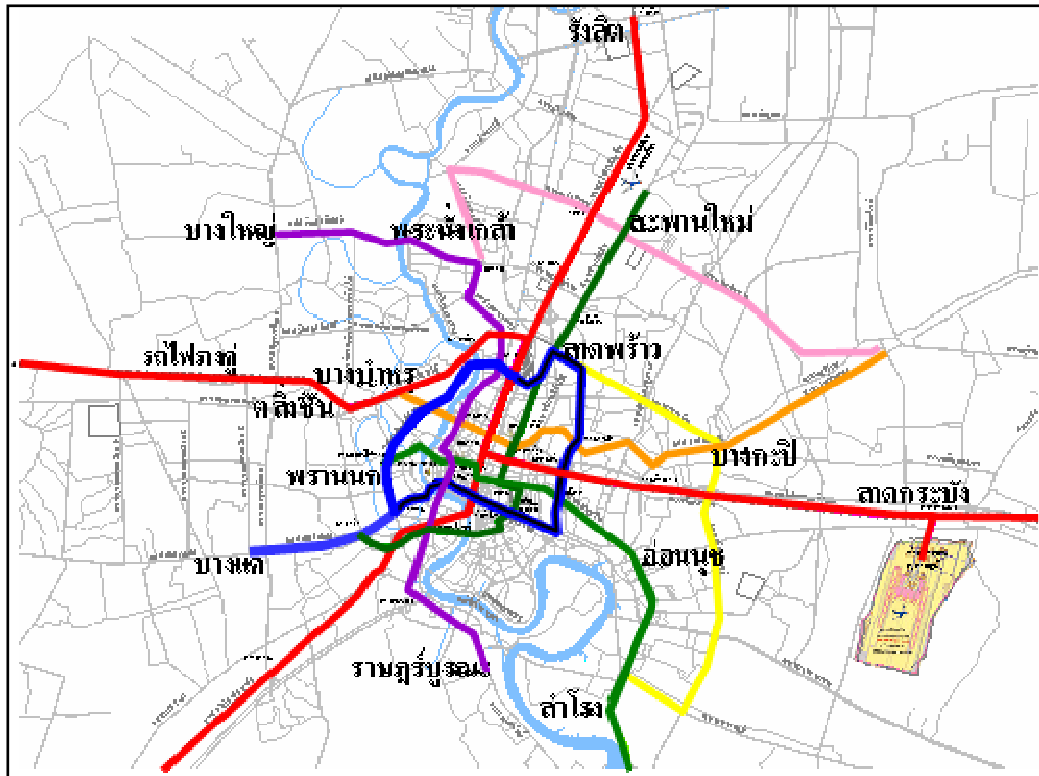


Figure 4.3-8 Rail public transportation network in 2031

The Bangkok transport model is currently a state of the art planning tool that is a credit to the many transport planning practitioners that have contributed to its development in both the private and public sector.

New features that are under consideration for inclusion in future versions of the Bangkok Transport Model include:

- Network Features
 - Better Link to GIS;
 - Single Estimation of Skims
- Elimination of model internal zone factors;
- Cargo Module;
- Large Data collection exercise subject to budget constraints
- Environmental Module;
- Full Implementation of Public Transport enhancements, and
- Boundary Conditions Link.

4.3.2 Two Mass Transit Configuration considered during TDMCV

Two of the five project cases as nominated by the ToR were undertaken using the Bangkok transport model namely:

- An evaluation of a three line rail mass transit system; and
- An evaluation of the rail transit system with a flat fare and also an alternative 10 line alignment with a significant change in the alignment of the Yellow Line.

The three line mass transit system is shown in figure 4.3-9 whilst the ten line system is shown in figure 4.3-10. The results from this analysis should be used with caution as the major purpose of this analysis was to illustrate the capabilities of the transport model. It was not undertaken to be choose detailed financial or economic results. The detailed results of these analysis is produced in the main report and also in two separate reports which further details this analysis.

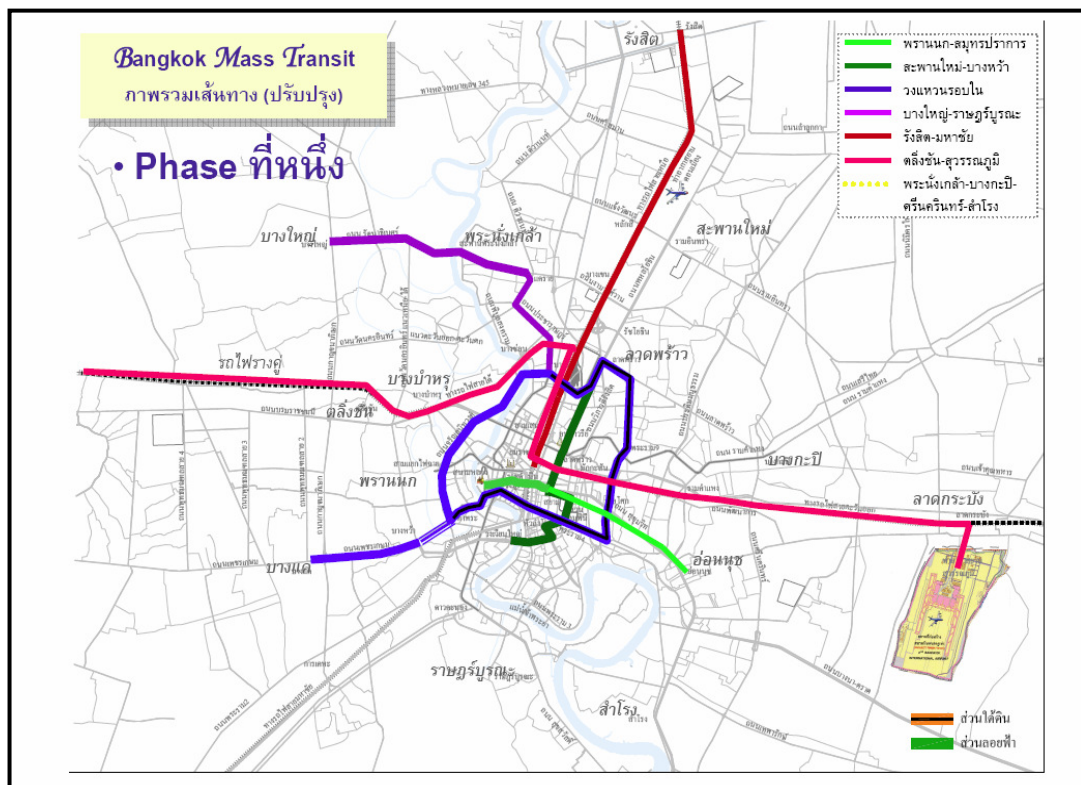
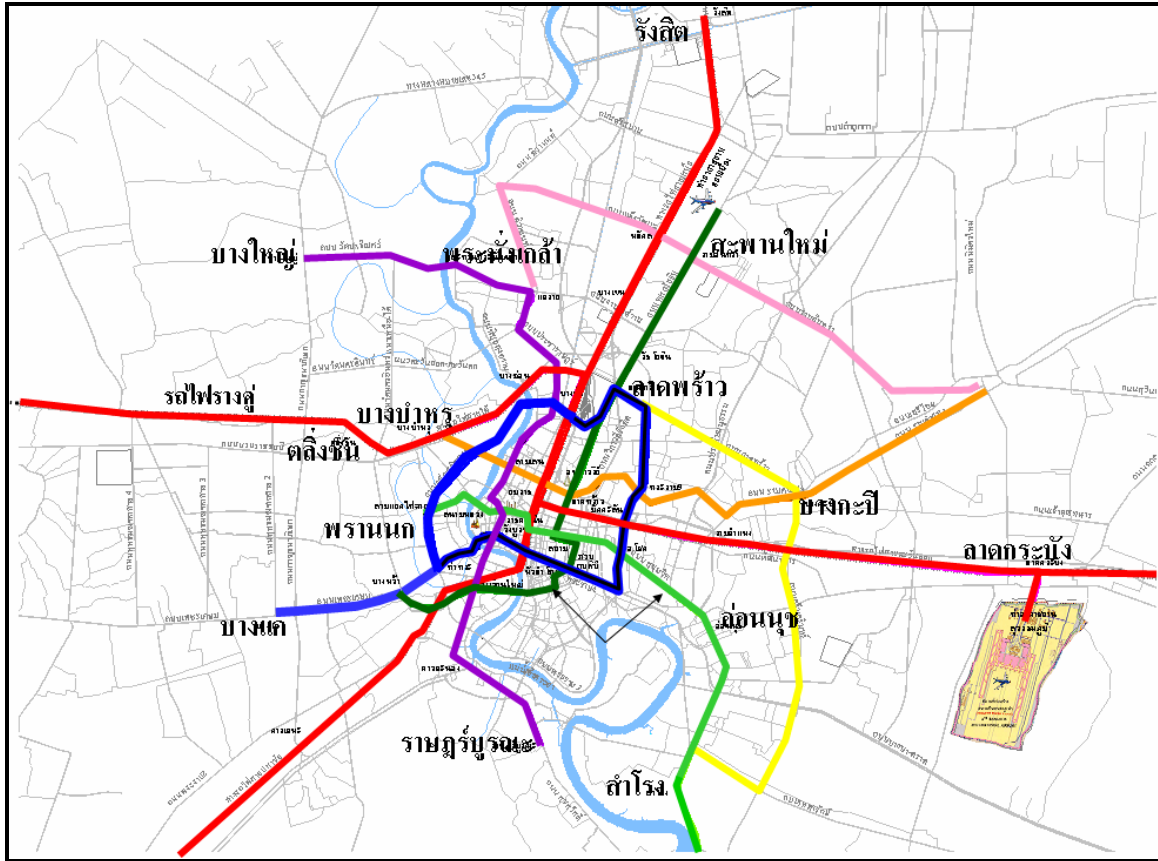


Figure 4.3-9 Three Line System



4.3.3 The eBUM Manual

In the earlier TDMC IV project, there was a quantum step forward in the enhancement of the Bangkok transport model both in the look and structure of the model now described by the acronym of eBUM, the enhanced or the extended Bangkok Urban Model. In future all updates of the model will follow this structure rather than the previous versions³ developed in the earlier TDMC II and TDMC III projects when the then model was referred to as the Bangkok Extended City Model(BECM)⁴.

⁴ This name, BECM refers to the original name of the transport model developed during the Urban Transport Database and Model Development Project” or UTM.

The new generation model, eBUM incorporates not only the catalogue features of CUBE⁵ but all of the transport modules are now written entirely in Voyager software script language with the exception of public transport⁶. These are all described in the user manual.

This should be considered a living manual and should be continually upgraded by serious practitioners and casual users of the transport model suite of programs referred to as the eBUM transport model. There are now many input database files into the transport model, collectively these are referred to as the eBUM database.

⁵ CUBE is the propriety transport planning software platform of the Citilabs Corporation. This corporation also includes the older TRIPS software in its stable of software.

⁶ The public transport sections of the transport model continue to use the older TRIPS software. This sections will likely be rewritten into Voyager script software as new releases of the software become available.

CHAPTER 5 Database System and Transport Model Application and Human Resource Capacity Development

- Database System and Model Application
 - Technical Consultation
 - Seminars
 - GIS and MIS Training
 - GIS Technical Tour
-

5.1 Database System and Model Application

The consultant has laid the direction of database system and model application to analyze and assess transport plans or projects according to Term of Reference. Also, MIS, GIS and transport model system has been applied into works and projects as outlined below:

1. The application of eBUM to analyze 3 MRT lines;
2. The application of eBUM to analyze 10 MRT lines;
3. The application of NAM to analyze the impact of increased fuel prize on goods transportation in Thailand;
4. The application of GIS, MIS and eBUM integrated system to analyze traffic impact of the construction of new road; and
5. The application of GIS to select bus route.

All works and projects explained above have been produced and submitted separately to OTP as technical document.

5.2 Technical Consultation

During the period of developing and maintaining of database, information system and transport model, the consultant team has fully cooperated OTP with respect to transport works namely;

- In-house consultation to OTP;
- Attending project meetings as requested by OTP;
- Commenting on transport study reports as requested by OTP;
- Giving suggestions and recommendations to OTP with respect of transport issues.

5.3 Seminars

During the project period, the consultant has organized two seminars for OTP and related agencies.

- The first seminar was organized on Tuesday, November 14th, 2007 at Room 401, 4th floor, OTP office building in Bangkok.
- The second seminar was organized during Thursday, January 18th, 2007 – Friday, January 19th, 2007 at Natee room 4th floor Chonchan Pattaya Resort Hotel Chonburi.

5.4 GIS and MIS Training

The consultant has arranged technical training for 10 OTP officials in GIS and MIS technology concerning transportation and traffic using aerial photos and/or satellite images to develop prototype and to make a PowerPoint presentation at King Mongkut's Institute of Technology North Bangkok during February 5-6, 2007.

5.5 GIS Technical Tour

The consultant has provided the GIS Fly through Technical Tour for 11 OTP officials at ESRI (Hong Kong) in Hong Kong, China during January 25th – 26th, 2007.