CHAPTER 2

LITERATURE REVIEW

2.1 Traffic congestion effects in Chiang Mai

Traffic congestion causes many problems locally, nationally, and even globally. Locally, the main problems are those that concern with the environmental issues such as air pollution, noise pollution which are the direct impact on emission. Furthermore, health problems especially those related to respiratory system have become the major concern. Nationally, traffic congestion causes increment in fuel consumption rate. With the oil crisis experienced by most part of the world, it causes economic depression. Thai government has to spend billions of baht to freeze the fuel price, preventing even worse economic depression. The poisonous emission (Carbon Monoxide gas) of vehicles causes the depletion in global atmosphere which has become the world's major environmental problem.

2.1.1 Environmental and health problems

Chiang Mai is ranked among the worst province with severe environmental problems. Kruger Consultant (1996) studied urban environmental management of various cities in Thailand. Chiang Mai is identified to have severity and poor issues on air quality, traffic, open space, slums and sewages with the two most serious issues are air quality and traffic.

Sutjit (1995) has seconded the above study that air pollution is one of the city's most severe environmental problems which is caused by traffic emission, and industrial and solid waste burning. The problem of air pollution is worsened by the geographic of Chiang Mai. Tangsikhabut (1995) has concluded that the severity of Chiang Mai's air pollution is caused by the physical endowment of the city that is surrounded by mountains.

2.1.2 Urban productivity

One of the problems that often excluded in the effects of traffic congestion is reduction in urban productivity. Yostrakul (2001) presented the evidence from World bank (1991) that traffic congestion has reduce the mobility of good and services which reduce the agglomeration economic of the city. Traffic congestion causes the reduction of time that people should spend on productive activities. Furthermore, the study has also shown the estimated losses due to traffic congestion in 7 cities from the paper presented at the "Mayors' Asian Pacific Environmental Summit", Honolulu, Hawaii, ADB(1999) cited in Yostrakul (2001). The data is shown in **Table 2.1**below:

City	Annual of cost of time delay ($M)	Percentage of Regional GNP
Bangkok	272	2.1
Hong Kong	293	0.6
Jakarta	68	0.9
Kuala Lumpur	68	1.8
Manila	51	0.7
Seoul	154	0.4
Singapore	305	1.6

Table 2.1: Estimated losses due to traffic congestion

Source: Integration Public Bus System, Yostrakul, 2001

2.2 Solution to traffic congestion

Institute of Public Policy Studies (1990) analyzed the five causes of traffic congestion in Thai regional cities which are: disorder in road using, incorrect or improper design of road infrastructures, improper traffic signal/post, lack of skillful local officer, and budgeting problems. The solutions suggested are: urban community and land use development, development on road infrastructures and network, traffic and travel management, and improvement on public transportation system.

Another effective solution to traffic congestion is through Travel Demand Management (TDM). Sharma(1997) summarized the concept of TDM is the strategic management of traveling pattern of people. The purpose of TDM is to reduce the traffic problem through improved management of vehicle trip. TDM combines transportation and non-transportation means to change the trip type and frequency of the people, mitigate the

burden of transportation, reduce high cost construction/expansion of transportation facilities, and diminish negative influence of environment.

The approaches TDM attempts are to create barrier of ineffective travel (low passenger per vehicle), increase incentive to efficiency travel (increase number of passenger per vehicle, carpool, public vehicle), and reduce needs of people to travel. The techniques of TDM include Traffic constrain, Peak-period dispersion, Ride-sharing, Parking control, Land use control, and Public transportation improvement. Once again improvement on public transportation is mentioned.

World resources (1997) also suggests that expansion of transportation infrastructures and improving of service quality in crucial to discourage the over reliance on personal transportation.

Therefore, according to the solutions provided the priority could be to develop an effective mean of public transportation to utilize the effective use of space and lower per passenger pollution level. An ideal mean of public transportation for a medium size city like Chiang Mai is the bus transit system. Bus is affordable and effective system, despite the poor customer service and unreliability which cause the unpopularity.

2.3 Background on public transit in Chiang Mai

Tungkavachiranon (1994) studied the two main means of public transportation in Chiang Mai; minibuses and city bus which at the time were still operated.

The city bus was once running until the service was terminated during the country's economic crisis due to bankruptcy. The study revealed that the city bus operated at speed 15.3 to 21 Kph which was the lowest among all means of public transport. The average load factor of city bus during peak period was 0.5-0.78 and off-peak period was 0.26-0.373 with average personal trip length of 7.47 Km. the study summarized that the number of bus was not enough resulted in long waiting time which drove the users to other means. Another reason was due to the small coverage area of the city bus.

The minibus operated with high frequency due to the large number of minibus. It preferred to serve on crowded streets during peak period. The travel speed was not so high,

18.9-24.8 Kph, due to the cruise on searching passengers. The average load factor was 0.25 and average person trip length was 4.52 Km. the study suggested that minibus operators had higher net income comparing to the city bus despite the intensity of competition.

A more recent study of Saowapol (2004) described the public transport user characteristics that the main users had average income of lower than 8000 Baht per month. The age of the users was divided into percentage with 49% of user age between 21-30 years old, and 38% age between 11-20 years old. The majority of the users were students with 68% of the total number of users. The average fare per trip was 10-15 Baht with average waiting time of 5-10 minutes.

2.4 Urban transportation planning

Black (1995) describes public transit system as one of many services provided by government. The system depends on size, density, and settlement pattern of the city. Therefore the transit system should be included with the comprehensive planning for the future of the city to ensure that the system complements other public goals.

Furthermore, Black (1995) suggests that mix improvements approach is needed to improve public transit system. One of the advantages of using mix improvement is a range of opportunities offered to the user. Improving service, which includes faster service, higher frequency, more coverage area, is more effective than lowering the fare in order to attract user. It is specifically mention that bus improvement should be undertaken much more than they are.

Better bus service in the inner city is probably the best way to serve the poor and minorities where increasing bus service is relatively inexpensive compared to building rail tracks. Thus, there is consensus among experts that bus is very energy efficient mean.

2.5 Route selection

To determine the feasible bus routes to ensure the successful future of the public bus transit, there are number important criteria to be considered. Some of those important criteria are demand for public transport, investment and operation cost, passenger's needs, and related laws and regulations. All 33 routes to be studied in this thesis are established with consideration of the above criteria. To determine the route or routes for co-investment, the most important aspects to be considered are demand and cost to at least minimize or avoid the chance of bankruptcy. Demand analysis and cost estimation techniques are discussed below.

2.5.1 Demand analysis

There are numbers of techniques used to estimate the demand for transportation planning. Isarasana na Ayuthaya, Sirisopolsil, and Naruepiti (1999) described 3 different demand analysis methods, each with its pros and cons. The first method is Demand Elasticity, which can be used to quickly identify the demand for public transit. The advantage is the ability to predict the changes in number of passengers if there is a change in fare price or level of service in short period. The second method is Route Level Analysis. It determines the transit demand in smaller and more accurate level. The method is most benefit the new route selection analysis and route efficiency improvement process. The third method is the four-step method. The method simulates the passenger's decision method on transport means.

Probably the most commonly use technique is The Urban Transportation Modeling System (UTMS)'s classic four-step model. Meyer and Miller (2001) describe that " UTMS is used to predict the number of trips made within an urban area by type (work, non-work, etc), time of day (peak, non-peak period, daily, etc.), zonal Origin-Destination (O-D) pair, the mode of travel used to make those trips, and the routes taken through the transportation network by these trips. The final product of UTMS is a predicted set of modal flowson links in a network. As such, it represents an "equilibrium" procedure in which the demand for transportation, represented by zonal O-D flows by mode, is assigned to modal networks constituting the transportation system, where this assignment is a function of networks' performance characteristics. The major inputs to UTMS are a specification of activity system generating these flows and the characteristics of the transportation system that will serve these flows." They also presented the four-step model as a sequence of four sub-models.

1. Trip generation: Forecasts the number of trip that will be produced or attracted in each zone, which depend on land use pattern and socioeconomic characteristics of each zone.
2. Trip generation: Determines the trip for pair of origin and destination.
3. Mode split: Predicts the trip among various modes available for travel.
4. Trip assignment: Establishes the route that the trip will take, resulting in demand in highway system and transit system.

Although this classic four-step model is commonly used by many organization, there are number of researchers attempt to improve the model. Ortuzar and Willumsen (1995) and Wright and Ashton (1998) suspected that the travel decisions might not be made in order like assumed in four-step model. Furthermore, the model seems to concentrate on limited range of travelers' response. Fukuda et al (1999) has developed an alternative model to use in demand forecasting. The study has integrated Modal split and Trip assignment into the same step. In combined Modal split and Trip assignment model, travel time on network is considered with the trip volume. Kraft (1968) and Manheim (1979) (cited in Ortuzar and Willumsen (1996)) combined all four steps into one single step called direct demand. However, direct demand model are not widely used due to its complexity, lack of inherent logic, and etc.

Despite the disadvantages of the four-step model, ITSC of Chiang Mai University stilled applied the model for demand estimation of Chiang Mai's minibus. Also ETA (1996) applied the model for transit demand estimation in Chiang Mai. The study has forecasted future demand by using TRIPS package, a computer program that based on the four-step model.

2.5.2 Travel time estimation

The definition of travel time is defined by McShane and Roess (1990) as "The total time for vehicle to complete a designated trip, over a section of road or from a specified origin to a specific destination."

Time data can be collected by field measurement method such as test car, license plate observation, and etc. Pichayapan (2001) described a more recent technique of collecting time data by involving advanced technology such as electronic distance-measuring instruments (DMIs), computerized and video license plate matching, cellular phone tracking,

automatic vehicle identification (AVI), automatic vehicle location (AVL), and video imaging. Turner (1996) (cited in Pichayapan (2001)) commented that DMIs are low in cost but have limitation in traffic congested area. Computerized and video license plate matching solve the problem but with higher expense. AVI and AVL provide real time information but they involve significant investment in infrastructure.

2.6 Cost estimation

There are several techniques for cost estimation. Wohl and Hendrickson (1984) showed three project cost estimation techniques.

The first one is the engineering unit cost estimation. It starts off with break down project cost into components and unit cost determination. Then the total cost of the project is the summation of every component multiplied with the unit cost. The accuracy of components determines the reliable of the project. Therefore, the breaking down task requires experts to perform and the unit cost must be ascertained. However, the cost estimated may not be accurate since the unit cost can vary extremely in the future.

The second technique is the statistical cost estimation. Cost function developed by this technique is usually consists of few important parameters of the project. Although the form of cost function can be developed in many ways, the assumption from experts' experience is widely used. The accuracy of this technique is subjected to the uncertainty of form of function and the estimated cost.

The final technique is the accounting cost allocation. The basic idea is every cost can be allocated to particular characteristics of the project and each item has the allocation factors. This technique assumes no economy of scale and allocation factors and their items has linear relationship. This technique has many limitations, therefore it must be used with caution.

As project cost is one of the decisive factors, estimated cost must have enough accuracy to represent the actual cost. However, it is commonly found that the actual cost could overrun the estimated cost. Skamris and Flyvbjerg (1996) recommended the cost for traffic cost estimation should be overestimated by 20 to 60 percent. Overestimated demand and underestimated project cost could lead to serious miscalculation and severe budget problem.

2.7 Business decision making

Making a decision is vital in today's business due to the intense competition in the market. A correct decision can mean millions in term of profit, on the other hand an incorrect decision on even a small business matter could lead to bankruptcy. The manner of business decision making can be divided into two scenarios, to solve the problems that business is facing or to improve the current business process. (Ratanakuakungwan and Rijirawanich, 1997)

2.7.1 Quantitative decision process

Ratanakuakungwan and Rijirawanich (1997) states that quantitative data or information is commonly used in business decision making due to the ease of predicting the business outcome since everything is measurable. Apart from the reason above, high accuracy of the predicted result is also another advantage of using quantitative information. The predicted result of the decision is determined from the outcome of mathematically processed model. The model is created as a substitute of the system that the decision is based on. A good model should represent important relationships of the functions in that system. Another advantage character of the predicted result from quantitative decision making method is the comparability between results in different alternatives. The result can easily be compared, and then the better result is selected. As a result, quantitative method for decision making is commonly used in business decision making.

Quantitative decision process is divided into 7 sub-processes which are:

1. Recognition of needs
2. Problem formulation
3. Model construction
4. Data collection
5. Model validation and sensitivity analysis
6. Interpretation of result and implication
7. Decision making, implementation, and control

2.7.1.1 Techniques used in quantitative decision process

There are several techniques in quantitative decision process. Some of those techniques are shown below. However, in this thesis only economic decision techniques are used to help in decision making process of the project planner.

Some of the common quantitative decision technique:

1. Simulation
2. Queuing Decisions
3. Inventory Decisions
4. Resource Allocation Models
5. Network Models
6. Economic Decisions
7. Replacement Decisions

2.7.1.2 Economic decisions

The four methods used in economic decision making are:

1. Net Present Value (NPV): The higher positive NPV, the more attractive of the investment project.
2. Benefit cost ratio: The ratio of average business must more than 1, the higher the better. However, different type of businesses has different minimum value for ratio.
3. Payback period: The high risk business should have short payback period, while longer payback period is more suitable for low risk business.
4. Internal Rate of Return (IRR): The IRR gives clearer picture of the investment project. A good investment project must have IRR higher than standard interest rate.

2.7.2 Decision dnalysis

Decision analysis is the tool to use for reducing the risk of making wrong decision under uncertain situations and environments. The four important topics to consider in decision analysis are: Structure of decision, Decision making under uncertainty, Quantitative method by probability theory, and Decisions tree.

2.7.2.1 Structure of decision

The better and more accurate the data being used for construction of the structure, the higher chance of correct decision is being made. The structure of decisions includes:

1. Alternative strategies
2. States of nature or Environmental state
3. Outcomes
4. Likelihood of each of environmental state
5. Decision criterion

2.7.2.2 Decision making under uncertainty

A decision making under risk and uncertainty is a decision which has multi alternative strategies and under multi environmental states. The two criteria for decision making under uncertainty are: Maximize decision criterion, which considers the factors such as profit and income and Minimize decision criterion, which considers factors such as expenditure and investment cost,

2.7.2.3 Quantitative method by probability theory

Probability theory is applied to the business quantitative decision making when the needed information is insufficient and more information cannot be gathered

2.7.2.4 Decision tree

Under circumstances of multiple alternative strategies, multiple states of nature, and joint outcomes, to determine the result decisions tree is being used. The process for conducting a decisions tree includes four steps:

1) List and group each alternative strategy and its outcomes,
2) Calculate probability for each alternative,
3) Calculate the result for each outcome, and
4) Select the best average outcome.

2.8 Financial feasibility

Thingprasert and Jantaro (2002) described that financial study involves the project's budget and expenditure, the source of investment, the profit and benefit from the project, and analysis of benefit cost ratio. Financial study is crucial for the decision making of the project. The decision to proceed with the project or not is based on four methods discussed earlier which are NPV, Benefit/Cost ratio, Payback period, and IRR. Their acceptance conditions are as discussed previously.

2.9 Economic and environmental studies

The result from financial study would determine how good the project is in the investors' point of view, however the types of study in this part is different. The benefits being considered in this part is social benefit provided by the project such as the increasing rate of employment in the area, the benefits for consumers, and etc. The study also considers the impact on environment created by the project (Thingprasert and Jantaro, 2002).

2.10 Formation of a co-investment organization

Co-investment between government and private sector is one of the solutions to reduce the risk of bankruptcy of the public bus transit system. An organization under this manner must be established to manage and control all the operations related to public bus system. In the process of an organization establishment there are several important issues to be considered: co-investment manner and management studies.

2.10.1 Co-investment manner

Saowapol and Therarattanaket (2004) proposed that to keep improving and ensure the success future of Chiang Mai's public transportation, three parties should be involved. Those parties are government, municipal government, and private investors. The study has proposed that the management of the city's public transportation system is divided into two periods. The first 3 years of the project the manner of investment should be 70% government, 20% municipal government, and another 10% from private investors. After 3 years, the manner of investment should be 50% municipal government, 40% private investors, and 10% government.

In an interview with Mr. Panyapol, the municipal layer, he suggested that according to the municipal act 2003 the municipal government must hold more than 50% of share in any co-investment. However, on behave of municipal's share it can include the share from the central government and other governmental organizations.

2.10.2 Management study

Thingprasert and Jantaro (2002) stated that many project fail due to the lack of management skill. The objective for this management study is to increase the management skills to steer the project to success. The management can be divided into two phases: Pre-operational phase and operational phase.

For pre-operational period, the three major tasks of management involve project activities, project construction, and scheduling. The project activities are such as conducting the five stages of project feasibility study, studying the taxation structure, and conducting investment study. Any construction in the project can be either hiring the specialist or do it themselves. The material needed for construction must be prepared by the project manager. For scheduling task, the tool and techniques such as Gantt Chart, PERT, and CPM are commonly used.

For operational period, the management study should consider three topics; organization structure, management structure, and personnel. The organization structure selected must be able to fulfill at least one of the following objectives:

- Able to manage the organization
- Attractive for management level and investor
- Maintain good business relationship
- Maintain business's secrets
- Increase profit

The choices for organization structure are Single owner, Partnership or Limited Partnership, Cooperative, and Company or Public company.

Management structure is important to steer organization to success. The management structure should consider the objectives of the project, the operational process, and organization structure.