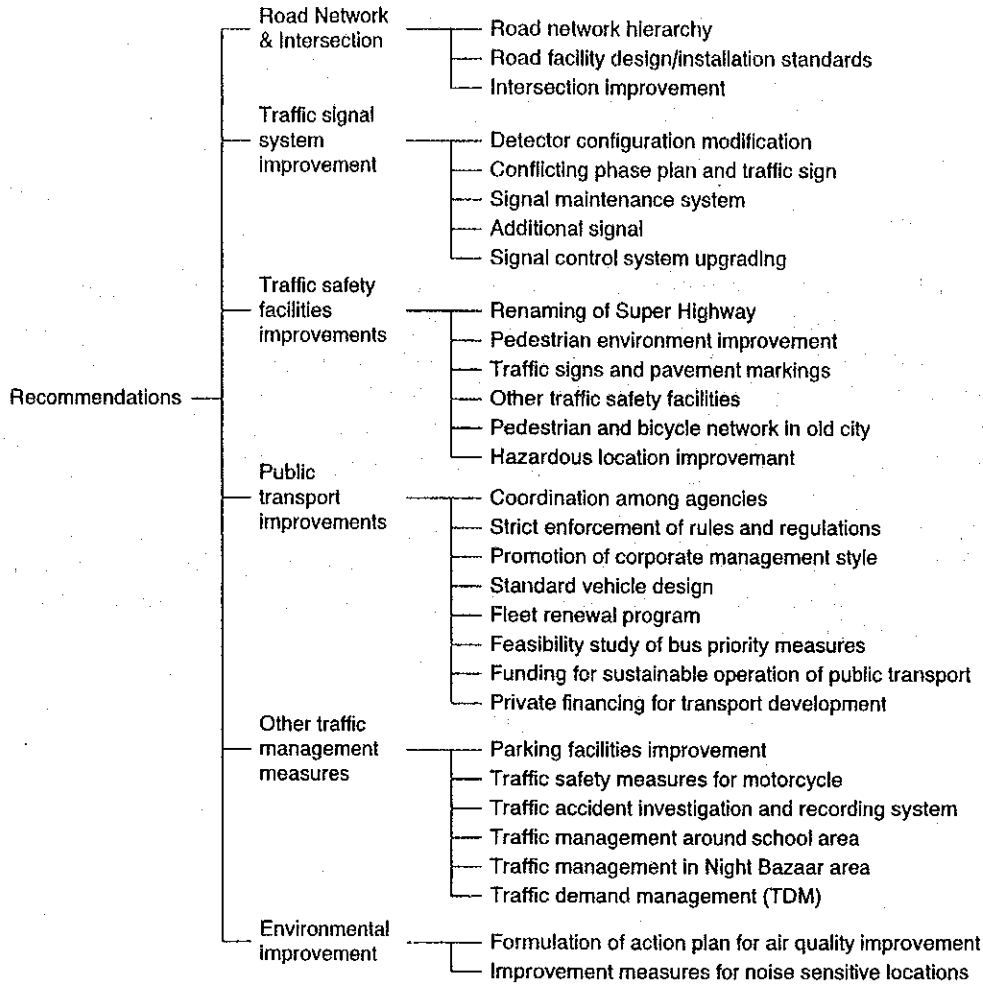
Chapter 9

Recommendations: Options for Improving Traffic Congestion and Safety:

9.1 Introduction

Various traffic management problems and issues have been analyzed in the preceding chapters. They range from congestion at intersections, to the operation of traffic signal systems, to accident and traffic safety, to the concentration of school-related traffic in particular areas. Chiang Mai has a unique public transport system, which also has its own problems. Improvement measures are recommended in this chapter. Some of them however, require further in-depth study before implementation.

The study covered a wide range of issues related to traffic management, from the policy on public transport to improvement plan of specific location, and recommendations have been formulated on the most of them. Figure 9-1 summarizes the issues included within recommendations.



Source: This study

Figure 9-1 Issues Taken up by Recommendations

9.2 Road Network and Intersections

Improvements or recommendations for the road network of Chiang Mai Municipality are discussed below.

(1) Develop Clearer Hierarchy of Road Network

The existing road network is adequate in some areas, yet lacking in others. For instance, the Super Highway or Inner Ring Road is effective in dispersing or diverting traffic away from the city center. Furthermore, radials are well allocated in four directions thus distributing the total load of city bound traffic. The arterial road system in Chiang Mai is adequate.

The major deficiency within the road network system is the collector roads, especially in less developed sub-districts (including Ta Sala, Noi Hoy, Haiya or residential sub-districts such as Chang Phuak and Sri Phum). The Municipality recognizes this deficiency and plans to renovate/construct a total of eight (8) existing/planned roadways. These collector roads should be further developed, by upgrading small access roads that connect to the arterials, while at the same time reducing the number of access points that connect small access roads to the arterials, especially those leading to the Super Highway and the radial roads.

As a result, an improved road network with a clear hierarchy can be achieved. Traffic from access roads should be first channeled into collectors, and then on to arterials. Direct connections for access roads or buildings to arterials should be avoided in road network development.

(2) Develop Design/Installation Standards for On-Street Facilities

The design of roads in Chiang Mai by the DOH and Municipality basically follows that of AASHTO, but some inconsistency still exists. Road marking for instance, is rather inconsistent and stop lines with stop signs are missing at particular intersections.

In addition, the installation of urban facilities such as lamp posts, wayside trees, refuse bins, signals, and traffic signs requires more consistent specifications and requirements. Many of these facilities are of varied specifications. In many cases, these facilities are poorly located on sidewalks and obstruct the safe and comfortable flow of pedestrian traffic. It is recommended that the Municipality develop good design and installation standards for the various facilities as well as road markings and traffic signs.

(3) Intersection Improvement

Improvement plans were prepared for each of the 20 intersections as summarized in Table 9-1 (see Appendix F for detailed analysis and drawings). It should be noted that only short-term measures that do not require substantial capital investment are considered. The improvement measures are classified into seven groups. These are briefly discussed below[1].

- Geometric improvement for these intersections aims to correct physical deficiencies without acquiring additional right-of-ways. Intersection No. 12 Huay Kaew – Hadsadhi Sawee Road, which is already saturated, is an exception. An additional approach and turning lane on the widened portion along Hadsadhi Sawee will help ease the congestion.

[1] Appendix F contains description of each intersection, including improvement proposals. For each intersection, there are four descriptive sheets. The first sheet is comprised of five sections: physical conditions, traffic conditions, analysis, improvements and cost. The second sheet depicts a schematic drawing of the existing conditions, while the third sheet depicts the proposed measures. The fourth sheet contains peak hour traffic volume data (in PCU).

- Traffic signals are needed at intersections with traffic volumes that exceed a certain threshold value. Warning flashers are proposed at intersections where traffic volume is not sufficiently high enough to warrant a signal, yet safety is a concern.

- Adoption of new pavement marking layouts is proposed for all 20 intersections. The marking materials should comply with Thai Industrial Standards:542-2530. Test samples should be taken at the site for testing at reliable laboratories.

- Improved traffic regulation in this instance means the adoption of right-turn prohibitions. Such prohibitions should be adopted in two intersections in particular, namely Intersection No. 1 Huay Kaew - Super Highway and No. 13 Charoen Muang - Charoen Rat, and will enable overlapping phasing and increase intersection efficiency[2]

- Traffic signs, mostly stop signs for minor road, should be installed at all locations that require such facilities, yet currently are without them.

For intersection No. 7 Chiang Mai Land Road – Aom Muang Road, DOH opted to close the intersection in May 2002 instead of installing a traffic signal recommended in the improvement plan. As a result, those vehicles used to make turn there are now forced to travel further to Han Don Road for westbound traffic and to Ping River underpass for eastbound traffic to make U-turn, or take other route.

[2] Adoption of such bans should be investigated closely as they actually adversely affect some movements.

Table 9-1 Proposed Improvement Measures at 20 Selected Intersections (See Appendix F for Detailed Analysis & Drawings)

No.	Intersection	Proposed Improvement Measures						
		Geometric Improvement	Signal or Flasher Note[2)]	Signal Phase/ Timing	Pavement Parking	Traffic Regulation	Traffic Sign	Others
1*[1)]	Huay Kaew Road-Super Highway	✓		✓	✓	✓		
2	Super Highway-Soi Wat Chet Yod	✓	S		✓			
3	Klong Chonpratan Road - Soi Chet Yod Khian...		F		✓			
4	Hadsadhi Sawee Road-Chang Phuak Soi 4		F		✓		✓	
5	Mahidol Road - Haiya Road		S		✓		✓	
6	Thipanet Road - Wua Lai Road		S		✓		✓	
7	Chiang Mai Land Road-Aom Muang Road		S		✓			
8	Chiang Mai Land Road/Soi 15-Chang Klan Road		S		✓		✓	
9	Rakhang Road - Kamphang Din Road				✓		✓	
10	Rattanakosin Road - Trat Wong Road	✓	S		✓		✓	
11	Rattanakosin Road - Bumrung Rat Road	✓	S		✓		✓	
12*	Huay Kaew Road - Hadsadisawee Road	✓			✓			
13*	Charoen Muang Road - Charoen Rat Road			✓	✓	✓		
14+	Ratchawithi Road-Ratchaphakhinai Road	✓			✓			
15+	Ratchawithi Road - Phra Pokklao Road	✓		✓	✓	✓		
16+	Inthawororot Road - Singharat Road	✓			✓			
17+	Phra Sing Road - Phra Pokklao Road				✓			
18+	Super Highway - Charoen Muang Road	✓		✓	✓			
19	Chang Khlan Road - Loi Kroh Road[3)]		S		✓			
20	Rot Fai Road - San Na Lung Road[4)]				✓			

Notes: 1) (*) sign attached to No. denotes existing ATC signal, while (+) existing isolated signal.
2) S denotes signal is required and F denotes warning flasher is required.
3) Traffic management measures in Night Bazaar Area are separately discussed.
4) Railroad crossing improvement to be carried out by State Railway of Thailand.

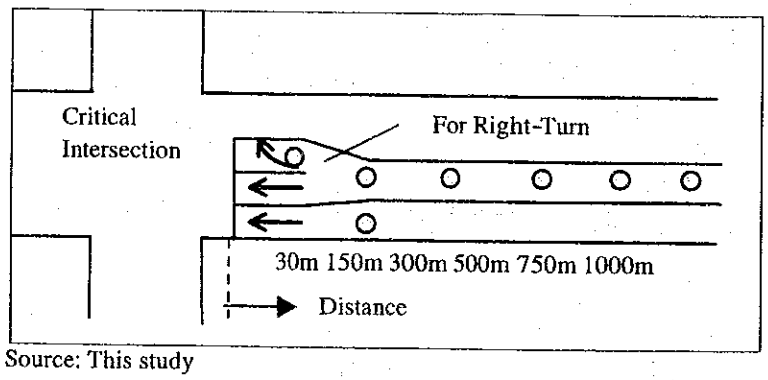
Source: This study

9.3 Traffic Signal System Improvement

The improvement measures for the existing SCOOT ATC system in Chiang Mai are presented below.

(1) Change Detector Configurations

It is observed that at some critical intersections under ATC control, the queues of the two intersecting roads are not balanced. The queue on one approach does not clear during green, while green continues for the crossing road even though there are no coming vehicles. To improve the balance of queue lengths and to reduce wasted green time, the configuration of detectors needs to be changed. Detectors should be installed every 100–200 m from the stop line to measure queue length. To detect right-turning vehicles, a detector in the right-turn lane is essential for more accurate control. A typical configuration is shown in Figure 9-2.

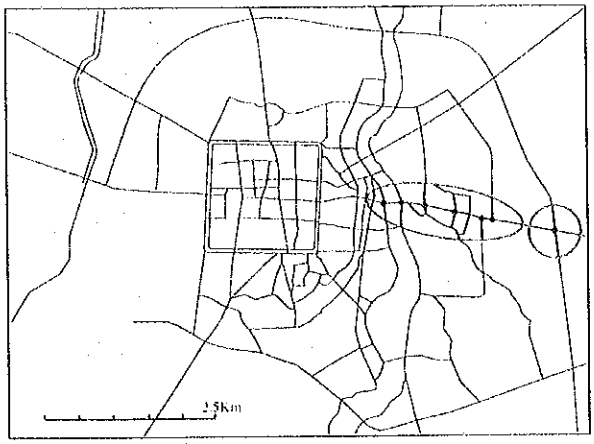


Source: This study

Figure 9-2 Typical Detector Configuration

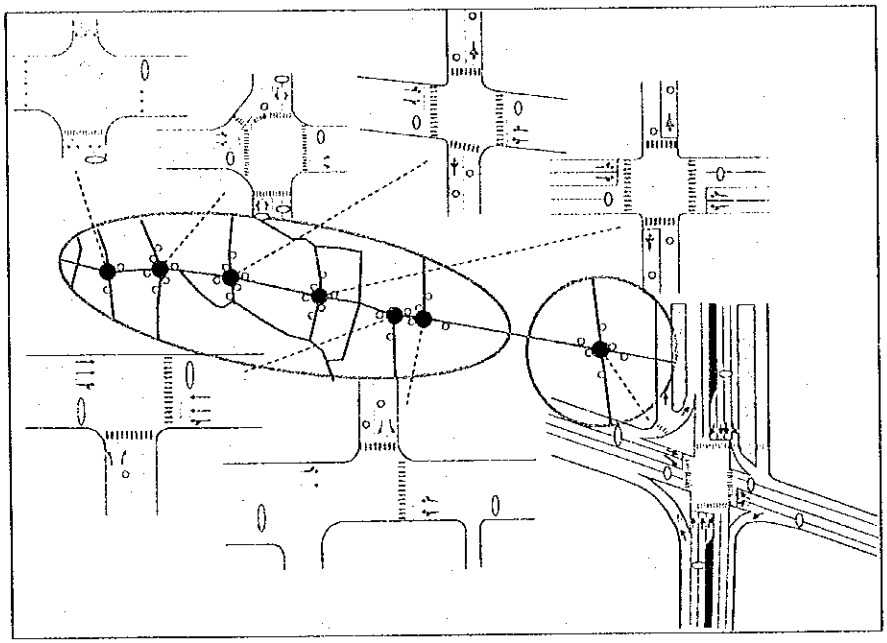
Two intersections on Charoen Muang Road serve as an example for the enhancement of detector configurations. Figure 9-3 shows the location of sample sub-areas and intersections. Figure 9-4 shows the existing detector configuration setup.

In the sample area, there are two sub-areas, one with six intersections and another with one intersection. Altogether seven intersections are under the SCOOT system. Within this area, two critical intersections, the rightmost intersection and the second intersection from left in Figure 9-3, are saturated during the morning and evening peaks. The other five intersections are unsaturated and do not cause congestion, as the crossing roads have little traffic compared with that on the main road (Charoen Muang Road).



Source: This study

Figure 9-3 Locations of Sample Intersection on Charoen Muang Road



Legend:

○ Traffic Volume, Occupancy Detectors

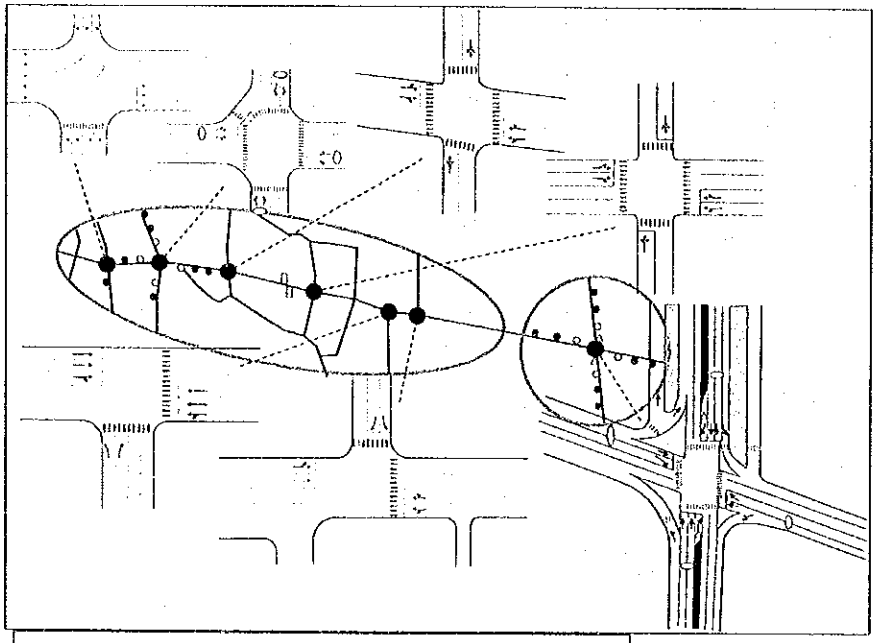
Source: This study

Figure 9-4 Existing Detector Configuration (SCOOT System)

To reduce congestion, detectors should be deployed in such a way to increase intersection capacity and balance queues on intersecting roads. In the SCOOT system, however, detectors are installed at every intersection at the approach near the stop line

and at the outlet irrespective of congestion level assuming that all the intersections have the same level of priority as shown in Figure 9-4. Queue length is estimated from the traffic volume at the detector near the intersection and the estimated saturation ratio of the intersection. If the queue stretches beyond the detector location, the queue length cannot be measured. Detectors should rather be installed around the two critical intersections to enhance congestion control.

It is proposed that more detectors be installed along the approach of critical intersections, and some of the detectors at less congested intersection be omitted. The proposed detector configuration is shown in Figure 9-5. The detectors installed at all lanes will count the traffic volume, while the detectors installed along the main road at some intervals will be used to measure queue length.



Legend:

- ○ Traffic Volume Detector at Critical Intersection
- ● Saturation (Volume & Occupancy) Detector
- △ Right-Turn Traffic Detector
- ▯ Traffic Volume Detector for Offset Control

Source: This study

Figure 9-5 Proposed Detector Configuration

The proposed configuration would solve the problem, as the queue length would be accurately measured using the dedicated detectors and split would be adjusted to balance the queue on all approaches. In addition, detector will be installed at the right-

turn lane, if there is an exclusive right turn lane, and actuation control will be applied to dynamically shorten or lengthen the green time every signal cycle.

The existing SCOOT system has 33 detectors, whereas the proposed configuration would reduce this number to 27. Table 9-2 shows the number of detectors classified by their usage for existing and proposed cases.

Table 9-2 Detector Classification by Usage

System	Detector Classification by Usage		Quantity
Existing (SCOOT)	Traffic Volume, Occupancy	Total	33
Proposed Configuration	Traffic Volume at Critical Intersections		8
	Saturation (Volume and Occupancy)		15
	Right-Turn Traffic		2
	Traffic Volume for Offset		2
		Total	27

Source: This study

(2) Resolve Phase Plan and Sign Conflicts

First of all, all phase plans at 38 intersections should be reviewed to find out if there are any conflicts. Improvements to the existing plans should be flexible enough to be implemented quickly and without delay. The process of approving such plans and other installation designs should be kept clear. Furthermore, documents pertaining to the intersection design should be filed properly and any resulting construction or amendments to the configuration should be clearly noted.

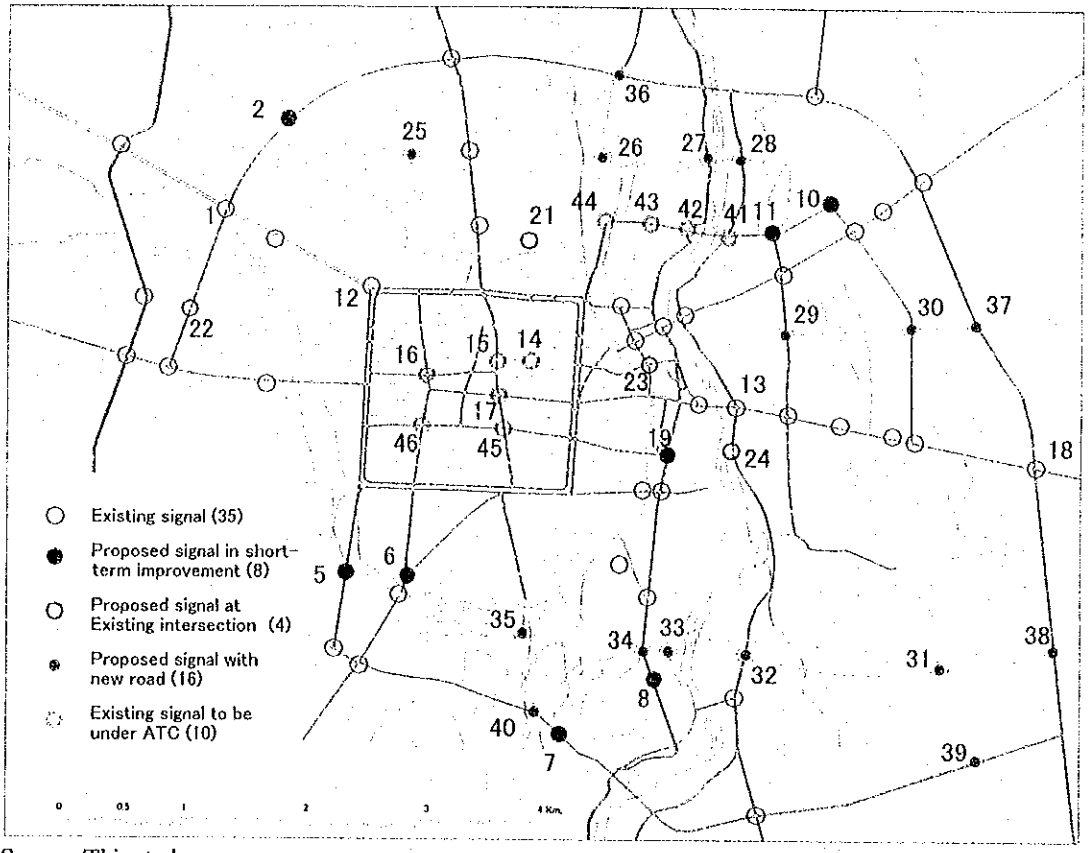
In addition there are many traffic signs in the study are, which are old and dilapidated. Review should assess the condition of such signs to assure that they are clearly visible without obstruction and maybe more importantly to assure that signs are not confusing and resulting in traffic movement conflicts.

(3) Improve Maintenance System

The biggest problem related to signal system maintenance is the low MTBF (Mean Time Between Failures). To reduce the failure rate, analysis of all failures should be commenced. Currently, the statistics only classify failures according to the malfunctioning piece of equipment such as bulb, controller, detector, communication line etc. If failure analysis was taken to an even finer level of detail, the true causes of these failures can be found. For example, some parts may easily break down from high temperatures or vibrations, and particular parts may break more frequently than others. With the adoption of a more refined system, so-called preventive maintenance regimes could be adopted and the resulting MTBF would be improved.

(4) Install Additional Signals

More signals are needed as summarized in Figure 9-6. There are three types of improvement namely, 1) installation of new signal, 2) upgrading of existing isolated signal to ATC signal, and 3) addition of pedestrian lantern to existing signal.



Source: This study

Figure 9-6 Proposed New Signals

New Signal

The intersections for new signal were selected in the following manner. First, eight (8) intersections are identified for new signal in the improvement plan for 20 intersections[3] developed in this study. Based on the current traffic conditions and the result of traffic demand project for 2010[4], four (4) existing unsignalized intersections and 16 new intersections to be constructed on the future roads are selected. The first 12 existing intersections are listed in Table 9-4, while the 16 new intersections are listed in Table 9-6

[3] Refer Table 9-1.

[4] Refer Chapter 3.

The criteria to select these intersections for signaling are explained below. Intersections with high traffic demand are likely to be more accident-prone if left unsignaled. Table 9-3 shows the Japanese design standard for warranting signal installation. The situation in Japan, however, is much different from Chiang Mai, as the vast majority of vehicles are assumed to be automobiles, whereas in Chiang Mai, motorcycles are more prevalent. Therefore, Table 9-4 has been proposed for Chiang Mai.[5]

To determine whether a traffic signal is needed or not at a intersection, many factors should be taken into considerations, such as traffic volume, queue length, number of accidents, intersection shape, the width of the road, etc. The intersections where traffic signal is required were determined in accordance with the following factors. As for the traffic volume, the criteria shown in Table 9-4 are used. As for the queue length, experientially if more than 4 vehicles are waiting in row on the minor road at the peak hour, and then it is better to install the traffic signal.

Table 9-3 Peak Hour Traffic Volume to Warrant Signal (Japanese Standard)

Two-Way Traffic Volume on Major Road (Vehicles/Hour) [A]	Traffic Volume From Minor Road (Vehicles/Hour) [B]
900	420 (350)
1,000	320 (270)
1,400	220 (190)
1,800	160 (140)

Notes: [A] This data is for roads with lanes wider than 10 m.
[B] The data in parentheses is for minor roads with lanes narrower than 10 m.
Source: Japan Road Association, *Exposition and Operation for Act of Road Structure*, Japan, 1970

Table 9-4 Proposed Signal Warrant for Chiang Mai

Two-Way Traffic Volume on Major Road (PCU/hour) [A]	Traffic Volume From Minor Road (PCU/hour) [B]
660	308 (257)
733	235 (198)
1,026	161 (139)
1,320	117 (102)

Note: [A] This data is for roads with lanes wider than 10 m.
[B] The data in parentheses is for minor roads with lanes narrower than 10 m.
Source: This study

[5] Original data from Table 9-4 is converted to PCU based on the observed traffic composition observed in the traffic surveys (from Table 3-2) as well as the PCU conversion coefficients (from Table 3-4).

Table 9-5 Main Factors to Determine the Installation of Traffic Signals

No.	Intersection Name	Factors				
		Traffic volume	Queue length	Accidents	Geometry	Pedestrian
2	Wat Chet Yod	✓		✓		
5	Mahidol & Haiya	✓				
6	Thipanet & Wua Lai	✓				
7	Chiang Mai Land & Aom Muang	✓		✓		
8	Chang Klan & Chiang Mai Land	✓				
10	Rattanakosin & Trat Wong	✓				
11	Rattanakosin & Bumrung Rat	✓				
19	Chiang Klan & Loi Kloh	✓				✓
21	Municipal Studium		✓		✓	
22	Nimmanhamin & 2 Chiang Rai		✓	✓		
23	Ratachawong & Chang Moi		✓	✓		
24	Chiang Mai Lamphun & Loi Kroh		✓			

Source: This study

Table 9-6 New Intersections Proposed for Signal Implementation

No.	Intersection (Major Road – Minor Road)	Geometry
29	Super Highway – Bumrung Rat Road and Super Highway Link	T
30	Aom Muang Road – Suriyawongse Road to Aom Muang Link	Uncertain
25	Inner Link – Hadsadhi Sawee Road	Cross
26	Inner Link – Assadathon Road	Cross
27	Inner Link – Wang Sing Kham Road	Cross
28	Inner Link – Faham Road	Cross
29	Bumrung Rat – Bumrung Rat Road and Super Highway Link	T
30	Inner Link – Bumrung Rat Road and Super Highway Link	Cross
31	Inner Link (Thung Hotel Road to Aom Muang Link) – Inner Link (Super Highway to Thipanet Road Link)	Cross
32	Chang Mai-Lamphun Rd – Inner Link	Cross
33	Inner Link – Charoen Prathet Road	Cross
34	Inner Link – Chang Klan Road	Cross
35	Inner Link – Suriyawongse Road to Aom Muang Link	Cross
36	Super Highway – Assadanthon Road	Uncertain
37	Super Highway – Bumrung Rat Road and Super Highway Link	T
38	Super Highway – Super Highway to Thipanet Road Link	T

Source: This study

Signal Upgrading

There are six (6) isolated signals in Old City and another four (4) isolated signals along Rattanakosin Road. Although the intersections are not heavily congested at the moment, upgrading of these signals to ATC signal will improve the operational efficiency, and at the same time, signal operation can be monitored at the Control Center and any malfunction of the signal equipment can be detected easily. For these reasons, upgrading of these ten (10) signals is proposed.

Pedestrian Signal/Lantern

The existing intersection signals in Chiang Mai have no pedestrian lantern except the signal at Rattanakosin – Wang Sing Kham. As a result, pedestrians are subjected to the risk of accident by turning vehicles and at the same time, no discipline to observe traffic signal has been developed among the pedestrians. In order to enhance the pedestrian safety, installation of pedestrian signal and addition of pedestrian lantern were studied.

When installing pedestrian signals, the magnitude of pedestrian traffic crossing the road and the level of vehicular traffic along the road are two major factors to consider. The different criteria may be applied to intersection, where new signal is need for pedestrian, or pedestrian lantern is added to existing signal, and to mid-block section, where signal is installed exclusively for pedestrian crossing. Installation guidelines formulated by the Study Team are briefly described below and summarized in Table 9-7.

- *Intersection*: Intersections with more than 650 vehicles/hour and 200 pedestrian crossings/hour during the peak hour should install pedestrian signals[6]. On roads with three or more lanes, pedestrian signals should be installed. Furthermore, land use considerations (such as school area) may also play a part in this decision, even if traffic (either vehicular or pedestrian) does not surpass the threshold identified above.

- *Mid-Block Sections*: At mid-block road sections, pedestrian signals are recommended where crossing demand is high such as in front of a school, a hospital, a department store, a market, or any large-scale facility that attracts many pedestrians. Pedestrian signals should also be installed at any location with an abnormally high rate of pedestrian accidents. The following factors also determine the installation decision.

  - If there is an existing crossing (zebra crossing) near the proposed installation site, this intersection should receive greater consideration.
  - If the proposed site is 100 m or farther from an existing crossing facility, installation of signals should be based on the number of pedestrian crossings.
  - If a new pedestrian signal installation is less than 200 m from an existing ATC signal, two signals must be coordinated.

[6] These are the thresholds used as a guideline for signal installation in Japan.

Table 9-7 Installation Guidelines for Pedestrian Signals

Classification	Installation Guidelines
Intersection	• Peak hour traffic: more than 650 vehicles and 200 pedestrian crossings • Pedestrian crossing has 3 or more lanes • Must consider land use
Mid-block	• Peak hour traffic: more than 650 vehicles 200 pedestrian crossings • If proposed location is near an existing crossing (zebra crossing), greater consideration will be given to installation of signals • If proposed pedestrian signal is within 200 m of existing traffic signal, timing adjustment of signals is necessary • Must consider land use type along the roads such as large-scale institutions and important tourist facilities, schools, hospitals, markets, and sport stadiums, etc. as well

Source: This study

Based on the guidelines outlined above, installation of pedestrian signal and addition of pedestrian lantern are recommended for the following intersections:

- Intersections for Detailed Study - The 20 intersections studied in detail are examined in terms of the pedestrian traffic demand and vehicle volumes. Among them, eight (8) intersections are currently signalized while 12 are not. Using the traffic survey results and the above installation guidelines, seven (7) existing signals warrant addition of pedestrian lanterns and six (6) new signals must have pedestrian lanterns as shown in Figure 9-6.[7]

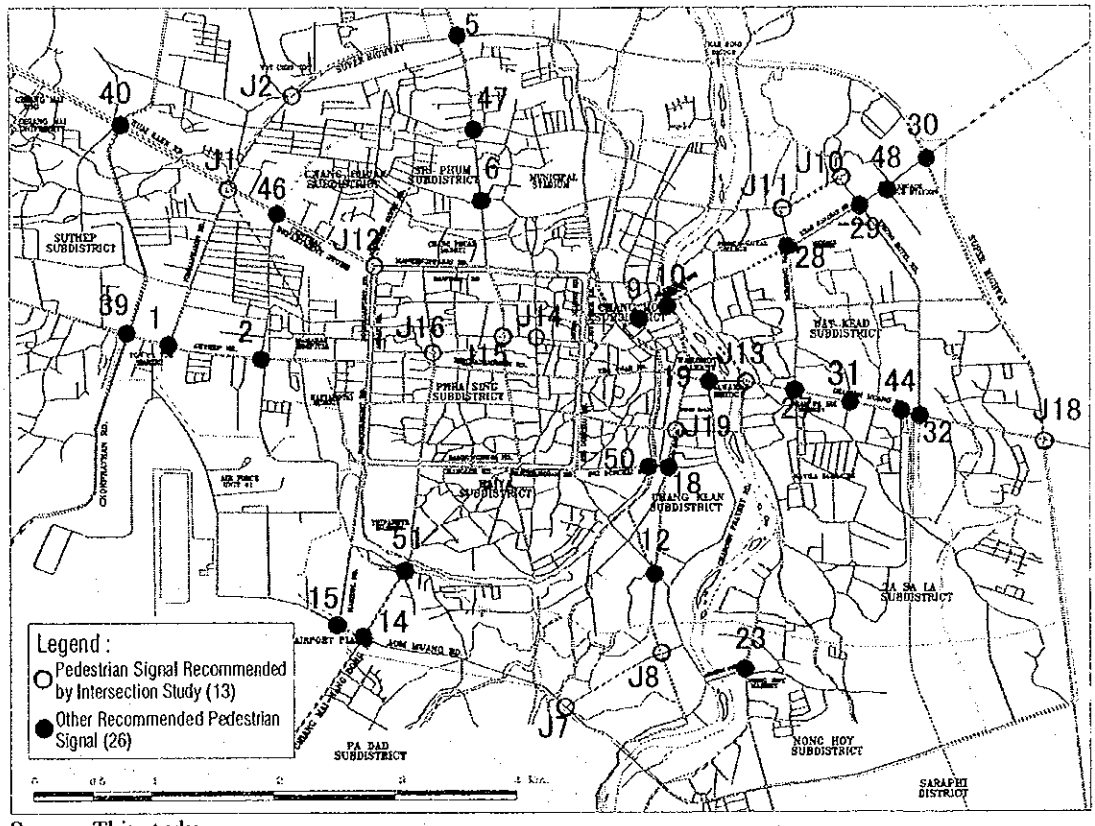
- Other Signalized Intersections - A total of 34 existing signalized intersections are also examined. The number of lanes and the type of land uses are also taken into consideration. Out of 34 signals, 26 intersections were found to require the installation of pedestrian signals as shown in Figure 9-6.[8]

- Mid-block Sections - At present there are 6 pedestrian signals installed at road section crossings and one at a signalized intersection in the city. The OCMLT is undertaking a JBIC financed project to install more pedestrian signals at road section crossings in the city. The Study Team examined 43 candidate locations and assessed their needs for pedestrian signals based on available data and site observation. Of the 43 candidate locations, 31 were found to warrant the installation of pedestrian crossing signals.[9]

[7] The list of 13 intersections is found in Appendix G: Table G-1.

[8] The recommended list of 26 intersections is found in Appendix G: Table G-2.

[9] The list of 31 locations is found in Appendix G: Table G-3. Furthermore, at the other 12 locations, the pedestrian traffic is relatively low. However, since the necessity of such installation cannot be determined on land use and observations alone, the 12 locations should be re-examined.



Source: This study

Figure 9-7 Proposed Pedestrian Signal Installations

Priority of Traffic Signal Installations

Installation of new signals and upgrading of existing isolated signals at 38 intersections are proposed. The addition of pedestrian lantern is also recommended at 34 intersections. Among the candidate locations, the highest priority must be given to those intersections where a signal is warranted but currently no signal is installed, and to existing signals without pedestrian lantern. The existing isolated signals operate with a fixed timing pattern throughout the day and do not respond to variation in traffic demand. These signals must be upgraded to ATC signal so that operation will be more efficient and malfunction of signal equipment can be detected easily. These signals are given the second priority. There are several new roads planned by Municipality or DOH. Intersections along the new roads will most probably require a signal as they are planned as arterial road. Signals will be installed as the new road is constructed and this group of signals is given third priority. Table 9-8 summarizes signal installation priority.

Table 9-8 Signal Installation Priorities

Priority	Criteria	Number of intersections	Intersection in Figure 9-6	Schedule
1	New signal at intersection where signal is warranted	12	2, 5, 6, 7, 8, 10, 11, 19, 21, 22, 23, 24	As soon as possible
1a	Addition of pedestrian lantern	34	See Fig. 9-6	As soon as possible
2	Connection of isolated signal to ATC	10	14, 15, 16, 17, 41, 42, 43, 44, 45, 46	
3	New signal on new road	16	25 - 40	As new road is constructed
	Total	72		

It is noted that a signal is already installed at No. 2 Wat Ched Yod intersection under the pilot project of this study. Moreover, a new signal was installed in June 2002 at the intersection No. 22 Nimmanhamin – Chiang Rai 2.

(5) Upgrade Signal Control Software

The current SCOOT system is not responding adequately to heavy traffic conditions and long queues appear. As a result, during the peak traffic period, a policeman must go to the field and control the signal manually. This is because its algorithm does not respond to the queue length. The SCOOT system could be improved to solve this problem, but this would take time and money. On the other hand, there are new signal control technologies such as MODERATO developed in Japan, which has the standard function of balancing queue lengths even at heavy traffic periods. From this standpoint, the partial implementation of MODERATO system should be considered. To do this, some reorganization of sub-areas and relocation of the controllers are necessary. Although a more detailed study is necessary, the cost to introduce MODERATO may partially balance the cost to step up the control level of SCOOT system. It is worth noting that if the queue length shortens, the load on the police controller becomes light and the benefits to the motorists increases.

9.4 Traffic Safety Enhancement

(1) Changing Name of Super Highway and Speed Limit

Super Highway is the most dangerous road in Chiang Mai. As one of the measures to enhance its safety, the Study Team recommends changing the name of Super Highway to Inner Ring Road. All road signs bearing the name of Super Highway must be changed to Inner Ring Road and a public campaign should be held to ensure acceptance of the new name.

The Super Highway name is considered inappropriate because:

- The name "Super Highway" gives a wrong impression to drivers that it is an expressway or high speed is allowed.
- The worst six accident-prone intersections are located on the Super Highway.
- Most intersections along Super Highway are the at-grade type and their interval is 1 – 3 km along the northern half of Super Highway.
- Moreover, U-turn opening is provided to median at 500m – 1 km interval for long section.

Vehicles travelling at speeds exceeding the limit of 90 km/h are commonly observed on Super Highway. High speed seems to contribute to the high rate of accidents at intersections. It is recommended to reduce the speed limit from 90 km/h to 60 km/h for 300 meter on approach and for 200 meter on exit.

- Speed limit sign showing the limit of 60 km/h will be installed at 300 m upstream of at-grade intersection.
- Speed limit sign showing the limit of 90 km/h will be installed at 200 m downstream of the intersection.
- At-grade intersection ahead sign will be installed 200 m upstream of the intersection.
- Different road marking, for example wider lane line, will be applied to the section with the reduced speed limit.

(2) Pedestrian Environment Improvement

While pedestrian crossings are generally provided at intersections and mid blocks, pedestrian signals at some large intersections remain uninstalled. The large volume and high speed of vehicular traffic at such intersections makes it dangerous for pedestrians to attempt to cross the road. It has been observed that drivers often do not give way to pedestrians at intersections. Sidewalks are often too narrow, or obstructed by various improperly located objects like lamp posts, trees, refuse bins, telephone booths, sign posts, etc.

The following recommendations intend to improve the level of safety on sidewalks

- Set up a maintenance program to repair broken sidewalks with re-laying on firm sub-base.
- Upgrade sidewalks systematically to encourage walking, as well as to create a continuous and comprehensive network. The upgrading work includes the following:
  - Widening to a minimum of 2 m (3.5 m if trees are planted).
  - Lower curb height
  - Gentle slope of crosswalk ramp
- Add additional pedestrian lanterns to the existing signal.
- Install pedestrian crossing signals at mid block of streets with heavy traffic.

- Install pedestrian refuge islands with lighting at allocated crossing points to improve pedestrian safety and enhance pedestrian considerations
- Provide "buffer" or screening space between moat sidewalks and circulating carriageway, possibly by parking bay allocation, pavement build-outs and sidewalk expansion. Initiate moat environment enhancement plan
- Driver education should focus on emphasizing the importance of giving way to pedestrians.

As a case study of sidewalk improvement, sidewalk conditions of several roads were studied and an improvement plan was prepared. The selected roads are located in the city center. The common characteristic of these roads is narrow sidewalks, thus endangering safety and reducing comfort for pedestrians and other users. Irrespective of the sidewalk width, many obstructions exist such as telephone booths, which force pedestrians to walk on the roadway, hence interfering with the flow of vehicle traffic. The top priority of improvement is to ensure a comfortable and safe sidewalk width. Once this requirement is met, objects such as trees and telephones booths will be considered.

The planting of wayside trees is undoubtedly a good practice, as it improves the walking environment and segregates vehicles from pedestrians, helping to ensure better safety and comfort for pedestrians. However, a width of 1.5 m is normally required for planting of wayside trees. The width to be provided for walking must be provided separately from this. Wayside trees are present on the selected roads, with most being planted in the center of the already narrow pedestrian sidewalks. Such a situation raises the question of whether the sidewalk is for the pedestrians or for the planting of trees.

To ensure sufficient and effective width for sidewalks, the following methods/steps may be taken.

- Integration of several signs onto common posts will reduce the number of sign posts on the sidewalks (unwanted/unneeded poles should also be removed immediately)

- Large telephone booths (1.0 m × 1.0 m), that presently occupy much of the sidewalk, should be removed and replaced by smaller or less obstructive units. For those phones with few users, permanent removal or relocation should be considered, to secure the effective sidewalk width.

- Priority should be given to secure effective sidewalk width for pedestrians. Thus, wayside trees planted on sidewalks that are less than 3 meter wide should be removed and relocated. Moreover, care must be taken to ensure that the roots of these trees do not impact sidewalk continuity.

- Installation of objects such as sign posts and trees should be as close to the curbside as possible, to ensure the maximum space on the sidewalk for pedestrians.

- Reduction of roadway width and widening of sidewalks should occur whenever possible, to achieve a balanced environment for both vehicles as well as for pedestrians.

After considering the above matters, the proposed considerations and improvements for each of the roads are given below. Existing conditions and proposed improvement plans for these sidewalks are given in Table 9-9.

Table 9-9 Consideration for Possible Improvement

Road Name	Method of widening sidewalk width				
	Integration & Rearrangement of Signs	**Telephone Booth**	**Relocation/ Removal of Wayside Trees**	**Repositioning of All Objects on Sidewalks**	**Reducing Carriageway Width & Widening of Sidewalk**
Tha Phae	Too many types of signs. Integration will be effective to reduce the numbers.	Removal will produce significant effect.	There are almost no wayside trees.	Repositioning of objects including various advertisement signboards is necessary	Section of this road towards Thae Phae Gate has been widened from 9.0 m to 10.4 m. This extra 1.4 m should be given to widening of sidewalks.
Charoen Prathet	There are relatively few signs along this road	There are no phone booths along this road	Due to the narrow width, trees should either be transferred or removed.	There are relatively few sign poles. This effort may not produce much effect	By limiting carriageway width to 6.6 m for the 2 lanes, sidewalks can be widened by 1.0 m each to 2.25 m.
Sri Donchai	Rearranging traffic signs within controlled road section is necessary	Telephone usage is relatively low. Their removal will produce significant effect.	Trees need to be removed to secure the minimum sidewalk width	Objects such as poles, signs, and signboards should be rearranged.	Reduction of road width is difficult.
Loi Kroh	Rearranging traffic regulation signs is necessary	There are no telephone booths	Remove trees to secure the minimum effective sidewalk width.	There are few objects.	Reduce the present 7.45 m carriageway width to 6.50m as a 2 lane road. The 0.95 m saved may be used to widen the sidewalks from (1.65+1.20) to (1.9+1.9) m
Chang Klan	There are relatively few signs.	Effects will be insignificant.	Trees are planted only along the southern section.	Power poles have been rearranged towards curb side.	Secure the width needed for the 3 traffic lanes. The extra width may be used for widening the sidewalks.

Source: This study

(3) Traffic Signs and Pavement Markings

Road signs and markings in the Municipality are generally inadequate. The type, design, size, location, reflectivity, etc. of the existing signs are not satisfactory. Likewise, the material, design, and size of markings are not consistent. The basic reason for this situation is a lack of national standards and installation guidelines. The Study Team recommends to develop Road Signs and Marking Manuals. The Road Sign Manual consists of the following items:

Table 9-10 Contents of Road Sign Manual

	Title	Contents
1	Introduction	Purpose of standard, applicable works, definition of terms
2	Design of sign	Basic consideration, selection of location, spacing, visibility, installation method, sign size, font and size, reflectivity, etc.
3	Definition of sign	Design, size, meaning, application, etc. for regulatory, warning and guide signs
4	Installation work	Installation method, material, structure, work procedure
5	Maintenance	Inventory, inspection and repair

For pavement marking, currently different agencies adopt different standards resulting in inconsistent design and application. It is urgently necessary to develop similar national standards for pavement markings. Moreover, strict compliance of marking materials to Thai Industrial Standard 542-2530, which stipulates thermoplastic materials for road markings, must be ensured. This is possible only by testing samples collected at the project site.

Table 9-11 Contents of Pavement Marking Manual

	Title	Contents
1	Introduction	Purpose of standard, applicable works, definition of terms
2	Design of sign	Basic consideration, materials, font and symbol, color, bead, reflectivity
3	Definition of marking	Design, size, color, spacing, meaning, etc.
	Sample design	Intersection, mid-block section, merging and separating lanes
4	Installation work	Installation method, inspection, test piece, and testing method

(4) Other Traffic Safety facilities

The following recommendations pertain to the provision of other kinds of traffic safety facilities in Chiang Mai.

- Guardrails should be installed to protect pedestrians along narrow sidewalks and corners from approaching vehicles.
- Road mirrors should be installed at intersections with sharp curves and poor sight distances to improve line-of-sight.
- The reflectivity of concrete barriers placed in the center medium should be improved.
- The reflectivity of standing pins and guardrails should be improved along curving road sections, especially near rivers, to improve safety and visibility at night.

(5) Pedestrian and Bicycle Network in Old City

Planning for a bicycle/pedestrian network should be aimed at providing continuity in access and connecting various points of interests and major destinations, thus providing a safe and comfortable environment for both locals and tourists to move around in the old city. This initial effort may be thought of as a rallying point to encourage and promote travel modes that are non-polluting and generally improve the living environment in Chiang Mai. Once local residents begin to appreciate the benefits of a cleaner atmosphere and safer environment, such efforts may also be extended to other parts of the city in the future.

The following considerations must be taken into account when planning for NMT network in the old city:

- It must be recognized that there is a need to maintain continuity of routes linking the entrance gates to major historical sites or sightseeing spots/major destinations.
- The inner circular road and the east-west Ratchadamnoen Road/Phra Sing Road will form the major axes that compose the network.
- All the existing color paved sections should be utilized.
- Presently, both cyclists and pedestrians use the existing Soi in a free manner without any specific demarcations. To ensure walking space, a 2.0 m wide bicycle lane marking should be applied to help streamline the flow of bicycles during busy hours.
- The standard width to be applied are as follows: 1.5 m (0.75 m x 2 lanes) for pedestrians and 2.0m (1.0 m x 2 lanes) for bicycles.
- Similar color interlocking pavements should be utilized for all suggested routes, to avoid creating confusion for users.

[10] The list of 31 locations is found in Appendix G: Table G-3. Furthermore, at the other 12 locations, the pedestrian traffic is relatively low. However, since the necessity of such installation cannot be determined on land use and observations alone, the 12 locations should be re-examined.

- Guide signs and/or route maps should be provided at major junctions of such a network. These should however be placed so as safe movement of users is not obstructed, nor minimum sight lines obscured.
- Major tourist attractions, road names, and the pedestrian/bicycle network route itself should be displayed on these signs to facilitate easy identification of the present location of users and of the potential path/route the user may take.

As a result of above considerations, a proposed bicycle/pedestrian network plan is shown in Figure 9-8.

Legend

- Ancient Area
- School Area
- Market
- Existing Colored Pavement
- Municipality Plan Colored Pavement
- Proposed Colored Pavement
- Proposed Information Guide for Tourists

Source: This study

Figure 9-8 Proposed Bicycle and Walkway Network Plan within the Old City

(6) Improvement of Hazardous Locations

Recommendations on the safety improvement measures presented in the preceding sections were applied to the hazardous locations identified in Chapter 6.7 and recommended measures are summarized in Table 9-12.

Table 9-12 Safety Improvement Measures for Hazardous Locations

No.	Location of Hazard	Recommended Measures
1	Charoen Raj Road near Wat Sri Klong	• Improve reflective materials used in pavement markings so as to improve reflectivity. • Install surface delineator and road mirror. • Install warning signs for hairpin and sharp curve.
2	Chiang Mai-Lamphun Road at the southern side of the Kelkaram T-Junction	• Install road mirror to improve sight distances. • Install flashing warning light at the center of the intersection (for example, by using a solar cell). • Install stop sign and stop markings at the approach to the access road.
3	Chiang Mai-Lamphun Rd. on the southern side of Tha Satoi Rd.	• Install "Narrow Road Section Ahead" warning signs. • Install zebra markings for lane reductions. • Install delineator at the bottleneck section.
4	Chiang Mai-Lampun Rd. and Rat Uthin Rd. Intersection	• Install road mirror to improve sight distances. • Install "T-type junction ahead" warning sign on CM Lampun Rd. • Install stop sign at the approach to the access road.
5	Northern Approach of Wang Sing Kham Road near Rama IX Bridge	• Install delineator for safer driving especially during the nighttime. • Provide centerline and borderline road markings. • Install warnings sign for 'sharp curve'.
6	Southern Approach of Wang Sing Kam Road near Rama IX Bridge	• Install delineator for safer driving during the nighttime. • Provide centerline and borderlines road markings. • Install warnings sign for "sharp curve". • Extend guardrail to entire curved section.
7	End of Southern Section of Chang Klan Road	• Install "NARROW ROAD AHEAD" warning sign to warn drivers of sudden change. • Install zebra markings for lane reduction. • Install warning signs about 50 meters before the beginning of the guardrail. • Install warning sign before the hairpin curve. • Install delineators along hairpin curved section • Improve reflectivity along centerline and borderline markings.
8	Chang Klan Rd. Near Aom Muang Intersection	• Install warning sign for the Y-junction. • Install flashing light at the intersection. • Install delineators on the main road (Chang Klan) at the curved intersection section. • Install road mirror to improve sight distances.

Table 9-12 Safety Improvement Measures for Hazardous Locations (continued)

9, 10	Inner Circular Road along the Moat near Suan Dok Gate and Chiang Mai Gate	• Install "Narrow Road Ahead" warning signs to caution drivers. • Install zebra markings for lane reductions and delineators along bottleneck sections.
11 12 13 14	At the 4 corners of the Old City Moat	• Install warning sign 60 meters upstream to warn drivers of upcoming curve. • Install high reflective pavement markings. • Install road studs with reflective function along the lane markings. • Install road mirrors at the corners to improve sight distances.
15	Southern End of Chotana Rd.	• Install "Sharp Curve" and "Narrow Road Section" warning signs. • Install zebra marking for lane reductions.
16	Prakot Road, Chang Phuak Road along East-West Direction.	• Install road mirrors to improve sight distances at junctions. • Install stop signs and stop line markings at the junctions.

Source: This study

9.5 Public Transport Improvement

According to issues brought up in Chapter 7, the initial recommendations to provide a sustainable public transportation system may be summarized as follows:

(1) Promote Coordination among Agencies

Traffic problems and congestion in Chiang Mai are largely due to the fact that 85 percent of all trips are taken using private transportation, whereas only 12 percent are taken on public transportation. This ratio is surprisingly low compared to other medium-sized cities throughout the world. In addition, there is great potential for the share of trips taken on private transport to increase in the future, given several trends including a relatively young population and increasing average income levels. Congestion will surely increase given the current status of road traffic in the Municipality.

Therefore, the attitudes of public transport operators (primarily between *songtaew* cooperatives and minibus cooperatives) must shift from one of confrontation and in-fighting, to one of cooperation and collaboration. Public transport operators should focus their efforts on making public transport as attractive and convenient as possible to increase ridership and reduce traffic congestion. They need to unite to form a powerful political block to push ordinances or legislation that favors their operation and sustainability. Although it may be difficult at first, traditional antagonistic feelings must be put aside, so agencies can maintain and increase their market share, despite growing vehicle usage in the Municipality.

(2) Stricter Enforcement of Rules and Regulations for Public Transport

LTD is responsible for public transport regulation and enforcement. Throughout the last twenty years however, it has failed in this responsibility, in large part due to lack of a budget to expand supervisory staff for inspections, combined with the ever-increasing number of vehicles in the *songtaew* cooperatives for instance.

A first step towards improved enforcement/regulation of public transport is the reduction of the total number of red *songtaews* in operation (several plans have been mentioned including the elimination of new vehicle registrations, the cancellation of vehicle registrations for certain groups of drivers, and the introduction of air-conditioned vehicles). To maintain profitable operations, fare levels are set exceedingly high compared to other cities in Thailand, which burden low-income and public transport dependent residents. Therefore, LTD should improve its license renewal/verification system. The number of vehicles operating on a particular route (which consists of a minimum and maximum number of daily vehicles) should be reduced somewhat. In other words, the minimum number of vehicles for a particular route should remain the same, but the maximum number of vehicles should be reduced.

Another step would be the creation of a new organization to supercede or replace part of the functions and responsibilities of the LTD. As noted previously, it lacks "real" jurisdictional powers over the Chiang Mai Provincial Planning Office. The new body would be directly responsible to and be organized by the Provincial Governor of Chiang Mai.[11] The Municipality is now considering the establishment of a special team, consisting of six full-time staff devoted to the enforcement of public transport policies and regulations along the proposed nine minibus routes.

(3) Promote Corporate Management Style

The cooperative management style of the *songtaews* has contributed to a weakening of the enforcement capabilities of LTD. Accordingly, it is recommended that cooperatives corporatize themselves in which case more direct control will be asserted over drivers (mostly in the form of regulated working hours and fixed-route service networks) or divide themselves further into smaller cooperatives, based on the route. The first alternative would bring regulation and order to the provision of *songtaew* transport, while the second alternative would reduce the problems associated with large cooperatives. Corporatization of the cooperatives is also an opportunity to introduce a uniform standard of vehicle to replace the mixture of vehicles (varying in condition, operating order, and interior) currently providing *songtaew* service for instance.

(4) Standardize Vehicle Design

A standard "bus type" is envisaged for future bus services in Chiang Mai, especially if services are operated on a fixed route basis. It is recommended that a bus standard,

[11] This reform package is part of a program that includes direct election of provincial officials instead of the existing procedures in which the central government appoints these officials.

fully compliant with the technical specifications for public transport vehicles as set down under the Law of Transport Act 1979, be developed. Based upon statistics collected for this study which indicate that buses in Chiang Mai presently carry approximately 60 to 70 passengers per day, it is expected that the new bus standard should feature both front and rear doors and possess higher capacity than those of the existing fleet.

(5) Adopt Fleet Renewal Programs

At present, according to statistics collected for this study, nearly 25 percent of the buses operating in Chiang Mai are 20 years or older, while nearly half are 10 years or older. In order to improve the quality of service and the level of safety while rationalizing the total number of bus units in operation, it is proposed that a maximum age for buses (chassis) be established.[12] In addition to reducing operating costs and increasing service reliability, limiting the age of the fleet should also reduce the number of accidents involving older vehicles.

Furthermore, as the current oversupply of public transport on the streets of Chiang Mai is addressed and operational costs are correspondingly reduced, it is expected that the bus operators will be able to capitalize their companies. This process should greatly facilitate the introduction of standardized bus types as replacements for buses that have reached the end of their serviceable life. However, as individual companies are known to have great difficulty in obtaining the necessary financial guarantees (letters of credit, etc.), it is important that the Municipality and other related government agencies also lend adequate and appropriate support to a comprehensive fleet renewal strategy.

As the case of the Mega Taxis and Jeepneys in Metro Manila showed (Box 7-1), the introduction of air-conditioned vehicles, offering significantly improved levels of service, is one means of accomplishing the task of fleet renewal. Thus, the mandatory introduction of air-conditioned vehicles for the Red *Songtaew* Cooperative provides a good opportunity to reduce the number of redundant and deteriorated vehicles in operation.

(6) Feasibility Study of Bus Priority Measures

Assessments should be conducted to analyze the feasibility of bus priority lanes within the Municipality. Lanes in which buses have exclusive priority access are designated as "Bus-Only Lanes," and provide improved public transport service in terms of speed, reliability, frequency, and operational costs. Bus traffic is then permitted exclusive use of the left-hand lane of the designated street, permitting unrestricted turns into streets leading to and from it. Such lanes would be paved in reinforced concrete in order to improve the quality and comfort of the public transport ride. These bus priority measures are to be complimented by traffic engineering improvements including appropriate lane markings, signage, sidewalk enhancements, and upgraded traffic signal

[12] The proposed maximum age of vehicles should be determined based on an analysis of accident, maintenance and breakdown records of the existing fleet in Chiang Mai.

systems. Such measures would likely go into effect after fixed route bus networks are established.

(7) Secure Funding for Sustainable Operations of Public Transport

The financial weakness of the public transport sector is a continuing problem in terms of sustaining operations as well as enforcing of operations. For instance in 1996, there was no alternative left for either LTD or the minibus operator but to terminate operations. LTD lacked the budget to subsidize operations. The operators were independently unable to sustain operations under the large operating deficit. Likewise, the LTD has been unable to expand its staff assigned to public transport regulations enforcement as the allotted budget is insufficient. Similar to minibus operations, private operators including *songtaew* cooperatives are unable to independently fund such activities and have requested central government aid to subsidize their operating expenses.

It is therefore essential that financial strengthening of the public transport sector be improved to create more sustainable operations. Some suggestions included the earmarking of fees related to public transport vehicle registration and terminal usage fees paid by operators towards the development of the public transport industry. For example, the privatization of terminal operations may contribute further towards increasing revenues. Furthermore the subsidization of gasoline purchases to keep them at stable price levels by the public sector as well as a vehicle leasing system operated by the public sector, would also serve to improve solvency.

(8) Private Financing for Transport Development

It is apparent that transport services (in the form of *songtaew* and minibus operations), solely financed by the public government or Municipality, will continue to face financial hurdles and institutional barriers. Similarly however, the cooperative-style of management has been shown to be poor in terms of funding capacity as they are essentially an assemblage of individual operators. Partnerships with other private enterprises, outside of the transport-related realm, may be one solution to the funding problem that has historically arisen. Thus privately financed transport facilities and services may be introduced in Chiang Mai, from non-transport related sources.

Precedent for private financing in transport projects in Chiang Mai has already been set in 1995 as Auchon, one of the major supermarkets that sprouted up alongside Super Highway, fully-funded the construction of an underpass beneath Super Highway[13]. Big C, and other large supermarkets, may have an interest in alliances with public transport operators to improve direct access to their stores, as well as their marketing and publicity efforts. Examples of privatization in the public transport sector are shown below:

[13] The Big C Supermarket now occupies this site, while the underpass was donated to the Department of Highways.

- The construction of joint-terminal facilities (i.e. all *songtaew* cooperatives hubbed at one location) at large supermarkets for school-based transfer trips to/from the suburbs. This is a great public relations and marketing opportunity for supermarkets to gain notoriety. For instance, parents would become familiar with the supermarket name and perhaps stop for a quick shopping trip in the mornings (when dropping their children off) or in the afternoons (when picking them up). The supermarkets have ample open areas within their parking lots to accommodate the expected traffic.
- The construction of separate terminals for red, white, and yellow *songtaews* to eliminate route duplication. As public funding for such construction is lacking, however supermarkets could provide basic terminals within their parking lots.
- The creation of new transport routes to/from the supermarkets (fully or partially funded by the supermarkets themselves of course) to give customers direct access to their stores.

While the above examples may be too costly, too risky, or simply infeasible for non-transport related entities to undertake, they nonetheless represent different means of involving the private sector in public transport provision. In the future, it is likely such imaginative schemes will be needed to further develop the public transport system in Chiang Mai.

9.6 Other Traffic Management Measures

The following sections discuss other types of traffic management measures that should be employed or investigated further.

(1) Parking Facilities Improvement

Generally speaking, there is an ample supply of parking space in the study area. Parking is not a problem, even in busy areas such as Chang Klan Road. Furthermore, parking facilities are provided free of charge by many commercial establishments as well.

Parking problems exist at several locations, most notably in the CBD (Central Business District). Off-street parking does not exist in the CBD, thus it is commonplace for drivers to park on the street to load/unload goods/passengers or to visit nearby stores. It was observed that many vehicle owners violated parking regulations posted in the area however. At the moment, supply exceeds demand and paid parking only operates when there is high demand.

Furthermore, there are no government regulations applicable to the privately operated parking facilities except a mandatory requirement for private buildings to have parking lots for their tenants. As a result of a lack of government regulations, there is a severe lack of data or information about privately owned parking, including vehicle capacity, parking fee, operating hours, occupancy rate, average occupancy time, etc. This lack of

basic parking data makes it difficult to understand the current parking situation, not to mention identify issues and devise plans for the future.

Lastly, the Municipality and the Traffic Police have contrasting objectives. Parking fees from public facilities are a major revenue source for the Municipality. Thus it would suit the Municipality if more public parking facilities were created. The Traffic Police on the other hand would likely advocate either the reduction or limiting of public parking facilities to improve traffic flow.

Although currently not a problem, parking may soon become a particularly significant issue increasing traffic congestion if vehicle ownership rates continue to increase along with economic development and per capita wages. In order to deal with the expected demand, the Study Team recommends the following measures.

- The Municipality and all related-agencies must realize that a reduction in parking supply or higher parking fees will NOT reduce vehicle usage by themselves. Vehicle owners will not stop using their cars until other transport modes are more attractive. Insufficient parking supply would produce increased illegal on-street parking and/or long queues of vehicles waiting to enter parking lots. It is recommended that an adequate supply of parking must be ensured to avoid worsening congestion.

- A parking management policy must be formulated, based on estimates of future modal shares. Subsequently, means to satisfy the demand must be developed. If the future demand is deemed too large for the Municipality to accommodate, measures to reduce the demand must be considered. As a first step in policy formulation, parking data should be collected and the operation of parking facilities should be monitored to better comprehend the parking situation.

- A review and possible revision of on-street parking regulations is necessary. It is expected that tighter parking control on on-street parking will be necessary to accommodate future traffic volumes, since parking will depend more on off-street parking in the future.

- Both public and private sectors should contribute to the supply of parking. Parking must be supplied by the private sector, while the public sector may supply parking where the private sector is unable/unwilling to do so. The parking facility at Warorot Market is a good example of a public-private partnership.

- The Municipality and the Traffic Police must reach a consensus on a unified approach and vision for parking in Chiang Mai.

(2) Traffic Safety Measures for Motorcycle

Traffic surveys found that motorcycle traffic represents nearly 50 percent of all vehicles on the roadways in Chiang Mai. Traffic accident records show a very high level of accident casualties involving motorcyclists (almost 70 percent). Motorcyclists are

known to disobey traffic regulations such as driving without safety helmets, carrying one or more passengers, carrying heavy loads, driving erratically and speeding. More stringent regulations on motorcycle traffic are therefore required. Suggestions for improvement include:

- Strengthening of enforcement of motorcyclists such as the introduction of more stringent punishment such as the suspension of driving licenses for repeat offenders (drivers) involved in serious accidents, so as to deter disregard for traffic safety rules.
- Improving public support and awareness through the use of public relation campaigns.
- Promote safe driving and the introduce safety education at school. Furthermore, traffic safety instructors and administrators need to be developed and nurtured.
- Adopting more stringent measures for license application and renewal.
- Introducing education and counseling for repeat offenders (drivers) involved in serious accidents.
- Enforcing regulations and rules, especially the compulsory use of safety helmet for motorcyclists, is necessary.
- Adopting additional measures to improve motorcycle safety including systematic widening of road shoulders to accommodate motorcycle traffic, as well as better enforcement of speed limits for other vehicles.

Table 9-13 presents recommended safety measures targeted for motorcycle safety.

Table 9-13 Proposed Traffic Safety Measures for Motorcycle in Chiang Mai

Recommendations/Improvement Measures	Main Safety Problems			
	Unlicensed Youth on Roads	Driving Without Helmets	Frequent Night-Time Accidents	Disregard of Signals and Signs
Traffic Regulation				
1. Strengthen traffic regulations, and expansion	✓	✓	✓	✓
2. Strengthen enforcement	✓	✓	✓	✓
3. Impose severe punishments, such as license suspension for persons involved in serious accidents, repeat or overly-aggressive offenders	✓	✓	✓	✓
4. Commence public relations campaign through mass media such as newspapers, TV, and radio	✓	✓	✓	✓
Traffic Safety Device				
1. Signalize non-signalized crossings			✓	✓
2. Improve traffic safety devices			✓	✓
3. Improve road signs and use more reflective materials to improve visibility of road markings			✓	✓
Traffic Safety Education				
1. Provide traffic safety lesson to/in public/schools	✓	✓	✓	✓
2. Investigate motorcycle usage by students	✓	✓	✓	✓
3. Improve traffic safety training for education leaders	✓	✓	✓	✓
4. Use audio-visual education aids, such as movies and videos, during traffic safety instructions	✓	✓	✓	✓
5. Study recurrent causes of traffic accidents	✓	✓	✓	✓
6. Improve safe driving training for administrators	✓	✓	✓	✓
7. Introduce traffic safety instructions during license presentation and motorcycle purchase	✓	✓	✓	✓
Driving License/Renewal				
1. Reexamine the existing licensing system	✓	✓	✓	✓
2. Require traffic safety course for license renewal	✓	✓	✓	✓
3. Introduce driver awards to encourage safe driving	✓	✓	✓	✓
4. Require traffic/safe driving classes for offenders	✓	✓	✓	✓
5. Refuse renewal for repeat violators	✓	✓	✓	✓
Enforcement by Related Authorities				
1. Improve Traffic Police enforcement	✓			
2. Conduct traffic safety campaigns for the public	✓			
3. Enforce and promote helmet usage (campaign)		✓		
4. Enforce headlight/indicator usage			✓	✓
5. Counsel frequent accident offender			✓	✓

Source: This study

(3) Traffic Accident Investigation and Recording System

The Study Team has produced the following suggestions towards the construction of a better traffic accident recording system in Chiang Mai.

It is important that the Traffic Police Department concerned with traffic accident investigations fully recognizes the seriousness and purpose of such investigations. The department:

- has a legal responsibility to conduct such investigations to establish the truth in the event of such occurrences; and
- must understand the importance of collecting the fundamental accident data showing the causes of traffic accidents, which in turn will help police to comprehend accident characteristics and enable them to devise mitigation measures.

To organize a traffic accident investigation team, training should be conducted for members to ensure that the data entries are accurately, consistently, and precisely written in the investigation forms, without leaving any items or question unanswered (or partly answered).

Furthermore, it may be necessary to review data entry categories or items found on the traffic accident investigation record form, and if necessary to redesign the format so as to make it easier for investigators to enter the information or data. In particular, it is important that such a format take into account the need to integrate these particular traffic accident statistics with a compatible format with that used by local hospitals.

Thus the overall objectives are:

- To construct a computerized traffic accident data processing system that quickens the compilation of traffic accident records, statistical analyses, and reporting; and
- To undertake a comprehensive macro and micro-analysis when formulating various mitigation measures.

(4) Traffic Management Around School Areas[14]

Traffic Demand Analysis and Countermeasures

Issues regarding the present state of traffic demand around the school areas may be summarized as follows from the traffic surveys:

Table 9-14 Congestion Issues and Potential Countermeasures around School Areas

Issues	Background	Countermeasures
High rate of students being sent to school by parents	• Low service level of public transport • Traffic safety problems • Parents wish to see their children safely to school	• Development of public transport, particularly around the school areas • Improvement of pedestrian facilities • Introduction of campaign for traffic congestion alleviation
Low rate of students commuting by themselves	• Low service level of public transport • Fears about traffic safety problems	• Development of public transport, particularly around the school areas • Improvement of pedestrian facilities
Low pickup service utilization	• Fears about traffic safety and crime problems • Fare structure • Inflexible schedules	• Improvement in coordination with traffic police and LTD • Investigation of how to improve service levels • Development of high occupancy vehicle lane
Low passenger occupancy of vehicles	• Poor coordination within family • Fear of traffic safety and crime problems • Parental wish to see children safely to school	• Improvement of travel arrangement among parents and relatives. • Pedestrian facility improvement/ coordination with police • Introduction of campaign for traffic congestion alleviation
Concentrated location of schools	• Historical matter • Land acquisition matter	• Extension of campus • Establishment of branch school • Development of peripheral parking lots
Concentrated starting time	• Less coordination	• Improvement in coordination with school traffic committee
High number of commuters from suburban area	• Society of education-minded	• Extension of campus extension • Establishment of branch schools

Source: Study team

Among the countermeasures considered, the development of public transport is most necessary and desired in Chiang Mai. Particularly within the Chang Klan Area, no regular transport services exist, thus increasing the number of private vehicles in usage in this area. Furthermore, the overall quality of public transport should be improved. It

[14] It should be noted that the observed traffic demand in the Kaeo Nawarat Areas is significantly less than that in the Chang Klan Area. Therefore proposals discussed here will be applicable to the Chang Klan Area only.

was also found that safety was another big concern for those people who did not utilize pickup services.

Improving arrangements made for school trips is effective in alleviating congestion. Half of the parents had a positive response to any potential adoption of pickup transport services. Schools should take an initiative to further and improve coordination. Parent-Teacher Associations (PTA) may take a large role in this matter. The PTAs should investigate the quality of services and offer the operator quality level improvement.

Development of High-Occupancy Vehicle (HOV) lanes along Charoen Prateat Road in the Chang Klan Area may be considered.

Pickup Services

In regards to the pickup services, it would be wise to take into account flexibility so that services are not wholly concentrated during a particular time period and thus worse traffic congestion in the school areas.

The Study Team proposes that morning service for trips from suburban areas shall be offered as a first step of pickup service adoption. According to the interview with officials from the Red Bus Cooperative as well as nearby supermarkets, both have a positive opinion towards participating in such participation.

Coordination between schools, the traffic police, supermarkets, bus operators, and the parents is necessary. As such, campaigns promoting congestion alleviation are also necessary. It is necessary to develop the HOV lane for those operations. Table 9-15 shows potential route specifications for such service.

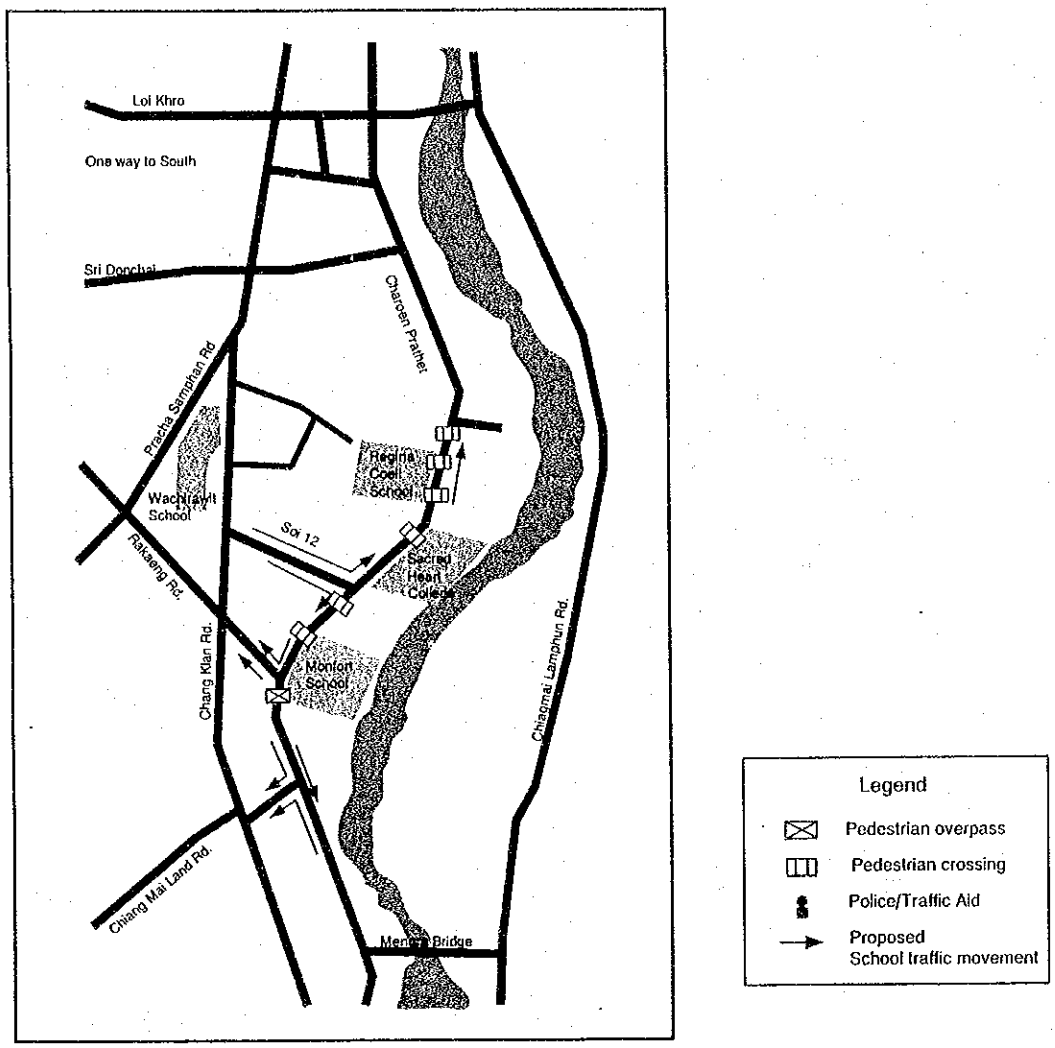
Table 9-15 Potential Specifications for Pickup Services

Routes:	1. Central Airport Plaza to Chang Klan Area 2. Central Airport Plaza to Kaeo Nawarat Area 3. Kaeo Nawarat Intercity Bus Terminal to Chang Klan Area 4. Big C Supermarket Chang Klan Area 5. Big C Supermarket to Kaeo Nawarat Area
Operating Hours and Service Frequency	For Chang Klan Area: 7:00 to 8:00 For Kaeo Nawarat Area: 6:30 to 7:30 Frequency: Every ten minutes (or earlier if a vehicle is full)
Vehicle Operator and Fare	Red Bus Cooperative: Six (6) baht per trip (standard rate for students) or cheaper, if possible
Parking Facilities	Borrow supermarket parking lots as "Kiss and Bus Ride Facilities"

Source: Study Team

One-Way System

An alternative one-way system in Figure 9-9 is proposed for the Chang Klan Area to improve traffic congestion and safety. Essentially, the proposal will utilize Soi 12 as a new entrance for Charoen Prathet Road for both Sacred Heart and Monfort School, so that traffic may be distributed in two different directions. The benefit of this proposal is that the traffic congestion will be shifted northwards, away from the school entrances along Charoen Prathet Road, to the intersection Chang Klan Road and Sri Donchai.



Source: This study

Figure 9-9 Proposed Traffic Management Scheme in Chang Klan Area

(5) Traffic Management in Night Bazaar Area

As noted previously, vehicular and pedestrian traffic is quite heavy throughout the Night Bazaar Area. Tourists as well as other visitors likely find the crowded conditions uncomfortable and unpleasant. The pedestrian environment must be improved to

increase the attractiveness of the Night Bazaar Area. The following measures should be examined as potential means of improving the traffic situation:

- Adopting outright or partial restrictions (according to time of day) on vehicle traffic[15]
- Adopting improved means of controlling vehicle speeds such as installing signals and/or speed humps
- Installing pedestrian signals
- Prohibiting vehicular parking

Moreover, the following measures should be considered to improve the pedestrian environment.

- Allotting adequate sidewalk space for pedestrian to walk comfortably
- Decreasing curb height between sidewalk and roadway
- Leveling sidewalks to create a flat, consistent, and contiguous surface
- Extending pedestrian crossings

Alternative plans have been proposed for changing the street as a transit mall with a priority to pedestrians. The mall itself would run for about 750 m from Tha Phae Road to Sri Donchai Road. These alternative plans are discussed in Table 9-16.

Table 9-16 Transit Mall Options around Night Bazaar Area

Option	Vehicle Restriction	Speed Regulations	Speed Reduction Measures	Sidewalk Improvement Efforts
A	• Regulate vehicles only when Night Bazaar is held • Restrict all vehicles except buses, taxies, and urgent vehicles	Maximum speed: 30 km/hour	• Extend pedestrian crossings • Install humps at pedestrian crossings • Raise intersection pavement level slightly	• Reduce main road to two lanes
B	• Regulate vehicles from 1:00 PM to end of Night Bazaar • Restrict all vehicles except buses, taxies, and urgent vehicles	Maximum speed: 30 km/hour	• Extend pedestrian crossing • Install humps at pedestrian crossings • Raise intersection pavement level slightly	• Reduce main road to two lanes • Reduce height of curb
C	• Maintain present conditions • Maintain existing regulations	Maximum speed: 45 km/hour	• Extend pedestrian crossings • Install signals to lower vehicle speeds	• Maintain existing width and other roadway conditions • Partially reduce curb height

Source: This study

[15] The Study Team regards banned vehicles in this instance to consist of motorcycles, private cars and small freight vehicles. Public buses and other forms of transport will be permitted however.

Lastly, in order to examine these options in more detail, it is recommended that frequent meetings be conducted with participating agencies, which should cover the following topics:

- impact studies on altered traffic patterns and volumes;
- impact studies on Night Bazaar merchants, as well as nearby stores, hotels and restaurants, etc;
- impact studies on Night Bazaar customers and visitors;
- technical examination of sidewalk improvements; and
- cost estimations for improvements.

Some drawing for improvement design of this area is provided in Appendix C.

(6) Traffic Demand Management (TDM)

It is likely in the *short-term* that the following TDM initiatives will have the greatest effect upon improving the traffic congestion situation in Chiang Mai and potentially stemming the high growth of private vehicles on its roadways (not in any particular order):

- Improvement and the creation of existing/new transfer/interchange facilities
- Vehicle restrictions such as limits on the issuance of permits as well as the prohibition of certain vehicles from busy urban areas
- Encouragement of car-pooling and ride share facilities.
- Increased provision of parking meters as well as higher parking fees
- Establishment of public relations campaigns to alert the public to the problems posed by traffic congestion
- Establishment of a fuel tax

No single intervention will result in reduced congestion and improved traffic flow within the Municipality. Only with a joint series of measures, will traffic mitigation efforts even come close to being successful. For instance, if zoning regulations are instituted, which encourage developments alongside primary transport corridors or at important transfer/interchange nodes, the Municipality must adopt other initiatives that facilitate the construction of public transport facilities, including light rail transit infrastructure and bus terminals, as well as sustained policy and management measures that promote the sustainability of public transit, including fuel taxes on private vehicles, increased parking charges, improved parking meter enforcement, and the establishment of park-and-rider facilities, not to mention public awareness campaigns to promote public transport.

As the prior example showed, the adoption of a coordinated TDM initiative indeed creates an intricate and complicated web. Such endeavors will no doubt face difficulties given the autonomy of many traffic/transport-related entities within the Municipality, but these differences must be put aside for a common goal. Therefore special sub-committees, most notably the Sub-Committee of Chiang Mai Land Transportation System Management, will play a key coordination and leadership role in this respect as

many organizations are brought together under its auspices. Last but not least, the enforcement of traffic regulations as well as regulation of the public transport industry must increase to allow these initiatives to effectively serve their purpose.

9.7 Recommendation for Environmental Improvement

The pedestrian and historic environment in Chiang Mai has been neglected as priority has gone to accommodating the high volume of motorized traffic. Suitable plans are necessary to reverse this trend and promote sustainable modes of transport. There is however a danger that stand-alone ad hoc environmental plans will never be acted upon or implemented due to a lack of budget. Integration of environmental measures with traffic management proposals is therefore essential to ensure realistic action. Policies to gradually divert funds from highway construction to pedestrian-friendly measures should also be considered, while low-cost traffic management measures such as pedestrian-only walking malls only help to raise awareness. In many cities, parking restrictions including charged parking are generally viewed as effective methods for managing traffic and creating an organized environment with a clear hierarchy. Income can also be gained through the collection of parking violations, which may then be allocated as special funds for environmental measures.

Although an abundant amount of air pollution data exists, a formal system of verifiable targets, monitoring and investment with clear responsibility and incentive is lacking. While targeting the source is the only sustainable solution, maintenance measures such as road cleaning can facilitate acceptable pollutant levels in the short-term. The procedures utilized in Chiang Mai for addressing particulate pollution in require a special targeted review.

General Environment

- Introduce Action Plan for Environment integrated with a Traffic Management Plan
- Consider earmarking special funds for environmental measures, possibly through parking income/fines.

Air Quality

- Introduce Action Plan for Air Quality with quantifiable targets and verifiable indicators
- Reduce the qualifying age of vehicles requiring vehicle inspection (currently 7 years for motor cars)
- Allocate resources for Smog Verification Project to ensure permanent routine checking
- Introduce publicity campaign to ban private engine re-tuning/tampering that causes pollution, with penalties for violators. Integrate with Smog Verification Project
- Investigate dry suction road cleaning methods and consider purchasing specially-equipped vehicle

- Prohibit public retrieval and use of dust collected from road sweeping. Arrange environmentally acceptable method for disposing of such road dust
- Analyze deposited dust from road cleaning to determine sources and relative proportions

Noise

- Review noise level standards to bring them into accordance with standards in other counties
- Prepare prioritized list of noise-sensitive locations for ameliorative measures, such as low noise pavement, noise barriers, and consideration of noise shielding in new property development

9.8 Summary of Recommendations

(1) Summary of Recommendations

Table 9-17 presents a summary of recommendations.

Table 9-17 Summary of Recommendations

Issue Item	Proposed Measures
Road Network	• Develop clearer hierarchy of road network • Develop design/installation standards for on-street facilities
Intersections	• Introduce channelization, traffic islands, and traffic signals to reduce traffic conflicts • Improve markings and signs at intersections
Traffic Signal System	• Change detector configurations • Resolve conflicts between phase plans and traffic signs • Improve maintenance system • Install additional signal, expand ATC controlled signals and install pedestrian signals • Upgrade signal control software
Traffic Safety Issues	• Change name of Super Highway and speed limit • Improve pedestrian environment • Improve traffic signs and pavement markings • Develop traffic safety facilities • Develop pedestrian and bicycle network in Old City • Improve hazardous locations
Public Transport System	• Promote coordination among agencies • Promote stricter enforcement of rules and regulations for public transport • Promote corporate management style • Standardize vehicle design • Adopt fleet renewal programs • Introduce bus priority measures • Secure funding for sustainable operations of public transport • Promote private financing for transport development
Other Traffic Management Measures	• Develop database/analyses system on parking facilities and refine parking management policy • Introduce measures for improving motorcycle safety • Introduce traffic management measures around school areas • Improve pedestrian safety in Night Bazaar Area • Introduce TDM measures for controlling traffic demand
Environmental Improvement	• Formulate action plan for air qualities • Improve noise sensitive locations

Source: This study

(2) Priority Projects

The recommendations include short-term to long-term measures as well as the establishment of management policy on some issues. Some of the measures are do not cost much and relatively easy to implement without acquiring land. Yet they are expected to yield benefits immediately, if they are implemented. These measures are considered as high priority and must be implemented in a near future. More specifically, priority projects have been selected based on the following criteria:

- No land acquisition required
- Project is ready for implementation
- Medium to large benefits are expected

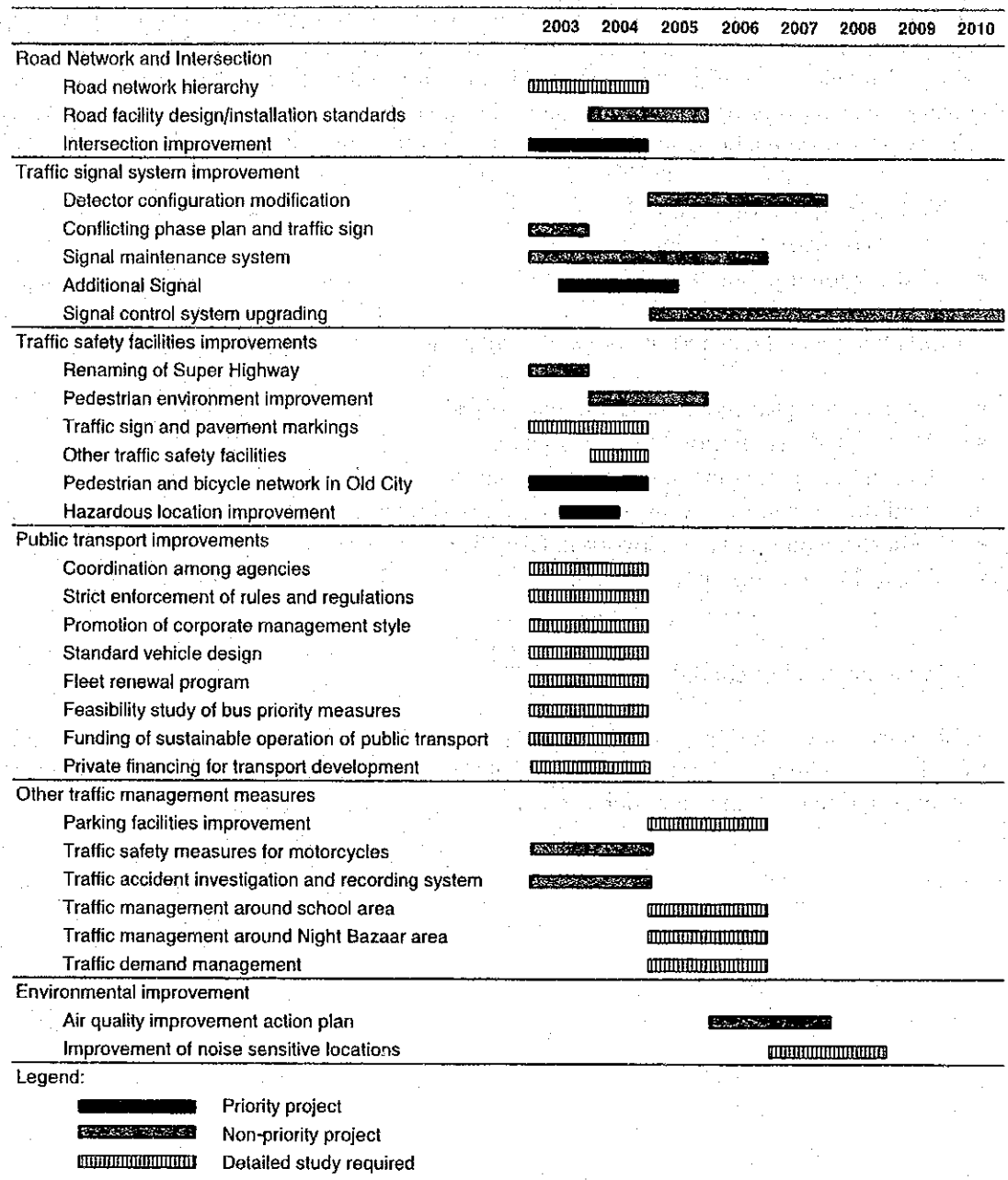
Projects that meet the criterion above have been selected. They are listed below.

- Intersection Improvement (20 intersections)
- New signal installation (12 new signals)
- Upgrading of existing signals (10 signals connected to ATC system)
- Addition of pedestrian lantern (26 existing signals)
- Pedestrian and bicycle network in Old City
- Hazardous location improvement

(3) Implementation Schedule

Table 9-18 shows the proposed implementation schedule. It is necessary further study for projects which are not clearly envisioned yet, therefore the schedule includes implementation of studies for such projects

Table 9-18 Proposed Implementation Schedule



Source: This Study

9.9 Funding Source and Organization for Implementation

(1) Estimated Cost

The total cost of the proposed recommended projects is 351.4 million Baht as summarized in Table 9-19. The breakdown of these costs is presented in Appendix K. For the cost of measures which are not clearly envisioned yet, the costs of detailed studies for such projects are estimated.

Table 9-19 Estimated Cost of Proposed Projects

	Chiang Mai Municipality	DOH	Total	Remarks
Road Network and Intersection				
Road network hierarchy	3.5		3.5	Detail study
Road facility design/installation standards		6.9	6.9	
Intersection improvement	26.3	15.8	42.1	Priority projects
Sub-total	29.8	22.7	52.5	
Traffic Signal System Improvement				
Detector configuration modification				
Conflicting phase plan and traffic sign				
Maintenance system				
Additional signal	43.0		43.0	Priority projects
Signal control system upgrading	44.8[1]		44.8	
Sub-total	87.8		87.8	
Traffic Safety Facilities Improvements				
Renaming of Super Highway		14.0	14.0	
Pedestrian environment improvement	54.0		54.0	
Traffic sign and pavement markings	7.7		7.7	Detail study
Other traffic safety facilities	3.1		3.1	Detail study
Pedestrian and bicycle network in Old City	39.8		39.8	Priority projects
Hazardous location improvement	0.9		0.9	Priority projects
Sub-total	105.5	14.0	119.5	
Public Transport Improvements				
Coordination among agencies				
Strict enforcement of rules and regulations				
Promotion of corporate management style				
Standard vehicle design				
Fleet renewal program				
Feasibility study of bus priority measures				
Funding of sustainable operation of public transport				
Private Financing for Transport Development				
Sub-total	24.6[2]	0.0	24.6	Detail study
Other traffic Management Measures				
Parking facilities improvement	3.1		3.1	Detail study
Traffic safety measures for motorcycles	24.4		24.4	
Traffic accident investigation and recording system	17.5		17.5	
Traffic management around school area	7.5		7.5	Detail study
Traffic management around Night Bazaar area	4.1		4.1	Detail study
Traffic demand management	5.8		5.8	Detail study
Sub-total	62.5	0.0	62.5	
Environmental Improvement	0.0			
Air quality improvement action plan	2.8		2.8	
Improvement of noise sensitive locations	1.7		1.7	Detail study
Sub-total	4.5	0.0	4.5	
Total	314.6	36.8	351.4	

Note: 1) This cost includes another measures for signal system improvement such as a detector configuration modification, conflicting phase plan and traffic sign, and maintenance system.
2) This figure includes detail study for all measures of public transport improvement.
Source: Study Team

The total cost of the proposed short-term priority projects is 126.1 million Baht as summarized in Table 9-20. These projects are to be undertaken by Chiang Mai Municipality except the works on Super Highway, Aom Muang Road and Mahidol Road, which will be implemented by District 2, Region 1 of the Department of Highways (DOH), as these roads are under the management of DOH.

Table 9-20 Estimated Cost of Priority Projects

	Projects	Estimated Cost (million Baht)	Remarks
1	Intersection improvements	42.1 (15.8)[1]	20 intersections including 8 new signals and additional pedestrian lanterns at 7 existing signals
2	New signal installation	(27.9)[2] 10.4	12 signals 4 signals only
3	Signal upgrading (Connection to ATC)	14.5	10 existing signals
4	Addition of pedestrian lantern	18.1	26 existing signals
5	Pedestrian/bicycle network in Old City	39.8	Total length: 7,270 m
6	Hazardous location improvement	0.9	16 locations
	Total	**126.1**	
	-Done by Chiang Mai Municipality	110.3	
	-Done by DOH	15.8	

Notes: 1) The cost of the works to be done by DOH.
2) The figure includes cost of eight (8) new signals under Intersection improvements
Source: Study Team

(2) Financial Status of Municipality

Table 9-21 shows the revenue of Chiang Mai Municipality for the last five years (1997-2001). It is noted firstly that the revenue level dropped substantially from 705 million Baht in 2000 to 486 million Baht for 2001 with the elimination of special supporting funds, which are mainly a financial assistance from the central government agencies. Tax collection is also expected to decrease in 2001 due probably to the slack economic situation of the country.

Secondly, the revenue of Municipality relies heavily on the tax collected and distributed by the central government. This means that the revenue would not be stable and susceptible to the policy change by the central government.

Table 9-21 Revenue of Chiang Mai Municipality (1997-2001)

Category	1997	1998	1999	2000	2001	(%) 2001
Tax	422,300,102	458,481,096	411,895,180	459,105,665	390,700,000	80.3
(kept by municipality)	93,722,813	98,343,000	99,744,216	114,351,660	102,700,000	(21.1)
(kept and given by state)	328,577,289	360,138,095	312,150,964	344,754,005	288,000,000	(59.2)
Admission fee and fine	18,520,156	21,554,050	18,127,427	15,243,288	16,470,000	3.4
Municipality asset income	51,550,017	80,839,593	64,969,069	30,935,804	33,252,500	6.8
Public utility and commerce income	10,125,107	10,452,608	12,766,396	11,024,714	12,766,400	2.6
Miscellaneous and donation	6,110,961	6,921,121	9,824,536	15,945,134	6,510,000	1.3
Supportive fund from central and provincial administration	26,417,800	27,771,460	28,988,500	30,165,250	26,477,200	5.5
Special supporting funds	96,739,224	63,409,525	77,850,065	142,252,548		0.0
Grand Total	631,763,369	669,429,456	624,421,175	704,672,406	486,176,100	100.0

Note: Forecasted figure for 2001.
Source: Chiang Mai Municipality

Corresponding to the fluctuation of the revenue, the expenditure of the Municipality also varies as shown in the Table 9-22. The expenditure level of 2001 is about 75% of the expenditure of the previous year. The majority part of the expenditure is used for the daily operation of the administration and other regular items. Only 8.5% of the expenditure is spent on the infrastructure and construction projects.

Table 9-22 Budget of Chiang Mai Municipality (1997-2001)

Category	1997	1998	1999	2000	2001	(%) 2001
Permanent wages	121,409,151	130,269,710	99,133,144	135,273,081	94,055,810	19.8
Temporary wages	46,381,534	47,829,915	48,424,798	47,808,755	48,338,640	10.2
Material cost	119,226,150	123,881,148	193,860,828	263,710,334	253,356,952	53.2
Public utilities	3,117,475	10,632,133	4,177,281	8,868,747	15,254,460	3.2
Supportive funds	1,412,319	1,135,343	1,757,600	2,502,418	3,650,000	0.8
Other expenses	1,774	156,421,153	364,529	220,000	2,240,000	0.5
Land, construction and other assets	101,630,350	157,579,858	74,714,058	152,220,716	40,362,513	8.5
Other expenses	35,252,177	34,509,913	20,806,434	23,562,471	18,738,100	3.9
Grand Total	428,430,930	662,259,175	443,238,676	634,166,526	475,996,475	100.0

Note: Figure for 2001 is a forecast.

Source: Chiang Mai Municipality

Notwithstanding the financial status of the Municipality described above, the Municipality official stated that annual new investment in the amount of 14 million Baht for the recommended projects is attainable for the Municipality with the possible financial support from the central government. But the amount is too small compared with the total project cost of 126 million billion Baht. In addition, considering the uncertainty of the support by the central government, faster project implementation is expected if a financial assistance is secured from an international financial institution.

(3) Financial Status of DOH

District 2 is one of the six districts under Region 1 of the Department of Highway (DOH). It is an agency responsible for the construction, operation and maintenance of road infrastructure managed by DOH in the study area. Table 9-23 is the budget of the Region 1, DOH for the year 2002, while expenditure record of District 2 for the last three years is shown in Table 9-24. As is the case with Municipality, budget size changes every year. Moreover, decision on the infrastructure project is made by DOH Headquarters in Bangkok and budget for the project is provided separately from the regular operational and maintenance expenditures.

DOH is now undertaking two underpass projects along Super Highway at Khuang Singh and Doi Saket intersections. Bidding for the projects were held and these projects are expected to cost about 243 million Baht and 269 million Baht, respectively. As described above, the budget for the projects comes from the DOH Headquarters in Bangkok. Comparing the size of DOH budget and the scale of the on-going projects with the estimated cost of the proposed projects, the proposed projects to be carried out by DOH is well within its financial resources. But even the amount is not large, the project is submitted to DOH Headquarters for approval and allocation of budget. Another possibility is to make all improvement works into one package to facilitate the project.

Table 9-23 Budget of DOH Region 1 for Year 2002

Category	Baht
Scheduled and special maintenance	382,343,667
Periodic maintenance	204,544,600
Asphalt pavement works on highway	126,000,000
Safety works	89,130,920
Improvement works in communities	82,000,000
Constructed and restored bridge project	17,986,000
Asphalt pavement works in communities	15,000,000
Management works	3,339,571
Road maintenance works	781,414
Total	921,126,172

Source: DOH Region 1

Table 9-24 Expenditure of District 2, Region 1, DOH

Fiscal Year	1999	2000	2001
Salary (permanent & temporary workers) Overtime, Traveling	28,384,005	27,276,986	28,849,657
Maintenance work and construction work	50,250,474	40,322,859	96,841,500
Traffic sign, traffic signal road marking guardrail and lighting	19,134,818	14,096,230	19,524,774
Vegetation, sidewalk, and gutter works	14,331,838	4,591,900	24,205,265
Total	112,101,137	86,287,976	169,421,198

Source: DOH Region 1

(4) Funding Sources

As described in the preceding sections, financial status of both Chiang Mai Municipality and DOH District 2 is not stable and varies every year. In order to accelerate the implementation of priority projects, it is necessary to find funding sources other than annual budget of Municipality and DOH. The possible sources would include international funding institutions such as the World Bank, Asian Development Bank (ADB) and Japan Bank for International Cooperation (JBIC). The prospective projects seem to be good candidates for loans from those institutions. It is suggested also that priority projects be divided into several packages of suitable size regardless of the road administrator (Municipality or DOH) from the project management perspective.

(5) Implementing Organization

Organization chart of Chiang Mai Administration is shown in Figure 9-10. The administration has 429 general municipal staff, 5 special municipal staff, 228 permanent staff and 937 temporary staff. Traffic Engineering Section under Civil Works Division, Mechanical Works Office, is in charge of the works related to traffic engineering such as traffic analysis and planning, traffic system planning and traffic light and signs. Thus the section will be responsible for the recommended projects if any of them is to be implemented. The section has one civil engineer, one electrical engineer and one expert of art, under the section chief, who is also a civil engineer.

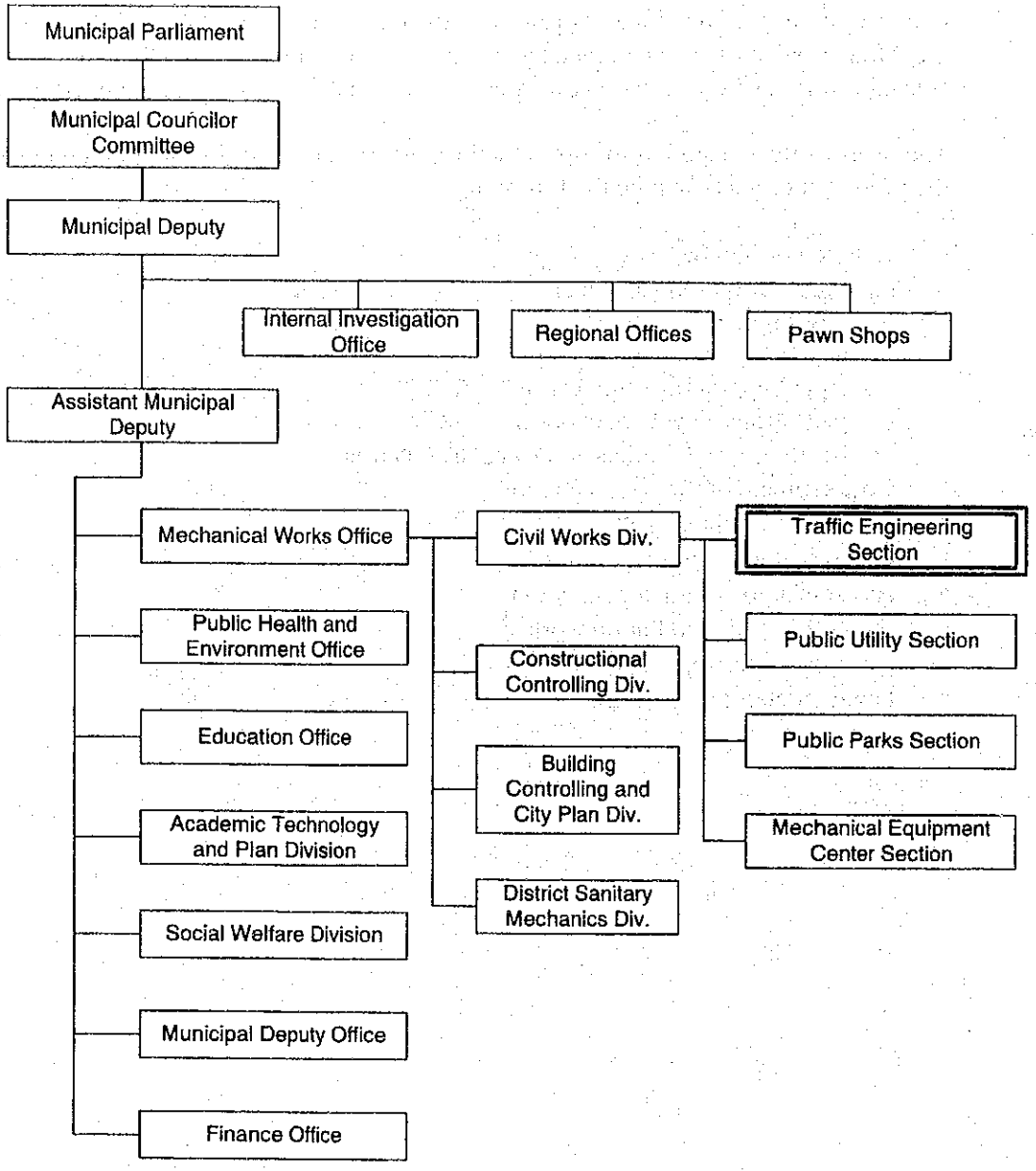
Design, cost estimation, and supervision of the traffic engineering work were usually carried out by the section staff in the past. If the in-house man-power was not enough or the work requires specific expertise, the section utilized outside resources such as Northern Technical Center for Traffic System Management, Chiang Mai University, but no consultant, either foreign or local, has not retained by the section for the traffic engineering project.

All of the proposed projects require preparatory works such as detailed design and cost estimate before actual implementation. These works require expertise and can only be

done by the experienced and capable personnel. Considering the current resources of the Municipality, it is recommended to avail of the outside resources like consultant specialized in traffic engineering for the implementation of the recommended projects.

The tasks of the consultant to be retained by the Municipality for the implementation of the proposed projects will be the following:

- Detailed design of
  - intersection improvement
  - new signal
  - additional pedestrian lantern
  - signal upgrading (connection to ATC)
  - pedestrian/bicycle network in Old City
  - traffic safety facilities at hazardous location
- Cost estimate of the works above
- Packaging of the project
- Contract document preparation
- Assistance in contractor selection
- Supervision of installation work
- Acceptance testing/inspection of work
- Payment claim verification



Source: Brochure issued by Public Relations Work, Academic and Planning Department, Chiangmai Municipality

Figure 9-10 Organization Chart of Chiang Mai Administration