# Chapter 8

# Other Traffic Management Issues

## 8.1 Parking Facilities and Control Measures

Vehicles need space to park either on-street or off-street. Parking management is one of the measures to control the use of vehicles. In this section, parking facilities and their management practices within the study area are presented and reviewed.

Parking lots or spaces available in the study area can be classified into two management categories: public and private organization/ownership. The former consists of two types: (i) parking lots that are managed by the Municipality and whose fees are collected by the Municipality; and (ii) curbside parking on the streets that is permitted for either a portion or the entire day.

Private parking is further divided into two groups: (i) parking facilities operated for revenue; and (ii) parking facilities attached to commercial buildings or commercial complexes. In the study area, there is no regulation on parking facilities, as registrations/licenses are not required to open and operate them.[1]

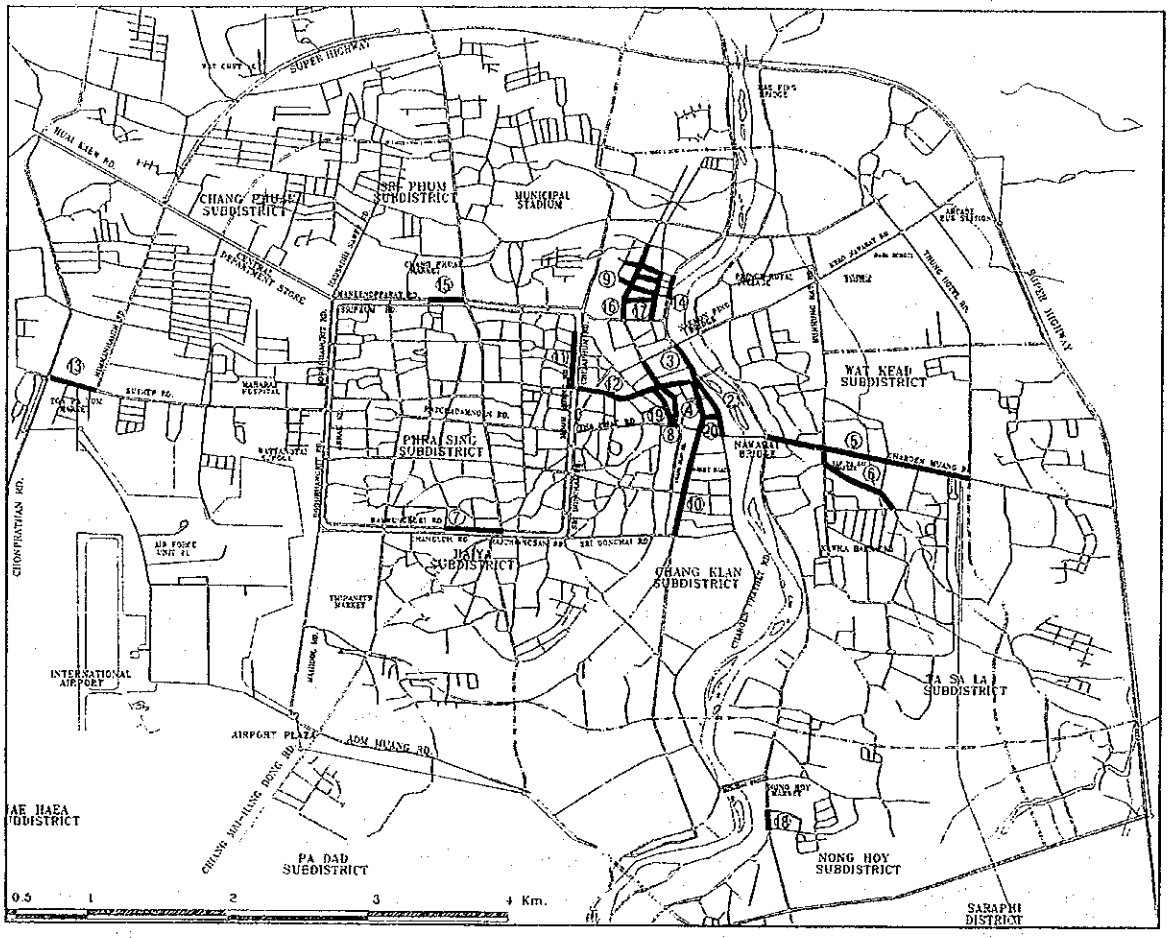
(1) Public Parking Facilities

The agency responsible for parking management in the municipal area is the Financial Bureau of the Municipality.[2] As its name suggests, parking management is regarded as one of the prime revenue sources and not simply as a means of traffic management control. All municipally-managed parking facilities consist of on-street curbside parking. The parking management is based on several municipal declarations.[3] A total of 40 roads in the municipality area were specified as areas for parking by these declarations. In reality however, the Municipality handles parking management at the 19 locations shown in Figure 8-1.

[1] This situation precludes the Government from obtaining accurate information on private parking facilities.

[2] The actual department is the Income Development Section within the Benefit and Commercial Task Division.

[3] Four declarations were issued in the past on 15 July 1988, 13 July 1989, 13 December 1990 and 27 January 1998.




Source: This study

**Figure 8-1 On-Street Parking Managed by Municipality**

The parking fee is collected from 6:00AM to 8:00PM at these facilities, based on the fee rates shown in Table 8-1. Fees are charged on an hourly basis and any portion of time over an hour is regarded as one whole hour when charging.

**Table 8-1 Parking Fee Rate (Baht/Hour)**

| # | Vehicle Type | First Hour | Succeeding Hours |
|---|---|---|---|
| 1 | Motorcycle | 2 | 4 |
| 2 | Sedan (5 or fewer wheels) | 5 | 10 |
| 3 | Truck (6 wheels) | 10 | 20 |
| 4 | Truck (8 wheels) | 20 | 30 |
| 5 | Truck (10 wheels) | 30 | 40 |
| 6 | Truck (10 or more wheels) | 40 | 50 |

Source: This study

Fees are manually collected by Municipality staff in exchange for a receipt. A total of 46 persons are assigned to the 19 locations shown in Figure 8-1. Each collector has a target collection amount. The Municipality annually collects about 5-6 million baht from parking operations, which go towards the general budget.

There is a problem however between the perspectives regarding on-street parking taken by the agency and the Traffic Police. While the Financial Bureau wants to expand public parking to maximize revenues, the Traffic Police considers the prevention of traffic jams caused by on-street parking as its highest priority, thereby wishing to prohibit on-street parking during peak hours. There must be a consensus between these two bodies on the criteria for where and when to allow on-street parking.

(2) On-Street Parking Management

From the viewpoint of parking management, roads in the study area are classified into three groups: (i) roads where parking is prohibited all day; (ii) roads where parking is prohibited during certain times of the day; and (iii) roads where parking is allowed throughout the day.

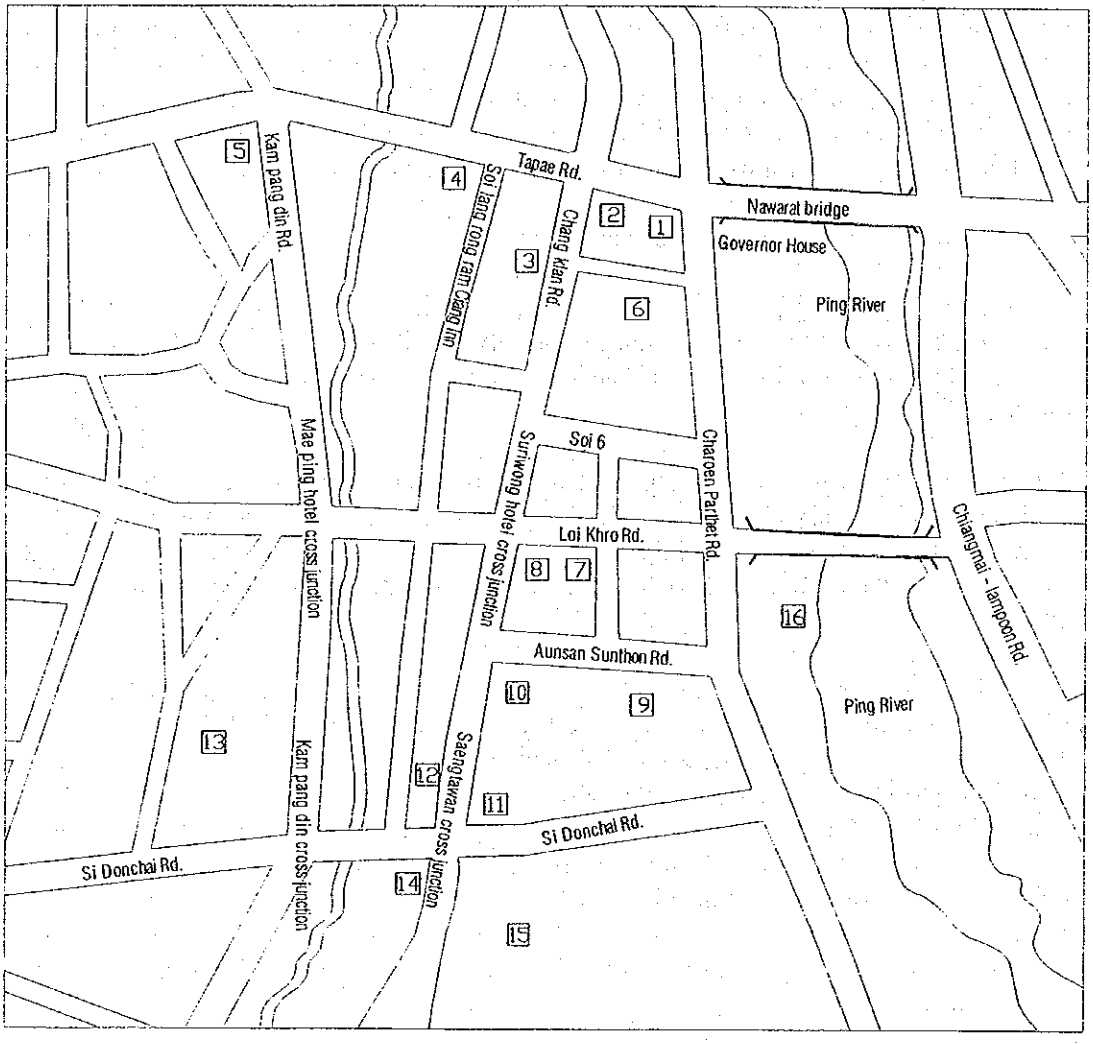
All-day parking restrictions are applied to small roads where two-way movements of vehicles are physically obstructed. On the other hand, parking is permitted at all times on roads outside of the Super Highway, except on some arterial roads such as Huay Kaew and Chotana Road, where parking is prohibited from 6:00-9:00AM and 3:00-6:00PM.

Time-based parking prohibitions are applied to arterial streets within the Super Highway. Normally parking is prohibited from 6:00-9:00 and 15:00-18:00 on most of these streets, yet there are some exceptions. Along Huay Kaew, parking is prohibited from 6:00-9:00AM on the south side, while on the north side parking is prohibited from 3:00-6:00PM. Meanwhile, a different time zone restriction is applied on Charoen Muang, where parking is prohibited from 6:00AM-12:00AM and 4:00-6:00PM on the south side and from 6:00-8:00AM and 12:00AM-6:00PM on the north side. On Chang Klan Road, a southbound one-way road, where a nightly bazaar is held on both sidewalks, parking is prohibited from 7:00-9:00AM and 3:00PM-12:00PM on both sides of the road.

(3) Private Parking Facility

There are numerous parking facilities in the study area from multi-story parking buildings attached to large establishments to unpaved vacant lots used as makeshift parking lots. Parking facilities at commercial establishments are constructed and operated as a service to customers, thus no parking fees are collected, one exception being the Central Department Store (Kad Suan Kaew). Some parking facilities operate as businesses however. The location of parking lots in the Night Bazaar Area, where many parking facilities exist, is shown in Figure 8-2. Table 8-2 shows the parking facilities in this area together with their respective parking fees and other relevant information. Total capacity in the area is about 3,200 and 2,200 spaces for motorcycle

and motor vehicles, respectively. Some of this capacity however is only available during special events, so for all practical purposes, parking capacity is approximately 1,200 spaces for motorcycles and 1,400 spaces for motor vehicles. This disparity implies that generally, there is a sufficient parking supply to meet the demand in the area.




Locations of parking space car

| | | | |
|---|---|---|---|
| 1. Parking space at putasatan | 5. Parking space at AIS | 9. Parking space at Anusaan market | 13. Mae ping Hotel |
| 2. Parking space at Wat Oopakut | 6. Parking space at Galae food Center | 10. Parking space at Wat Chidonchai School | 14. Gasstation |
| 3. Parking space at Chiang Inn Plasa | 7. Parking space at Foundation | 11. Parking space at Wat Chidonchai | 15. Back of lanna theater |
| 4. Parking space at Back of the the peek | 8. Parking space at Mc Donald | 12. Parking space at emply building | 16. Back of KhongSuach Resaurant |

Source: This study

**Figure 8-2 Parking Facilities in Night Bazaar Area**

**Table 8-2 Parking Facilities around Night Bazaar Area**

| | Capacity | | | Fee (baht) | Operating Hour | | Remarks |
|---|---|---|---|---|---|---|---|
| | MC | Car | Motorcycle | Car | Start | End | |
| 1 | 400* | 200 | - | 10 baht/2 hrs; Next hour 5 baht/hr | 6:00 AM | 5:00 PM | No motorcycle parking now |
| 2 | - | 30-35 | - | 10 baht | 6:00 AM | 9:00 PM | Collected fee is donated to temple |
| 3 | 160* | 320 | - | 20 baht/hr | 11:00 AM | 1:00 AM | No motorcycle parking now; Stamped on ticket for free park 3 hrs |
| 4 | 100 | 50 | 10 baht/2 hrs; Next 5 baht/hr | 20 baht/2 hrs; Next hour 5 baht/hr | 24hr | | |
| 5 | 50 | 110 | - | 20 baht | 24hr | | No charge for customer (Stamped) |
| 6 | 100 | 120 | 5 Baht | Stamped on ticket for free park 3 hrs; Next hour 10 baht/hr; 30 baht/3 hrs; Next hour 10 baht/hr | 8:00 AM | 8:00 PM | |
| 7 | 100* | 80* | - | - | 6:00 AM | 6:00 PM | Currently not operating |
| 8 | 200 | 150 | 10 baht/2 hrs; Next hour 10 baht/hr | 30 baht/2 hrs; Next hour 10 baht/hr | 24hr | | No charge for customer (Stamped) |
| 9A | - | 50 | - | 5 baht/2 hrs; 10 baht/2 hrs for Van; Over 2 Hrs Plus 15 baht | 3:00 PM | 11:00 PM | |
| 9B | - | 50 | - | 5 baht/2 hrs; 10 baht/2 hrs for Minibus; 30 baht/2 hrs for Van | 5:00 PM | 12:00 PM | |
| 9C | - | 70 | - | 10 baht/hr , 20 baht/2 hrs; 35 baht/3 hrs; Over 3 hrs 50 baht | 5:00 PM | 12:00 PM | |
| 9D | 300* | 50* | - | - | - | - | No charge for motorcycle and car |
| 10 | 100* | 40* | - | - | 8:30 AM | 5:00 PM | Currently not operating |
| 11 | 50* | 30* | - | - | 6:00 AM | 5:30 PM | Currently not operating |
| 12 | - | - | - | - | - | - | Empty building and closed |
| 13 | 400 | 200 | - | - | 24hr | | No charge for customer |
| 14 | 500* | 250* | - | - | - | - | Currently not operating |
| 15 | 600* | 300* | - | - | - | - | Currently not operating |
| 16 | 200* | 100* | - | - | - | - | Currently not operating |

Source: This study
Note: Asterisk (*) donates the estimated number of spaces.

(4) New Warorot Market Building

A new four-story building is being constructed on the site along Wichayanon, east of the existing Warorot Market. Flower shops currently occupy the space between Wichayanon and the Ping River bank will move to the first floor of the new building. The second, third, and fourth floors of the building serve as parking areas; each floor can accommodate 28 vehicles. In addition, the rooftop will also be used for parking, increasing the total capacity by 20 units. The site belongs to the Municipality, while the building is constructed and operated by a private entity. Provision of additional parking is expected to contribute to the alleviation of congestion around the site. But there are other problems such as the unloading of goods or roadside terminals used by *songteaws*. The building and parking is opened in November 2001.

(5) Parking Requirement for Commercial and Office Building

The number of parking lots to be provided for commercial and office buildings is regulated by the Interior Ministry. The latest regulations in force set forth parking requirements for each type of building as summarized in Table 8-3.

**Table 8-3 Requirements for Parking Lot**

| Type | Building | | Requirements |
|---|---|---|---|
| A | Theater | | 5 lots/seat |
| B-1 | Hotel | Up to 100 rooms | First 30 rooms: 5 lots<br>1 lot / 10 rooms |
| B-2 | Hotel | More than 100 rooms | First 100 rooms: same as B-1<br>Over 100 rooms: 1 lot/15 rooms |
| C | Apartment | | 1 lot/family |
| D | Restaurant | | 1 lot/40 square-meter |
| E | Department Store | | 1 lot/40 square-meter |
| F | Office | | 1 lot/120 square-meter |
| G | Hall of Hotel, Restaurant, and Office Building | | 1 lot/240 square-meter |

Source: This study

(6) Parking Survey

In order to collect data on parking characteristics such as demand, parking duration, etc. a parking survey was conducted. The Warorot Market Area was selected as the survey area.[4]

In the survey, each surveyor was assigned a certain section of road around the Warorot Market. The surveyor was to patrol the assigned section every ten minutes and record the license plate numbers of parked vehicles on the survey sheet. After the field survey was completed and data sheets were collected, data was inputted into a computer database to match license plate numbers. From this survey, the following information

[4] The survey was conducted on 7 September, 2001 from 6:00 to 20:00.

was obtained: (i) the number of parked vehicles at any given time; (ii) the total number of vehicles parked in the area; and (iii) the parking duration of the vehicles.

## 8.2 One-Way Street Systems

### (1) Existing Situation

Due to the unique road network configuration of the developed area in the Municipality, few one-way systems exist. One-way street systems are adopted in four areas in the Municipality, whose locations are shown in Figures 8-3 and 8-4. These areas include:

- Chang Puak Road between Soi 2 and Rattanakosin Road;
- Ratchamanka Road and the southside road of Wat Phra Sing in the old city;
- Phra Pokklao Road in front of Chiang Mai Gate Market; and
- The area between the east moat and the Mae Ping River.

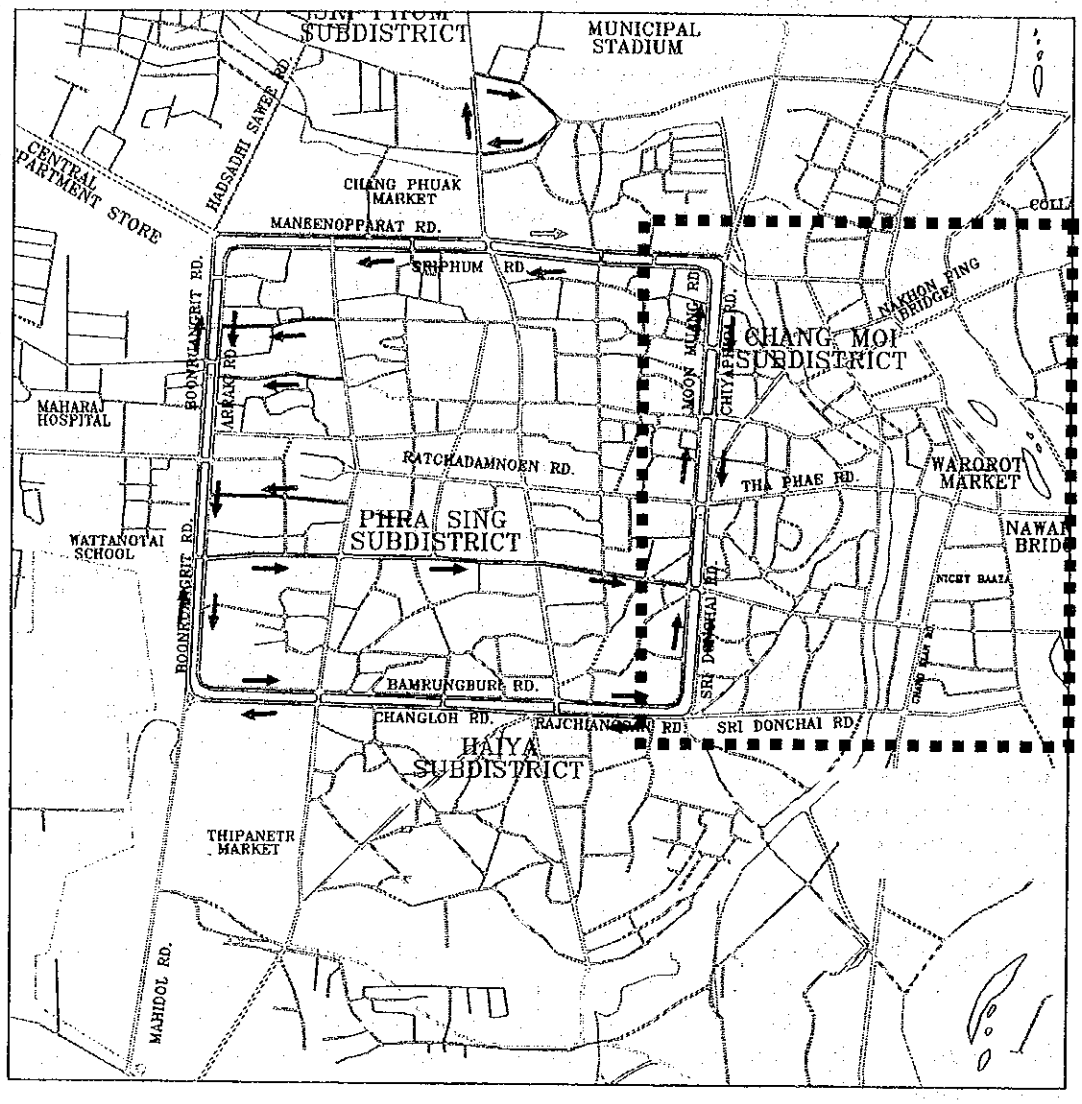
*Chang Puak Road:* A one-way loop is formed at a section of Chang Puak Road. Chang Puak is a four-lane undivided arterial running from Chang Puak Gate located at the north moat, heading northwards. Only a section between Soi 2 and Rattanakosin Road is one-way northbound. Southbound traffic has to turn left at Rattanakosin and take Soi 2 to return to Chang Puak. Although the width of Chang Puak is almost constant, the one-way system helps to reduce congestion in this section, where the Chang Puak Bus Station is located.

*Ratchamanka Road:* Ratchamanka is a local road with a width of 8.0 m in the old city running in an east-west direction (one way) from the west moat to the east moat. The total length is 1.5 km. Traffic in the opposite direction primarily uses the road on the south side of Wat Phra Sing, which is also one-way and headed westbound. This road however only exists between Samlan Road and the west moat for about 430 m. The low traffic volumes in the area do not cause any traffic problems on the pair of roads however.

*Phra Pokklao Road:* The Chiang Mai Gate Market is located just inside the Chiang Mai Gate on the south moat. Phra Pokklao Road has a one-way northbound section starting from the entrance to the market to ease the traffic congestion heading to the market. Southbound traffic has to make a left turn before the market and must take a detour to reach the south moat.

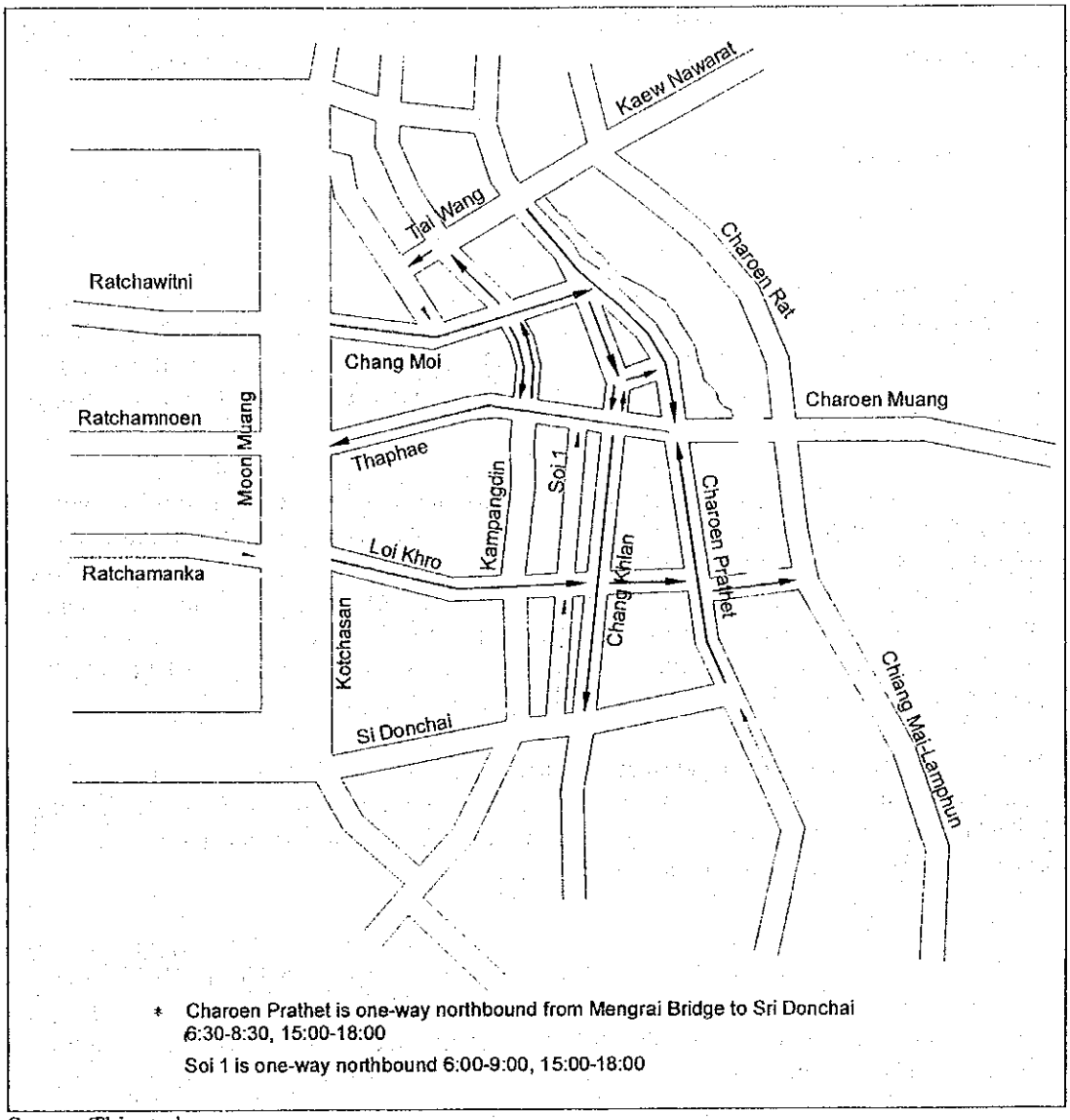
*From Moat to River:* The area between the east moat and the Mae Ping River is mostly a commercial and business area. One-way systems are extensively adopted in this area. Chang Moi Road (eastbound to Warorot Market), Tha Phae Road (westbound to Tae Phae Gate) and Loi Kroh Road (eastbound to Chiang Mai Lamphun Road crossing the Mae Ping River) form a one-way street system in the east-west direction. A one-way system in the north-south direction is complicated and regulations change at the road intersection in the east-west direction.

It is noted that counter flow traffic is adopted in two locations, in which vehicles run on the right side of road. One is applied on a short section of Chang Klan, south of Warorot Market, and another on a section of Ratchawong Road, between Tha Phae and Chang Moi Road. Although counter-flow traffic is effective in a one-way network, it might prove to be a potential hazard for visitors who lack knowledge of such systems.




Source: This study

**Figure 8-3 Existing One-Way System**




Source: This study

**Figure 8-4 Existing One-Way Systems in Central Business District**

(2) Proposals for One-Way Systems

The area between the moat and Super Highway is served by radial and circumferential arterial streets. There is no suitable pair of roads for a one-way system in this area except those, which already are using one-way systems. In the old city however, a semi-grid road network is formed and there are a number of road pairs. One of the possible road pairs is Phra Sing Road and Inthawarorot Road, which runs in the east-west direction. Phra Sing will be one-way westbound from Phra Pokklao Road (or possibly from Moon Muang Road) to Samlan Road (Wat Phra Sing). Inthawarorot Road will be one-way eastbound from Singharat Road to Phra Pokklao Road. The one-

way system will ease the load at intersections such as that at Phra Pokklao and Phra Sing, where congestion is observed in both the morning and afternoon peak periods.

## 8.3 Motorcycle Safety Issue

(1) Introduction

The use of motorcycles has rapidly increased in recent years. The number of automobiles registered in Chiang Mai Province for the year 2000 was 712,468 and of these, 72% or 510,974 were motorcycles. Over the last three years, the number of registered motorcycles has grown 33.4%, while that for registered vehicles has only increased 26.6%.

On the other hand, the use of public transport has not increased in tandem with the increase in travel demand. Public transport, in particular, that of fixed-route bus transport, is only limited to the city's radial routes, while the intra-city service is provided by the red *songtaews*, which operate on non-fixed routes and are a demand-based type of transport. Due to this situation, people living in outlying areas have little access to public transport, making the motorcycle a popular and affordable choice of private transport especially among the young people.

With this rapid increase in motorcycle traffic, the number of traffic accidents has also increased. This is a serious traffic safety problem that has many social repercussions as an increasingly numbers of young lives are lost. This problem must be addressed in earnest by the city and provincial governments.

As shown in Table 8-4, the number of motorcyclist casualties is much higher than other modes. In 1997, 85% of all injured were motorcyclists. Additionally, it may be assumed that the probability of injury to motorcyclists is very high when they are involved in an accident. The number of motorcyclist fatalities is also high though there also appears to be a high risk of fatality within other modes, reflecting the importance of improving safety for all modes including pedestrians.

**Table 8-4 Injury and Fatality Ratios of Traffic Accident in Chiang Mai Province by Type of Vehicles, 1997**

| Vehicle Type | Injury | | Fatality | |
|---|---|---|---|---|
| | Casualty | Ratio (per 100,000 persons) | Casualty | Ratio (per 100,000 persons) |
| Motorcycle | 33,162 (84.6%) | 1,989 | 476 (71.6%) | 28.6 |
| Others | 6,052 (15.4%) | 363 | 179 (28.4%) | 10.7 |
| Total | 39,214 (100.0%) | 2,353 | 665 (100.0%) | 39.9 |

Sources: Public Health Bureau and Private Sectors

The probable reasons for the high casualty risk from motorcycles compared to passenger cars are as follows:

- Many motorcyclists are known to drive dangerously and recklessly, violating traffic rules and safety regulations;
- The younger-age groups compose the majority of motorcycle users. Many of them in fact are driving without valid licenses:
- Motorcyclists have little protection and mass absorb the majority of the impact resulting from an accident with a larger vehicle;
- Although motorcyclists are required to wear safety helmets by law, many do not. According to the results of a helmet survey by the Study Team, only about 50% of motorcyclists wear safety helmets; and
- Many motorcycles carry more than two riders (three or sometimes four as well).

Although traffic accidents have many possible causes, drunken driving is a particular problem in Chiang Mai. Riding motorbikes without a helmet is a major factor in causing injury as demonstrated by the figures in Table 8-5. This table also shows the monthly distribution of accidents, which tend to concentrate in April, corresponding to the annual Song Kran Festival. The accident record during the Song Kran Festival of 2001 shows that out of 2,764 persons injured from traffic accidents, more than half or 1,612 were serious injuries (of these 64 were fatal). Most of these casualties were motorcyclists and the accidents were chiefly due to drunken driving.

**Table 8-5 Monthly Distribution of Accident Casualties by Causes of Injuries**

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEPT | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Drunken Driving | 329 | 777 | 452 | 1,071 | 523 | 405 | 522 | 484 | 535 | 5,098 | 29.0 |
| Drug | 2 | 8 | 0 | 1 | 63 | 2 | 1 | 5 | 6 | 88 | 0.5 |
| No Seat Belt | 45 | 65 | 73 | 203 | 101 | 281 | 86 | 96 | 81 | 1,031 | 5.9 |
| No Helmet | 766 | 1,441 | 1124 | 2,151 | 1,195 | 998 | 1,242 | 1,195 | 1,227 | 11,339 | 64.6 |
| Total Casualties | 1,142 | 1,515 | 1,649 | 3,426 | 1,882 | 1,686 | 1,851 | 1,780 | 1,849 | 17,556 | 100.0 |

Sources: Public Health Bureau Report

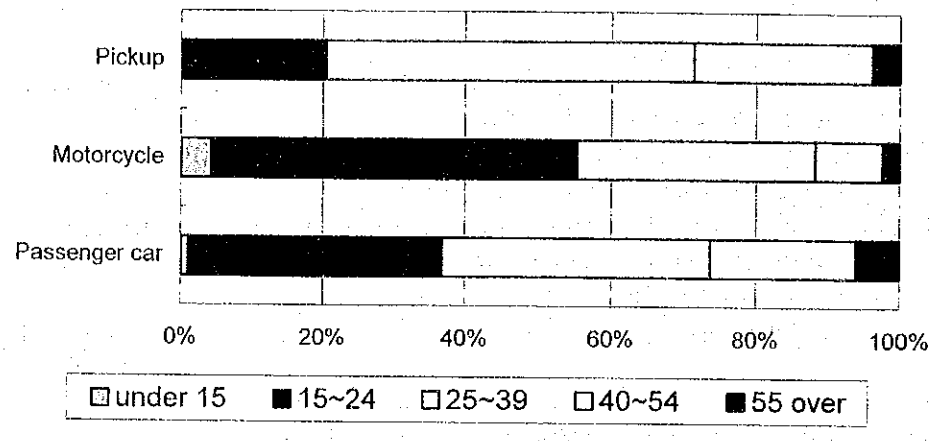
(2) Characteristics of Motorcycle Accidents and Causes

This problem is further analyzed and elucidated in the following sections.

*Age of Drivers Involved in Traffic Accident*

Automobile accidents were compared with motorcycle accidents in terms of the age of the person found to have caused the traffic accident in Figure 8-5. The figure shows that among motorcycle drivers involved in accidents, more than 50% are 24 years of age or younger. It is also important to note that 4.4% were 14 years of age or younger. Comparing the age group distribution for passenger car drivers and pickup drivers,

motorcycle drivers causing accidents are predominantly from the younger age groups (at or under 24 years of age).




Source: Northern Technical Center for Traffic System Management, Thailand.

**Figure 8-5 Age Group Distribution of Drivers Involved in Accidents**

*Time of Accidents*

Table 8-6 shows the number of motorcycle traffic accidents according to time of day. The number of accidents involving motorcycles between 16:00-24:00 is comparatively high. In fact, 48.4% of the accidents occurred between 16:00-21:00, indicating that roadways are significantly more dangerous during twilight and sunset periods.

**Table 8-6 Number of Accidents Involving Motorcycles by Time of Day**

| | Hour | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | 1-3 | 4-6 | 7-9 | 10-12 | 13-15 | 16-18 | 19-21 | 22-24 | |
| # of Accidents | 74 | 10 | 42 | 40 | 55 | 69 | 142 | 4 | 436 |
| % Share | 16.9% | 2.3% | 9.6% | 9.2% | 12.6% | 15.8% | 32.6% | 0.9% | 100.0% |

Source: Northern Technical Center for Traffic System Management, Thailand.

*Causes of Motorcycle Accidents*

The causes of motorcycle accidents are shown in Table 8-7. The top reasons for accidents include: (i) failing to yield to vehicles on the right; (ii) sudden lane changing or weaving; and (iii) driving with unsafe headway (following too closely behind the first vehicle).

**Table 8-7 Major Causes of Traffic Accidents Involving Motorcycles**

| Rank | Causes | Frequency | % Share |
|---|---|---|---|
| 1 | "Failing to yield to vehicles on the right" | 14 | 16.7 |
| 2 | "Sudden lane changing/weaving" | 13 | 15.5 |
| 3 | "Driving with unsafe headway" | 11 | 13.1 |
| 4 | "Overtaking illegally" | 9 | 10.7 |
| 5 | "Driving in between traffic lanes" | 9 | 10.7 |
| 6 | "Violating traffic signal/sign" | 7 | 8.3 |
| 7 | "Driving in the wrong lane" | 6 | 7.1 |
| 8 | "Driving without competent skills" | 3 | 3.6 |
| 9 | "Turning without giving signal indication" | 3 | 3.6 |
| 10 | "Driving drunk" | 2 | 2.4 |
| 11 | "Stopping suddenly without warning" | 2 | 2.4 |
| 12 | "Speeding" | 2 | 2.4 |
| 13 | "Others" | 3 | 3.6 |
| Total | | 84 | 100.0 |

Source: Northern Technical Center for Traffic System Management, Thailand.

*Unlicensed Drivers*

A license to drive a motorcycle can be obtained by passing a written examination and a skills test for persons 15 years of age or older. Nevertheless, many youngsters are known to drive without a license.

According to the Chiang Mai Provincial Police Report, out of 32,851 motorcyclists that were apprehended for traffic regulation violations in the year 2000, 28 percent were found to have been "driving without a helmet" and 25 percent were found to have been "driving without a license". Table 8-8 shows the proportion of violators based on the type of violation in 2000.

**Table 8-8 Motorcycle Violators According to Type of Violation, 2000**

| | Failure to Wear Helmets | Unlicensed Drivers | Lack of Registration Documents | Others | Total |
|---|---|---|---|---|---|
| Violators | 9,139 | 8,362 | 7,530 | 7,820 | 32,851 |
| | (28%) | (25%) | (23%) | (24%) | (100%) |

Source: Chiang Mai Provincial Police Department, 2000.

*Usage of Safety Helmets*

The Chiang Mai Provincial Police charged as many as 9,139 persons in the year 2000 with failing to wear a safety helmet while driving motorcycles. Although this represented 28 percent of the total apprehended violators, it must be said that this is just

a fraction of the actual violators. Visual observations has found that an alarmingly high number of motorcyclists, both drivers and passengers, ride without safety helmets.

The Study Team conducted a sample survey at three locations on major roads in the city to find out the actual rate of helmet usage among the motorcyclists in Chiang Mai. The results of this investigation are summarized in Table 8-9 and as follows:

- The average usage rate of safety helmets among motorcyclists (drivers only) is only 52 percent.
- The usage rates differ between the three survey locations, ranging from 41 percent to 59 percent.
- When there are pillion riders (passengers behind the driver), the rate of helmet usage falls even further. In the survey, the helmet usage rate for motorcycle pillion rider (one passenger only) ranges from 10.9 to 16.2 percent. When there are two pillion riders (or more), this rate falls from 0.0 to 6.7 percent.
- When combined with usage of drivers, the rate of helmet usage among motorcycles with one driver and one passenger is between 23.4 to 29.9 percent. The corresponding rate for one driver and two or more passenger is between 11.1 to 18.0 percent only.

## Table 8-9 Motorcycle Rider and Passenger Helmet Usage Rates

**A) Driver-Only**

| | Total | Wearing | Compliance |
|---|---|---|---|
| Location 1 | 1,194 | 709 | 59.4% |
| Location 2 | 886 | 457 | 51.6% |
| Location 3 | 798 | 328 | 41.1% |
| Total | 2,878 | 1,494 | 51.9% |

**B) Driver + One Passenger[A]**

| Location 1 | Total | Wearing | Compliance |
|---|---|---|---|
| Person 1 | 411 | 164 | 39.9% |
| Person 2 | 411 | 45 | 10.9% |
| Consolidated | 822 | 209 | 25.4% |
| Location 2 | Total | Wearing | Compliance |
| Person 1 | 308 | 134 | 43.5% |
| Person 2 | 308 | 50 | 16.2% |
| Consolidated | 616 | 184 | 29.9% |
| Location 3 | Total | Wearing | Compliance |
| Person 1 | 263 | 94 | 35.7% |
| Person 2 | 263 | 29 | 11.0% |
| Consolidated | 526 | 123 | 23.4% |

**C) Driver + 2 or More Passengers[B]**

| Location 1 | Total | Wearing | Compliance |
|---|---|---|---|
| Person1 | 18 | 5 | 27.8% |
| Person2 | 18 | 2 | 11.1% |
| Person3 | 18 | 1 | 5.6% |
| Total | 54 | 8 | 14.8% |
| Location 2 | Total | Wearing | Compliance |
| Person1 | 15 | 3 | 20.0% |
| Person2 | 15 | 1 | 6.7% |
| Person3 | 15 | 1 | 6.7% |
| Total | 45 | 5 | 11.1% |
| Location 3 | Total | Wearing | Compliance |
| Person1 | 24 | 11 | 45.8% |
| Person2 | 24 | 2 | 8.3% |
| Person3 | 24 | 0 | 0.0% |
| Total | 72 | 13 | 18.1% |

Source: This study

Notes:
[A] Since the driver and passenger are not distinguished, it is assumed that if only one of them wears a helmet, Person 1 wears the helmet. [B] A total of three (3) persons on the motorcycle is assumed.

Survey Location:
Location 1: Charoen Muang Road, east side of Nawarat Bridge.
Location 2: Kaeo Nawarat Road, east side intersection of Nakphon Phing Bridge.
Location 3: East side intersection of Huay Kaeo Road, in front of Public Library.

Survey Date and Time:
Location 1: September 3 (13:15-14:15); September 7 (07:30-08:30).
Location 2: September 4 (10:45-11:45); September 6 (07:30-08:30).
Location 3: September 5 (07:30-08:30); September 5 (10:45-11:45).

An interview survey was conducted with motorcycle riders and passengers who did not wear safety helmets. A total of 234 were asked their reasons for not wearing helmets as well as their knowledge of traffic safety issues relating to wearing helmets. It was found that: (i) 45% of motorcyclists thought helmets were "hot and stuffy"; (ii) 24% felt that wearing a helmet was troublesome; and (iii) 2% felt that a helmet is expensive.[5] Furthermore, the survey revealed that: (i) 19% felt it was "very dangerous" to ride without a helmet; (ii) 40% felt it was "dangerous" to ride without a helmet (40%); and (iii) 40% felt that it was "not dangerous" to ride without a helmet. Thus nearly 60% of respondents felt it was not dangerous to ride motorcycles without helmets. Table 8-10 shows the results of this survey.

[5] The remainder of respondents gave irrelevant reasons (which are unimportant to this study) such as "Forgetting to bring a helmet today" or "Lending helmet to a friend".

**Table 8-10 Results of Survey on Reasons for Failing to Use Safety Helmets**

| Response | Reason for Failing to Wear Helmet | | | | | | |
|---|---|---|---|---|---|---|---|
| | Helmet is Costly | Others Do Not Wear | Trouble some | Hot and Stuffy | Other Reasons | Total | % |
| Not Wearing is Very Dangerous | 0 | 0 | 16 | 9 | 20 | 45 | 19.2% |
| Not Wearing is Dangerous | 3 | 8 | 23 | 43 | 16 | 93 | 39.8% |
| Not Wearing is Not Dangerous | 1 | 3 | 18 | 53 | 18 | 93 | 39.8% |
| Others | 0 | 0 | 0 | 0 | 3 | 3 | 1.2% |
| Total | 4 | 11 | 57 | 105 | 57 | 234 | 100.0% |
| % | 1.7% | 4.7% | 24.4% | 44.8% | 24.4% | 100.0% | |

Notes:
1) Other reasons included: 'Forget to Wear", "Lost", "Don't Have", "No Free Helmet from Bike Shop after Buying Motorcycle", "Only Short Distance Trip", 'Obstructs One's View of the Road", "Hair Style Distorted".
2) Survey Locations: A) Kaeo Nawarat Road, east of the Nakhon Phing Bridge intersection; and B) East of Huai Kaeo Road intersection, in front of the Public Library.
3) Survey Date (Time): A) 7 September 2001 (10:30-12:00); B) 10 September 2001 (10:30-12.00); and C) 11 September 2001, (07:30-08:30).

Source: This study

(3) Summary of Issues

Dangerous driving behavior of motorcycle users has been observed in the city. Many motorcycle users are:

- Failing to wear safety helmets;
- Failing to stop at intersections where there is no traffic signal;
- Failing to use signal indicator while turning or parking;
- Violating designated traffic directions, especially around one way roads;
- Driving in the wrong lane in order to get to the front of the queue while waiting for traffic signal to change;
- Failing to stop at pedestrian crossing;
- Violating red traffic signals during the night;
- Failing to stop the motorcycle before stop lines at intersection areas;
- Driving motorcycles with no lights or no turn indicators;
- Using mobile phone while driving;
- Driving under the influence of alcohol; and/or
- Driving fast and in an erratic manner in busy areas.

Several traffic safety measures to mitigate the various problems associated with motorcycle usage in Chiang Mai are proposed in Section 9.6.

## 8.4 Traffic Accident Investigation and Record System

(1) Background

The Ministry of Transport and Communication (MOTC) of Thailand, in a Road Safety Master Plan Study, has formulated an action plan for establishing a traffic accident information database system for Thailand. This action plan was approved by the Thai Cabinet in September of 1998 and subsequently implemented as a pilot project in two selected provinces. However, considerable time is still needed before a nationwide, comprehensive traffic accident data record analysis can be put into practical use.

Traffic accident data collection is conducted by two agencies in Chiang Mai. The basic accident investigation data is collected and recorded by the Chiang Mai Traffic Police Department. Other data on accident victims sent to hospitals is collected/gathered and compiled by the respective health care facility.

As these data collection/reporting activities were carried out by two independent agencies, each espousing a different perspective and possessing perhaps conflicting interest, mutual consistency in data formatting/recording is non-existent.

A database recording accident sites from Traffic Police records has been prepared by the Northern Technical Center for Traffic System Management (NTCT). The lack of a specific accident data recording unit within the Chiang Mai Traffic Police Department was a major hindrance to this effort. It was found that accident records gathered from the site vary according to the individual sent to investigate. Unfortunately, data was inconsistent and not accurate due to the lack of a standardized format adopted.[7]

At present, public use and application of such traffic accident data is very limited and primarily confined to official purposes. The effort by NTCT is one of the first (or perhaps the first) attempt to compile a traffic accident database based on data from numerous police stations scattered around the province.

The creation of a comprehensive traffic accident database for Chiang Mai is an outstanding issue for the city, which requires further investigation and detailed study. Below is a description of a traffic accident recording system that has been adopted in Japan, which the JICA Study Team wishes to introduce as a reference when formulating an appropriate system for Chiang Mai.

(2) Basic Objectives of Traffic Accident Investigation

When a traffic accident occurs, it is customary for a traffic policeman to arrive at the site and conduct an investigation. It is very important that the person concerned recognizes the two basic objectives in traffic accident investigation:

- The investigation is to establish the legal responsibilities of those parties involved in the accident. The investigation is to determine the type of behavior that may have led to the occurrence of the accident.

- The investigation is to analyze both the direct and indirect causes of the accident, in an attempt to comprehend how the accident happened and thus provide the fundamental data to prevent such further accidents. As such, the system demands that the policeman sent to investigate the accident, be fully aware of these two objectives and be diligent in his/her efforts.

(3) Traffic Accident Investigation Methodology in Japan

In Japan, every police station throughout the country has a traffic accident record and investigation team, composed of four to five well-trained policemen. When an accident occurs, this team will rush to the site in a special vehicle with a large, internally-illuminated warning sign on top that reads: "Traffic Accident Disposal in Progress". The team will conduct its duties according to the following steps:

*1) Preservation of Site Condition after Accident*
- Cordon-off an appropriate area from oncoming traffic
- Perform traffic control duties
- Interview and secure involved parties and any eyewitnesses

*2) Accident Investigation*[8]
- Pinpoint the exact collision spot
- Record in detail, the position and condition of accident vehicles and/or victims involved
- Record the position of other physical objects (i.e. vehicle parts) that may aid in the accident investigation

*3) Traffic Accident Investigation Recording*
- Accuracy and completeness in data entry are the two most important aspects of traffic accident recording. For this purpose, a standardized traffic accident data entry form or sheet is essential. This standardized form will therefore assist the team to ensure all necessary information is accurately and fully entered into the form.
- Accuracy is essential as incomplete entries or inaccurate information may eventually lead to adverse legal consequences and claims. Furthermore, inaccurate data may endanger the reputation and reliability of the traffic accident data rendering may also become questionable.

*4) Special Concerns when Conducting Investigations*

- Help/rescue injured people at the scene
- Take necessary steps to prevent secondary accident
- Relieve traffic congestion

(4) Contents of Traffic Accident Investigation

Comparing the current practice in both Chiang Mai and Japan, it is found that investigations in Chiang Mai record fewer accident items and categorize results more simply. Furthermore, the potential answers provided are simpler than those utilized on forms in Japan. The table below shows this comparison.

**Table 8-11 Comparison of Chiang Mai and Japan Traffic Accident Investigation**

| Item Recorded in Japanese Standard | | Items recorded in Chiang Mai System | |
|---|---|---|---|
| | | Yes/No | Remarks |
| Time, Situation | Date | Yes | |
| | Time | Yes | |
| | Weather | Yes | |
| Place | Road configuration | Yes | Simpler classification for Chiang Mai, as it is sketched on-site |
| | Road alignment | Yes | Simpler classification for Chiang Mai |
| | Surface condition | Yes | Simpler classification for Chiang Mai |
| | Safety facility | No | Chiang Mai enters it a sketched map |
| | Traffic regulation | No | |
| | Sight distance | No | |
| | Conditions of surrounding areas | Yes | Land use |
| Person Involved | Type of vehicle, pedestrian | Yes | |
| | Gender | Yes | |
| | Age | Yes | |
| | Occupation | No | |
| | Activity of the person | No | |
| | Driving hours before accident | No | |
| | Overwork | No | |
| | Alcohol/drug use | No | |
| | Frequency of driving | No | |
| | Type of license/driving experience | No | |
| | Companions | No | |

**Table 8-11 Comparison of Chiang Mai and Japan Traffic Accident Investigation (continued)**

| Items Recorded in Japanese Standard | | Items recorded in Chiang Mai System | |
|---|---|---|---|
| | **Yes/No** | **Yes/No** | **Remarks** |
| Vehicle Concerned | Registration plate numbers | Yes | |
| | Vehicle manufacturer | No | |
| | Year of manufacture | No | |
| | Usage of vehicle | No | |
| Type of Accident/ Severity of Collision | Type of accident | Yes | In Chiang Mai, type is selected from among various accident patterns provided |
| | Severity of damage | No | |
| Causal Relation | Causes of accident | Yes | |
| | Types of violation | Yes | |
| How the Accident Occurs | Position of persons involved; condition of other parties | No | |
| | Activity in attempt to avoid collision | No | |
| | Collision/contact position | No | |
| | Final stopping position | Yes | Chiang Mai enters in a sketch map |
| | Vehicle damage situations | No | |
| | Condition of injured | Yes | Chiang Mai provides entry items |
| Others | Tread/skid marks | No | Chiang Mai fills out site sketch map. |
| | Conditions of any fallen objects | No | |
| | Safety belt/helmet usage | Yes | |
| | Car inspection | No | |
| | Insurance coverage | No | |

Source: CM Provincial Traffic Police and this study

The traffic accident record form of Chiang Mai is given in Appendix C.

(5) Present Status of Accident Data Recording on the Chiang Mai Accident Form

Traffic accident data records for a period of four months, housed at the Muang Distrcit Police Station, were examined. All entries for date, time, and location were complete. There were however many missing/uncertain entries for the accident type, road configuration, gender of victims, age, and severity of victim injuries. In addition, many of the sketch maps were not drawn at all.

**Table 8-12 Proportion of Traffic Accident Data that is Missing/Uncertain in Chiang Mai Accident Forms**

| Information Type | % of Forms with Missing/Uncertain Information |
|---|---|
| Accident characteristics | 81.90% |
| Road configuration at site | 53.60% |
| Gender of driver (Car # 1) | 22.70% |
| Age of driver (Car # 1) | 50.90% |
| Number of injured persons | 78.60% |

Source: CM Provincial Traffic Police and this study

(6) Traffic Accident Data Processing System Practiced in Japan

Two sets of traffic accident data records have been made. One of them is kept in the police station as a basic information/archive to be used for to prevent accidents by analyzing such data and devising mitigation measures.

The other set is sent to the Prefecture Police Headquarters and archived on magnetic tapes to facilitate computer analysis and automated compilation. The data on the magnetic tapes are also sent via a dedicated telephone line to the Computer Center for the National Police Agency.

Based on the data filed in the Prefecture Police Headquarters and the National Police Agency, statistical computation and analysis is performed on a continuous basis. The results are published in the form of both monthly and annual reports, accessible by the public.

(7) Comprehensive Traffic Accident Analysis System

*Promoting a Comprehensive Analytical System*

In Japan, a special foundation co-managed by the National Police Agency, the Ministry of Transport, and the Ministry of Construction and called the "Comprehensive Traffic Accident Analysis Center' was established in 1992. The functions of this Foundation are:

- To collect all traffic accident and various other traffic-related statistics and to conduct comprehensive analysis and study to present the typical traffic accident characteristics and types;
- To analyze various factors that cause traffic accidents using both a national macro-database, as well as specific regional/area micro-databases or specific accident-type data archives; and
- To widely publish the results of such analyses for both government and the public, in an attempt to promote formulation of various traffic safety mitigation measures.

*Analyses by Macro and Micro-Databases*

The macro-database is a nationally-integrated traffic accident database, combining all the statistical data as described earlier (i.e. person, vehicle, road environment, etc.). It is therefore suitable for analyzing all traffic accident occurrences in a comprehensive manner.

The micro-database has accumulated data (of at least 1,000 cases) for selected traffic accidents that have taken place near the Center. A team of traffic accident specialists (comprised of four persons with in-depth knowledge of road, vehicle, and driver behavior) is sent to the accident site to investigate the causes of the accidents. Furthermore, they are to record the type of damages/injuries sustained by persons or vehicles, as well as the condition of the collision and the road environment.

It is important that traffic accident analysis utilizes both these macro and micro-databases in a cross-analytical manner, so as to completely comprehend the nature and cause of such traffic accidents. It is only with such an understanding can measures be formulated to mitigate and prevent accidents.

## 8.5 Traffic Management Around School Areas

The following subsections will describe the current status of traffic around dense school areas in the Municipality and discuss traffic management measures that have been adopted. Also, means of alleviating such traffic congestion are proposed.

(1) Background

Chiang Mai's rich cultural background has attracted a variety of secondary and higher institutions of learning to the Municipality. The abundance of such institutions has created traffic problems throughout the city, especially during the morning and afternoon periods (when students begin school and end school). This problem became increasingly prominent in the late 1980's, as increased rates of motorization resulted in significant traffic congestion in areas surrounding schools and colleges.

A list of schools in and around the Municipality is summarized in Table 8-13. The locations of these schools are shown in Figure 8-6.

**Table 8-13 List of Schools in the Municipality and Surrounding Area**

| Designation in Figure 8-6 | Educational Institution |
|---|---|
| KN | Dara Girls School |
| | Royal Prince College |
| | Payap University, KN Campus |
| | CM International School |
| CH | Chai Rot Secondary School |
| | Regina Secondary School |
| | Paharethai (Sacred Heart) Primary and Secondary School |
| | Monfort Primary School |
| | Soon Noi Primary School |
| | Wachirawit Secondary School |
| | Suntisuksa Nursery |
| | Suan Dek Nursery |

| Designation in Figure 8-6 | Educational Institution |
|---|---|
| 1 | Chiang Mai University |
| 2 | CM Polytechnic School |
| 3 | Technology and Vocational Institute |
| 4 | Rajabhat Institute |
| 5 | Physical Education College |
| 6 | Wat Pa Paeng Municipal School |
| 7 | Wattanotai School |
| 8 | Technical College |
| 9 | Yuparaj School |
| 10 | Buddhi Sophon School |
| 11 | CM Commercial College |
| 12 | Drama College |
| 13 | Christian School |
| 14 | Ping Karattana School |
| 15 | Monfort Secondary School |
| 16 | CM Tech School |
| 17 | Payap University |

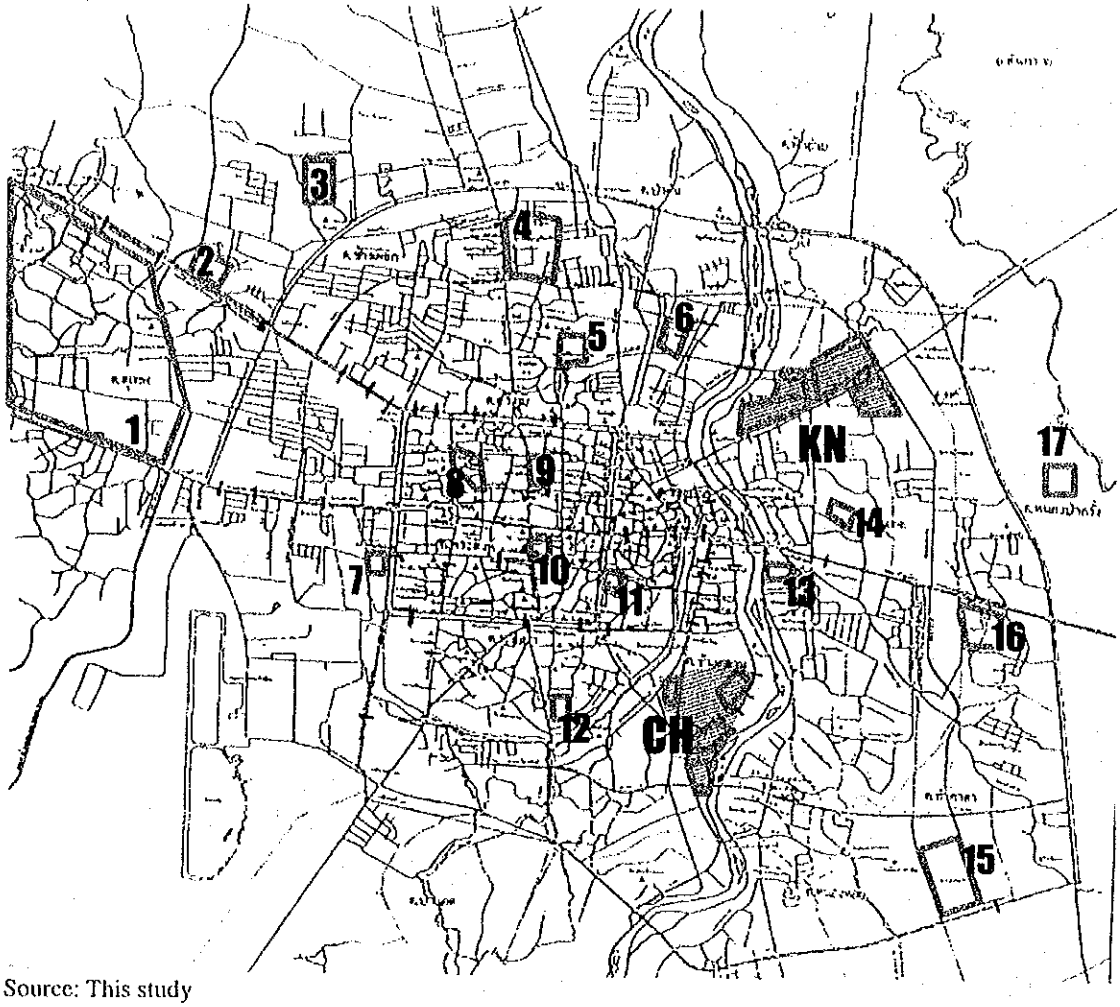
Source: This study

The high concentration of educational institutions has placed a strain on Chiang Mai's roadways as high traffic volumes in the morning and afternoon are produced. The poor state of public transport has produced significant traffic congestion as well. Two areas are particularly congested due to the dense concentration of schools and colleges (especially private schools, which cater to mid-high income families with personal vehicles) within their locales:

1) The area defined by Charoen Prathet Road, Sri Donchai Road, Pracha Sampha Road, Rakaeng Road, Chang Klan Road and Chiang Mai Land Road (denoted by the notation "CH" in Figure 8-6); and
2) The area along Kaew Nawarat Road from Super Highway to Charoen Rat Road (denoted by the notation "KN" in Figure 8-6).[9]

Due to their significance/severity of its traffic congestion and the importance of the many schools in these locales, these two areas were chosen as the areas for the detailed study.

[9] The area denoted by "KN" has a history dating back to the middle of the 19th Century, when Protestant groups established the Prince Royal's College (PRC). The area denoted by "CH" also has a history dating back to the middle of the 19th century, when Catholic missionaries established the famous Monfort Primary School (of which Prime Minister Taksin Shinawatra is an alumnus) as well as several sister and support facilities.




Source: This study

**Figure 8-6 Locations of Schools in the Municipality and Surrounding Areas**

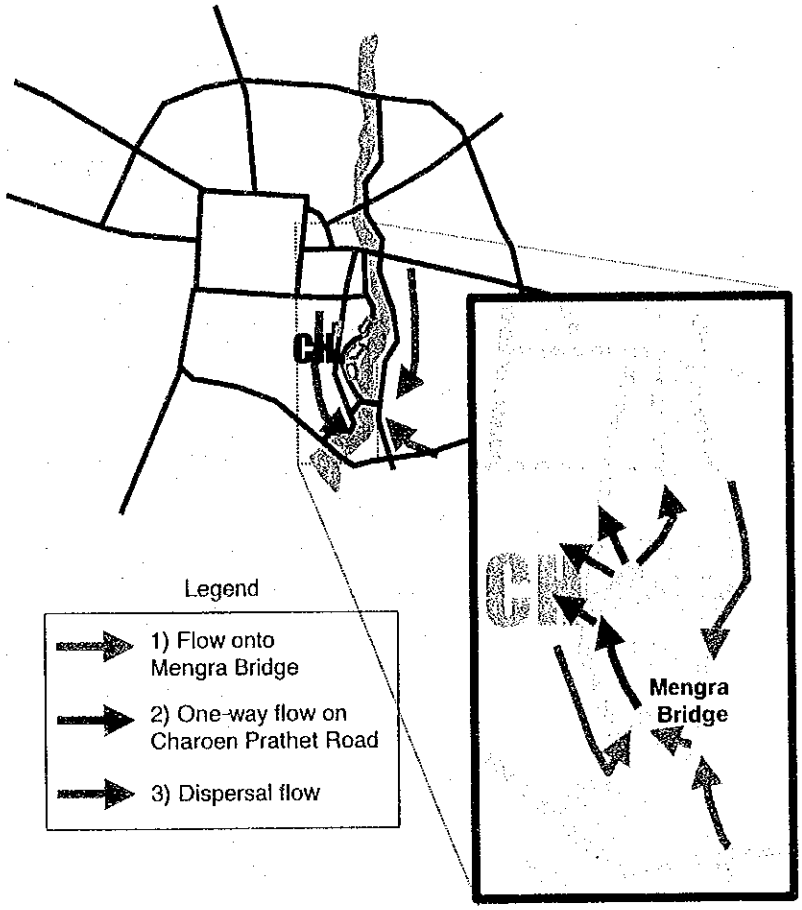
(2) Traffic Management and Conditions in Study Areas

School traffic may be classified as either private transport (personal automobiles, motorcycles, bicycles, etc.) or public transport (supplied by the broadly-defined bus system which includes shared-taxis, minibuses and vans). Students are both picked up/dropped off inside the school campus, or on nearby roadways close to the school.

Major activity periods during the day coincide with the beginning and the ending of the school day. The periods between 7:00-8:00AM and 3:00-4:30PM were observed to be the peak traffic hours. After the beginning of school at 8:00AM, a significant reduction in traffic was witnessed. Although most schools dismiss class around 3:15-3:30PM, queues begin to form around 3:00PM.

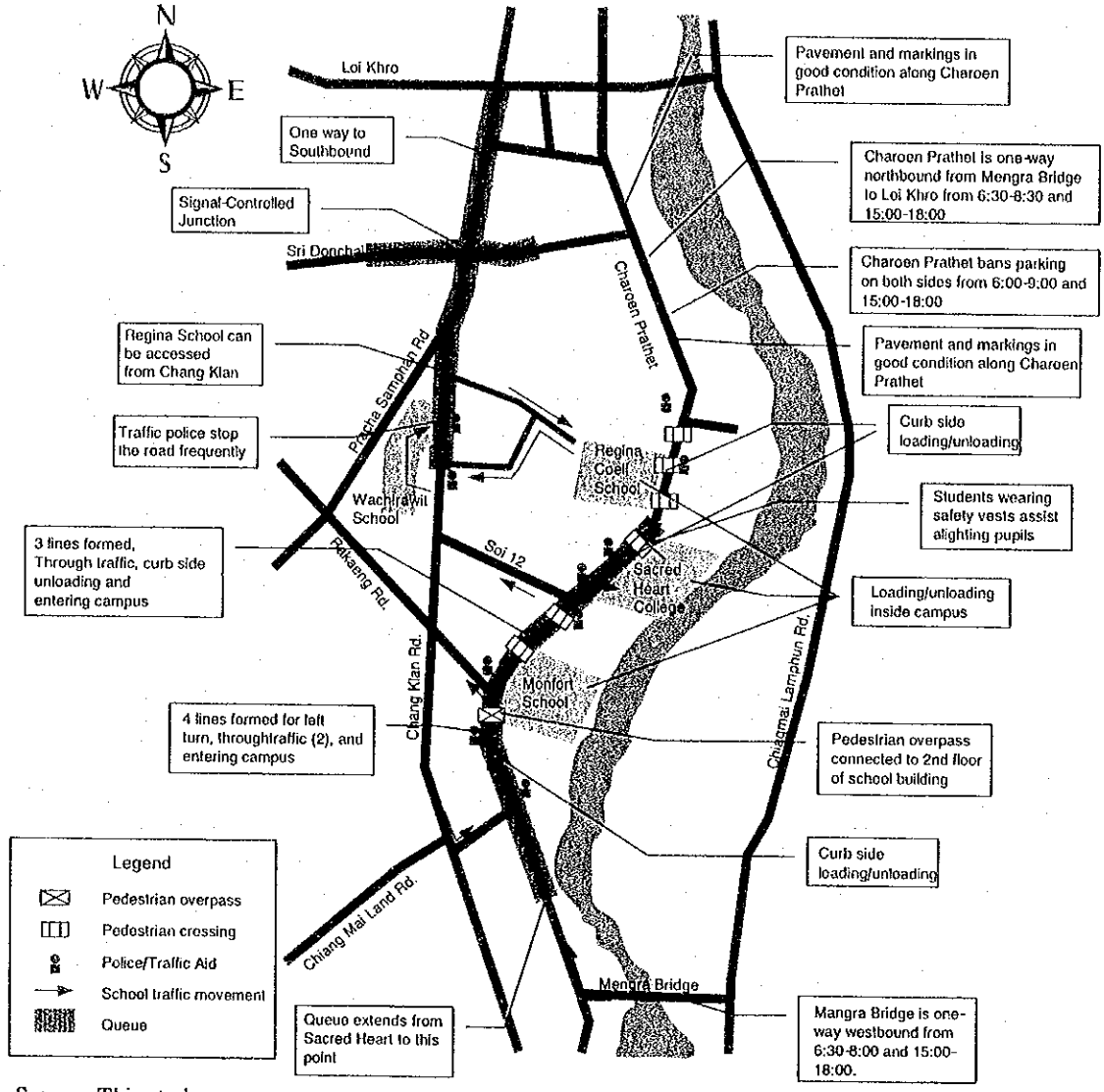
*Chang Klan Area*

There are 4 schools and 3 kindergartens located within the Chang Klan Area, numbering some 9,300 pupils and students. Figure 8-7 shows the direction of traffic flows in the area, while Figure 8-8 depicts the various traffic management measures that have been adopted in the area.




Source: This study

**Figure 8-7 Flow of Traffic on Major Thoroughfares in Chang Klan Area**




Source: This study

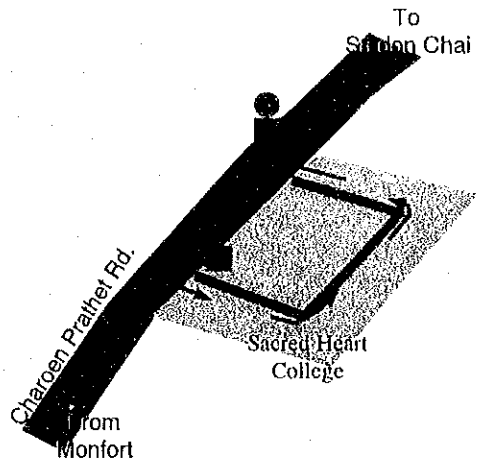
**Figure 8-8 Existing Traffic Management Measures in Chang Klan Area**

Some of the basic measures adopted are as follows:

1) The Mengra Bridge was designated as the entrance to the district;
2) Charoen Prathet Road was converted into a one-way street heading northwards towards the locations of several large schools; and
3) Several connecting roadways leading from Charoen Prathet Road were converted into one-way streets to facilitate traffic dispersal from the area.

The segment with the heaviest traffic is from the Mengra Bridge to the Sacred Heart School, with queuing beginning at the gates from the school with policemen regulating merging traffic onto Charoen Prathet Road. In contrast to this situation, there is no

traffic congestion north of the Regina School as traffic can use Chang Klan Road. Figure 8-9 shows a schematic of the roadways near the Sacred Heart College.



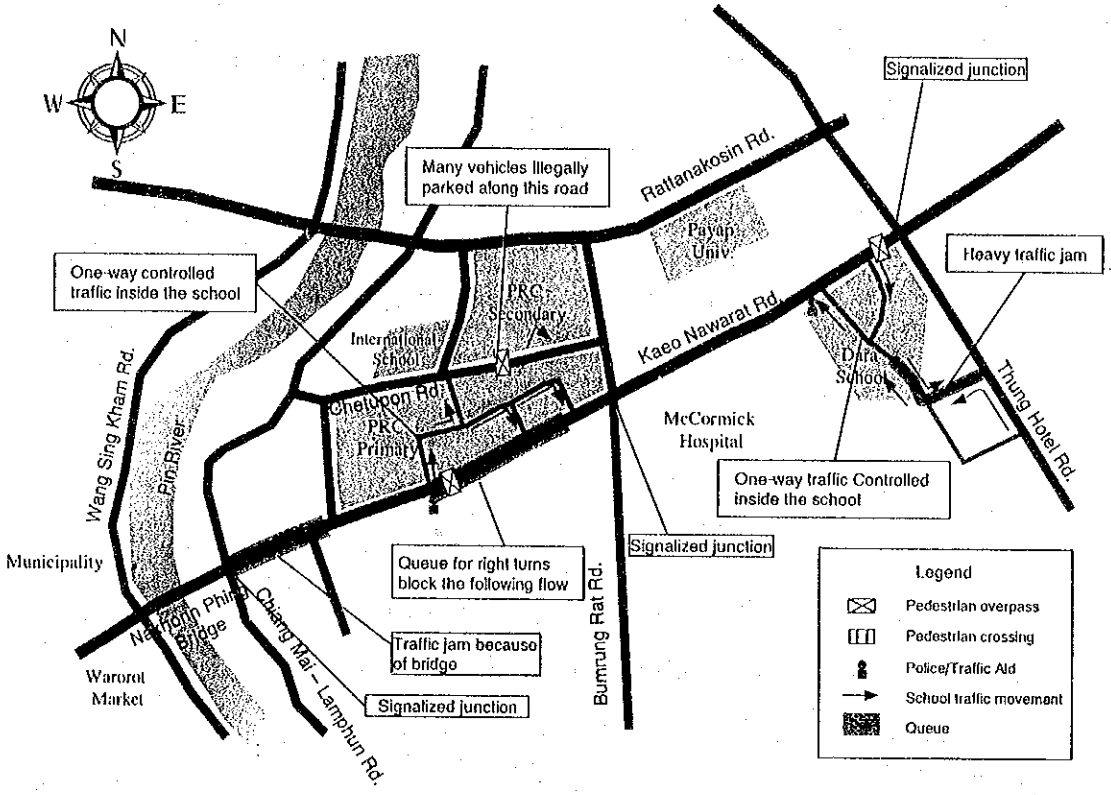

Source: This study

**Figure 8-9 Traffic Flow Around Sacred Heart College**

Congestion also occurs along Chang Klan Road at the entrance to the Watchirawit School, where police officers regulate traffic entering the roadway. To make the matter worse, the resulting queue affects traffic all the way to the Sri Dornchai Road intersection. The queue in the north direction extends up to Loi Khro Road.

*Kaeo Nawarat Area*

There are four major schools located within the Kaeo Nawarat Area, including the PRC School, which has over 13,000 students enrolled in classes for levels ranging from kindergarten, up to high school. Figure 8-10 shows the traffic management measures employed around the area.




Source: This study

**Figure 8-10 Existing Traffic Conditions and Traffic Management in the Kaeo Nawarat Area**

Some basic traffic management measures have been put into effect as follows:

1) The traffic from the PRC School was distributed onto two arterials (Ratanakoshin and Kaeo Nawarat), and one collector (Chetupon Road); and
2) The capacity of the campus for Dara School was large enough that queuing traffic did not back up onto the neighborhood streets.

The PRC Primary School has an entrance along Kaeo Nawarat Road. There is some traffic congestion in the direction heading towards the Pin River as vehicles dropping students off either stop on the shoulder of the roadway to unload their children, who consequently use the pedestrian overpass to enter campus, or make a right turn against on-coming traffic into the campus itself. The three exits leading from the campus (two of which direct traffic back onto Kaeo Nawarat Road and one onto Chetupon Road) are usually uncongested. The aforementioned Chetupon Road, with very light traffic flows, is an ideal spot to load/unload students, although it is not as convenient for students as being dropped off through the main campus entrance off of Kaeo Nawarat Road.

The traffic situation near the Dara School is more amenable as the campus is large enough to accommodate loading/unloading within campus grounds. The *soi* off of the

nearby Thung Hotel Road has traffic in both directions, despite its small width, resulting in heavy traffic into and out of the Dara School.

(3) Traffic Survey

The following traffic surveys were conducted:

- Vehicular traffic counts and surveys within the two target areas during morning and afternoon peak periods (five (5) survey locations in the Kaeo Nawarat Area and six (6) in the Chang Klan Area).[10]
- Interviews with school authorities to assess traffic issues and traffic mitigation methods.
- Classroom surveys to assess state of commuting.
- Questionnaire surveys for parents/guardians to assess the level of support for various traffic mitigation efforts (including specially-designated school buses, vans, or cars as well as potential staggering of school operating hours).[11]

The surveys were conducted from August 27th to August 31st, a period of five days.[12] Some of the results from these surveys are summarized in Appendix H.

According to the results of the interview and questionnaire survey, the school commuting situation may be summarized as follows:

*Existing Status of School Commuting and Response from School Authorities*

The interview surveys with school principals are summarized in Table 8-14. According to the results, there are approximately 10,000 trips to and from these areas every morning and afternoon. Traffic flows are more concentrated in the morning than the afternoon periods. Schools hire private guards with their own budget.

The authorities for the Monfort, PRC, and Dara Schools gave a positive response to potential plans for adopting collective transportation to alleviate the congestion. All agree that crime and traffic problems are hurdles to eventual adoption. Some principals do not regard funding to be difficult.

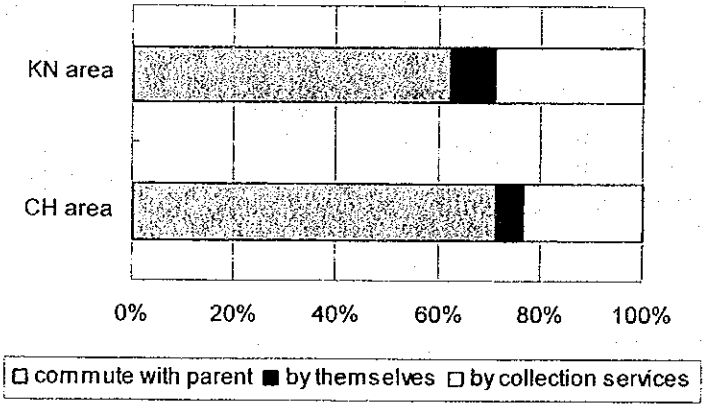
**Table 8-14 Summary of School Authority Interviews**

| | Chang Klan Area (CH) | | | | Kaeo Nawarat Area (KN) | | |
|---|---|---|---|---|---|---|---|
| Item/Questions | Monfort | Sacred Heart | Regina | Total | PRC | Dara | Total |
| Number of students | 2,294 | 4,652 | 2,410 | 9,356 | 6,141 | 7,080 | 13,221 |
| Number of classes | 42 | 94 | 55 | 191 | 138 | 146 | 284 |
| Starting time (for primary/secondary schools) | 8:00 | 8:20 | 8:30 | | 8:00 | 7:50 | |
| Closing time (for primary schools) | 17:00 | 15:35 | 16:30 | | 15:40 | 15:35 | |
| Number of private guards | 6 | 10 | 3 | | 11 | 11 | |
| Budget for hiring private guards (THB/month) | 20,000 | 50,000 | N.A. | | 48,000 | 60,000 | |
| Existence of collective transport by school | No | No | No | | No | No | |
| Interest in collective transport | Yes | Yes | No | | Yes | Yes | |
| Participation in collective transport | Yes | No | Yes | | Yes | Yes | |
| Criminal and traffic issues are problem for collective transport | Yes | Yes | Yes | | Yes | Yes | |
| Financial issues are problem for collective transport | Yes | No | No | | Yes | No | |

Source: CMU survey and Study team

*High Reliance on Parents for Transportation to/from School*

Figure 8-11 shows the proportion of students that commute with their parents, by themselves or via collective services in the Kaeo Nawarat and Chang Klan locales. From the figure, it is clear that over 60 percent of students commute with their parents. Around 30 percent of the students commute via collective transport services. The proportion of those students "commuting by themselves" in Kaeo Nawarat Area is higher because the Yellow Bus Cooperative operates regular services along Kaeo Nawarat Road.

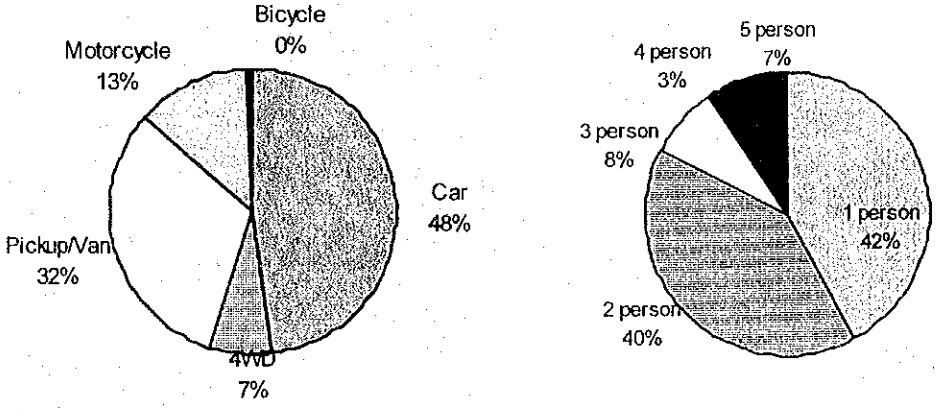



Source: This Study

**Figure 8-11 Means of Student Transportation by School Area**

*School Trips Made by Parents Generally Have Few Occupants in the Vehicle*

Figure 8-12 shows the type of vehicle that parents utilize to take their children to/from school, as well as the number of persons riding in the vehicle during these trips. It was found that 80% of parents use either a pickup truck/van or a car to make these trips. Furthermore, it was found that for these trips, 42% of them are made with only the parent and the student inside the vehicle.

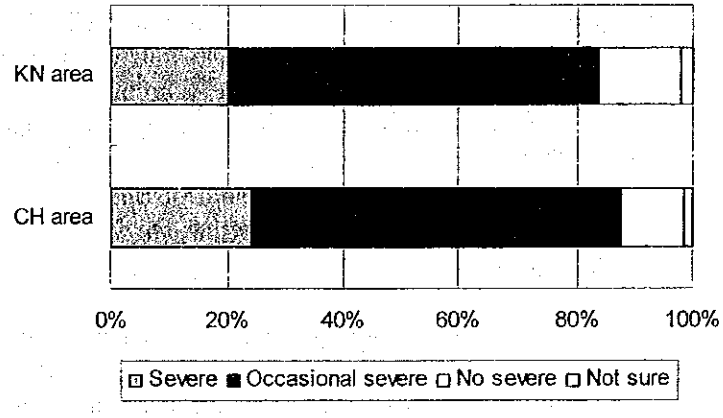



Source: This Study

**Figure 8-12 Type of Vehicles and Occupancy for School-Related Trips Taken by Parents**

*Severity of Traffic Jams in School Area*

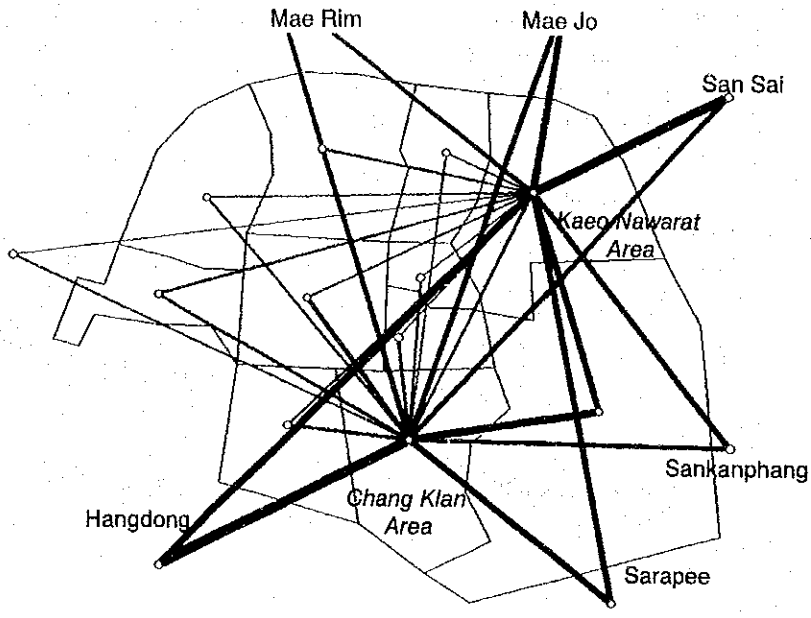
Figure 8-13 summarizes the impression of parents that send/retrieve their children from schools in regards to the traffic congestion within the two school areas. Over 80 percent of parents thought traffic congestion was severe. Overall, there is very little discrepancy between the responses in each school area.




Source: This Study

**Figure 8-13 Opinion of Traffic in School Areas by Parents Making School-Related Trips**

*OD Characteristics for School-Related Trips*




Source: This Study

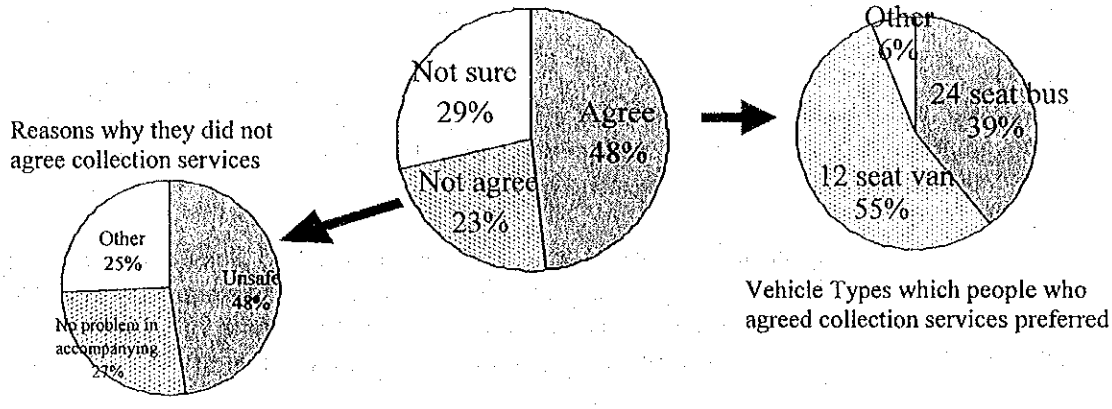
**Figure 8-14 O/D Demand for School-Related Trips**

Figure 8-14 depicts trip demand between the targeted school areas and various traffic zones. It is clear that trips from suburban areas to the schools has a significant volume. The ratio of trips from outside the Municipality is 66 percent for the Chang Klan Area and 78 percent for the Kaeo Nawarat Area, respectively.

*Opinion of Transportation Collective Services*

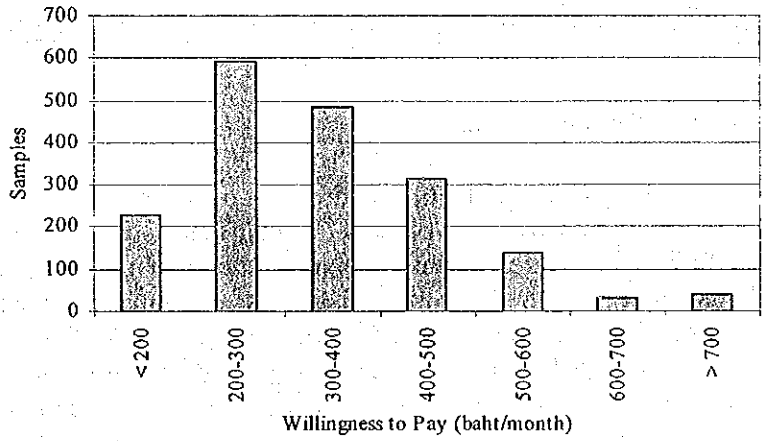
Figure 8-15 shows the opinion of parents with regard to potential proposals to adopt bus collection services to/from schools. It was found that half of the parents accepted the idea of such services. In fact, 55 percent of the parents that viewed such ideas positively preferred 12-seat vans to minibuses. Nearly a quarter of parents expressed no desire to utilize such services. It was found that security was the biggest reason for expressing a negative opinion on service implementation. Furthermore, flexibility and frequency of service was another concern for those that answered "not sure" to whether they would utilize such services.

Figure 8-16 shows the preferred fare levels for such a service. It was found that a monthly fare of between 200-400 baht would be an acceptable fare level for parents for such services. This is quite feasible as a student using a *songtaew* would pay a student fare of six baht per trip.




Source: This Study

**Figure 8-15 Opinion of Collection Services for School Trips by Parents**




Source: This Study

**Figure 8-16 Desired Fare Levels for Collection Services for School Trips**

(4) Constraints Hindering Traffic Improvement

There are several constraints, which continue to obstruct initiatives toward traffic improvement around these schools. These obstacles are not only due to lax traffic control for instance, but also a myriad of other issues, which are discussed below.

*Lack of Public Transport*

There is a shortage of public transport service in the two areas. Yellow *songtaews* operate along the Kaeo Nawarat Road corridor, while red *songtaews* do not.[13] In the Chang Klan Area, very few red *songtaews* operate during peak hours because of the significant amount of congestion produced.

There has been some interest, expressed by the President of the Red Bus Cooperative, to participate in a school traffic improvement committee and to subsequently provide increased mobility to pupils in these areas as long as competition with other *songtaews* is reduced and new bus terminals are developed on the outskirts of the city.

*Students Using Their Own Vehicles*

Some students were observed using motorcycles and automobiles to commute to/from school, despite the fact that many were probably unlicensed. These vehicles are sometimes illegally parked and consequently restricted traffic flow, especially around the PRC School and the Monfort Secondary School.

*Drop-off/Pick-up of Students by Parents*

Surveys have found that many students are dropped-off/picked up from school by private vehicles (either driven by their parents or chauffeurs). There may be several explanations for this trend. Parents may wish to assure that their children are safe outside of the home environment. They may wish to ascertain that their children attend classes as scheduled. They may also be commuting to work and out of convenience, take their children as well. A less intuitive reason may also be that parents just want to spend more time with their children. The schools however, have failed to mount a concerted effort to present viable alternatives to the parents such as official school shuttles or carpooling programs, etc.

*Relocation Constraints*

There are also several hindrances to improving traffic flow around the target areas due to the schools themselves. While it is true the schools would welcome a reduction in traffic congestion outside their campuses, schools have been reluctant to relocate their campuses to facilitate improved traffic flows.[14] While they have never ruled out this possibility, they have not shown great enthusiasm for the idea either as the relocation costs would likely be prohibitively high compared to the time-savings benefits. Furthermore, while villages on the outskirts of Chiang Mai have elementary schools, there are no secondary schools, forcing students to commute into the Municipality for higher education opportunities. Lastly, the concept of establishing schools that are more accessible by walking has yet to garner enough support to warrant construction.

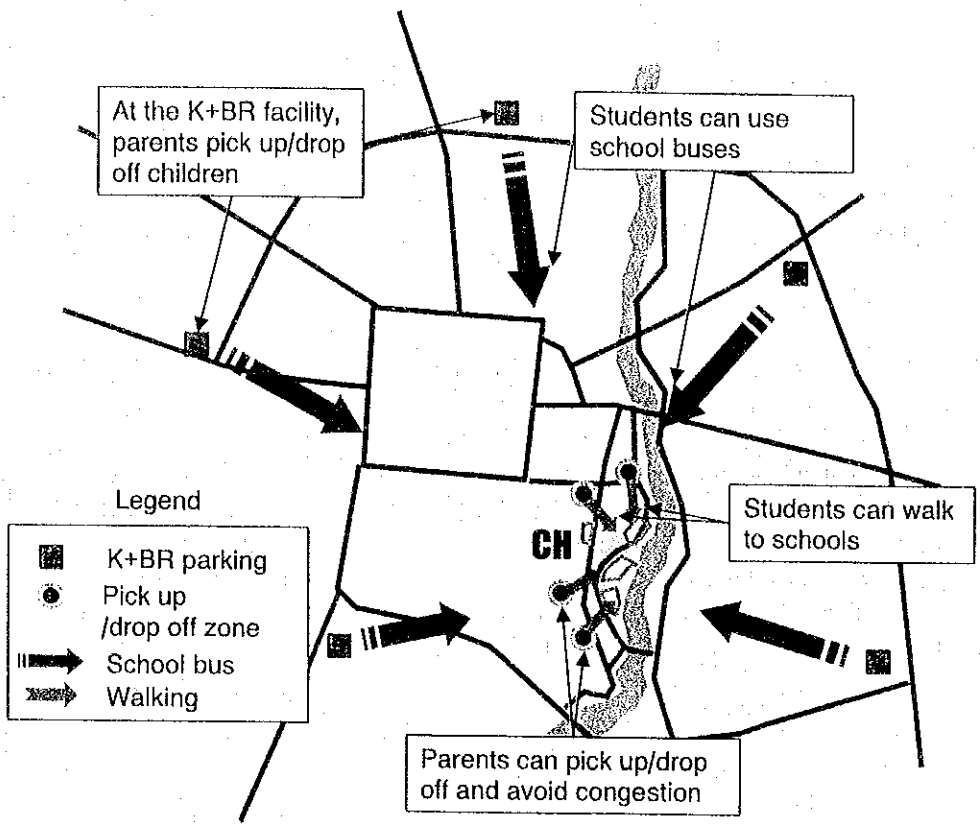
(5) Existing Improvement Efforts

There are several important factors/players that will contribute greatly in the continuing effort to reduce traffic congestion in the Municipality. These are discussed below.

*Provincial School Traffic Committee*

The Provincial Office has organized a specific committee, devoted to the improvement of school traffic. The committee consists of members from the Chiang Mai Traffic Police and the Municipal Construction Office, as well as representatives from municipal schools, etc. The first meeting was held at the end of July 2001, with three more meetings planned within the year.

Projects, that the Traffic Committee has undertaken, include the preparation of a loading/unloading area along Chang Klan Road as well as the rerouting of *songtaew* around schools and the loading area. The Committee also realizes that provision of a safe pedestrian network is essential to reduce traffic within the target areas.[15] Lastly, the Study Team must present and submit all traffic mitigation proposals to the Committee. Individual members making up the Committee[16], have the power to suggest and recommend changes through their organization to these plans. Thus it is important that the Study Team maintain close contact with the Committee to be up-to-date and in accordance with the latest line of thinking or plans.




Source: This Study

**Figure 8-17 Proposed School Traffic Improvement Plan by Traffic Sub-Committee**

Figure 8-17 below shows a proposed traffic reduction scheme drawn up among Committee members. The scheme includes: (i) the dispersion of parking facility; and (ii) the improvement in public transport utilization. (K+BR: kiss and bus ride)

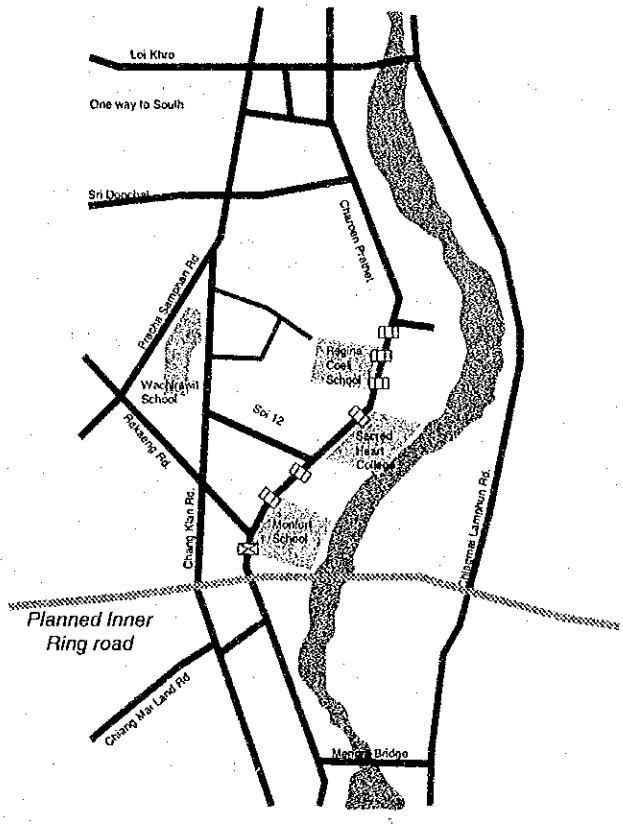
*Other Forms of Transport to/from School*

Various forms of organized transport to/from school are used throughout Chiang Mai. For instance, the Chiang Mai University Hospital has a fleet of six (6) buses to take children of hospital employees to/from school. Employees gather at the school with their children around 7:00AM. After schools, the buses pick the children up, where they wait for their parents to finish work. This service costs 100 baht per month per student.

Other forms of organized transport to/from school are provided by schoolteachers and village volunteers that use small vans (20-25 seats) to shuttle children back and forth. Furthermore, some red *songtaew* operators living outside of the city use their vehicles for this purpose as well. Depending on the distance from home to school, parents must pay between 400-500 baht per month for the service (regardless of vehicle type). Most of these services are unregulated by the LTD however.

*Road Network Improvement*

According to the future road network improvement plans, a new link crossing the Mae Ping River will be built by the end of 2010, in the Chang Klan Area. The link will be part of another Inner Ring Road encircling the Municipality and shall provide another means of dispersing traffic away from areas west of the river. Figure 8-18 shows the proposed link.




Source: Chiang Mai Municipality and this study

**Figure 8-18 Proposed Location of Inner Ring Road in Chang Klan Area**

## 8.6 Pedestrian Safety Around Night Bazaar Area

The major thoroughfare in the Night Bazaar Area is Chang Klan Road, along which many large hotels exist and is one of the busiest pedestrian areas in Chiang Mai. Chang Klan Road. Roadway width varies by section, but generally is 17.5 m wide.[17] One-way traffic flow has been adopted on the three-lane road, heading southwards. In the peak hour, vehicular traffic was observed to be 1,805 vehicles/hour or 1,262 PCU/hour. Motorcycles accounted for 48% of this traffic. Passenger cars, including pickup vans, accounted for 41% of the vehicles, and minibuses accounted for 6% of the traffic. Vehicles classified in the "Others" class accounted for the remaining 5%. In terms of pedestrian traffic, the intersection at Loi Kroh Road (in front of the McDonald)

witnessed 488 pedestrians/hour crossing Chang Klan (from 5:00 to 6:00PM). Pedestrian traffic on the western side of the sidewalk amounted to 122 persons and 214 persons on the eastern side, during the same time period.

The Night Bazaar itself is held nightly from 6:00 to 11:30PM. It is estimated that pedestrian traffic volumes may be double those witnessed during the peak hour. Sidewalks however are narrow, producing significant congestion and potentially making tourist trips less enjoyable due to the crowding. Furthermore, it is difficult to cross the street. Overall, the pedestrian sidewalks/walkways in the Night Bazaar Area are less than comfortable for pedestrians.

(1) Overseas Experience in Pedestrian Mall Development

There are several road designs that provide pedestrian priorities. One good example is the Radburn System, developed in 1928, which installs pedestrian-only roads in residential zones of new urban areas. Furthermore, the Netherlands introduced a restrictive vehicle policy by developing the "Woonerf" (meaning "life garden") system, where cars and pedestrians safely co-exist. These measures provide protection for pedestrians from vehicles, however they would be applicable only under certain circumstances.

More recently, traffic calming has been introduced in several countries, starting in the United Kingdom in the early 1990's. Japan has adopted its own form of traffic calming in its so-called "Community Zone", where vehicle speeds are restricted to 30 km/hour, within zones of 50-100 ha, in order to lessen traffic passing through the area. In urban areas for instance, the German city of Munich has adopted pedestrian-only roads. Strict enforcement of these regulations prevents automobiles from using them. Another popular method has been the adoption of transit malls that are for pedestrian use, yet permit vehicular traffic, in the form of public transit vehicles such as taxis and buses.

Legislation advocating such pedestrian facilities has grudgingly gained acceptance over the years. Table 8-15 describes recent statutes to improve pedestrian facilities that have been approved in Japan.

**Table 8-15 Statutes Promoting Sidewalk Improvements in Japan**

| Year | Name/ Category | Type of Order | Description |
|---|---|---|---|
| 1958 | Road Structure Ordinance | Ordinance | • Sidewalk is set up on city area roads (design speed: 50 km/hour) |
| 1964 | Improvement of Sidewalk, and Design Standard of Sidewalk Height | Notice | • Height of sidewalk for main roads is 20 cm; 15 cm for all other roads. |
| 1970 | Road Structure Ordinance | Ordinance | • Sidewalk are required not only in city areas but also in local areas |
| 1973 | Structure of a Sidewalk and Solid Crossing Institution | Notice | • Standard sidewalk running off slope should be 8% so that wheelchairs may pass<br>• Driveways and sidewalks should be separated with a curbstone<br>• Standard sidewalk and driveway run off and level difference should be 2 cm |
| 1999 | Standard about the Level Difference and Slope in a Sidewalk | Notice | • Width in flat areas should be 1.0 m or wider, but potentially 2.0 m or wider to permit two wheelchairs to pass side-by-side<br>• Sidewalk running off slope should be 5% or less to permit safe passage of wheelchairs<br>• Level difference between sidewalks and driveways is set to 2 cm in consideration of safe passage of visually impaired people |
| 2000 | Traffic Barrier Free Law | Law | • The law aims to improve convenience and safety of movement using public means of transportation for elderly and physically disabled<br>• Strong promotion of "barrier free" walking space |
| 2001 | Amendment Road Structure Ordinance | Ordinance | • Sidewalks should be at least 2 m or wider for roads that are 3.5 m or wider and have high pedestrian traffic. Establishing the sidewalk, roadside trees add 1.5 m and benches add 0.5 m. |

Source: This study

(2) Local Experience in Street Closures

Prior pedestrian improvement efforts on Chang Klan Road prohibited vehicles on some stretches, turning these sections into pedestrian-only streets. The following problems arose however, which prevented full-scale implementation of such plans:

- Convenient access to the Night Bazaar was limited, thus reducing visitors and shoppers.
- Convenience was hampered as few nearby parking lots existed.
- Difficulties arose for hotel guests wishing to visit the Night Bazaar Area.
- Vendors received fewer customers.

These experiences have provided valuable experience and knowledge to transport

planners in Chiang Mai that must be incorporated and accounted for in any future improvement proposals. Recommendations are discussed in Section 9.6.

## 8.7 TDM Options for Chiang Mai

As cities faced increasing traffic congestion, they began to adopt TDM (Traffic Demand Management) measures as an alternative to costly roadway expansion. The following sub-section briefly discusses the potential types of TDM measures that Chiang Mai should consider. Another sub-section then follows, which analyzes the feasibility/applicability of particular TDM measures, given the existing as well as expected circumstances in Chiang Mai.

TDM measures may be categorized into six different classes of interventions. These interventions may be further divided into sub-components such as for private vehicle or public transport. The discussion below identifies the six general types of interventions, focusing on the overall objective and purpose, and briefly highlights some relevant examples from each category.[18]

(1) Management/Policy Measures

Management and policy measures can be divided into interventions meant to reduce/limit private vehicle usage, improve public transport attractiveness/service levels, and reduce freight traffic in urban areas. For instance, regulatory restrictions may be placed upon the owners of private vehicles, to limit the annual number of permits issued, which can substantially reduce the growth in new vehicles. Furthermore to control traffic flow into downtown areas, vehicle bans may be instituted, based on the license plate number of each vehicle.[19] Lastly, high occupancy vehicle lanes may be installed on highways to speed traffic and encourage car-pooling. These measures are considered to be short-mid term solutions as they only deal with particular issues, but will not significantly alter existing travel and personal vehicle usage patterns. They are however a good start in limiting the vehicular growth rate in the Municipality and provide a stimulus to encourage other means of transport besides private vehicles.

Tables 8-16 discusses applicability of various management/policy measures in Chiang Mai.

## Table 8-16 Traffic Management/Policy Measures

| Measure | Feasibility and Applicability to Chiang Mai |
|---|---|
| Traffic Calming Measures | • Traffic calming measures are employed throughout Chiang Mai's road network<br>• The *soi* system of roadways is a combination of both segregation measures, including the adoption of one-way streets, banned turning movements, and closures, as well as integration measures such as low speed areas, speed bumps, chicanes, pinch points and planter barriers<br>• Chiang Mai must maintain a coordinated and consistent policy and planning view towards additional calming measures, based on the overall effect upon traffic flows |
| Vehicle Restrictions | • Restrictions that either limit the number of new vehicle permits issued each year or make such permits expensive intend to stem rapid vehicle growth rates has good potential in Chiang Mai<br>• The public may disapprove of such plans due to inconveniences caused by being unable to freely enter certain areas, and from difficulties in obtaining new permits<br>• High vehicle permit fees may discourage some from purchasing new vehicles, but may not be an obstacle for middle-upper class citizens, especially with rising income levels in Municipality<br>• Furthermore, restrictions may prohibit the entrance of certain vehicles into urban areas on certain days, based on their license plates for instance to control urban traffic congestion<br>• Enforcement of vehicle restrictions would require either devoted checkpoints and/or a much large police/enforcement body throughout the Municipality, resulting in high operational costs |
| Parking Control Regulations | • Parking control regulations are possible in Chiang Mai, but considering that demand already exceeds the supply, more congestion may be produced<br>• Public transport must be improved and become more reliable to justify reductions in parking spaces or other such regulations<br>• Pricing measures to make urban parking more costly should be focus of initial Chiang Mai efforts |
| Car-Pooling | • Municipality should actively encourage car-pooling<br>• Currently, car-pooling is unpopular as people are eager to use their own vehicles<br>• Advertising campaigns are inexpensive and can be organized quickly<br>• Grassroots campaign should focus efforts upon suburban housing estates |
| High-Occupancy Vehicle (HOV) Lanes | • HOV lanes are infeasible as there is little or no room to expand existing roadways<br>• People are eager to use their own vehicles |
| Cycle Priority Measures | • Ineffective to reduce traffic congestion as bicycle use is unpopular<br>• A more effective measure may be the development of motorbike and motorcycle priority measures. |
| Lorry Restrictions | • Lorries are currently prohibited from entering the city (inside of Super Highway) except during late night hours<br>• Bans should remain in place as congestion and pollution emission would likely worsen if lifted, as would safety as the risk of deadly chemical/toxic spills would increase |
| Bus Priority Measures | • Bus priority measures are unlikely within the Municipality as road space is scarce and congested as it is, and routes are not of a fixed nature<br>• There is some potential on inter-city routes that have heavy bus traffic |

**Table 8-16 Traffic Management/Policy Measures (continued)**

| Measure | Feasibility and Applicability in Chiang Mai |
|---|---|
| Public Transport Service Level Upgrades | • Such measures are unlikely to benefit Chiang Mai if fixed route services did not exist, since cooperatives have very limited authority over drivers in the cooperatives<br>• Bus reliability measures already exist in the form of checkers, stationed at each terminal to assure vehicles depart at the correct times<br>• If fixed route service is initiated, checkers could be placed at the origin and destination points, and in the middle of the route to assure arrival time reliability<br>• After the introduction of fixed routes, a monitoring system should be established to tie the salary of drivers to their corresponding on-time performance<br>• Improved passenger feedback system to assure operators are meeting the needs of riders should be established by the Municipality and operators |
| Vehicle Reliability Improvement | • Improved maintenance regime and replacement schedule for deteriorated vehicles can reduce breakdowns and accidents in Municipality<br>• Improved training regime will increase awareness of importance of maintenance and introduce new and proven techniques |
| Quality Bus Partnership | • A "Quality Bus Partnership" is intriguing for Chiang Mai to consider<br>• Red Bus Cooperative has interest to develop new terminal facilities near Super Highway<br>• Progress has stalled as the Red Bus Cooperative is reluctant to shift operations to a fixed route network (stipulation for terminal agreement) |

Source: This study

(2) Pricing and Fare Level Measures

Pricing and fare level measures, instituted on a national as well as a municipal level, are intended to make the costs of driving higher and to encourage public transport usage as well as non-motorized means of travel such as walking or bicycling. For instance, Singapore has instituted a successful program called ERP (Electronic Road Pricing), which charges vehicles for entering the Central Business District (CBD). Road fees vary according to the time of day and the existing congestion levels.[20] Such schemes discourage non-essential users from driving into the congested city areas and also discourage drivers from entering the CBD during the peak hours, when charges are higher. High parking charges may likewise discourage workers from commuting into work. National measures may be adopted such as vehicle purchase and fuel taxes to make the costs of driving more expensive. Lastly, revised fare structures offering off-peak discounts or concessions may promote greater usage of public transport. These measures are considered short-mid term solutions. Huge shifts in travel patterns and private vehicle usage are unlikely, given that convenience will likely remain the preeminent factor in the decision to drive, since the physical infrastructure of the public transport system will not be improved by such measures. These measures are a good start though, as they will remove some cost-conscious drivers from the roadways.

Tables 8-17 discussed applicability of various pricing and fare level measures in Chiang Mai.

## Table 8-17 Pricing and Fare Level Measures

| Measure | Applicability to Chiang Mai |
|---|---|
| Parking Fees/Lots/ Meters | • On-street parking fees are collected by roving meter maids (on foot) and fee-based parking lots exist near Warorot Market<br>• Higher parking fees will make drivers more reluctant to use their vehicles in the city center during congested time periods<br>• Higher fees translate into increased municipal revenues for fortifying parking and traffic enforcement, as well as new project funding such as the installation of parking meters to regulate collection of parking duties and reduce corruption (if any) |
| "The Workplace Parking Levy" | • Surcharges would be difficult to uniformly apply to all companies in Chiang Mai<br>• Surcharges may penalize large companies over small ones, and penalize companies with employees that live far from the office with no other means of transport besides their private vehicles<br>• Alternative public transport modes need to be developed further |
| Urban Road Pricing | • Good potential to reduce congestion, but infeasible in Chiang Mai presently<br>• Large infrastructure backbone and regulatory/enforcement body/force is needed to maintain/operate system (i.e. Singapore scheme)<br>• It is likely that toll revenues will fall well short of operating and startup costs<br>• Public may be reluctant to purchase costly vehicle transponders (if the system automatically deducts credit from a SMART Card) |
| National Vehicle Ownership Tax | • Little evidence to show taxes make significant impact on vehicle ownership, since this is a one-time fee and only deals affects new purchases<br>• Revenue source for Municipality to spend on public transport improvement<br>• May be perceived as inequitable as it essentially penalizes the low-middle class (depending on the taxation rate), keeping them from owning personal vehicles |
| Fuel Tax | • Depending on the taxation rate, can have significant impact in reducing traffic congestion, consequently reducing pollution rates as well in Municipality<br>• If public transport operators are given tax exemptions, they may be able to maintain low passenger fares and increase ridership from displaced drivers<br>• Revenue source for Municipality to spend on public transport improvement<br>• Must increase police vigilance to stop illegal or black market gasoline vendors<br>• May be viewed as inequitable as it penalizes low-middle class drivers as well as rural residents that need to make long-distance trips frequently |
| Company Vehicle Ownership Tax | • Currently, no distinction made between private and company car purchases<br>• Should be enacted in conjunction with private vehicle ownership tax to eliminate loopholes in law<br>• Revenue source for Municipality to spend on public transport improvement<br>• Will not affect the traffic congestion in Chiang Mai |
| Adjustment of Fare Levels | • Fare levels are relatively high in Chiang Mai compared to other cities in Thailand<br>• Lower fare levels may increase ridership, but may reduce fare revenues for operators, causing them to take shortcuts such as decreasing routine maintenance, reducing safety<br>• Service levels may be degraded if vehicles are more crowded and have longer average trip times (from the increased loading/unloading times)<br>• Operators should assess fare elasticity to determine rider willingness to pay for certain services<br>• Operators should assess financial viability to assure overall operator sustainability with changes |

**Table 8-17 Pricing and Fare Level Measures (continued)**

| Measure | Applicability in Chiang Mai |
|---|---|
| Changes in Fare Structure | • Altering the fare structure in public transport has great promise in attracting new passengers and reducing traffic congestion in Chiang Mai<br>• Zonal fares may be introduced to more equitably charge riders for the amount of service consumed<br>• Incentives, primarily in the form of lower fares, can be introduced to encourage riders to use public transport in non-peak hours or during the weekend<br>• Weekly/monthly passes with discounted trip fares will further encourage ridership |
| Introduction of Concessionary Fares | • Concessionary fares should improve attractiveness of public transport in Municipality<br>• Concessionary fares may be given to students, the elderly, military personnel, government and municipality employees, and/or the disabled<br>• Currently, some concessionary fares are given on *songtaews*, however these discounts are not uniformly applied by every driver or on every route<br>• Fares may be further subsidized by supermarkets and souvenir shops, in exchange for direct service to these locations |

Source: This study

(3) Information Provision Measures

Information provision measures intend to improve traveler information on the roadways, in the vehicles, or on the public transport network, as well as to inform the public and increase awareness to the critical problems faced in the transport sector. For instance, Variable Message Signs (VMS) placed at key locations, give updated roadway information to permit drivers to change their routes to avoid the traffic congestion or accidents. In-vehicle information systems can recommend alternative driving routes (again to avoid congestion or accidents etc.) on a real-time basis. Public transport agencies may post fixed schedules and/or route information to improve passenger information and knowledge of the system. Lastly, public awareness campaigns may be launched, intended to convince drivers to forsake their vehicles and find alternate means of transport. Such measures are short-term solutions, the majority of which can be implemented rather quickly, with little planning. While these measures will not produce a permanent or significant reduction in traffic and vehicle usage patterns, they can help to reduce the severity of congestion for instance, and make public transport more convenient and time-efficient. In some cases however especially for in-vehicle driver information systems, users would be limited to the upper class, as they would be able to afford such amenities.

Table 8-18 discusses the applicability of various information provision measures in Chiang Mai.

**Table 8-18 Analysis of Information Provision Measures**

| Measure | Applicability to Chiang Mai |
|---|---|
| Addition of Conventional Traffic Signs | • More than a specific measure, it should be an overriding concern of the traffic agencies and Municipality to assure safety for drivers, vehicles, and pedestrians<br>• Campaign should be conducted to assess the appropriateness of revised/new signage at all locations that are either unsigned or have high vehicular and pedestrian accident rates |
| Variable Message Signs (VMS) | • VMS utilized for advertising purposes only in Chiang Mai<br>• Potential for wide application of VMS throughout Chiang Mai, with either fixed or mobile units<br>• Municipal or DOH oversight agency should be created to monitor placement of VMS at strategic locations, to assure information is up-to-date and consistent |
| Real-Time Driver Information/ Route Guidance Systems | • Impractical in Chiang Mai due to high costs and lack of monitoring and dispatching infrastructure<br>• If technology improves and costs decline, such technology may become more affordable in the future |
| Parking Guidance Systems | • Electronic parking guidance systems do not exist in Chiang Mai<br>• These systems do not reduce traffic congestion, but make parking faster and more convenience considerably<br>• Considering the narrow streets and lack of on-street parking, such systems could provide additional capacity and reduce the amount of double-parking<br>• Parking lot owners may be unwilling to purchase and install such systems, thus the Municipality may need to subsidize or fund such activities |
| Public Awareness Campaigns | • Public awareness campaigns promoting public or non-motorized transport have not appeared in Chiang Mai<br>• Such campaigns are inexpensive and effective if targeted correctly<br>• Promotion and message must involve all traffic/transport-related agencies<br>• Campaigns must show traffic congestion will worsen, and the public can play a crucial role<br>• Campaign must focus attention upon the consequences that heavy traffic congestion brings, in terms of lower quality of life (time spent commuting instead of with family, etc.) as well as in terms of lost economic productivity (time spent commuting could be spent on more productive activities) |
| Public Transport Timetables and Service Information | • Currently fixed schedule and timetable information does not exist<br>• Most users inherently know vehicle schedule and route from experience<br>• Such information should be posted when fixed route service is initiated and when reliability of public transport is greatly improved (assuring accuracy of schedules)<br>• Vehicle schedule/route information useful for first-time users of the system as well as tourists |
| Real-Time Passenger Information Systems | • Infeasible in Chiang Mai until fixed route service is instituted, as variability in service level and routing is too great, rendering such systems useless<br>• Large and costly infrastructure needed to obtain, interpret, dispatch, and display such information |

Source: This study

### (4) Office/Work-Related Measures

Office or work-related measures intend to disperse the concentrated traffic flows observed during the morning peak and the afternoon peak hours when workers are going to and departing from work, thus reducing traffic congestion during these times and making travel speeds faster. They also intend to promote public transport usage

over private vehicles. Many companies have instituted a "flex" schedule, to give employees greater freedom in choosing when to start the working day (of course employees must work a minimum number of hours in a day), in order to reduce the concentration of traffic entering the urban area during the morning peak hour and that leaving during the evening peak hour. Companies may also give monetary incentives to employees to foster public transport utilization. These measures are considered to be short-term solutions and can be implemented quickly. They do not significantly alter travel and vehicle usage patterns in the Municipality, but should reduce the severity of congestion within peak periods during weekdays.

Table 8-19 discusses applicability of various office/work-related measures in Chiang Mai.

**Table 8-19 Office/Work-Related Measures**

| Measure | Applicability to Chiang Mai |
|---|---|
| Flexible Working Hours | • Relatively easy to implement, although rigid working regime may prevent adoption in traditional companies<br>• Also an option for schools to consider, although this may prove infeasible if starting times are inconsistent with working hours of parents |
| Tele-Commuting | • Good option for companies, but they must be convinced that employees can work productively outside office<br>• Tele-commuting requires a computer and in some cases, modem and Internet connections, which may be too costly for individuals or for companies to provide<br>• Internet use is gaining popularity, but its use as a business tool is just beginning<br>• Only certain types of occupations would require tele-commuting |
| Public Transport Travel Incentives | • Presently, most companies do not have such policies<br>• Good potential if employers can be convinced of societal benefits and partnerships formed with public transport operators or the Municipality to partially/fully subsidize such schemes<br>• Public transport needs to be improved, i.e. introduction of fixed route operations with schedules/frequencies |

Source: This study

(5) Infrastructure Enhancement Measures

Measures that improve or expand the existing physical infrastructure are intended to make public transportation more accessible/convenience and to encourage use of alternative modes of transport like bicycling and walking. In addition to the provision of public transport infrastructure such as light rail right-of-ways, guided bus lanes or transfer terminal facilities, infrastructure provision may also consist of the extension of cycle networks, pedestrian walkways and bridges, as well as the creation of park-and-ride lots. The creation of transshipment terminal facilities to reduce the number of freight lorries in urban areas is another typical intervention measure. These measures are considered to be mid-long-term solutions, depending upon the type of infrastructure funded. Similar to zoning/development measures, any such plans should be closely coordinated with those of the Town Planning Office and all related transport agencies. If appropriately implemented, traffic congestion can be significantly reduced if light rail transit is funded for instance. There is a significant change that traffic and vehicle usage patterns can truly be altered, depending on the type of intervention. Cycle and

pedestrian networks however, are measures that are unlikely to make any impact at all, but will please certain lobby groups.

Table 8-20 discusses applicability of various infrastructure enhancement measures in Chiang Mai.

**Table 8-20 Infrastructure Enhancement Measures**

| Measure | Applicability to Chiang Mai |
|---|---|
| Establishment of Guided and/or Exclusive Bus Lanes | • Exclusive bus lanes are unlikely in the Municipality given the existing nature of public transport<br>• Guided bus ways are infeasible in the Municipality due to cost as they would require the construction of separated and possibly elevated roadways<br>• Potential for bus lanes when fixed route service is instituted and reliability improved |
| Establishment of Park-and-Ride Facilities | • Park-and-Ride facilities are feasible, however they must be located on the outskirts of the Municipality where open space is more prevalent<br>• Viable connection from the lots to urban destinations must be encouraged/provided, whether it is public transport, private shuttle buses, or car-pool networks<br>• Parking lot capacity must be large enough to accommodate non-peak as well as peak commuters<br>• Municipality must allow free parking to encourage users |
| Provision of Enhanced/New Transfer/ Interchange Facilities | • Plans are in the works to relocate several provincial *songtaew* terminals to the outskirts of the Municipality, near Super Highway, with expenses covered by Municipality<br>• Stipulations on the Red *Songtaew* Cooperative to switch operation to fixed routes are still under negotiation, delaying the project<br>• Improvements such as more comfortable waiting/loading areas, or the establishment of concession stands and small stores may make the terminals a more entreating place for commuters<br>• If fixed services are introduced, better collaboration between operators must occur, primarily in schedule coordination and facility-sharing |
| Expansion/ Upgrade of Existing Cyclepaths and Facilities | • Expansion/upgrade of the cycle network will do little to ease traffic<br>• Additional parking facilities will improve convenience for bicycle riders, but will not change existing travel patterns and private vehicle usage<br>• Construction costs may become expensive in dense areas with little available spare land corridors |
| Expansion/ Upgrade of Pedestrian Area | • Existing network is well-developed, but of varying quality<br>• The impact of these measures is limited as most workers do not walk to work<br>• Commercial areas specifically served by such pedestrian areas will be pleased with upgrades |
| Expansion/ Upgrade of Lorry Parks/ Transshipment Facilities | • Expansion of lorry parks will not reduce traffic congestion in the peak within the Municipality since lorries are already banned except late at night<br>• Similarly, the upgrade/provision of transshipment facilities would not impact traffic during the day<br>• Such facilities will improve the freight handling efficiency of Chiang Mai |

Source: This study

(6) Land Use/Development Measures

Measures that introduce zoning, land-usage, and development regulations reduce average trip length, promote non-motorized modes of transport such as walking or bicycle, as well as encourage public transport usage and car-pooling. For instance, development along transport corridors, or near major transportation nodes, can

substantially increase public transport convenience and reduce dependence on private vehicles. Developers may be given discounts on land prices or loosened zoning regulations (i.e., height of buildings, number of floors, number of residential units, etc.) to encourage construction in designated zones. The densification of developments close to activity centers such as office buildings, schools, and markets also intends to reduce reliance upon private vehicles, by shortening work and school-related trips. These measures are considered to be long-term solutions and should thus be developed in close coordination with the Provincial Town Planning Office, as well as all related transport agencies. If appropriately implemented, traffic congestion can be significantly reduced. Significant and permanent changes in existing traffic patterns and personal vehicle usage habits may be witnessed if such measures are implemented.

Table 8-21 discusses applicability of various land use/development measures in Chiang Mai.

**Table 8-21 Land Use/Development Measures**

| Measure | and Applicability to Chiang Mai |
|---|---|
| Require Land Developers to Contribute to Transport Infrastructure Improvements | • These contributions would help to improve the existing public transport infrastructure, although developers may bristle at the added costs<br>• Municipality needs to create a management body for equitable distribution of funds to operators<br>• Should be adopted when service providers operate fixed route services and/or they or the Municipality owns/operates its terminal facilities<br>• Payments should not only be allotted for infrastructure, but also for public transport research (i.e. electric buses, etc.) |
| Require Land Developers to Provide Adequate Parking for All Tenants | • Requirements are essential for new development complexes<br>• Additional parking spaces can be created for fee-based public usage to reduce on-street demand |
| Permitting Developers to Make Commuted Payments to Chiang Mai Municipality | • Viable option for the Municipality so long as it collaborates closely with the developer to create easy and convenient access between lots and developments<br>• Developers may be resistant as clients may choose other developments if parking spots are excluded from lease payments and are situated off-site |

Source: This study

## 8.8 Environmental and Social Considerations

The following section describes an overview of environmental and social issues within Chiang Mai to highlight problem areas and recommend appropriate measures. The observations and environmental measurements also serve as baseline data for further study and environmental model building.

(1) Air Pollution

*Introduction*

Air pollution is a well-known problem in Bangkok and is also recognized in Chiang Mai. A substantial amount of investigation has already been initiated in the city by the Pollution Control Department, based in Bangkok, in the form of partnerships with international governments/institutions and annual air quality monitoring. Three air monitoring stations have been measuring air quality in Chiang Mai since 1996 and the results indicate that the city is at 'caution level' for pollution. A comprehensive understanding of the source and properties of air pollution in Chiang Mai is necessary to sustainably preserve the environment not only for its residents, but also for the attraction of tourists who are important contributors to the local economy.

Air pollution arises from (1) vehicles and transportation; (2) industry; (3) construction and material transportation. In rural and residential areas, garbage and garden burning and agricultural chemicals also contribute to air pollution. Roadside air measurements indicate that traffic is the prime cause of air pollution in the city. Regarding vehicles and transportation, there are two main causes of air and sound pollution i.e. high traffic volume and sub-standard exhaust emissions. In Chiang Mai the high number of vehicles due to both a lack of mass transit and low usage of non-motorized modes creates congestion and driving characteristics that exacerbate pollution. Poor engine maintenance causes sub-standard emissions and black smoke from exhaust pipes is a common sight in the city. It is widely accepted that Chiang Mai's greatest problem in pollution is the high level of dust and particulate matter (PM-10). Deaths in Chiang Mai related to the respiratory tract increased sharply between 1993 and 1994 and is one of the most common causes of death. Respiratory disease is no doubt exacerbated by the high level of particulate matter in the city.

*Air Quality Management Initiatives*

Historic measures taken by the Thai Government to remedy the deteriorating air quality situation are:

| | |
|---|---|
| May 1991: | Introduction of unleaded gasoline at prices below leaded gasoline |
| January 1992: | Reduction of maximum allowable lead in gasoline from 0.4 to 0.15 grams per liter with a plan to phase out premium leaded gasoline by 1996. |
| September 1992: | Reduction of diesel 90% distillation temperature (T90) from 370 to 357 C to increase fuel volatility. |

January 1993: Catalytic mufflers required on all new gasoline-fuelled cars with engine sizes greater than 1600cc (Sept 93 for engines less than 1600cc).
September 1993: Reduction in the sulfur level of automotive diesel from 1.0% to 0.5%.

In addition, an advanced Air Quality Management System has been developed at the Pollution Control Department (PCD), based in Bangkok, with assistance from the Swedish Government. The PCD is capable of reporting ambient air quality from monitoring stations around the country, estimating emissions from industry and traffic, simulating conditions for "what-if" scenarios, and informing decision-makers through a comprehensive Information System.

In July, 2000, the Chiang Mai Air Quality Management Initiative was launched as a partnership between the Maryland Department of the Environment of USA and the Thai Pollution Control Department. This USAID sponsored project was the beginning of an 18 month long initiative to improve air quality planning capacity. MDE provided a budget of 150,000 US dollars and the USEPA organization distributed 193,818 US dollars for training. This training was divided into five parts: air quality monitoring; information collection from source; methods to control air quality; and air quality management and plan. MDE assigned an expert to train officers of Chiang Mai. On 15-16 January 2002 there was a mission meeting to prevent and solve air and sound pollution.

The main objective of the initiative is to develop an Air Quality Management Plan for Chiang Mai that can be replicated throughout Thailand. The Police, LTD, and the Municipality are all cooperating in this initiative to produce an action plan. The Plan is currently being constructed and is likely to comprise eleven action points as listed below:

1. Turn off engine while filling petrol and stationary
2. Annual vehicle checks
3. Promote bicycle riding
4. Promote public transportation
5. Prevent dust from construction and transportation
6. Control air pollution from vehicle paint spraying at garages
7. Prevent farmland burning and forest fires
8. Prevent pollution from gas stations
9. Prevent open air garbage burning
10. Reduce pollution from hospital and school boilers
11. Restrict burning of hospital waste

For each point, the Plan will include objectives, resources, publicity channels, target groups, actions, and so on.

Chiang Mai Municipality are also proposing to introduce trial electric shuttle buses which have no emissions and thus promote a healthy environment. While the Songtaew cooperative is providing some resistance to such move, this provides a clear message toward environmentally friendly vehicles.

Such measures help to ensure that traffic pollutants are at an acceptable level in Chiang Mai. However, particulate matter remains the greatest concern and no measures thus far appear to have made a discernable impact on this pollutant.

*Ambient Air Quality Monitoring and Reporting*

The Pollution Control Department of the Ministry of Science, Technology and Environment operates an ambient air quality monitoring network comprising over 50 monitoring stations throughout Thailand. Data is gathered at four regional centers including Chiang Mai. Such data includes air pollutants: sulphur dioxide, nitrogen dioxide, carbon monoxide and ozone as well as meteorological information.

As stated above, the greatest level of pollutant in Chiang Mai is particulate matter. This can be caused by construction activities and traffic, and both appear to be contributing to the situation in the city. Dust pollution in Chiang Mai appears to be exacerbated by the block pavement construction of many pavements around the city with dirt getting trapped in the crevices. Collapsed paving also allows loose underlying material to escape to the surface. Other contributors are construction material transported within the city.

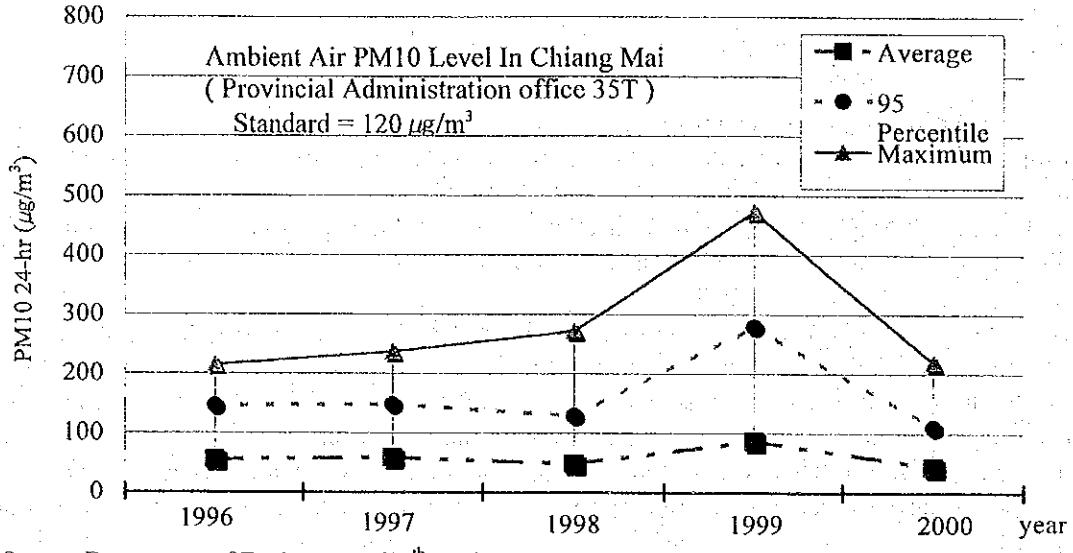
The table below shows annual variation of each pollutant and highlights particulate matter as the greatest pollutant in Chiang Mai, with annual levels clearly exceeding the standard. Ozone also exceeds the standard while the other parameters can be considered generally acceptable.

**Table 8-22 Air Quality in Chiang Mai**

| Parameter | Unit | 1996 | 1997 | 1998 | 1999 | Standard |
|---|---|---|---|---|---|---|
| Sulphur Dioxide | 1-Hour ppb | 50.9 | 42.3 | 15.0 | 7.0 | 300.0 |
| Nitrogen Dioxide | 1-Hour ppb | 146.0 | 52.0 | 52.0 | 62.0 | 170.0 |
| Carbon Monoxide | 1-Hour ppb | 28.7 | 2.6 | 8.5* | 8.5 | 30.0 |
| Carbon Monoxide | 8-Hour ppb | 14.3 | 1.5 | 5.5 | 2.0 | 9.0 |
| Ozone | 1-Hour ppb | 119.0 | 113.0 | 110.6 | 144.0 | 100.0 |
| Particulate matter (<10micron) | □ /m$^3$ 24-Hour | 214.8 | 239.8 | 215.3 | 472.9 | 120.0 |

Source: Department of Environment (10th Region)
Note: Station of Measurement at Government Centre, Chiang Mai or *Yuparaj School

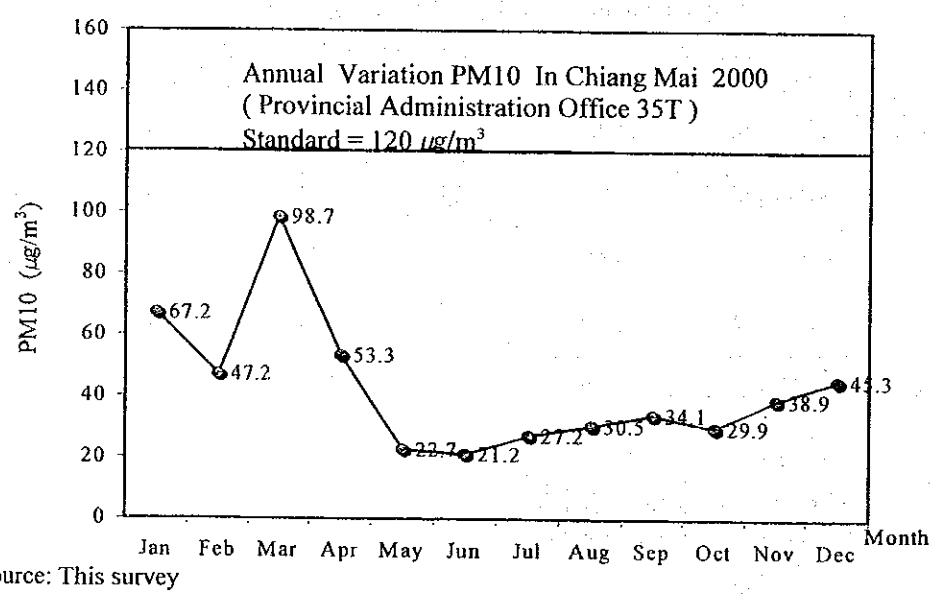
Figure 8-19 shows ambient PM10 levels in terms of average, maximum, and 95 percentile measurements. Causes for the peak in 1999 are not clear but reflect the potential for significantly poor air quality under certain atmospheric circumstances.




Source: Department of Environment (10th Region)

**Figure 8-19 Annual Variation of Ambient Air PM10 Level in Chiang Mai**

Figure 8-20 shows seasonal variation for PM10 in Chiang Mai. There is a clear peak during March, when the standard is exceeded, which was observed at both monitoring stations. This is most likely to be caused by forest fires burning during the dry season.

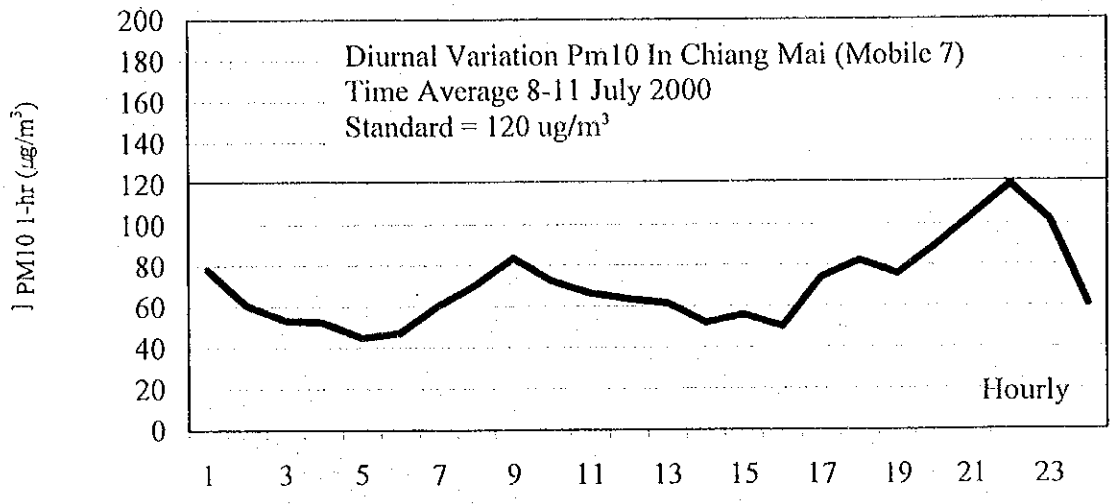



Source: This survey

**Figure 8-20 Annual Variation in PM10 in Chiang Mai 2000**

Finally, Figure 8-21 shows the variation in PM10 throughout the 24 hour day. High measurements can be observed at the morning and evening peak traffic hours. The

highest reading however is at 22:00 and may be caused by the climate condition at night time when the ground level temperature is cooler than the upper atmosphere level, causing an inversion effect and poor dispersal of pollution. Another cause is that most open burning of agricultural waste and garbage occurs at night time.




Source: Department of Environment (10th Region)

**Figure 8-21 Diurnal Variation Pm10 in Chiang Mai**

*Chiang Mai Vehicle Inspection and Maintenance*

Observation of traffic reveals visible black fumes from many vehicle exhaust pipes. Congestion resulting in stop-start acceleration exacerbates traffic pollution. Diesel engines utilized by *songtaews* in Chiang Mai produce high levels of particulates when they are not well maintained. The two-stroke engines of *tuk-tuks* and motorcycles, which mix oil with fuel, also contribute to particulate levels.

The motor vehicle emission standards are as follows:

**Table 8-23 Motor Vehicle Emission Standards**

| Vehicle | Pollutant | Standard<br>percentage of exhaust emissions |
|---|---|---|
| Car | CO | <4.5% |
| | HC | <600 ppm |
| | Black Smoke | <50% |
| | Noise | <100 dB |
| Motorcycle | CO | <4.5% |
| | HC | <10,000 ppm |
| | Noise | <100 dB |

Source: Chiang Mai Vehicle Inspection Station

Vehicle inspection is governed by LTD, which licenses vehicle checking stations throughout the Municipality. There are currently 68 inspection stations, some of which

also operate as repair garages, while others simply inspect vehicles and issue pass certificates. The number of inspection stations is limited by LTD to reflect the demand and ensure their profitability. LTD grants three-year licenses to the stations with a formal letter setting out the required checks. Applications from garages to operate as vehicle checking stations require details on location, building, space, black smoke monitoring equipment, gas analyzing equipment, gas leaking equipment, and facilities to inspect vehicle chassises. Random undisclosed checks are carried out four times each year on the inspection stations themselves to ensure that they conform to the required standards. Some licenses have even been suspended due to inappropriate methods.

Source: This survey

**Figure 8-22 Vehicle Inspection Facility**

The cost for inspection is: Motorcycles - 60 baht; Private Cars - 150 baht; and Large Trucks - 250 baht.

Vehicles less than 7 years old and motorcycles less than 5 years old are not required for inspection, while all public vehicles must be checked. Inspections are also required at LTD when transferring ownership of vehicles. If a vehicle fails the inspection, repairs should be carried out within 15 days and re-tested at half the original fee. While this re-testing provides some incentive to apply rigorous inspection checks, incentive tends to be profit-related. Thus, the operation of inspection-only stations requires review in this respect.

A survey of diesel vehicles in Chiang Mai in 2000 revealed that 93% of the sample exceeded the standard for black smoke. Private pickups and trucks also had high levels of excessive black smoke. The "Black Smoke Checking Project", is a collaborative effort between the Traffic Police and the Chiang Mai Land Transportation Office, to check and find diesel vehicles emitting high amounts of pollutants. The LTD supplies specialists and monitoring equipment, while the Traffic Police enforces the law and apprehend violating vehicles. The project is being maintained but does not have a formal program thus tending to depend on requests from the Police to LTD based on resources and seasons or festivals. Motorists of vehicles that fail the roadside test are liable to pay 500 Bt penalty. Re-checks are then only required on large vehicles and

public transport vehicles.

Representatives of LTD consider that much of the air pollution is caused by misconceived owners tampering with the engines to gain fuel efficiency. This occurs between the annual inspections and can only by rectified through random checking and police enforcement. This issue could be further addressed through an appropriate publicity campaign.

The Land Transport Act (1979) does not specify specific details for vehicle maintenance. Also, the cooperative management style of songtaews means that drivers undertake maintenance themselves without standard procedures. The result is old and poorly maintained vehicles, which emit relatively high levels of pollutants. Unlicensed operators exacerbate the situation. It is only by formal structuring and provision of enforced regulations including licensing that maintenance and engine performance can improve with benefits to air quality.

*Road Cleaning*

Appropriate measures to ameliorate particulate pollution from the source are essential for a long term air quality strategy. However, in order to realize benefits in the short-term, an appropriate system of maintenance needs to be in place.

Road cleaning in Chiang Mai is undertaken by four sub-municipalities. Each is equipped with two vacuum assisted wet sweeping vehicles and a similar smaller vehicle for residential streets (*soi*). The budget for the purchase of these vehicles was approved by the Mayor and a committee of the Municipality decided upon the company to contract the vehicles. The vehicles operate daily from about 5am or earlier and typically of 2 hours duration. The vehicles are relatively new i.e. most were purchased within the last 5 years.

The road cleaning vehicles house two revolving brushes and two vacuum suction pipes, as shown in the picture. One staff operates each vehicle.

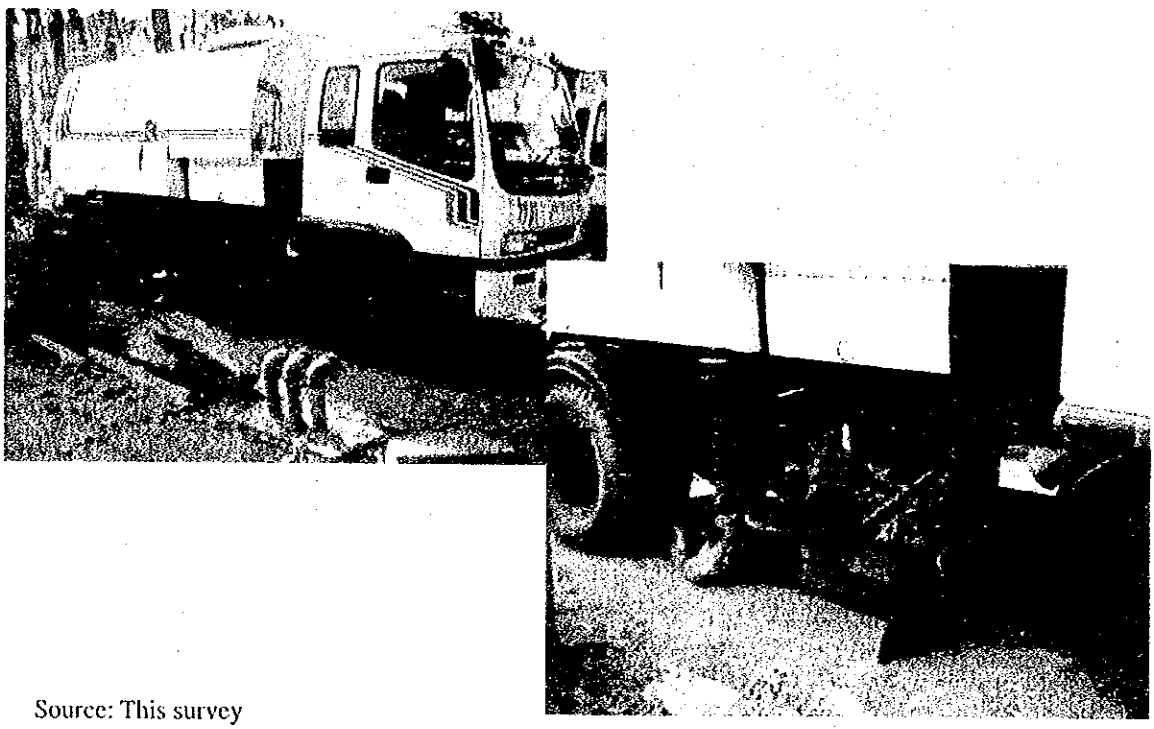
The road cleaning system comprises three stages: large garbage collection manually by the staff, dust suction, and water cleansing. The water cleansing stage is conducted by a second following vehicle. Water is also used during the suction stage, as recommended by the vehicle supplying company to improve movement and suction of debris. Each road is cleaned about 2 times per month. There are conflicting opinions from staff about the effectiveness of operations during the rainy season. Suction of dust is considered more difficult when waterlogged, but larger volumes of debris are reported as collected and deposited. Dry suction by manually turning off water sprayers has been attempted, but complaints by residents about increased air dust in the vicinity of the vehicle made wet suction preferable. As shown in the picture, such dust escape is clearly caused by the horizontal circular revolution of the brooms. Bi-directional brooms in the vertical plane with housing are thus preferable for dry suction.

The accumulated debris is separated between larger garbage and dust. The large garbage is disposed by a private company whilst the dust is dumped at the depot. Each day

approximately 1m3 of dust per vehicle is deposited, but the deposited pile does not accumulate appreciably due to local residents freely taking the dust for their own land purposes. This private use of dust is questionable in that it preserves particulate matter within the environment, however its impact is difficult to assess.

It is considered that the road cleaning equipment and methods employed within Chiang Mai are not sub standard. However, given the high level of particulate matter existing within the city, the efficiency and applicability of the equipment should be verified. For example, the effectiveness of wet suction for fine particulate matter is questionable and dry suction is recommended in many international company literatures. Also, the subsequent washing of the road by the second vehicle appears ineffective due to the lack of camber and gradient for run-off of many roads in the city. Moreover, conventional sweeping may not be appropriate for Chiang Mai.

Quantifiable tests using dry and wet methods of road cleaning could be carried out to compare collected dust loads. It is also recommended that a dry vacuum only road cleaning vehicle be investigated and potentially purchased. While vertical brushes are preferable, customization of the brooms, such as adding on broom housing to entrap dry dust or slowing/stopping the brush revolution speed for acceptable dry suction, could be sought from the supplying company. Finally, it is recommended that analysis of the deposited dust be carried out to help identify the exact pollution sources and their relative proportions.



Source: This survey

**Figure 8-23 Road Cleaning Vehicle**

(2) Assessment of Noise Pollution and Vibration

*Introduction*

Excessive noise is detrimental to social well-being and can affect human health. While standards can be applied to protect inhabitants, it is also important to take into account the existing environment and land use. For example, the perception of noise in bustling areas of Chiang Mai with significant tourist interaction is likely to be lower and more acceptable than in areas with mainly residential or cultural buildings. For this reason, some countries attempt to sub-divide standards for different land uses and times of the day.

Observation in Chiang Mai typically reveals little amelioration to high levels of road noise. Vehicles tend to be old and engines, such as those of motorcycles and *tuk tuks*, are small and noisy. Furthermore, poor maintenance of the highway results in an uneven surface increasing vibration, particularly from vehicles carrying construction supplies. However, large vehicles are prohibited from entering the city during the day and use the Super Highway. Buildings abutting the Super Highway, including those with historic and cultural value, tend to be protected from noise and vibration by parallel running access roads. Such protection could be further improved through enforcement of appropriate vehicle speeds.

The current noise standards for Thailand are shown in the table below.

**Table 8-24 Thailand Ambient Noise Standards**

| Standard | Sound Level Calculation Method |
|---|---|
| A-weighted Equivalent Continuous Sound Level (Leq) 24 hours should not exceed 70 dB (A) | Fluctuating Noise |
| Maximum Sound Level (Lmax) should not exceed 115 dB(A) | Steady Noise |

Source: Notification of Environmental Board No. 15 B.E.2540 (1997) under the Conservation and Enhancement of National Environmental Quality Act B.E.2535 (1992) dated March 12, B.E.2540 (1997)

When comparing the noise standards of Thailand to other countries, they appear lenient. Consideration should therefore be given to reviewing the standards, possibly with Chiang Mai setting its own standard. A noise standard that relates to land use or the equivalent highest recorded 10% is considered more appropriate. The maximum sound level of 115 dB(A) is unlikely to be exceeded by road noise.

*Noise/Vibration Measurements*

In 1985, an ambient noise monitoring program was undertaken to determine the level of noise in certain areas. Daily average noise levels (Leq) were reported and found to be in the range of 73-81 dB within the municipality.

In order to update noise data and assess the current level and nuisance of traffic noise and vibration in Chiang Mai, a survey was carried out from 29th January to 1st February 2002. This comprised a total of 16 key sites in the city where noise and vibration is considered a possible problem particularly for sensitive sectors of society, such as the elderly, blind and young. The results of the survey are described as follows.

Site 1 Wat Chet Yod Junction

$L_{eq}$ 1 hr levels ranged between 64.2-74.4 dB(A), $L_{eq}$ 24 hrs level was 71.9 dB(A), $L_{max}$ level was 109.6 dB(A), $L_{eq}$ 10 minutes levels ranged between 61.5-77.3 dB(A) and $L_{dn}$ level was 76.5 dB(A) respectively. $L_{eq}$ 24 hrs level was higher than the limitation of Community Noise Standard of 70 dB(A) while $L_{max}$ was lower than the limitation of Community Noise Standard of 115 dB(A).

Site 2 Muandam Phrakot Road

$L_{eq}$ 1 hr levels ranged between 59.5-73.1 dB(A), $L_{eq}$ 24 hrs level was 69.9 dB(A), $L_{max}$ level was 98.7 dB(A), $L_{eq}$ 10 minutes levels ranged between 55.0-74.7 dB(A) and $L_{dn}$ level was 73.2 dB(A) respectively. $L_{eq}$ 24 hrs and $L_{max}$ levels were lower than the limitation of Community Noise Standard of 70 and 115 dB(A).

Site 3 Public Library, Huai Kaeo Road

$L_{eq}$ 1 hr levels ranged between 62.1-67.6 dB(A), $L_{eq}$ 24 hrs level was 66.3 dB(A), $L_{max}$ level was 92.4 dB(A), $L_{eq}$ 10 minutes levels ranged between 51.4-69.0 dB(A) and $L_{dn}$ level was 71.9 dB(A) respectively. $L_{eq}$ 24 hrs and $L_{max}$ levels were lower than the limitation of Community Noise Standard of 70 and 115 dB (A).

Site 4 Maharaj Hospital, Suthep Road

$L_{eq}$ 1 hr levels ranged between 62.8-70.3 dB(A), $L_{eq}$ 24 hrs level was 67.9 dB(A), $L_{max}$ level was 96.7 dB(A), $L_{eq}$ 10 minutes levels ranged between 60.8-71.7 dB(A) and $L_{dn}$ level was 73.4 dB(A) respectively. $L_{eq}$ 24 hrs and $L_{max}$ levels were lower than the limitation of Community Noise Standard of 70 and 115 dB(A).

Site 5 Home for Blind at Arrak Road

$L_{eq}$ 1 hr levels ranged between 57.5-69.0 dB(A), $L_{eq}$ 24 hrs level was 66.0 dB(A), $L_{max}$ level was 88.6 dB(A), $L_{eq}$ 10 minutes levels ranged between 55.6-71.4 dB(A) and $L_{dn}$ level was 69.4 dB(A) respectively. $L_{eq}$ 24 hrs and $L_{max}$ levels were lower than the limitation of Community Noise Standard of 70 and 115 dB(A).

Site 6 Sripingmuang Road

$L_{eq}$ 1 hr levels ranged between 55.8-68.6 dB(A), $L_{eq}$ 24 hrs level was 65.1 dB(A), $L_{max}$ level was 100.3 dB(A), $L_{eq}$ 10 minutes levels ranged between 48.4-71.1 dB(A) and $L_{dn}$ level was 68.1 dB(A) respectively. $L_{eq}$ 24 hrs and $L_{max}$ levels were lower than the limitation of Community Noise Standard of 70 and 115 dB(A).

Site 7 Ruam Phaet Hospital, Suriyawongse Road

$L_{eq}$ 1 hr levels ranged between 62.3-72.7 dB(A), $L_{eq}$ 24 hrs level was 69.1 dB(A), $L_{max}$ level was 105.4 dB(A), $L_{eq}$ 10 minutes levels ranged between 56.5-78.3 dB(A) and $L_{dn}$ level was 73.2 dB(A) respectively. $L_{eq}$ 24 hrs and $L_{max}$ levels were lower than the limitation of Community Noise Standard of 70 and 115 dB(A).

Site 8 Home for Elderly at Jacng Ka Tam Corner

$L_{eq}$ 1 hr levels ranged between 56.5-64.5 dB(A), $L_{eq}$ 24 hrs level was 62.6 dB(A), $L_{max}$ level was 87.6 dB(A), $L_{eq}$ 10 minutes levels ranged between 55.1-66.5 dB(A) and $L_{dn}$ level was 67.1 dB(A) respectively. $L_{eq}$ 24 hrs and $L_{max}$ levels were lower than the limitation of Community Noise Standard of 70 and 115 dB(A).

Site 9 Regina Coeli School, Charoen Prathet Road

$L_{eq}$ 1 hr levels ranged between 55.9-72.0 dB(A), $L_{eq}$ 24 hrs level was 65.9 dB(A), $L_{max}$ level was 100.2 dB(A), $L_{eq}$ 10 minutes levels ranged between 49.7-76.6 dB(A) and $L_{dn}$ level was 68.4 dB(A) respectively. $L_{eq}$ 24 hrs and $L_{max}$ levels were lower than the limitation of Community Noise Standard of 70 and 115 dB(A).

Site 10 Tha Phae Road

$L_{eq}$ 1 hr levels ranged between 67.6-76.8 dB(A), $L_{eq}$ 24 hrs level was 74.2 dB(A), $L_{max}$ level was 102.9 dB(A), $L_{eq}$ 10 minutes levels ranged between 66.4-79.9 dB(A) and $L_{dn}$ level was 79.5 dB(A) respectively. $L_{eq}$ 24 hrs level was higher than the limitation of Community Noise Standard of 70 dB(A) while $L_{max}$ was lower than the limitation of Community Noise Standard of 115 dB(A).

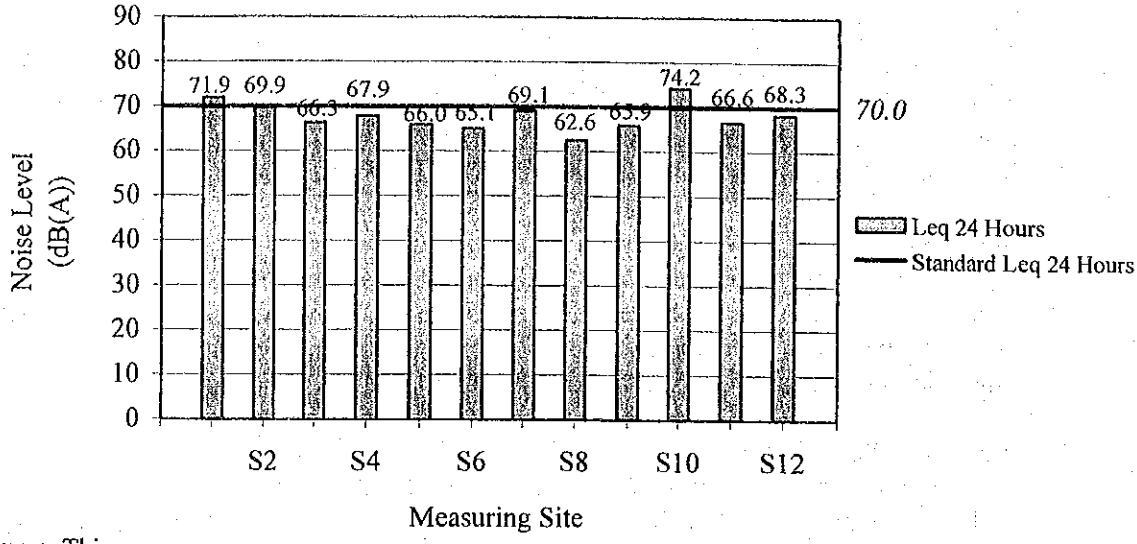
Site 11 Warorot Market, Wichayanon Road

$L_{eq}$ 1 hr levels ranged between 61.7-68.6 dB(A), $L_{eq}$ 24 hrs level was 66.6 dB(A), $L_{max}$ level was 97.7 dB(A), $L_{eq}$ 10 minutes levels ranged between 59.9-71.0 dB(A) and $L_{dn}$ level was 71.8 dB(A) respectively. $L_{eq}$ 24 hrs and $L_{max}$ levels were lower than the limitation of Community Noise Standard of 70 and 115 dB(A).

Site 12 Prince Royal College

$L_{eq}$ 1 hr levels ranged between 63.2-70.5 dB(A), $L_{eq}$ 24 hrs level was 68.3 dB(A), $L_{max}$ level was 97.0 dB(A), $L_{eq}$ 10 minutes levels ranged between 61.5-75.8 dB(A) and $L_{dn}$ level was 73.0 dB(A) respectively. $L_{eq}$ 24 hrs and $L_{max}$ levels were lower than the limitation of Community Noise Standard of 70 and 115 dB(A).

Figure 8-24 summarizes the results of the noise survey for all twelve sites.




Source: This survey

**Figure 8-24 Measured Noise ($L_{eq}$ 24hours) at Locations in Chiang Mai**

*Methods for Noise Reduction*

Measures to reduce noise pollution include:

- Strict enforcement of vehicle emission noise,
- Traffic management measures to reduce traffic volume and speed, i.e. remove congestion and cause a smooth flow of vehicles throughout the road network without stop-start acceleration,
- Deter short-cut routes through residential areas by signing and installing 'delays' within the route.
- Implement noise barriers close to sensitive receptors and pedestrian environments by street furniture and parking allocation.
- Develop urban planning that is harmonious to the environment and reduces frontages to major roads.

Regarding vibration, the restrictions on heavy vehicles within the city already minimize the impact on the environment. There is little physical evidence of vehicle vibration adversely affecting historic buildings and access roads on the Superhighway effectively provide a protective margin between buildings and heavy traffic. However, the high traffic volumes over river bridges are clearly causing large vibrations and increasing maintenance requirements. Vibration measurements were carried out at Aom Muang Road, Faham Road, Wat Mahawan Temple on Tha Phae Road, and Nakorn-Ping Bridge. Most measurements were low and only Nakorn-Ping Bridge recorded high levels of vibration, which would be expected from the passage of large vehicles and bridge deck resonance.

(3) Other Environmental and Social Issues

*Severance*

Over forty percent of all trips are between the city's inner and outer areas which is largely bounded by the Superhighway, a highly trafficked road with high vehicle speeds. The Superhighway therefore provides a barrier between outlying neighborhoods and the central city. Such a barrier creates safety problems and introduces daily stress to residents who require crossing.

Signalized junction control can help to provide regular breaks in traffic flow thus facilitating easier downstream crossing or access. Signalization of Wat Chet Yod junction will contribute to this effect. It is also important to identify the strategic network for long distance traffic and to design a road to meet its hierarchal role. In this sense, the construction of outer ring roads requires a review of the strategic role of the Superhighway and methods to reassign traffic if its long distance role is reduced. Any downgrading of the role of the Superhighway can facilitate reduced speed restrictions and increased crossing points, which will help reduce the severance effect.

*Public Transport*

The public transport system within Chiang Mai does not have standardized routes. Songtaew drivers decide their routes based on the requests of passengers. This tends to be confusing to tourists who for example are not aware that red songtaews operate within the city or of the level of appropriate fares. Fares for red songtaews are higher than those of other Thai cities. This is largely due to the lack of formal bus routes or standardized costs so that fares require negotiation. A lack of cheap public transport can present access problems for low income residents if they require frequent cross-city trips. This inevitably contributes to the high level of private vehicle use, such as the motorcycle.

An LRT development has been proposed for Chiang Mai, but progress was suspended due to the 1997 Asian Economic Crisis. Experience from new LRT in other cities throughout the world highlights the necessity for careful consideration of the high costs of construction and the impact on other modes of transport. For example, high fare levels to pay back large capital investment could impinge upon access to the system of low-income residents thus causing inequity. For an LRT system to be successful other public transport modes may require restructuring to provide feeder routes to the system to avoid redundant services. Furthermore, experience also shows that attracting private vehicle users to LRT remains difficult as most LRT riders originate from prior bus users.

*Heavy Vehicles*

Heavy vehicles are prohibited from entering the city during daytime hours. A heavy vehicle terminal, named Nim See Seng Co., Ltd., where goods from large vehicles are unloaded for distribution by smaller vehicles to locations within the city, is situated on the north-eastern section of the Superhighway near Trat Wong Road. Goods are distributed to locations within the city using trucks typically of two axles and 4200kg

loaded weight (2340kg unladen). A high proportion of deliveries are on the eastern side of the city around Tha Phae Road and vehicles tend to use Faham Road, crossing at Rama IX Bridge. Delivery routes are selected by the company based on minimizing transportation costs. No deliveries are made at night. The company has no record of residential complaints about their delivery routes or vehicles reflecting both the adequacy of the system and the apparent tolerance of Thai residents.

*Pedestrian Facilities*

The pedestrian environment is generally inadequate in that road space is provided at the expense of walking space. Sidewalks are narrow with frequent obstacles and block paving has been laid without a firm sub-base resulting in a loose and broken surface. The large width of roads without pedestrian refuge islands for staged crossing also hinders pedestrian movement. The recent Tha Phae Walking Street Scheme for Sundays is a progressive move toward raising the pedestrian profile. Such measures require integration with other traffic management steps to ensure that modal choice is also addressed and not the simple re-routing of traffic. A policy to 'win back' pedestrian/non-motorized space is required. Regarding Chang Klan Road which accommodates the night bazaar, partial restriction e.g. prohibition of private motor cars, could improve safety for pedestrians.

*Amenity Areas*

Chiang Mai is a city that has developed in consideration of vehicular access rather than environmental harmony. There are few areas within the city center or even the superhighway boundary that provide tranquility and relief to traffic noise and pollution. The impact of traffic is further exacerbated by the open-air design of restaurants. Only one park area exists i.e. Buak Had City Park, and is located in the south-west corner of the moat area. The moat roads that sandwich the moat itself carry high volumes of traffic and are used to circulate and distribute traffic between radial roads and inner streets. The historic and aesthetic appeal of this moat-side area has been largely ignored and eroded in parallel with the growth in traffic volume. The sidewalk between the moat and carriageway is narrow with trees providing obstacles. Improving the moat area for pedestrians by pavement widening and increasing amenity space for leisure activities would improve the aesthetic environment and help restore an historic asset. Pavement build-outs combined with parking bays, possibly for public transport vehicles, could be integrated into a traffic management strategy. This would provide 'protective' space between moving traffic and the amenity area thus helping to promote the pedestrian environment.

*Driving Behavior*

Observation of Chiang Mai motorists reveals a high tendency for unpredictable behavior by motorcyclists. Erratic steering, frequent lane changing, inattentive merging at junctions, and disobeying traffic signals cause many conflicts each day. This implies a lack of motorcyclist safety education, exacerbated by unlicensed driving. However, motor car drivers are generally tolerant, non-aggressive, and proficient at signaling or warning of potential dangers. Congestion works to reduce speed levels but inefficient

traffic signals at intersections contribute to driver stress and 'light-jumping'. A review of the adequacy of the licensing test and maximized enforcement are therefore appropriate measures.

(4) Conclusion

The pedestrian and historic environment of Chiang Mai has been neglected while accommodating high volumes of motorized traffic. Appropriate plans are necessary to reverse this trend and promote sustainable modes of transport. There is also 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 Walking Streets 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 low fining of parking violations. Such income can be allocated as special funds for environmental measures.

Although much air pollution data is being accumulated, a formal system of verifiable targets, monitoring and investment with clear responsibility and incentive is lacking. Whilst targeting the source is the only sustainable solution, maintenance measures such as road cleaning can facilitate acceptable pollutant levels in the shorter term. The procedures utilized in Chiang Mai for addressing particulate pollution in particular require targeted review.