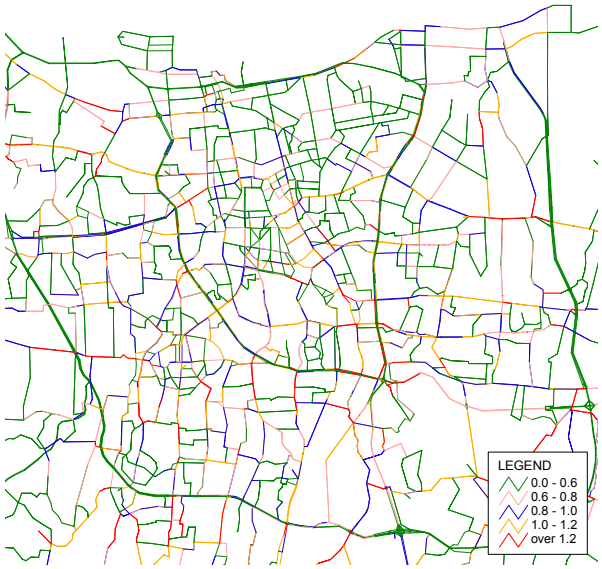
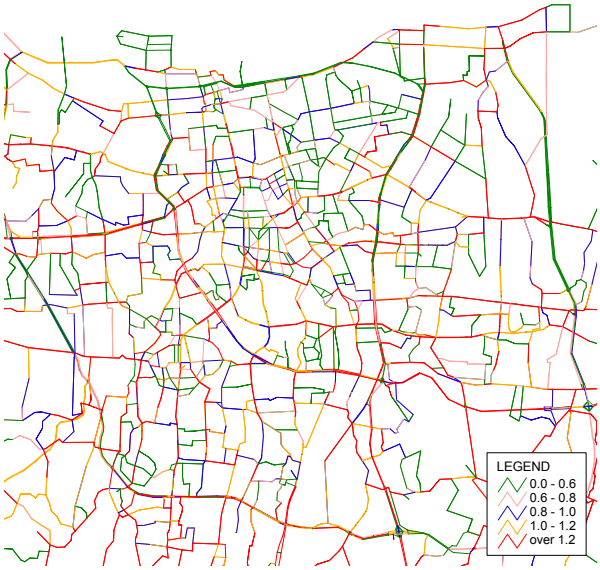
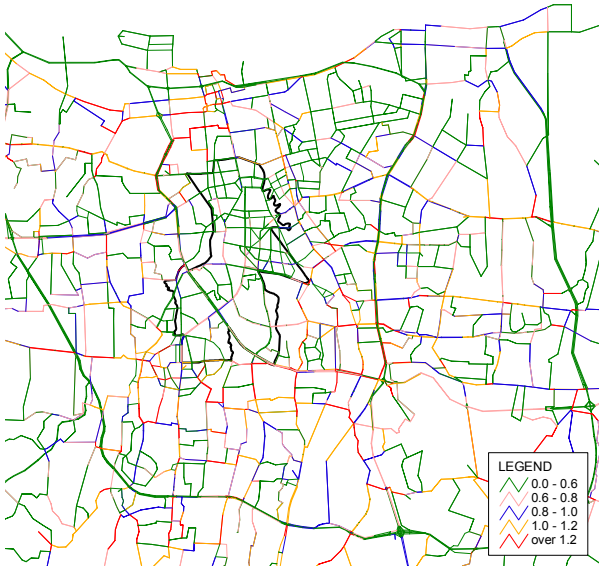
[Year 2007, Without TDM]



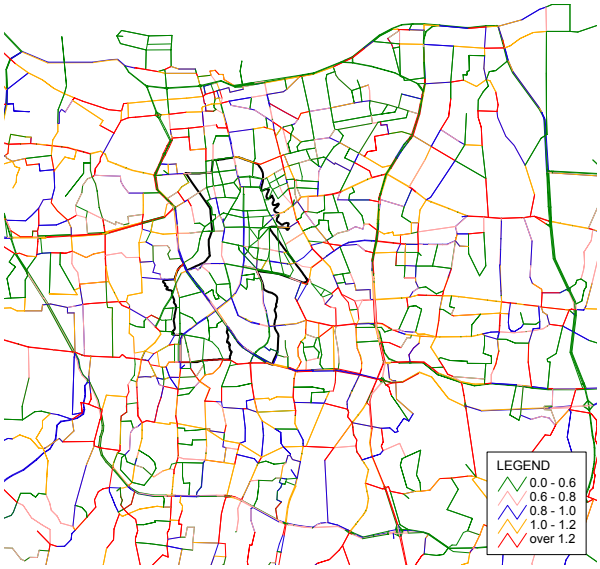

[Year 2020, Without TDM]



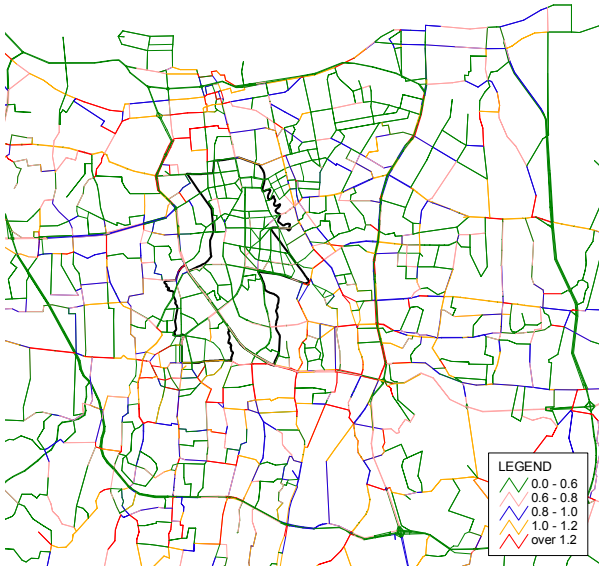

[Year 2007, Alternative 1, Case 2 (= Rp. 8,000)]




[Year 2020, Alternative 1, Case 2 (= Rp. 8,000)]




[Year 2007, Alternative 1, Case 5 (= Rp. 20,000)]




[Year 2020, Alternative 1, Case 5 (= Rp. 20,000)]

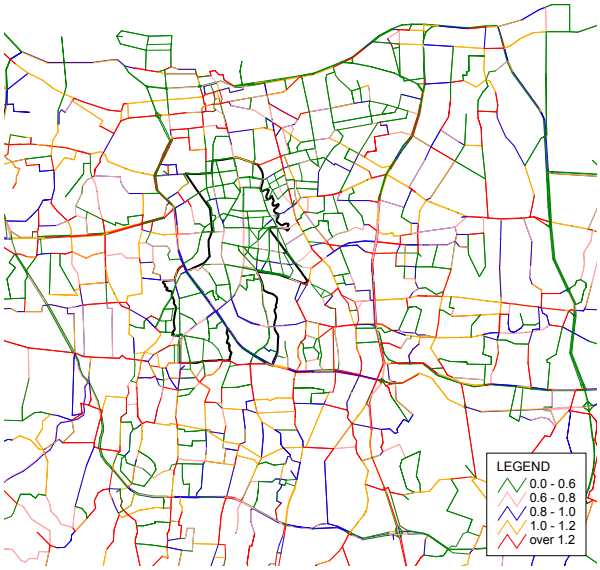
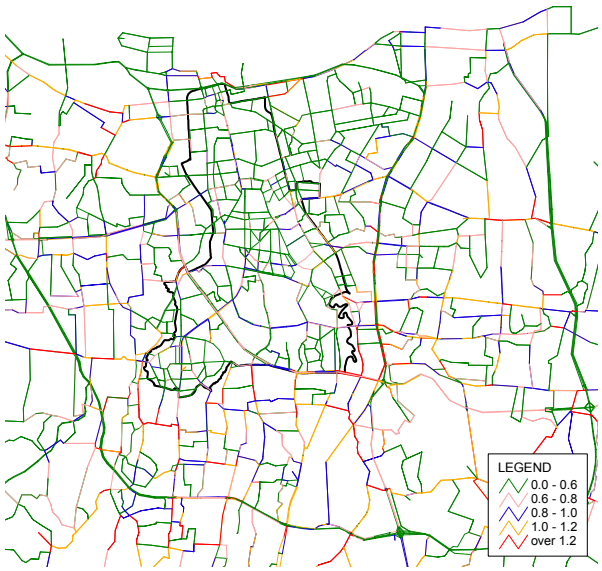
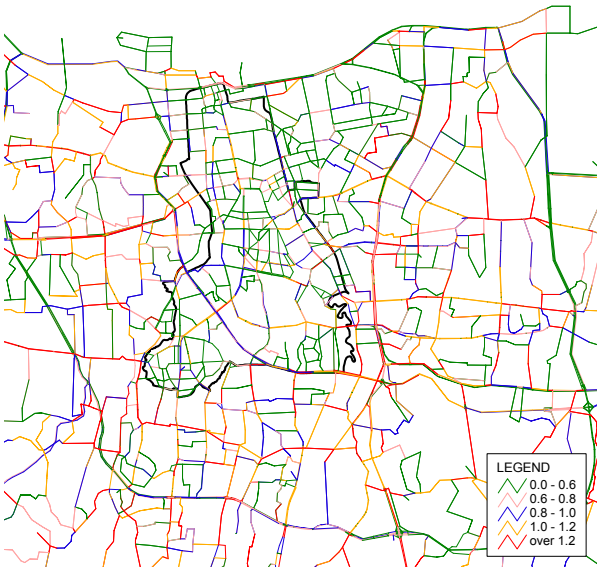



**Figure 3.4.11 Volume Capacity Ratio (1/3)**

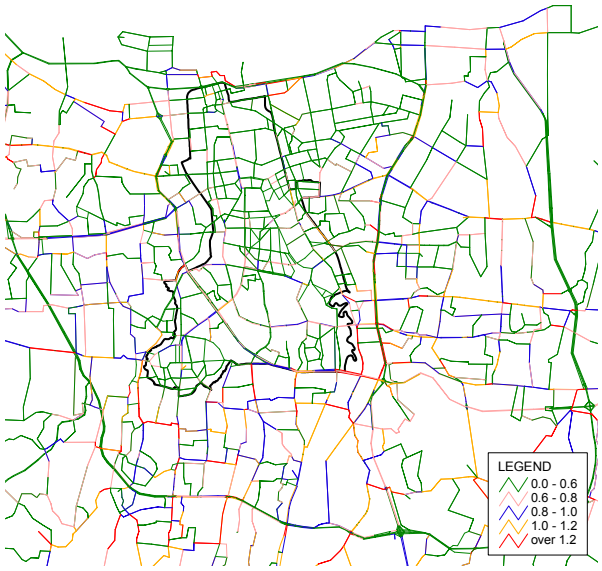
[Year 2007, Alternative 4, Case 2 (= Rp. 8,000)]



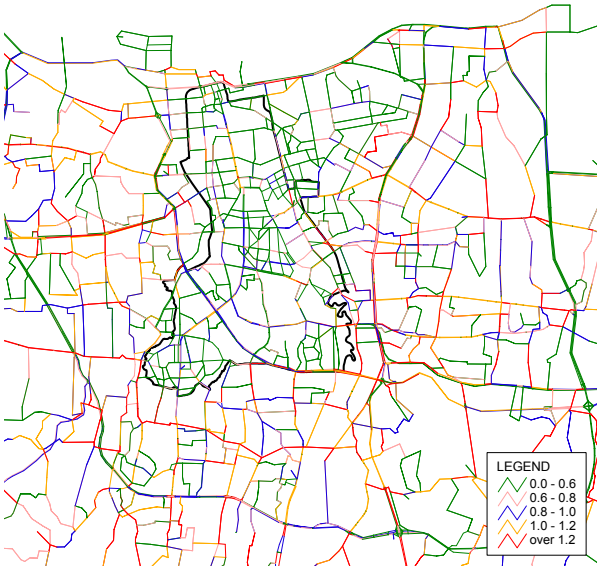

[Year 2020, Alternative 4, Case 2 (= Rp. 8,000)]



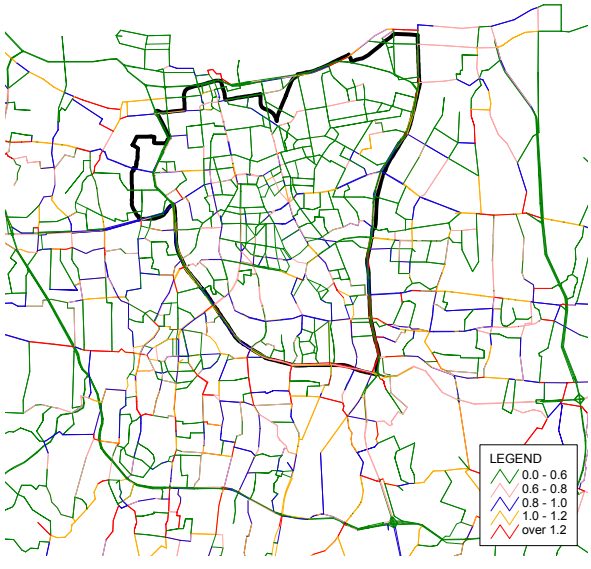

[Year 2007, Alternative 4, Case 5 (= Rp. 20,000)]




[Year 2020, Alternative 4, Case 5 (= Rp. 20,000)]




[Year 2007, Alternative 5, Case 2 (= Rp. 8,000)]




[Year 2020, Alternative 5, Case 2 (= Rp. 8,000)]

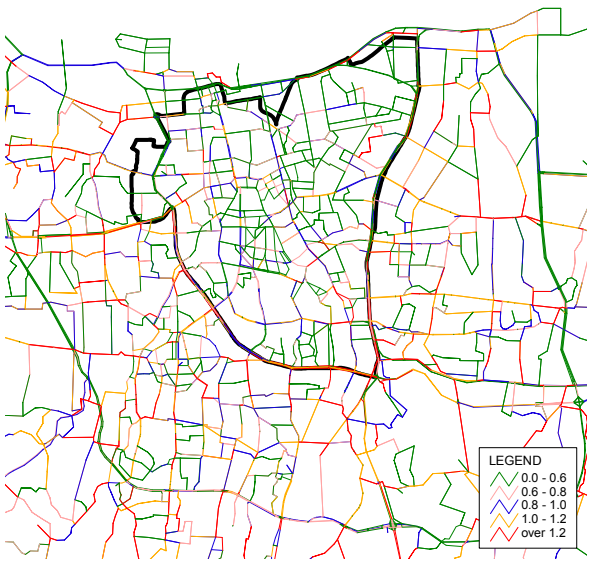
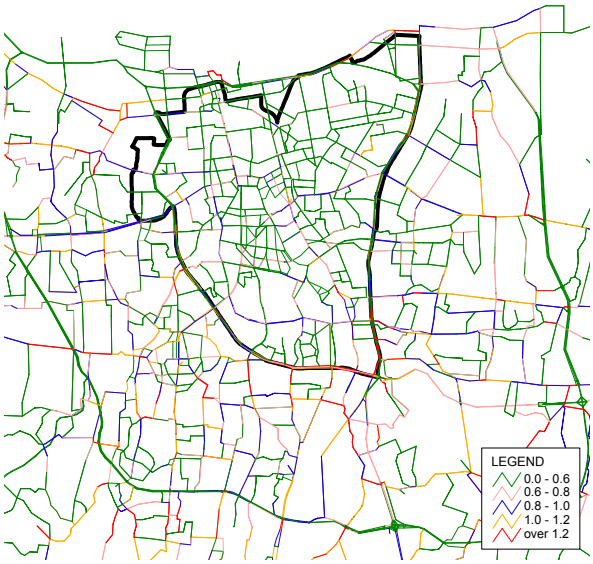
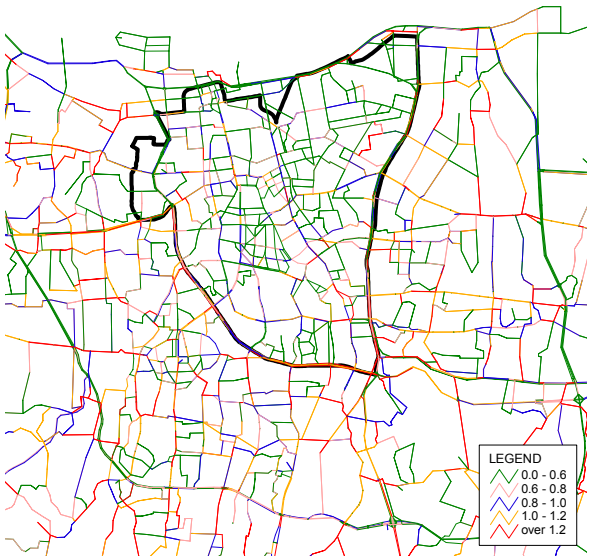



**Figure 3.4.12 Volume Capacity Ratio (2/3)**

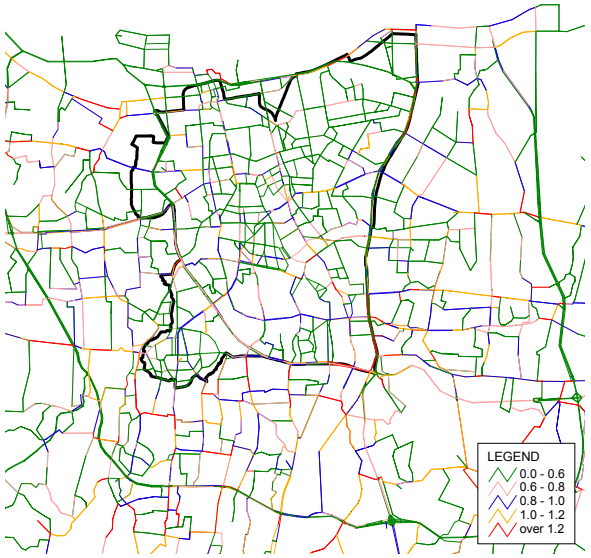
[Year 2007, Alternative 5, Case 5 (= Rp. 20,000)]



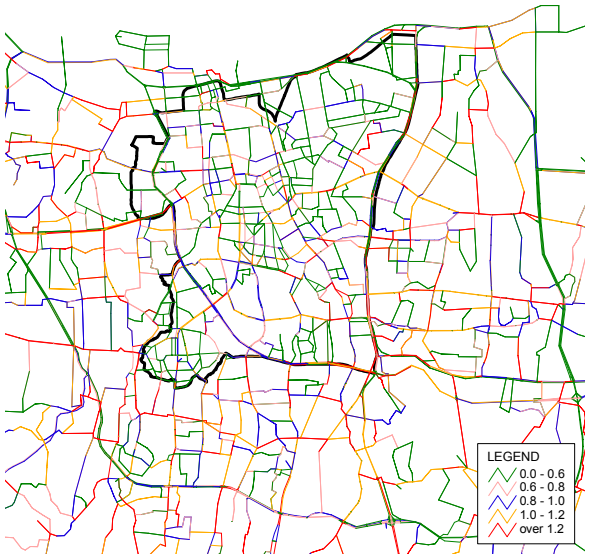

[Year 2020, Alternative 5, Case 5 (= Rp. 20,000)]



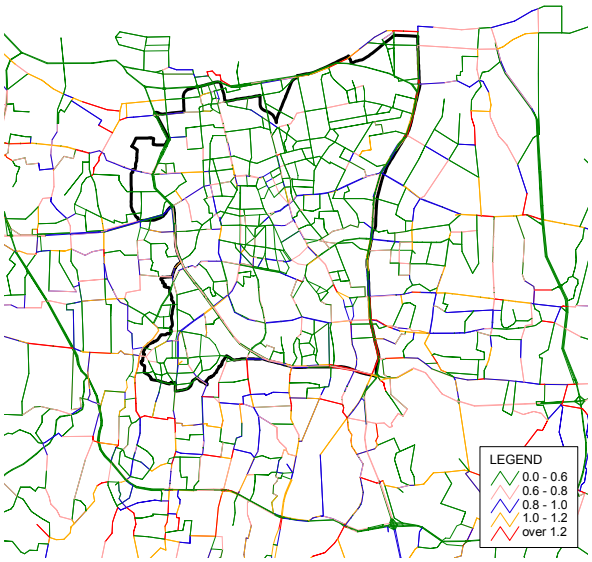

[Year 2007, Alternative 6, Case 2 (= Rp. 8,000)]




[Year 2020, Alternative 6, Case 2 (= Rp. 8,000)]




[Year 2007, Alternative 6, Case 5 (= Rp. 20,000)]




[Year 2020, Alternative 6, Case 5 (= Rp. 20,000)]

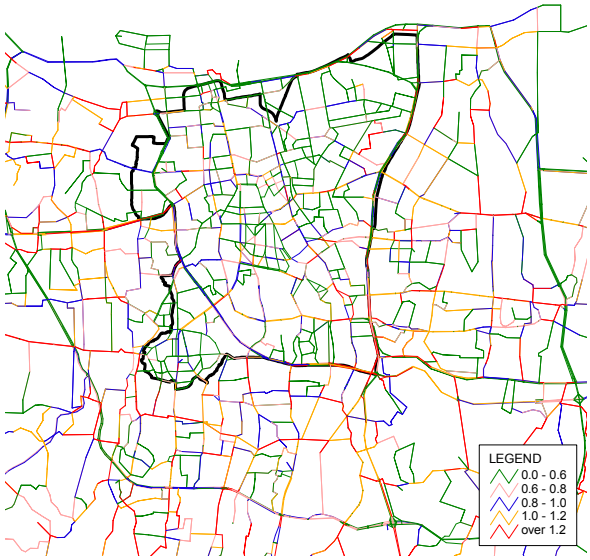



**Figure 3.4.13 Volume Capacity Ratio (3/3)**

## 3.5 PRICING METHODS

### 3.5.1 Alternative Pricing Measures

As discussed earlier in this chapter, when a push-type TDM is applied, normally it is necessary to apply pull-type measures such as quality public transportation provision. In this context, a pricing scheme should be determined based on a comparison with the cost of using such quality public transportation system. It is very obvious the TDM toll levy should be higher than the cost for the public transportation use as stated before.

Table 3.5.1 shows an example of possible combinations of implementing the proposed TDM. There will be three basic cases, namely, "area (or road) pricing," "parking pricing," and combination of area (or road) and parking pricing.

**Table 3.5.1 Combination of Push and Pull TDM Measures (Example)**

| | PUSH | PULL |
|---|---|---|
| Case A | Area (or road) pricing<br>- Sudirman Thamrin roads<br>- H.R. Rasuna Said<br>- Merdeka Barat<br>- GT. Subroto<br>- Prof. Dr. Satrio<br>Rp. 8,000 per entry and exit<br>(Master Plan case) | High quality bus service provision<br>Distance-proportion fare:<br>Rp. 1,000 + 200 per km<br>- Fatmawati – Blok M – Kota<br>- Blok M – Bekasi<br>- Pulo Gadung – Kalideres<br>AC Bus feeders in CBD<br>Flat fare: Rp. 2,000 |
| Case B | Parking pricing<br>- Parking lots in the designated area. | - Ditto |
| Case C | Area (or road) pricing + Parking pricing<br>- Combination of Cases A and B. | - Ditto |

One of the advantages of the area (or road) pricing is that this scheme can be applied to all the through traffic as well as generated trips in the area. Thus it can be said that it is the most effective in terms of traffic reduction. On the other hand, the parking pricing scheme will be rather easy to apply because it can be applied with the existing parking facilities, hence reducing the investment cost. Both pricing measures are discussed in more detail in the subsequent sections.

### 3.5.2 Area (or Road) Pricing Methods

There are two main methods for TDM toll collection: a manual method and a mechanical method. As for the mechanical method, it is further divided into two systems: a camera-surveillance system as adopted in London, and an ERP (Electronic Road Pricing) system as adopted in Singapore. However, electronic database of registered vehicles has not been established yet in

Jabodetabek, and therefore a camera-surveillance system such as in London cannot be adopted at present. Taking into consideration that the cost for the mechanical system establishment is high, it is desirable to adopt the manual method in the short term and to change over to the mechanical method in the long term. Singapore has also taken such a procedure. Furthermore, a camera-surveillance system such as in London can also be adopted in future.

As for targets for area (or road) pricing, there are three basic ways to identify them as follows:

1) Vehicles passing certain trunk roads (just like the existing 3-in-1 system) are charged (i.e., Road Pricing);

2) Vehicles entering the TDM area are charged (i.e., Cordon Pricing); and,

3) All vehicles passing/driving in the TDM area are charged (i.e., Area Pricing).

In this study, 2) "Cordon Pricing and 3) "Area Pricing" are focused on. As such, three major alternative area pricing techniques have been prepared to make a preliminary assessment on their impact: "Complete Area Pricing," "Preferential HOV + Cordon Pricing," and "Cordon Pricing" as shown in Table 3.5.2.

Table 3.5.3 summarizes the issues of each pricing scheme. Among them, the issue of equity between residents inside the TDM area and those outside the TDM area is critical in ALT 2 and ALT 3. In both cases, residents inside the TDM area are given preferential treatment, that is, they do not need to pay any money when they go to places inside the TDM area from their residence. Accordingly, values of houses inside the TDM area may increase.

In the case of ALT 2, a negative impact on the bus transportation is predicted in that there will be more car users than the other alternatives. ALT 3 has a technical issue of collecting the toll fee. If the amount of traffic bound for the TDM area is so large and the toll is collected directly at the gates, a long traffic queue may form at the gates. Monitoring of stickers, which can be purchased beforehand, or adopting a new technology like ERP might be effective in such cases though a certain amount of investment is required for ERP.

ALT 1 seems to be the severest policy to the public because nobody (no vehicle) has a chance to escape from payment; in other words, this is the fairest scheme in terms of equity between residents living inside and outside the TDM area. Furthermore, this technique can be applied by designating only specific congested roads, though an overall area pricing technique would be preferable. However, some preferential treatment such as discount on toll levy will be necessary for residents inside the TDM area, because they have no other route when making vehicular

travels. Monitoring is another issue because technical inspection officers must be allocated all over the TDM area.

**Table 3.5.2 Proposed Pricing Technique Alternatives**

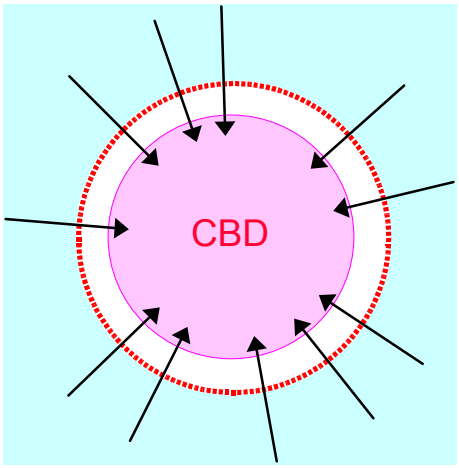
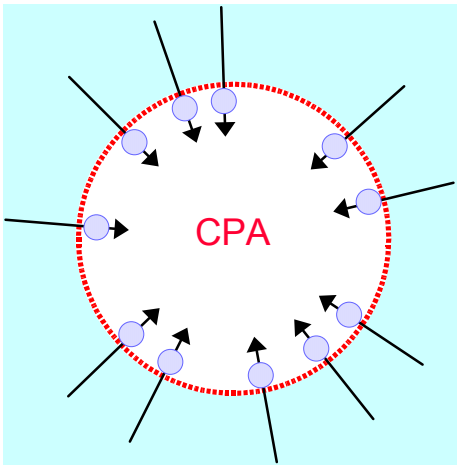
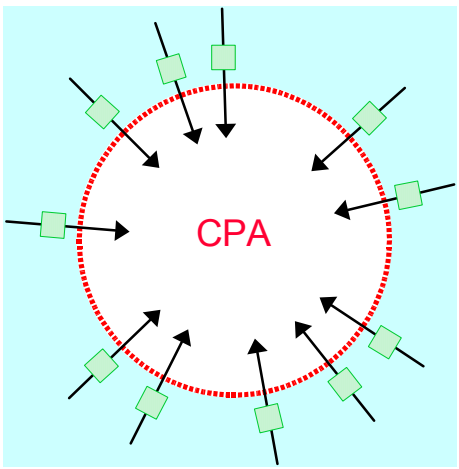
| | |
|---|---|
| ALT 1: Complete Area Pricing<br>  | General:<br>Charges are applied to all cars that are using congested arterial road segments in the CBD.<br><br>Exemption:<br>Buses, emergency vehicles, vehicles with handicapped drivers, government utility vehicles.<br><br>Payment & Enforcement:<br>- Sticker (no gate installed)<br>- Visual check by policemen on designated road segments<br>- ERP |
| ALT 2: Preferential HOV + Cordon Pricing<br>  | General:<br>Charges are applied to SOV entering the CBD.<br><br>Exemption:<br>HOVs (Cars with more than 2 persons), Buses, emergency vehicles, vehicles with handicapped drivers, government utility vehicles.<br><br>Payment & Enforcement<br>- SOV Sticker (no gate)<br>- Visual check by policemen at the cordon line |
| ALT 3: Cordon Pricing<br>  | General:<br>Charges are applied to all vehicles entering the CBD.<br><br>Exemption:<br>Buses, emergency vehicles, vehicles with handicapped drivers, government utility vehicles.<br><br>Payment & Enforcement:<br>- At the gate (ERP)<br>In the case of manual toll collection, preferential treatment can be applied to HOV. |

**Table 3.5.3 Comparison of Pricing Technique Alternatives**

| | Strengths | Weaknesses |
|---|---|---|
| **ALT 1**<br><br>Complete Area Pricing | - Reduce SOV (promote HOV indirectly)<br>- People can share a car (fee) if necessary<br>- People have a chance of solo-drive.<br>- Equity between residents inside the TDM area and those outside the TDM area<br>- Collected money is used for improvement of urban transportation<br>- Encourage people to use public modes | - Violation of the rule<br>- Allocation of policemen (running cost)<br>- Strong opposition by the public (needs to raise public awareness of public transportation) |
| **ALT 2**<br><br>Preferential HOV + Cordon Pricing | - Reduce SOV (promote HOV directly)<br>- Collected money is used for improvement of urban transportation.<br>- Encourage people to use public modes.<br><br>(Strong opposition by the public, but people can avoid payment if they can always arrange HOV) | - Inequity between residents inside the TDM area and those outside the TDM area (raise land price inside TDM area)<br>- LOV restriction may not contribute to public transportation (attract bus passengers to cars)<br>- Violation of the rule<br>- Allocation of policemen (running cost) |
| **ALT 3**<br><br>Cordon Pricing | - Violation is avoided by physical gates<br>- No policemen allocation necessary<br>- Part of the proposed toll systems can be used as part of the cordon toll gate system.<br>- Collected money is used for improvement of urban transportation<br>- Encourage people to use public modes | - Inequity between residents inside the TDM area and those outside the TDM area (raise land price inside TDM area)<br>- Additional infrastructure (gates, ERP) is necessary<br>- Traffic congestion if toll is collected manually at the gate<br>- Allocation of toll collectors (running cost) |

Note: HOV – high occupancy vehicle, LOV – low occupancy vehicle, SOV – single occupancy vehicle.

In conclusion, taking monitoring methodology[3] and public acceptance (especially by the resident inside the TDM area) into consideration, a complete, rigid area pricing may be difficult. On the other hand, a simple cordon pricing may cause too much inequity between residents inside and outside the TDM area. Moreover, as Table 3.5.4 shows, the ratio of internal (intra-TDM-area) trips to all the car trip generation in the TDM area is quite high in any area alternative or toll levy case, and it will make a big difference in traffic management as well as in revenue whether to include those internal trips or not. In this sense, a cordon pricing, with several checkpoints on the major roads inside the TDM area as well (i.e., "partial" area pricing), is more suitable in the context of Jabodetabek, which needs significantly a much wider TDM area.

In Jabodetabek, attention also has to be paid to the fact that the TDM will most likely start as a replacement or expansion of the current 3-in-1 scheme; therefore, ALT 2 may be worth considering. That is, further studies are necessary so that HOV vehicles with three or more passengers can be exempted from TDM toll levy at least while the TDM is operated through manual surveillance in the short term.

[3] In fact, there are several technologies that may be applied to the area pricing system, such as a radio beacon-based system or a global positioning satellite (GPS) system. However, such systems have not been actually implemented in the world due to the accuracy problem and the controversy of whether vehicles should be charged even when they are parked.

**Table 3.5.4 Ratio of Internal Trips to All the Car Trip Generation in the TDM Area**

| TDM Area Alternative | Year 2007 | | Year 2020 | |
|---|---|---|---|---|
| | Case 2 (Rp.8,000) | Case 5 (Rp.20,000) | Case 2 (Rp.8,000) | Case 5 (Rp.20,000) |
| 1 | 15.0% | 13.3% | 20.6% | 19.7% |
| 2 | 16.7% | 14.9% | 24.4% | 23.3% |
| 3 | 21.9% | 18.6% | 27.4% | 25.6% |
| 4 | 23.5% | 20.3% | 29.9% | 28.1% |
| 5 | 29.7% | 25.2% | 31.2% | 29.0% |
| 6 | 28.3% | 24.7% | 29.7% | 27.9% |

### 3.5.3 Parking Pricing Scheme

The parking pricing scheme will be rather easy to apply because it can be applied with the existing parking facilities, hence reducing the investment cost. The expense of obtaining parking affects modal choice in CBD of most of the metropolitan cities in the developed countries, and such a high parking price is often aimed explicitly at reducing downtown driving.

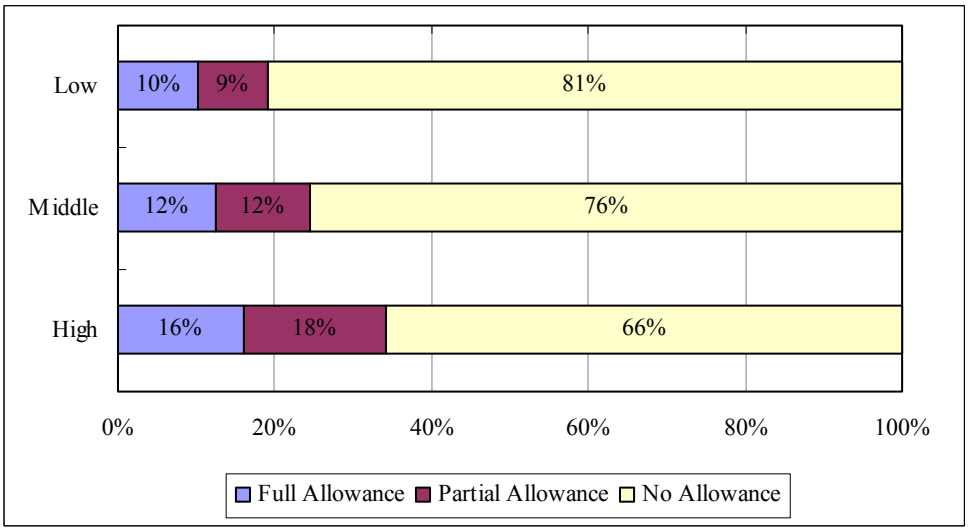
In the case of Jabodetabek, most of the parking lots in the CBD are managed by a single large parking lot operator named Secure Parking. If the government can establish a good business scheme with this company, TDM can be easily introduced with a minimum investment. However, as the price increase for parking may reduce the profit of the company by losing the users, a kind of compensation might be necessary.

Furthermore, it should be noted that, among those who commute to work by private car and use parking facilities, higher income workers tend to receive full parking allowance from their workplace in reality as can be observed in Table 3.5.5 and Figure 3.5.1; therefore, the parking pricing scheme again may affect lower income private car users the most.

**Table 3.5.5 Parking Facility Users with/without Allowance from Their Employers (Private Car Users, for Commuting Purpose Only)**

| Income Group | Parking Users | | Full Allowance | | Partial Allowance | | No Allowance | |
|---|---|---|---|---|---|---|---|---|
| Low | 9,248 | 100% | 934 | 10% | 828 | 9% | 7,486 | 81% |
| Middle | 133,348 | 100% | 16,593 | 12% | 15,904 | 12% | 100,851 | 76% |
| High | 94,205 | 100% | 15,137 | 16% | 16,949 | 18% | 62,119 | 66% |
| Total | 236,801 | 100% | 32,664 | 14% | 33,681 | 14% | 170,456 | 72% |

Source: SITRAMP Home Visit Survey (2002)




Source: SITRAMP Home Visit Survey (2002)

**Figure 3.5.1 Parking Facility Users with/without Allowance from Their Employers (Private Car Users by Income Group, for Commuting Purpose Only)**

## 3.6 OPERATION HOURS AND TARGET VEHICLE TYPE

### 3.6.1 TDM Operation Hours

Although the current 3-in-1 scheme has long been implemented during the morning peak hours, i.e., from 6:30 until 10:00 a.m., since December 2003 the operation hours have been extended from 7:00 until 10:00 a.m. and from 4:00 until 7:00 p.m., totaling six hours of operation.[4]

If a TDM project for this Study is considered to be an expansion of the current 3-in-1 scheme, the operation hours shall include at least those of the 3-in-1 scheme, that is, morning and evening peak hours. As for the daytime "off-peak" period in which many private trips such as shopping concentrate, it is difficult to decide whether it should be included in the TDM operation hours at the moment. In the Singapore case, TDM was first applied for the morning peak hours only, and then it was applied for the evening peak hours, and finally it was extended to the whole daytime in accordance with the change of traffic patterns.

If Jabodetabek is to follow a similar way as Singapore, all day[5] (except nighttime) TDM operation should be considered sooner or later. As such, the TDM for this Study will be discussed and evaluated mostly on an all-day basis. However, it will be easy to change the toll

[4] Extension of the 3-in-1 operation hours is scheduled to be implemented along with the DKI busway project on the Blok M – Kota corridor. The centermost lane in this corridor has been excluded from the general car traffic in each direction and will be used as busway. Extension of the 3-in-1 operation is expected to reduce the daily traffic on the corridor and also encourage people to use public transport including the busway.
[5] According to the traffic count surveys conducted in the Study, traffic volume does not fluctuate much but stays at a high level from 6 a.m. until 8 or 9 p.m. on the major roads inside the CBD.

levy depending on the time period if the ERP system is established in the long run. In addition, weekends and holidays are excluded from TDM operation.

### 3.6.2 Target Vehicle Type

In the short term, target vehicle type for TDM shall be passenger car (including van and pickup) only. However, in a longer term, targeting other vehicle types such as motorcycle should be considered through further analyses and studies of the changing traffic situation. Charging levels can be changed based on the vehicle type. In any case, emergency vehicles and regular public buses are exempted from TDM toll levy.

## 3.7 MONITORING AND SYSTEM CONFIGURATION

### 3.7.1 Manual Surveillance System

In the short term, it is preferable to first apply a manual area (or road) pricing system, just like Singapore did as the first step in 1975. Under this system, drivers need to purchase and display a paper area license or sticker, which is available at many sales outlets on the approach roads, to enter (in the case of cordon pricing) or drive in (in the case of area pricing) the TDM restricted zone. The entrances (TDM area boundaries) are marked by overhead gantry signs just like those of the existing 3-in-1. Such area licenses can be purchased on a daily or monthly basis. They can be in various kinds of shapes for different vehicle types and can also be color-coded for different months, in order to make it easier for inspectors to spot them.

Inspection officers are stationed at the gantry points (and also at any designated points in the case of area pricing) to observe whether passing vehicles display valid area licenses. Violating vehicles are pulled over and fined by the officers. After a database of registered vehicles has been established, violating vehicles will not need to be stopped but a notice of traffic offense will be sent to the driver later to pay a fine.

Such a manual surveillance system can be effective to keep the traffic congestion within manageable levels; however, it is cumbersome, labor-intensive, and inflexible.

### 3.7.2 Mechanical Surveillance System

In the long term, a mechanical surveillance system will be adopted for TDM in place of manual surveillance. That is, an ERP system will be established, or alternatively a camera-surveillance system can be established under the condition that a vehicle registration database has been completed.

(1) ERP System

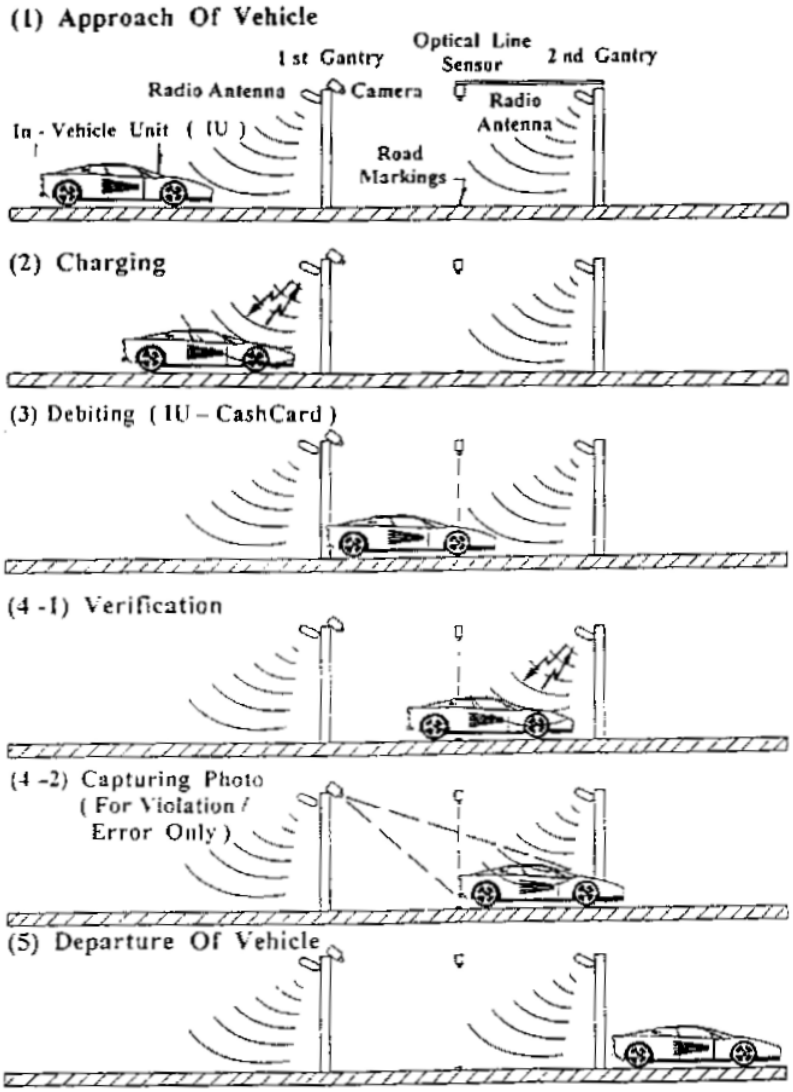
With ERP, drivers will be more aware of the true cost of driving. Charges will be levied on a one-time basis and can vary according to time and congestion levels. With this system of charging, drivers will be encouraged to choose whether to drive, when and where to drive, or whether to use public transportation. Those who choose to pay and stay on the road may get a smoother drive with less probability of traffic congestion.

The ERP system consists of three main components: the in-vehicle unit (IU), the outstation (gantry) and the central computer system (CCS). The IU is an electronic device installed in a vehicle which accepts an IC card. The IU deducts the appropriate ERP charges from the IC card each time the vehicle passes through and ERP gantry. License plates of vehicles making illegal entries, such as those without an IU, without an IC card, or with an insufficient balance on the IC card, will be photographed by the gantry cameras for subsequent enforcement action.

ERP system operation is depicted in Figure 3.7.1. An ERP outstation includes two overhead gantries spaced at about 15 meters apart and at a height of 6 meters above the road level. Each gantry has two antennae per lane meant to communicate with the IU by radio frequency. A set of optical vehicle presence detectors (optical line sensors) is on the second gantry to detect passage of vehicles. Two charge coupled device (CCD) cameras are placed to cover each lane on the first gantry to take the photographs of the rear license plates of the violating vehicles. This whole set-up, which is controlled by a local controller, is termed the outstation. Each outstation is connected by high-speed digital link to a CCS, and transaction data and image data of violating vehicles generated at the respective charging points are immediately sent to the CCS.

The in-vehicle unit (IU) is about the size of a small pocket diary and is powered by the vehicle battery. It is fixed permanently to the right bottom corner of the windshield by a bracket glued on by very high bond tape. The motorcycle IU, which has a protective covering to prevent rainwater from seeping in, is fixed permanently to the front of the machine (e.g., on handlebar or fuel tank). The IUs are color-coded for different types of vehicle classes because the ERP charges may vary for them. This will also prevent the IUs from being switched around.

Although it is preferable that the above-mentioned ERP system be adopted in the long term, it should be noted that Jabodetabek is not a closed area and therefore manual toll collection gates or manual checkpoints are also necessary at some major entry points of the TDM area for vehicles from outside Jabodetabek and without IUs.




Source : A P G Menon and Dr Chin Kian Keong, "The Making of Singapore's Electronic Road Pricing System," Proceedings of the International Conference on Transportation into the Next Millennium, Singapore, Sept. 9-11, 1998.

**Figure 3.7.1 ERP System Operation**

(2) Camera-Surveillance System

In a camera-surveillance system, no transactions with vehicles occur at the gantry. Instead, the controller with cameras and lighting units installed on the gantry takes images of all entering vehicles, receives and processes the images captured by the camera, and sends them to CCS. At CCS, the license plates in the images are read by OCR (optical character recognition) and all the vehicles are identified by collating them with the communication result.

Drivers who wish to enter the TDM area can pay the toll either in advance or on the day of travel before, during, or after their journey. At midnight, images of all the vehicles that have passed the gantry and entered the TDM area are checked against the vehicle registration numbers of vehicles, which have paid their congestion charge for that day. The computer keeps the registration

numbers of vehicles that should have paid but have not done so. A penalty charge notice will be issued to the registered owner of the vehicle.

Features of the manual surveillance system and the two types of mechanical surveillance system are compared in Tables 3.7.1 to 3.7.4.

**Table 3.7.1 Comparison of Road Pricing Mechanism (1/4)**

| Item | Manual Surveillance System | Camera Surveillance System | ERP System |
|---|---|---|---|
| **Basics** | | | |
| Mechanism | • Manual checking of license/sticker displayed on the windshield at checkpoint<br>• Different license/sticker required for different types of vehicle | • License plate recognition by TV camera and validation with database of registered vehicles | • Deduction of charge through data communication with in-vehicle unit |
| Check point location | • Boundary of restricted zone | • Boundary of restricted zone, or key locations within restricted zone | • Boundary of restricted zone, or key locations within restricted zone |
| Surveillance at multi-lane | • Difficult | • Low recognition rate if lane is not followed | • Technically feasible (already in use) |
| Restricted time | • Deployment time of enforcers | • Set by system | • Set by system |
| Modification/expandability | • Very flexible | • Can be modified by relocating TV cameras. | • Theoretically possible but costly to relocate data communication and monitoring equipment. |
| Technical feasibility | • Feasible | • Already in use (London) but development of new recognition algorithm necessary | • Already in use (Singapore) |
| **Charge** | | | |
| Amount | • Fixed by day, week and month, and vehicle type. | • Fixed by day, week and month, and vehicle type | • Can be flexible (changeable by time zone and day of week) |
| Multiple entry in a day | • One payment/day | • Per day or per entry | • Per day or per entry |
| Payment timing | • Prepaid | • Prepaid | • Prepaid (IC card)<br>• Post-paid type using credit card possible |

**Table 3.7.2 Comparison of Road Pricing Mechanism (2/4)**

| Item | Manual Surveillance System | Camera Surveillance System | ERP System |
|---|---|---|---|
| **Application/registration** | | | |
| Procedure | • Purchase of sticker at roadside booths, convenience stores, etc. | • Registration at convenience stores, through the Internet, etc. | • Purchase and installation of on-board unit<br>• Reloading to in-vehicle unit |
| Ease of application/registration | • Depends on number and location of sales points<br>• Congestion at roadside sales point<br>• Advanced purchase must be possible | • Not convenient for casual users<br>• Roadside sales point impractical | • Convenient to both regular and casual users<br>• Roadside sales point impractical |
| Sales facility and procedure | • Printing and distribution of stickers<br>• Collection of sales | • Registration facility | • Reloading facility |
| **Violation** | | | |
| Detection method | • Manual checking of effective licenses/stickers | • License plate matching with database of eligible vehicles | • Validity checking of in-vehicle unit |
| Detection reliability | • Depends on enforcer at check point.<br>• Lax enforcement on rainy days. | • Depends on license plate recognition and subject to position, size, color, angle, font and surface condition of license plate.<br>• Difficult to achieve sufficient reliability under the current license plate system in Jakarta. | • Sufficiently high. |
| Evidence of violation | • Witnessed by enforcer | • Captured video image | • Captured video image and data communication log |

**Table 3.7.3 Comparison of Road Pricing Mechanism (3/4)**

| Item | Manual Surveillance System | Camera Surveillance System | ERP System |
|---|---|---|---|
| **Violation (continued)** | | | |
| Collection of fine | • On the spot<br>• Payment of fine and issuance of receipt | • Issuance of citation ticket<br>• Voluntary payment of fine at specified bank<br>• Violation record checking at the time of annual tax payment possible | • On-the-spot apprehension possible<br>• Issuance of citation ticket<br>• Voluntary payment of fine at specified bank<br>• Violation record checking at the time of annual tax payment possible |
| **Counter fraud** | | | |
| Fraud by user | • Fake/falsified license/sticker | • Fake license plate | • Virtually impossible |
| Fraud by operator | • Pocketing of fine by enforcer | • Impossible unless database is manipulated | • Virtually impossible |
| **System configuration** | | | |
| Facilities/equipment | • Check point booths, enforcement tools, citation ticket | • TV camera, license plate recognition software, communication equipment, central computer system | • Road-vehicle communication unit, TV camera, communication equipment, central computer system |
| Supporting system required | • Closed system and no supporting system required | • Car registration database is required | • Car registration database is required |

**Table 3.7.4 Comparison of Road Pricing Mechanism (4/4)**

| Item | Manual Surveillance System | Camera Surveillance System | ERP System |
|---|---|---|---|
| **Implementation** | | | |
| Preparatory works | • Recruitment and training of enforcers<br>• Establishment of distribution channel of license/sticker<br>• Public campaign | • System design, detailed design, procurement of equipment, software development, and testing<br>• Public campaign | • System design, detailed design, procurement of equipment, software development, and testing<br>• Public campaign |
| Time requiredfor implementation | • 6 months | • 2 years minimum | • 2 years minimum |
| Initial investment | • Recruitment and training cost<br>• License/sticker printing<br>• Public campaign | • TV surveillance and license plate recognition software<br>• Data communication system<br>• Central computer system<br>• Data exchange system with vehicle registration database<br>• Staff training<br>• Public campaign | • Roadside vehicle communication system,<br>• Data communication system<br>• Central computer system<br>• Staff training<br>• Subsidiary to in-vehicle unit, if provided<br>• Public campaign |
| **Cost** | | | |
| Initial investment | • Depends on coverage area and number of checkpoints (~ US$ 200,000) | • Depends on number of TV cameras and other factors (~ US$ 120 million)<br>• Additional cost for upgrading car registration system may be required | • Depends on number of gates and other factors (~ US$100 million)<br>• Cost of in-vehicle unit, if borne by the system operator |
| Initial investment by user | • None | • None | • In-vehicle unit (~ US$ 200), which may be subsidized |
| Annual operation and maintenance | • Basically personnel cost<br>• ~ US$ 100,000 | • Leased communication line, spare parts, maintenance work, and personnel cost.<br>• About 1% ~ 2% of initial cost | • Leased communication line, spare parts, maintenance work, and personnel cost.<br>• About 1% ~ 2% of initial cost |