7.6 Road User Education.

Human error is a major contributory factor in road accidents and road safety education aims to directly influence the road user by changing his attitudes and behavior. It is, therefore, possible to improve the behavior of road users through systematic educational efforts. Unfortunately, lack of positive effects makes it difficult to estimate the value of road safety education as an accident prevention measure.

At the same time, even though road safety constitutes a severe problem for society at large, the likelihood of getting involved in an accident is relatively small for a given individual at a given moment in time.

Education should be seen as only part of an integrated approach to the problem of traffic management. Road safety education programs have therefore been the traditional means to develop appropriate knowledge and skills needed for safer behavior. Program objectives should focus on improving knowledge and changing behavior.

7.6.1 Driver/Rider Training.

Driver, rider and cyclist training would seem to be potentially the most useful measure for smoothing traffic flow and reducing accidents or potential accidents on the streets. From learning theory in psychology, it is true that at the early stage drivers/riders are willing and eager to accept important information (safety oriented tips are also included) whereas it is much more difficult to get useful information later on.

In Hanoi, those who wish to obtain a riders license for a motorcycle of less than 50cc do not have to undertake any formal training of education. At present, the majority of the rider population learn how to maneuver motorcycles without systematic training. Lack of courtesy and discipline, which are often observed on road, are simply due to a lack of proper instruction. To learn practical riding skills, most people learn either from a friend or relatives and no uniform format for riding motorcycles is currently available. However, whenever education is available, they should be required in the future to take advantage of it.

At this stage it is not considered worthwhile to move to introduce drivers/riders education in schools. It is essential that long term continuous road safety education is seen as more worthwhile to develop positive attitudes.

7.6.2 Safety Education for Children

The goal of road safety education can be defined as achieving an optimal use of the transportation system with optimal safety for all traffic participants including young pedestrians. An example of an educational objective would be that a child must have an understanding of the risks involved in traffic participation. However in Hanoi most of children are not aware of such matter. The problem of school based road safety education is essentially that of informing and motivating school teachers and persuading the majority of them to participate in the innovations.

However, the most majority of school teachers still have some preservation on school based road safety education. Particularly in Hanoi, the number of school teachers is limited and they have no intention to conduct safety education in their schools.

Traffic education is a complex matter. It involves knowledge, behavioral and most importantly attitudinal change (See Campaign). Therefore, traffic safety education is directed to all age levels so that road safety knowledge is supplied through the public education mediums to all road users, whether they are children, young adults, parents or the elderly.

Every child or student in school is a pedestrian, a commuter, or a motorist. They comprise more than half of population. Yet, there is no place in the elementary, high school, or college curriculum that deals specifically with traffic. This generally reflects the low priority that civic education has deserved in school curricula. Thus, the road system, which is the core of the "commons" of the country, is largely misused.

To summarize, the undertaking of traffic education and information is a vital function in its own right: negotiating and sustaining its inclusion in formal school and multimedia programming.

7.7 Future Recommendation

As the practice in Japan and Singapore, a system should be introduced to identify drivers/riders with poor records by means of a point demerit system. Each safety related driving/ riding offense has a number of points associated with it and, when a motorist offends, these points accumulate. If the total points exceed more than certain amount within a three year period, the driving/riding license may be suspended or canceled for certain period of time by the authority.

Offering suggestions of recommendations for implementation.

In order to upgrade the safety standard it is strongly recommended that an "International Traffic Safety Seminar" be held in Hanoi, which would stimulate related agencies and organizations to facilitate safety priority all over in Vietnam, particularly in Hanoi.

In the safety area, awareness raising and education on the part of drivers/riders, cyclist and pedestrians are essential. Establishing a bicycle training curriculum in primary schools and the establishment of "The Traffic Park' would be desirable in Hanoi.

The cost of creating the physical safety conditions for bicycles is minimal, consisting simply of painting the pavement and putting signs on many roads, erecting physical barriers and constructing cycle lanes of a few meters wide with light weight bearing pavements.

In order to decrease pedestrian traffic accidents to a minimum level, conflicts between vehicles and pedestrians should be reduced as much as possible. Appropriate traffic rules and regulations and their enforcement could be one of the tools for reducing such conflicts. However, generally speaking, priority rules between vehicles/cycles and pedestrians are not necessarily observed and appreciated by the current traffic environment in Hanoi.

Thus, for example, fences (i.g., guardrails) separating sidewalks and the carriageway should be installed wherever pedestrian volumes are sufficiently high to justify the expense. Sidewalks should be improved much more to accommodate easy separators for pedestrians. Pedestrian safety facilities must be improved to ensure a safe pedestrian environment.

Recognizing the fact that enforcement forces are limited in numbers, it is necessary to put higher priority in enforcing rules and regulations in more dangerous (congested) areas. The fact that certain types of driver/rider behavior will improve considerably if the police are present supports the theory that attitudes are important rather than lack of knowledge.

It should be ensured that each traffic enforcer is trained, disciplined, and worthy as a representative of government in direct and daily contact with the citizenry. For this purpose it should be required that enforcers take and pass a single, standard traffic management course and they should subsequently be placed under a unified performance oriented monitoring and evaluation system. (For example, to handle traffic

systems at local controllers, police officers may face the technical impact related to the operation. Minimum knowledge for signal operation should be provided to police officers).

Tentative Training Programs for law enforcers would include following details:

- Human, Vehicle and Flow Characteristics
- Traffic Laws and Regulations.
- Traffic Law Enforcement Techniques
- Traffic Signals.
- Intersection Control (Uniform Hand Signals).
- Traffic Accidents Investigation
- Safety Facilities and Control

(Adoption of this point demerit system requires a database held by large scale computers). In the near future such systems may be adopted on a trial basis in certain areas in Hanoi. Also, a rehabilitation program for those who are suspended or canceled would be considered at the same time.

Also, the introduction of the temper proof ID card type license is expected to reduce fake licenses and ease computerization.

Passing would be prohibited strictly in all two lane roads and one way roads in the CBD area. Other regulations such as no turning, no right turn, one-way street and no lane changing are also extensively applied and be observed (See Traffic Management Scheme).

It is strongly recommended that accident data should be collected and stored and that this information should be provided to related agencies who implement road conditions and safety facilities as well as to the general public. Divergence between related agencies should be carefully avoided at the minimum level. Instead of having a detailed report form, simple but accurate data collection and processing is urgently needed. (See Appendix) For the public, results would be conveyed by publication, mass-media and occasionally by road safety campaigns. At the same time, the results would be utilized as a basic database.

An example of a highly wanted publicity campaign would be that of educating the public about their problem behavior on road such as "hanging the horn". The campaign aims to educate drivers/riders about the danger or unpleasantness caused by their daily maneuvers. The effectiveness of altering this driving/riding behavior relies heavily on publicity to reduce their risks caused by themselves.

Following procedure is recommended:

- Formulate a strategy to improve the traffic safety campaign (education) consistent with existing social and economic constraints.
- Prepare a plan of a model road safety campaign to be effective to install road safety concepts among the general public as well as school children.

- Prepare the draft terms of reference for a feasible study for the realization of the preceding strategies toward better education and campaign for road users.
- Formulate the strategy based upon the assessment of the strengths and weakness of the current system.
- Avoid a negative approach and an extreme fear arousal approach.

The best method of education appears to be fair and strict enforcement and uniform application of traffic rules that confront the poor driving/riding syndrome. Encourage large and well organized fleet operations to train and discipline their drivers.

Safety driving/riding campaigns should be developed to enhance desirable attitudinal change. Expansion of safety campaigns particularly for motorcycle riders are highly recommended.

Long-term benefits may be delivered from educating those opinion leaders such as journalists and school teachers. This approach has special appeal where the educational infrastructure is still amenable to change as in Hanoi.

Example 1: " No Horn in Hanoi" Program .

There will be increased support for most of the penalties for driving/riding with use and the honking horn after the campaigns. The knowledge of these penalties will be widespread and people will gradually realize more comfortable and safer traffic attitudes.

Example 2: Safety Video (Film) Production.

By nature, safety campaign videos (films) are rather boring. Contents should be carefully selected and processed. Local personalities who are similar to the audience are preferable as this makes the audience feel that this is their own problem. If the character is regarded in the light of himself or herself, the audience get very involved with the film.(Oshin Doraemon or Disney's characters are good examples to be introduced as the characters). This video (a film) will be the first completed in Vietnam, and the content would be rather general.

To use mass media in this concept, important issues are as follows:

1. Effect of repetition:
   Like TV commercial, repeated persuasion is important even the spot is very limited.
2. Effect of dramatization :
   Instead of adopting fear arousal approach, cooperative approach would be preferable.
3. Measure public acceptance:
   It is important to find out the affect of the campaign by measuring public acceptance. Appropriate measures should be introduced.
4. Direction to implement behavior:
   Within the propaganda, it is strongly important to specify the goal.

Before finalizing Video (film) making, the following issues should be borne in mind:

(a) Everyone should give as much thought to traffic considerations as they do the

weather. After all, traffic is as much an inescapable part of their everyday lives.

(b) The seriousness of the losses due to traffic deaths and injuries are something that can not be quantified. Thus, the problem of traffic safety can not be overstated.

(c) Since we know that the incidence of traffic death or injury can not be reduced to zero, measures should be aimed at organizing and controlling traffic problems to reduce loss at minimum.

(d) If no action is taken at all, the traffic problem will literally strangle Hanoi (Congestion and air pollution, etc.).

(e) Technology transfer, especially software like safety education and campaign are rather difficult since human behavior modification is externally induced. We should bear in mind the problems peculiar to our situation in selecting the most appropriate solution.

(f) Get support from both the public and private sector because traffic safety can only be obtained through cooperation between several direction. In this connection, such as private organizations, private enterprise groups, parent-teacher associations will play important roles.

(g) A lot of work is short-term and unspectacular and difficult to publicize as rapid progress. The process of building a solid foundation for the sound development of a better transport system for Hanoi people is urgently needed.

- The zebra crossings should be at least 2 m wide for the crossing pedestrian. Kerbs are constructed along the road edge and the sidewalk is usually used by shop houses in front of the sidewalk. Sidewalks are sometimes hampered by shops and food management.

- Traffic signal maintenance should be carefully conducted by at least by-monthly basis. This includes changing and maintaining lamps in signal heads and painting poles.

The basic offering may be the beginner course consisting a of 1 hour lecture and 2 hours practice (which costs - VND or free of charge). Practice training should emphasize braking and handling, while the lectures should primarily cover traffic rules, riding manners and how to avoid collision with other vehicles, particularly at intersections. Some privileges such as that after completion of course they are waived from license examination, should be given. It should be noted that training may never make some people ride better than others, or it may only make them ride better initially.

An extensive safety education program should be considered carefully because young children will grow up as the road users for tomorrow. The school system should devote a significant period to the teaching of collective and social skills, such as traffic education, in addition to imparting personal skills and knowledge. It might be feasible to introduce a certain subject in high school which will include driving, first aid, environmental conservation, community project management, and development communications.

Traffic safety education in schools would be carried out more intensively as an important part of general safety education and as such is incorporated in various subjects, ethic classes and related subjects as science or social studies. The context of such education curricula would be provided by the Ministry of Education and Training

through the distribution of manuals to kindergarten, primary and secondary schools all over Hanoi.

Organization of child safety clubs sponsored by government or private sectors are also recommended. For example, children's traffic clubs seem to be useful when they motivate parents to teach their children correct traffic behavior on roads. Also, safety club schemes stimulate young people's attitude on safety. In this aspect, a Traffic Park would be a useful tool for kids to familiarize to the various simulated traffic situation by themselves. Traffic Parks either in Japan or in Singapore are a good example, where school children use the park in a series of road safety competitions. Safety school patrol systems could be introduced to increase safety consciousness by school children. This introduces some courses of the program into specific school curriculum.

Safety measures for children commuting to and from school, like designating of safer routes to school, encouragement of commuting in groups and distribution of reflective tags are desirable. Also, playing safely at playgrounds would be included. Basic education at kindergarten and lower grades of primary schools are most effective.

The emphasis in the road safety authorities is with the development of posters, leaflets, kits, guidelines and games. (See Campaign). Thus, MOET and MOCI play dominant role to develop curriculum syllabus which contain sections on road safety; curriculum support material; road safety policies and adoption and integrating bicycle safety into the primary school curriculum. Safety education may be conducted as a part of the ordinal school curriculum. necessary steps should be taken to promote for school teachers. at the sometime, necessary information like pamphlets or tabloid papers should be given to mothers at house as they are responsible for habit formation of children.

At this moment, road safety education is not a high priority in primary school education here in Hanoi; teachers do not have enough time; teachers need support to develop lessons from materials; Even before that, teachers do not realize the necessary of safety education in their schools. School teachers should have access to experts either at conferences or in service courses outside.

The education materials should be in Vietnamese, inexpensive, easily available, easy to follow, urban and rural in content, interesting and containing instructions, suitably designed from prep to year 6 or 7 (exercises done in foreign countries would be worthwhile to study).

Following table illustrates an example of traffic safety education program in schools:

Primary schools:

- To know the road laws relating to pedestrians, bicycles. :Knowledge.
- To develop in children an awareness of dangers on the roads. :Attitude.
- To develop in children the basic riding skills which will allow them to use bicycles safely and learn the need to be conspicuous and protected on bicycles (May include pedestrian skills and bicycle maintenance). :Behavior.
- To know the meanings of street signs, lights and markings . :Knowledge

- To make all children aware of the need to be courteous, considerate and careful in all traffic situations and to help children to desire this attitude. :Attitude.
- To understand the effects of accidents on children and the sorts of behavior which can lead to accidents involving children (like dashing out) :Knowledge

Secondary Schools:

- To develop a sense of responsibility when in charge of motorcycles :Attitude.
- To know and understand the road laws :Knowledge
- To understand the main cause of accidents and how to prevent them :Knowledge
- To develop skills involved in handling cycles :Behavior
- To develop good attitudes as a passenger and as a motorcycle rider :Attitude.

PART II

MASTER PLAN

CHAPTER 8 LAND USE PLAN
CHAPTER 9 DEMAND FORECAST
CHAPTER 10 TRANSPORT MASTER PLAN FORMULATION POLICY
CHAPTER 11 ROAD NETWORK DEVELOPMENT
CHAPTER 12 BUS PLAN
CHAPTER 13 RAILWAY PLAN
CHAPTER 14 TRAFFIC MANAGEMENT PLAN
CHAPTER 15 FREIGHT TRANSPORT PLAN
CHAPTER 16 TRANSPORT MASTER PLAN

CHAPTER 8 LAND USE PLAN

8.1 Socioeconomic Framework

Future population and industrial activities of Hanoi were estimated in relation to the economy of northern Vietnam. These estimates were divided by *phuong/xa* following the concept of the Land Use Plan 2020.

8.1.1 Economic Forecast of Northern Vietnam

Under the assumptions of productivity growth in the non-agricultural sector of 8 - 11% per year up to 2015 and agricultural land productivity growth of 2 - 3% per year, overall economic growth of 8 - 9% per year could be achieved, for the northern region of Vietnam as shown in Table 8-1-1.

Table 8-1-1 Economic Forecast of Northern Region of Vietnam

(M.VND at 1989 Constant Price)

	1989	1995	2000	2005	2010	2015
Agriculture Area (1000 ha)	3,800	4,100	4,200	4,250	4,300	4,300
Agricultural Sector	4,641,401	5,226,971	6,104,513	6,904,263	7,713,613	8,616,645
Non-Agricultural Sector	5,971,675	9,775,929	15,900,239	26,609,092	40,489,150	59,332,250
Northern Vietnam	10,613,076	15,002,900	22,004,752	33,513,355	48,202,763	67,948,895
Annual Growth Rate						
- Agricultural Sector	-	2%	3%	2%	2%	2%
- Non-Agricultural Sector	-	9%	10%	11%	9%	8%
- All Sectors	-	6%	8%	9%	8%	7%

Source: Statistical Yearbook

GRDP of Hanoi were obtained by following procedure;

a) GDP of target years was estimated from the GDP in 1994 and by applying a 7.8 % of annual rate of growth;
b) National population of target years was projected from the 1993 population by applying a 2.2 % of annual rate of growth;
c) GDP per capita was calculated using the results of (a) and (b);
d) The ratio of Hanoi consumption (in money terms) per capita to National consumption per capita in 1993 was 1.378 and the ratio of income was 1.373; and
e) GRDP per capita of Hanoi was obtained assuming that regional differentials of GRDP correspond to that of personal consumption.

Table 8-1-2 shows the figures derived using the above procedures.

Table 8-1-2 GRDP per Capita of Hanoi

Year	1994	1995	2000	2005	2010	2015
GDP(M.US$)	1,547,800	1,668,528	2,428,999	3,536,072	5,147,721	7,493,915
POP('000psn)	72,509	74,098	82,584	92,041	102,582	114,330
GDP per Capita	213	225	294	384	502	655
HANOI GDP/Capita	293	310	405	529	691	902

Source: Statistical Yearbook

8.1.2 Population Forecasts for Hanoi

(1) Approach

For a rapidly changing society such as that in Vietnam, it is not possible to forecast the population for a city by simply projecting a past trend into the future. It is necessary to incorporate structural changes into the forecasting method. One thing which is unanimously agreed on is that Vietnam will pursue industrialization along with its economic growth. Industrialization means more urban jobs especially at the early stage of industrialization. The question is how much urban employment will be created and where it will be located. The largest factor of population pressure for Hanoi comes from social migration. People would like to look for better income opportunities in a large city and businessmen want to invest in a favorable location in terms of infrastructure, proximity to markets, and support services. Hanoi offers an attractive location for the investors in terms of these aspects. Other cities have to compete with Hanoi to make up for their disadvantages in order to attract investors.

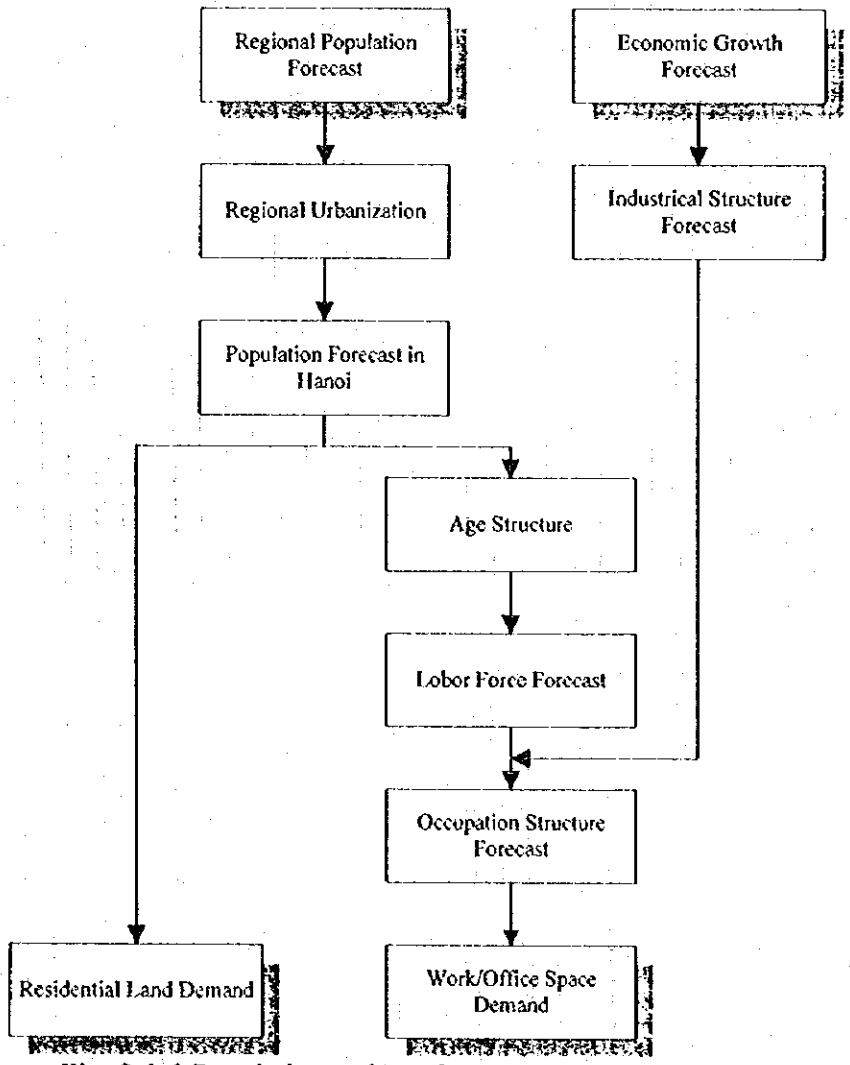


Fig. 8-1-1 Population and Land Requirement Forecast Flow

In our approach, northern Vietnam was taken as an independent economic unit. Fig. 8-1-1 shows method of estimation in flowchart form Based on official population projections for Vietnam, together with GDP growth targets, urbanization rates have been estimated. From the total urban population of North Vietnam the urban population of Hanoi was estimated. From the urban population, and the official projections for the age structure and labor participation rate for each age cohort, the total labor force of the city was calculated. Further breakdown of labor by industrial sectors and type of occupation were undertaken to estimate the space demand arising from employment.

(2) Urbanization and Industrialization

Urbanization (defined as urban population/total population) clearly has a positive correlation with the level of economic development. However, the rate of urbanization differs depending on the particular situation of each country. Urbanization is closely linked with the rural economy. Productive capacity of rural areas determines the supply side of urbanization, while better income opportunities determine the demand side of the dynamic. Table 8-1-3 shows the population forecast made by the Study Team.

Table 8-1-3 Population Estimate

(Thousand Persons)

	1989	1995	2000	2005	2010	2015
Population North Region	33,195	36,115	38,724	40,840	42,474	43,785
Annual Growth Rate		1.4%	1.4%	1.1%	0.8%	0.6%
Urbanization Rate	14%	16%	20%	25%	30%	35%
Urban Population	4,647	5,778	7,745	10,210	12,742	15,325
Hanoi Urban Population	1,022	1,271	1,704	2,246	2,803	3,371
Share	22%	22%	22%	22%	22%	22%
Annual Growth Rate		3.7%	6.0%	5.7%	4.5%	3.8%
Hanoi Rural Population	1,040	1,126	1,193	1,242	1,280	1,305
Annual Growth Rate		1.3%	1.2%	0.8%	0.6%	0.4%
Total Population of Hanoi	2,062	2,397	2,897	3,488	4,083	4,676
Share of Hanoi	6%	7%	7%	9%	10%	11%

Given the strong link between urbanization and economic growth, it is rather consensitive to assume that urbanization would reach 35% of the total population by the year 2015. As the hierarchy of the city tends to maintain relative proportions, it is reasonable to assume that Hanoi will retain the current proportion of 22% of the population of the Northern Region throughout the period up to the year 2015. According to the population forecast made under the above assumptions, the urban population of Hanoi will reach 3.4 million and the total population will reach 4.7 million.

(3) Rural Population of Hanoi

The expansion of urban Hanoi means conversion of agricultural land to urban uses. Inevitably, farmers have to be displaced or change jobs. The number of farmers to be included in the urban population, therefore, depends on the size of urban expansion within Hanoi. From the estimation of land use forecasts for urban Hanoi the number of rural population who will be included in urban area has been calculated.

8.1.3 Industrial Structure of Hanoi

(1) Future Labor Force

As the entire economy of the northern region becomes more industrialized, the major functions of Hanoi as the capital and the regional center will have to change. Hanoi will become more service oriented rather than an industrial center. It will serve as the national headquarters for enterprises. Table 8-1-4 shows the forecast of labor force for Hanoi and the North Region.

Table 8-1-4 Labor Forecast for Hanoi and North

(Thousand Persons)

	1989	1995	2000	2005	2010	2015
North Urban	2,381	3,080	4,283	5,891	7,368	8,874
North Rural	14,860	14,616	14,074	13,262	11,826	10,364
Hanoi Urban	523	678	942	1,297	1,618	1,954
Hanoi Rural	540	600	660	717	740	756
Total	1,063	1,278	1,602	2,014	2,358	2,710
Rate of Labor Participation	52%	53%	55%	58%	58%	58%

(2) Industrial Structure Forecast

Based on statistics of the type of occupations in the 1989 census, the current industrial distribution of the labor force was estimated. The future assignment of the labor force to industries was estimated from an international comparison of the industrial structure of major cities. The industrial structure forecast shown in Table 8-1-5 is a rough estimate based on those of other cities in Asia.

Singapore and Hong Kong were chosen for the estimation of occupation structure in the industrial sector. The share of office workers to direct workers varies between industries. Occupations were divided into three categories of administration, sales and direct workers.

Table 8-1-5 Industrial Structure Forecast

(Thousand Persons)

	1989	1995	2000	2005	2010	2015
Agriculture Forestry	5	6	7	9	9	10
Manufacturing	198	246	327	429	511	586
Construction	57	69	88	111	126	137
Commerce	82	136	232	377	543	742
Transportation/ Communication	37	47	63	83	101	117
Finance, Business Service	6	10	17	29	42	59
Health	14	18	25	34	41	49
Education	39	47	61	78	89	98
Government	51	58	70	82	83	78
Others	34	41	52	65	73	78
Total	523	678	942	1,297	1,618	1,954

There is less direct labor in manufacturing than in the construction industry. Projections to the year 2005 and 2015 are shown in Tables 8-1-6 and 8-1-7 respectively.

Table 8-1-6 Occupation Structure Forecast of Hanoi Year 2005

(Thousand Persons)

	Production	Sales/Service	Administration	Total
Agriculture Forestry	6	0	1	7
Manufacturing	212	16	98	326
Construction	71	1	17	89
Commerce	23	127	81	231
Transportation/ Communication	38	3	22	63
Finance, Business Service	2	4	19	25
Health	3	6	8	17
Education	12	21	28	61
Government	14	25	32	71
Others	10	18	24	52
Total	391	221	330	942

Table 8-1-7 Occupation Structure Forecast of Hanoi Year 2015

(Thousand Persons)

	Production	Sales/ Service	Administration	Total
Agriculture Forestry	9	0	1	10
Manufacturing	381	29	176	586
Construction	109	2	26	137
Commerce	74	408	260	742
Transportation/ Communication	70	6	41	117
Finance, Business Service	4	7	38	49
Health	12	21	26	59
Education	20	34	44	98
Government	16	27	35	78
Others	16	27	35	78
Total	711	561	682	1,954

8.1.4 Future Land Requirement

(1) Estimation Method

Communities change their character over the years. Hanoi, as well as other cities in Vietnam, is expected to undergo not only expansion but also structural transformation as the nation becomes more industrialized. The basic data for the future land requirements of Hanoi are the population forecast and the labor structure forecast which are described in the preceding section. The existing urban areas will change over time in intensity of land need for the increasing population. Land requirement estimates are divided into two segments, firstly residential land and secondly, productive land. These estimates are described below:

(2) Residential Land Requirement

The residential land estimates as shown in Table 8-1-8 based on the future average density of land use. The density is assumed to decrease over the years from 466 persons/ha in 1995 to 341 persons/ha in 2015.

Table 8-1-8 Urban Development Requirement Forecast

Year	1995	2000	2005	2010	2015
Urban Population (thousand person)	1,271	1,704	2,246	2,803	3,371
Increase in Population (thousand person)	-	433	542	557	568
Person/ha for Increased Population		350	310	280	260
Person/ha for Total Population	466	430	393	364	341
Additional Urbanization (ha)		1,237	1,748	1,989	2,185
Cumulative Urbanization (ha)	2,729	3,966	5,714	7,703	9,888

The total residential development required by 2015 is 9,888 ha for urban population. Between 1995 and 2000, additional development of 1,237 ha will be required which increases to 2,185 ha during the 2010 to 2015 period.

(3) Employment Space Requirement

Together with the household survey, commercial activities of "*shophouses*" were investigated to acquire indicators for space requirement for shops. Table 8-1-9 shows the results for manufacturing households and Table 8-1-10 for commercial households. The surveyed manufacturers were of small scale, mainly family business, therefore, the unit area requirement is much smaller than for large scale industry. It usually requires 50-80 m^2 per worker in a factory, but the area requirement for the manufacturers interviewed was significantly smaller than this figure. For commerce, international standards range from 15 to 30 m^2 per worker, and the small unit area in Hoan Kiem shows a striking difference.

Table 8-1-9 Work Space Requirement by Manufacturing Household

	District	Worker/Household	Area (m^2)	(m^2/Person)
Rural	Soc Son	2.2	98	44.5
	Dong Anh	2.0	28	14.0
	Tu Liem	2.3	83	36.1
	Thanh Tri	1.0	22	22.0
	Gia Lam	2.6	131	50.4
Urban	Hoan Kiem	2.7	19	7.0
	Ba Dinh	3.0	20	6.7
	Dong Da	N/A	N/A	N/A
	Hai Ba Trung	2.5	14	5.6

Table 8-1-10 Work Space Requirement by Commercial Household

		Worker/Household	Area (m^2)	(m^2/Person)
Rural	Soc Son	1.6	88	55.0
	Dong Anh	1.8	23	12.8
	Tu Liem	1.4	13	9.3
	Thanh Tri	2.0	18	9.0
	Gia Lam	2.2	67	30.5
Urban	Hoan Kiem	2.4	7	2.9
	Ba Dinh	1.8	10	5.6
	Dong Da	1.7	12	7.1
	Hai Ba Trung	1.9	16	8.4

The forecast for employment land requirement is based on calculating the floor space requirement as shown in Table 8.1.11 and then applying a floor to land ratio (Table 8-1-12) to arrive at the land requirement as shown in Table 8-1-13.

The productive land estimate consists largely of three types of land use which are factory, shops and offices, among which factory is the largest component, reaching over 1905 ha by the year 2015 as shown in Table 8-1-12.

Table 8-1-11 Employment Floor Requirement Forecast

(ha)

Year		1995	2000	2005	2010	2015
Office	Agriculture Forestry	0.3	0.4	0.5	0.7	0.7
	Manufacturing	60.2	80.0	105.1	143.2	184.5
	Construction	9.6	12.3	15.6	20.2	24.6
	Commerce	33.2	56.7	92.6	152.2	233.7
	Transportation & Communication	9.2	12.3	16.4	25.8	38.0
	Finance, Business & Service	11.8	20.1	27.0	33.1	43.9
	Government	46.5	56.1	65.2	66.7	70.3
	Others	28.9	36.6	45.7	58.6	70.3
	Total	199.7	274.5	368.1	500.5	666.0
	Health	62.5	86.8	144.4	211.9	292.8
	Education	188.7	244.9	311.0	356.5	390.5
	Commerce	97.8	166.8	388.9	801.2	1,001.5

Table 8-1-12 Floor to Land Ratio

	Year	1995	2000	2005	2010	2015
Office	Agricultural Forestry	0.8	0.8	0.8	0.8	0.8
	Manufacturing	1.3	1.4	1.5	1.9	2.3
	Construction	1.3	1.4	1.5	1.9	2.3
	Commerce	0.6	0.6	0.7	1.0	1.4
	Transportation & Communication	1.3	1.4	1.5	1.9	2.3
	Finance, Business & Service	0.6	0.6	0.6	0.7	0.9
	Government	0.6	0.6	0.6	0.7	0.9
	Others	0.6	0.6	0.6	0.7	0.9
	Health	0.9	1.0	1.2	1.5	2.0
	Education	0.6	0.7	0.8	0.9	1.0
	Commerce	0.6	0.8	1.1	1.3	1.5

Table 8-1-13 Employment Land Requirement Forecast

(ha)

Year		1995	2000	2005	2010	2015
Office	Agricultural Forestry	0.4	0.5	0.6	0.9	0.9
	Manufacturing (Office)	46.3	57.1	70.1	75.4	80.2
	Construction	7.4	8.8	10.4	10.6	10.7
	Commerce	55.4	94.5	132.3	152.2	166.9
	Transportation & Communication	7.1	8.8	10.9	13.6	16.5
	Finance, Business & Service	19.7	33.5	45.0	47.3	48.8
	Government	77.5	93.5	108.7	95.3	78.1
	Others	48.1	61.0	76.2	83.7	78.1
	Manufacturing (Factory)	202.3	533.0	875.2	1,660.8	1,904.5
	Health	69.4	86.8	120.3	141.3	146.4
	Education	314.5	349.9	388.8	396.1	390.5
	Commerce	163.0	208.5	353.5	616.3	667.7

8.2 Land Use Plan

8.2.1 Conceptual Design

(1) Allocation of Population

The population in 2015 was estimated to be 4.7 million including Ha Dong City. The Land Use Plan 2020 (awaiting the approval of the Prime Minister) proposed a controlled population policy for Hanoi central area which limits its population to 800,000. Following the guideline of Land Use Plan 2020, the Study Team developed the conceptual plan as follows (see Fig. 8-2-1);

a. The capital function should be concentrated on south side of the Red River in Hanoi.
b. The south side of the Red River in Hanoi is separated into two areas. The existing built-up area is planned to have a control population of 800,000. The concentration of employment opportunities will, however, continue. Workers taking up these employment opportunities will reside in the west and south of the built-up area (Hanoi Urban Development Corridor, HUDC). HUDC is planned to be well served by infrastructure so as to accommodate high density population. The population HUDC and immediately adjacent areas is expected to reach around 1 million by 2015.
c. The north side of the Red River is planned to be developed for industrial towns. At present there are proposals of 4 industrial estates and associated residential areas. Development has started or land acquisition works have commenced for three of these developments. These towns are planned to be self sufficient and accommodate a population of around 0.5 million in total by 2015.
d. Three sites are considered for the development of satellite cities. The first site is Hoa Lac. Hoa Lac City is expected to grow as complex of hi-tech industrial estates and Hanoi University. The second site is the Phuc Yen area. Phuc Yen has received investment by Toyota and Honda, and various additional investments are anticipated. The third site is Ha Dong. Ha Dong is growing as a residential suburb of Hanoi. The Land Use Plan 2020 assigned 1.5 million population to Hoa Lac and Yen Hoa. Half a million of the 1.5 million are considered to be relocated from the future anticipated Hanoi population. The population of Ha Dong at present is 0.1 million. It is planned to increase to 0.5 million by 2015 and this increase is considered as relocation of future Hanoi population attracted by the relationship between Ha Dong and Hanoi.
e. The rural population would be 0.8 million by 2015. It is slightly smaller than that at present. They would continue to cultivate land and maintain a self sufficient economy.

(2) Road Network and Town Location

The boundary of the area of controlled population is Ring Road No. 2 (RR No. 2) and the Dike Road. Other towns (excluding Soc Son) are located along Ring Road No.3 (RR No.3) Each town is connected to a National Highway (NH), for example, Gia Lam is connected to NH No. 5, Dong Anh to NHs No. 3 and No.2, Thanh Long North to NH

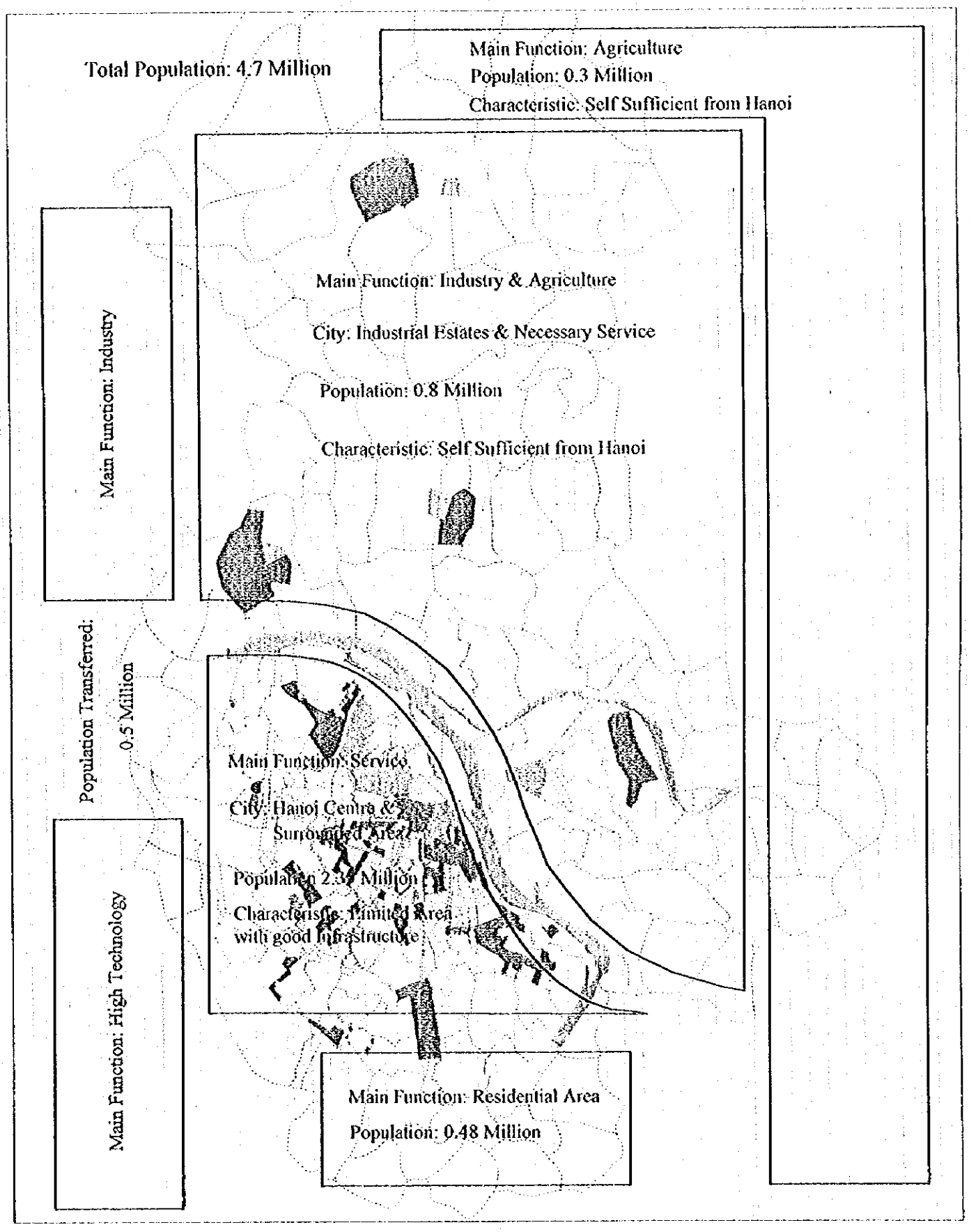


Fig. 8-2-1 Conceptual Scheme of Population Allotment

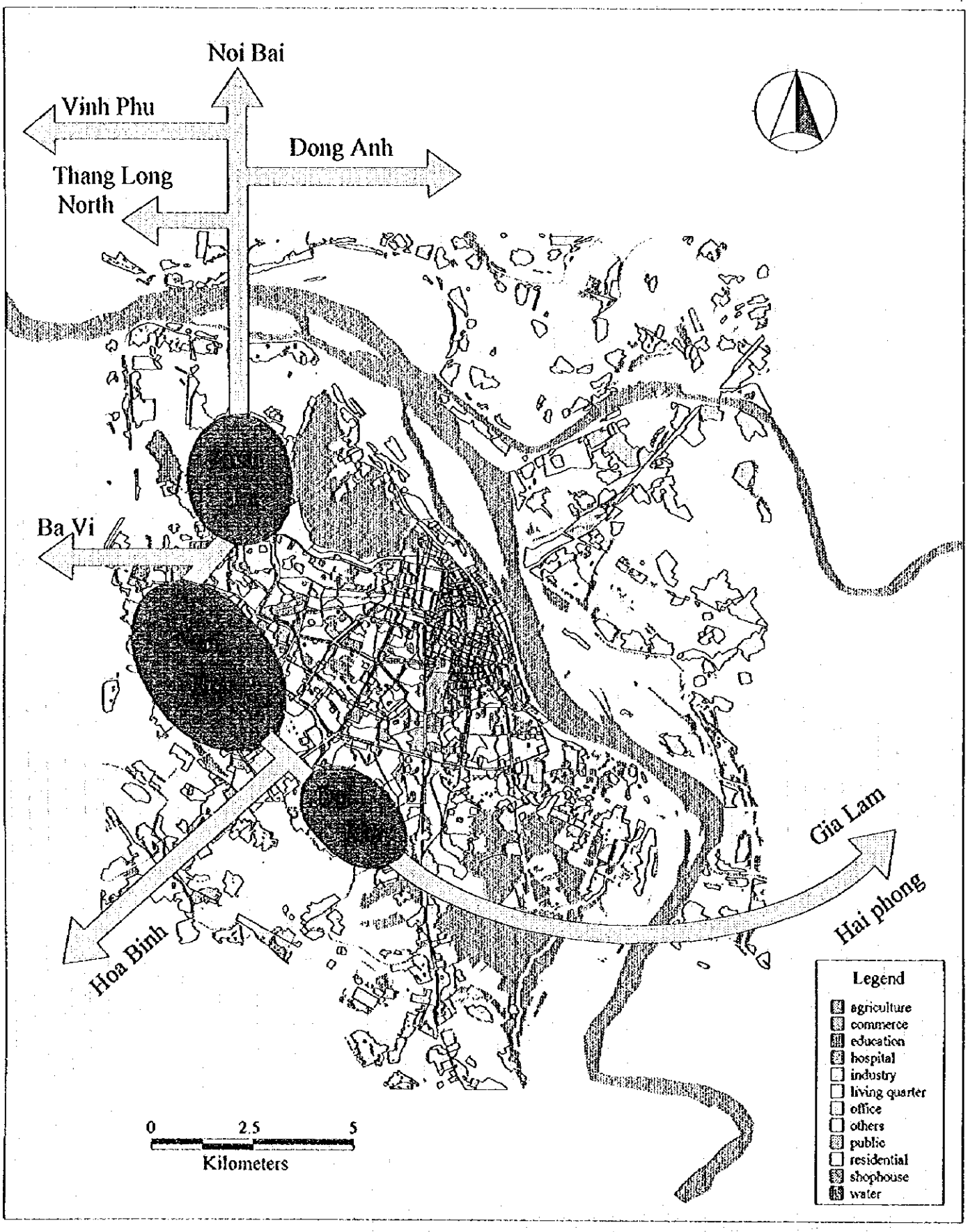


Fig. 8-2-2 Roads and Towns Developed

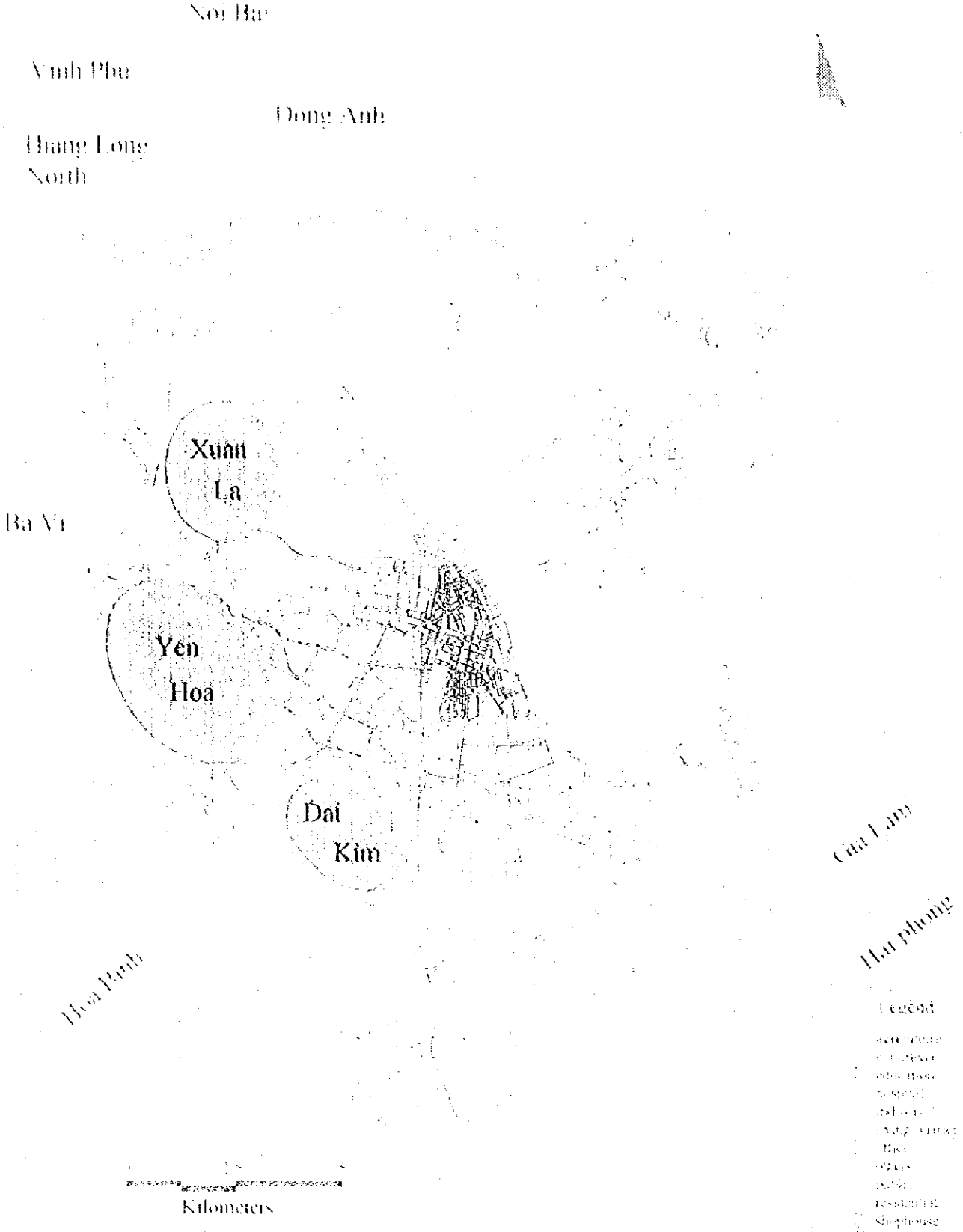


Fig. 8-2-2 Roads and Towns Developed

No. 23, Xuan La to NH No. 32, Yen Hoa NH No. 6, Dai Kim NHs No. 6 and No. 1A, and Soc Son NH No. 3.

All of the National Highways are radial from Hanoi and all cross RR No. 3. This ring road is expected to operate as by-pass road. To protect the city from the inflow of large trucks large scale truck terminals are planned. In the study period Dong Anh Truck/Rail Terminal would be constructed (see Fig. 8-2-2)

(3) Employment and Population

North Side of Hanoi and the North-West of the Red River

Plans of industrial estates and associated residential areas are illustrated in Fig. 8-2-3 and summarized in Table 8-2-1. Employment in the industrial estates was estimated using the area of the industrial estates and an employment density unit value of 200 employees/ha. Commercial and residential area requirements were estimated from the number of industrial workers.

Table 8-2-1 List of Planning Projects

No	Name	Area (ha)	Contents
1	Ciputra	400	- House: 177ha - Public facilities:: 50ha - Park and greenbelt:: 73ha - Road: 67ha - Others: 33ha
2	South Thang Long City	N/A	- House - Public facilities: hospital, sport, facilities, square and so on. - Commercial center. - Road.
3	Trung Yen Housing Area	N/A	N/A
4	Red River City	6	N/A
5	Nghia Do International Village	11	- House - Office tower 28 levels - Hotel: 450 rooms - Road.
6	Linh Dam - Dinh Cong Project	292	- Infrastructure facilities. - High-rise buildings and village.
7	New Van Tri Town	310	- House:: 120ha - Road: 39ha - Sport Area:: 92ha - Office:: 67,00sqm - Commercial : 350,000sqm - Hotel: 150 rooms
8	Thang Long North Estate	297	- Industrial estate:: 280ha - Cargo distribution center:: 50ha -Residential area:: 50ha - Others: 17ha
9	Thang Long South Estate	220	- Industrial estate:: 220ha
10	Dong Anh Estate	92	- Industrial estate:: 92ha including: factory lot, road, utility, park, etc,...
11	Gia Lam Estate	681	- Industrial estate:: 442ha - Cargo distribution center:: 90ha - Others:: 149ha
12	Soc Son (EPZ)	430	Export processing zone
13	Taiwan IE	63	Industrial zone
14	Daewoo IE	80	Industrial zone

South side of Hanoi

An imbalance of employment and resident workers will occur. this unbalance would be fulfilled by the residents in the HUDC, its outskirts and Ha Dong. HUDC is planned as a high population density area (250 persons/ha gross). It is also planned to transfer same business activities from present built-up area to HUDC so as to decrease traffic between HUDC and Hanoi.

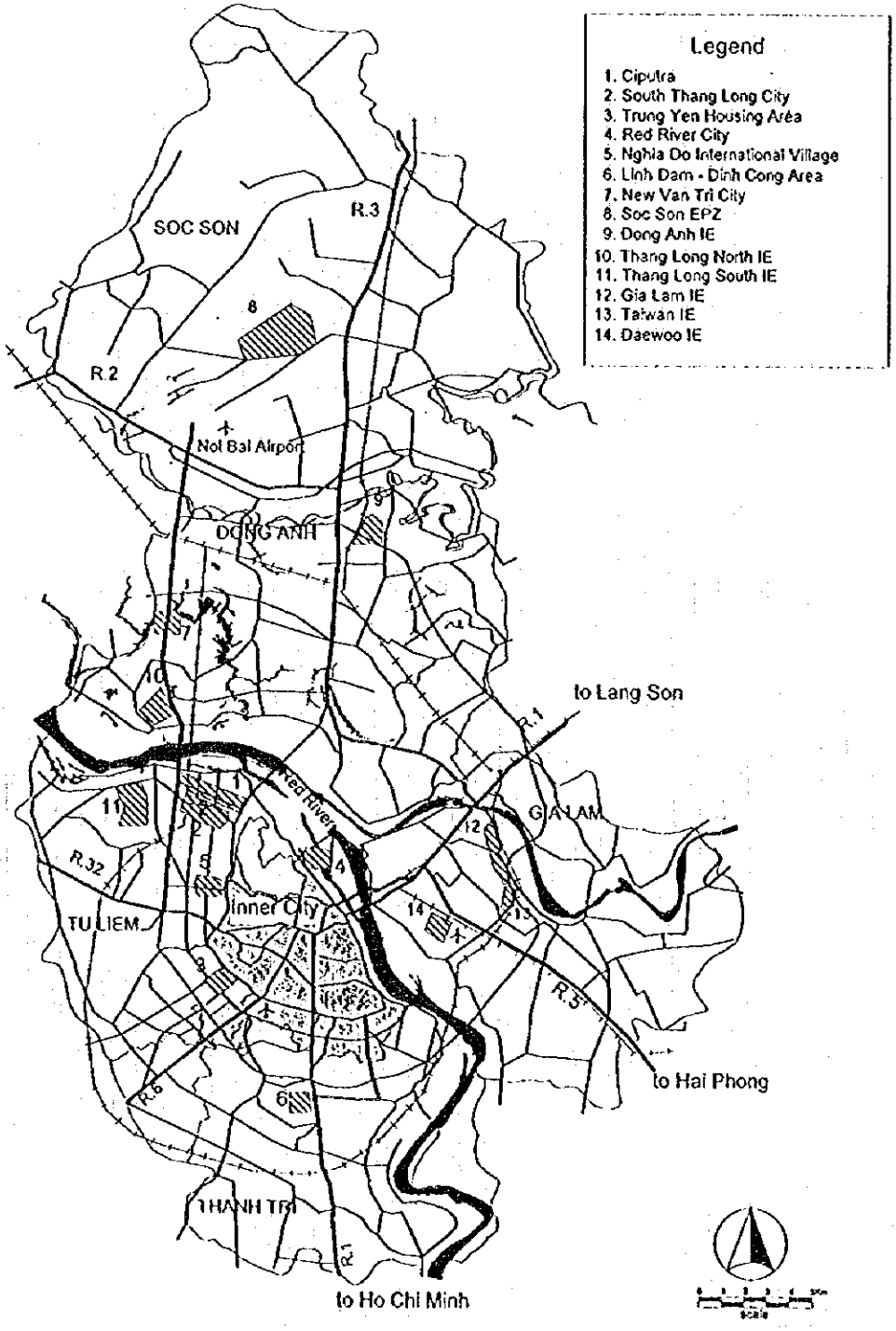


Fig. 8-2-3 Planning Projects

8.2.2 Land Use Plan

Alternatives

There were four alternatives for 2015, which were combinations of population control in present built-up area and the new CBD. As for alternatives for 2005, only two alternatives of with population control and without population control were examined(see Table 8-2-2).

Table 8-2-2 Alternatives of Land Use Plan

	2005		2015	
Population Control / CBD	w/ CBD	w/0 CBD	w/ CBD	w/o CBD
Built-up area controled to 0.8 mil.	o	x	o	o
No population control	o	x	o	o

The population assumptions for the existing built up areas for each of the controlled and non-controlled forecasts:

a) Controlled case 0.80 million
b) Non-controlled case 1.56 million

The employment assumptions for the existing built up areas for the without and with New CBD forecasts are as follows:

a) Without New CBD 867,000
b) With New CBD 735,000

Land Use

Based on the concept described in the preceding section, a land use plan was formed. The major land use of the with population control policy and the new CBD development case of 2005 and 2015 are set out in Figs. 8-2-4 and 8-2-5.

The area by land use and demography and other social indicators by the traffic zones are presented in Table 8-2-3 for 1995 and in Tale 8-2-4 for 2015. Despite of the close location to the present built-up area, Ha Don (Zone 74), which is the capital city of Ha Tai Province, is not included in Hanoi (Study Area).

Table 8-2-3 Land Use by Traffic Zone (1995)

Traffic Zone	Land Use (ha)						Demographic and Social Data			
	Com-mercial	Indus-trial	Insti-tutional	residents	Others	Total	Population	Students	Workers	Employment
1	0	2	0	25	186	213	17,826	2,533	9,507	2,944
2	4	8	6	55	139	212	43,103	6,124	22,988	16,841
3	5	0	11	90	1	107	42,336	6,014	22,579	15,880
4	0	1	4	152	4	161	33,201	4,717	17,707	11,174
5	0	1	7	101	111	220	42,835	6,086	22,845	12,406
6	11	0	0	3	17	31	25,750	3,659	13,733	1,742
7	14	2	30	24	71	141	13,741	1,952	7,328	37,482
8	3	1	8	60	57	129	50,536	7,179	26,952	12,177
9	2	1	0	68	96	167	38,047	5,406	20,291	3,823
10	5	0	30	22	4	61	18,513	2,630	9,874	35,567
11	41	0	14	12	47	114	90,345	12,836	48,183	21,608
12	11	3	1	107	65	187	101,306	14,393	54,029	9,354
13	1	3	0	80	89	173	42,955	6,103	22,909	6,164
14	9	6	34	58	137	244	30,951	4,398	16,506	46,525
15	9	0	64	67	3	143	50,382	7,158	26,870	77,072
16	5	2	13	28	114	162	39,983	5,680	21,324	17,678
17	10	2	1	20	35	68	56,464	8,021	30,114	5,084
18	4	2	14	33	66	119	28,986	4,118	15,460	18,873
19	0	1	0	90	6	97	44,909	6,380	23,951	4,493
20	5	2	8	167	61	243	62,376	8,862	33,267	17,319
21	2	39	6	201	189	437	52,250	7,424	27,867	54,203
22	7	1	0	83	67	158	80,314	11,411	42,833	5,572
23	0	3	0	97	61	161	43,882	6,234	23,403	7,355
24	1	1	0	142	97	241	45,999	6,536	24,533	6,937
25	4	6	6	198	4	218	44,366	6,304	23,662	21,512
26	0	14	0	112	180	306	65,905	9,364	35,149	17,769
27	3	12	0	57	19	91	34,757	4,938	18,537	14,727
28	0	9	0	235	4	248	28,983	4,116	15,457	19,525
29	0	0	0	2	3,564	3,566	9,873	1,692	5,264	682
30	0	0	0	2	2,536	2,538	16,444	2,820	8,768	1,336
31	0	0	0	2	3,892	3,894	13,708	2,349	7,309	948
32	0	0	0	2	2,161	2,163	9,241	1,584	4,927	639
33	0	0	0	2	5,345	5,347	44,879	7,693	23,928	3,104
34	0	0	0	2	3,911	3,913	28,834	4,943	15,373	1,994
35	0	0	0	2	2,728	2,730	12,911	2,213	6,884	892
36	0	0	0	2	2,064	2,066	23,920	4,100	12,753	1,654
37	1	2	1	2	2,354	2,360	19,186	3,288	10,229	3,298
38	0	0	0	2	3,972	3,974	50,829	8,714	27,099	3,515
39	0	0	0	2	3,446	3,448	33,477	5,739	17,849	2,315
40	0	0	0	2	3,669	3,671	37,881	6,493	20,196	2,620
41	1	7	1	2	2,015	2,026	30,184	5,162	16,056	8,986
42	0	0	0	2	2,443	2,445	47,327	8,112	25,233	3,272
43	0	1	0	2	2,850	2,853	33,931	5,817	18,091	3,333
44	0	0	0	2	1,444	1,446	11,378	1,951	6,056	786
45	0	0	0	2	3,450	3,452	26,797	4,593	14,287	1,853
46	3	0	1	2	1,603	1,609	13,156	2,256	7,014	909
47	0	3	0	2	1,573	1,578	16,957	2,907	9,041	4,131
48	0	5	0	100	1,347	1,452	43,707	7,493	23,303	7,904
49	0	12	0	133	2,699	2,844	52,874	9,064	28,190	15,425
50	0	5	0	13	758	776	15,910	2,727	8,483	6,024
51	0	1	0	5	1,619	1,625	35,179	6,030	18,756	3,417
52	0	0	0	2	1,277	1,279	46,719	8,009	24,909	3,231
53	0	0	0	2	791	793	10,087	1,729	5,378	697
54	0	0	0	2	2,408	2,410	29,092	4,987	15,510	2,011
55	0	16	0	5	2,406	2,427	39,907	6,841	21,277	18,537
56	1	2	1	8	868	880	38,725	6,639	20,647	4,647
57	0	0	0	2	502	504	14,070	2,411	7,501	972
58	0	5	0	2	1,781	1,788	26,164	4,485	13,949	6,740
59	0	0	0	2	1,331	1,333	18,212	3,122	9,710	1,259
60	0	0	0	2	3,111	3,113	32,473	5,566	17,314	2,246
61	0	3	0	2	1,404	1,409	39,654	6,798	21,142	5,700
62	0	3	0	2	1,232	1,237	10,915	1,871	5,820	3,713
63	0	3	0	2	862	867	24,375	4,179	12,996	4,643
64	1	1	1	2	854	859	15,859	2,719	8,455	2,082
65	0	1	0	2	739	742	17,907	3,070	9,547	2,224
66	0	3	0	2	290	295	9,089	1,559	4,846	3,586
67	0	3	0	2	387	392	15,195	2,605	8,101	4,009
68	0	0	0	2	595	597	9,758	1,673	5,202	674
69	0	2	0	2	102	106	5,949	1,019	3,172	2,383
70	0	2	0	2	538	542	22,312	3,824	11,896	3,515
71	0	0	0	2	1,625	1,627	16,361	2,805	8,723	1,131
72	0	0	0	2	1,314	1,316	16,183	2,775	8,628	1,119
73	0	0	0	2	2,545	2,547	38,245	6,556	20,393	2,647
Total	163	202	262	2,729	90,336	93,692	2,396,765	373,560	1,278,073	678,398

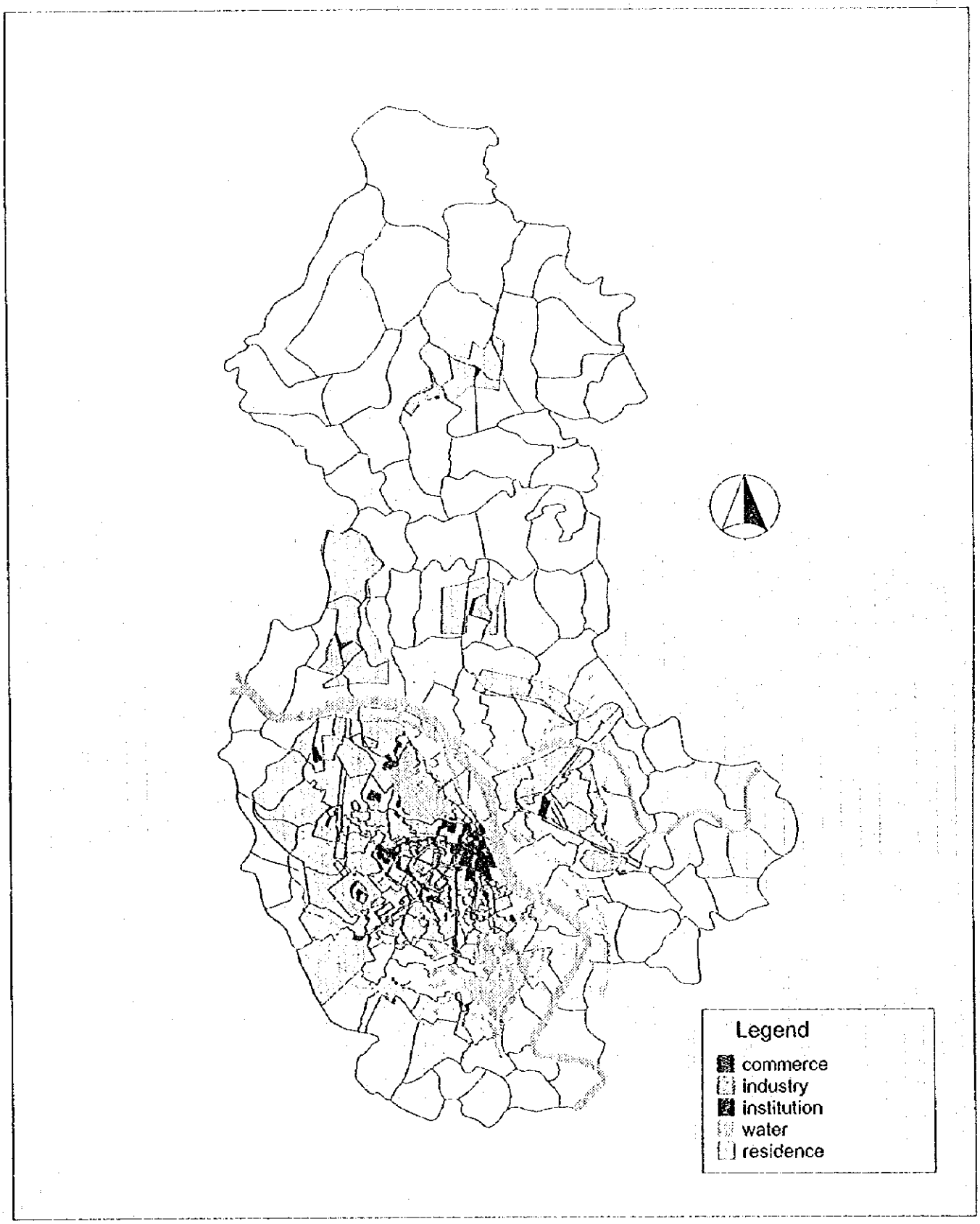


Fig. 8-2-4 Land Use Plan (2005)

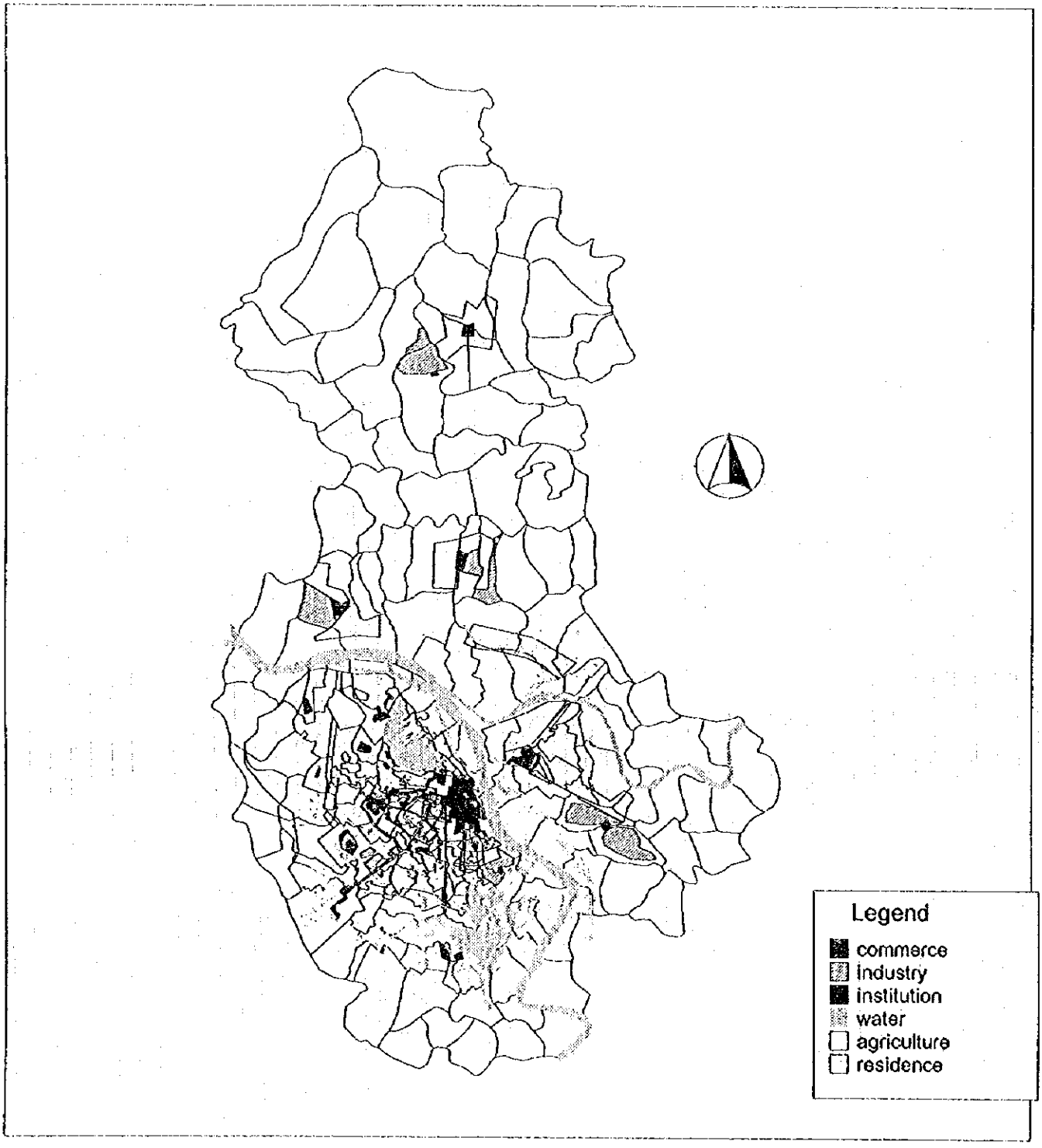


Fig. 8-2-5 Land Use Plan (2015)

Table 8-2-4 Land Use by Traffic Zone (2015)

Traffic Zone	Land Use (ha)						Demographic and Social Data			
	Com-mercial	Indus-trial	Insti-tutional	residents	Others	Total	Population	Students	Workers	Employment
1	1	1	0	79	132	213	22,840	3,100	12,841	2,078
2	4	1	6	86	115	212	24,828	3,476	14,400	14,727
3	5	0	11	80	11	107	23,415	3,278	13,580	24,076
4	1	1	4	108	47	161	30,176	4,225	17,502	9,647
5	1	1	7	209	2	220	58,162	8,143	33,734	16,753
6	26	0	0	4	1	31	7,592	1,063	4,403	17,024
7	15	1	31	17	77	141	8,451	1,183	4,902	64,680
8	9	1	22	73	24	129	22,473	3,146	13,034	45,929
9	9	1	20	84	53	167	25,524	3,573	14,802	42,606
10	11	0	31	7	12	61	4,683	656	2,716	61,891
11	87	0	14	2	11	114	22,250	3,115	12,905	83,413
12	12	1	2	160	12	187	47,328	6,626	27,450	14,235
13	1	1	15	113	43	173	31,561	4,419	18,305	29,108
14	9	1	45	139	50	244	40,761	5,707	23,641	87,625
15	16	0	77	5	45	143	5,375	753	3,118	146,126
16	5	3	19	27	110	162	8,729	1,222	5,063	37,207
17	11	1	8	38	10	68	13,273	1,858	7,698	21,946
18	4	1	19	18	77	119	5,985	838	3,472	36,393
19	1	1	0	85	10	97	23,802	3,332	13,805	2,187
20	5	1	12	205	20	243	58,052	8,127	33,670	28,094
21	2	165	6	110	154	437	30,979	4,337	17,968	57,573
22	8	1	0	147	2	158	42,729	5,982	24,783	7,870
23	6	1	5	133	16	161	38,350	5,369	22,243	15,139
24	1	1	0	224	15	241	62,319	8,725	36,145	4,696
25	4	1	6	172	35	218	48,658	6,812	28,222	16,281
26	1	62	0	135	107	306	37,934	5,311	22,002	18,845
27	3	25	0	62	1	91	17,928	2,510	10,399	9,321
28	1	7	0	121	119	248	33,778	4,729	19,591	4,585
29	0	0	0	0	3,566	3,566	9,126	1,278	5,293	595
30	0	0	0	0	2,538	2,538	15,199	2,128	8,816	990
31	0	0	0	0	3,894	3,894	12,671	1,774	7,349	826
32	0	0	0	0	2,163	2,163	8,541	1,196	4,954	557
33	0	0	0	0	5,347	5,347	41,482	5,807	24,059	2,703
34	30	0	10	410	3,463	3,913	56,625	7,928	32,843	40,372
35	0	80	0	100	2,550	2,730	12,971	1,816	7,523	20,828
36	0	0	0	0	2,066	2,066	22,109	3,095	12,823	1,440
37	5	279	0	300	1,776	2,360	39,456	5,524	22,885	27,991
38	0	0	0	0	3,974	3,974	46,981	6,577	27,249	3,061
39	0	0	0	0	3,448	3,448	30,943	4,332	17,947	2,017
40	0	0	0	100	3,571	3,671	36,049	5,047	20,909	2,349
41	50	282	10	750	934	2,026	103,014	14,422	59,748	129,051
42	0	0	0	0	2,445	2,445	43,744	6,124	25,372	2,850
43	0	1	0	0	2,852	2,853	31,363	4,391	18,190	2,043
44	0	0	0	0	1,446	1,446	10,517	1,472	6,100	684
45	50	320	10	700	2,372	3,452	96,535	13,515	55,990	138,124
46	0	0	0	0	1,609	1,609	12,160	1,702	7,053	792
47	0	1	0	350	1,227	1,578	45,352	6,349	26,304	2,956
48	90	10	15	1,200	137	1,452	165,988	23,238	96,273	96,947
49	5	10	0	120	2,709	2,844	50,161	7,023	29,094	6,447
50	0	2	0	186	588	776	24,101	3,374	13,979	1,570
51	40	1	35	160	1,389	1,625	183,641	25,710	106,512	99,032
52	20	0	5	60	1,194	1,279	73,081	10,231	42,387	26,281
53	0	0	0	5	788	793	9,698	1,358	5,625	632
54	0	0	0	0	2,410	2,410	26,889	3,764	15,596	1,752
55	5	532	5	0	1,885	2,427	37,223	5,211	21,589	147,302
56	5	1	0	248	626	880	236,578	33,121	137,215	18,594
57	0	0	0	110	394	504	103,064	14,429	59,777	6,715
58	0	1	0	20	1,767	1,788	25,682	3,596	14,896	1,674
59	30	35	15	373	876	1,333	374,777	52,469	217,370	79,651
60	0	0	0	0	3,113	3,113	30,015	4,202	17,409	1,956
61	0	1	0	0	1,408	1,409	36,651	5,131	21,258	2,388
62	0	1	0	0	1,236	1,237	10,089	1,412	5,852	657
63	30	24	15	240	558	867	250,163	35,023	145,095	67,784
64	0	11	0	172	676	859	161,154	22,562	93,469	13,249
65	0	1	0	148	593	742	138,667	19,413	80,427	9,035
66	0	1	0	30	264	295	28,108	3,935	16,303	1,831
67	0	27	0	0	365	392	14,045	1,966	8,146	7,660
68	0	0	0	40	557	597	37,478	5,247	21,737	2,442
69	0	1	0	10	95	106	9,369	1,312	5,434	611
70	0	1	0	55	486	542	51,532	7,214	29,888	3,359
71	0	0	0	81	1,546	1,627	75,892	10,625	44,018	4,945
72	0	0	0	0	1,316	1,316	14,958	2,094	8,676	974
73	0	0	0	0	2,547	2,547	35,351	4,948	20,501	2,302
Total	619	1,905	480	8,612	82,076	93,691	3,676,425	514,700	2,132,327	1,954,000

CHAPTER 9 DEMAND FORECAST

9.1 Outline of Demand Forecast

9.1.1 Available Data

(1) SIDA Home Interview Survey Data

The SIDA home interview survey covered all of 84 *Phuongs* of the 4 urban districts and 28 *Xas* adjacent to the urban area. The urban area trip generation/attraction model was formulated using survey results of the 4 urban districts and the rural area trip generation/ attraction model was formulated using survey results of rural districts adjacent to the 4 urban districts.

(2) Cordon Line Survey

The cordon line survey, which was carried out by the Study Team, at 20 locations gives detailed information on the traffic movements crossing the Study area border. The results of the cordon line interview survey were expanded to the full size cordon line OD matrix by the use of traffic counts.

These datas were processed to build the present OD matrix, synthesizing the empty area from the information on the shaded area in Fig. 9-1-1.

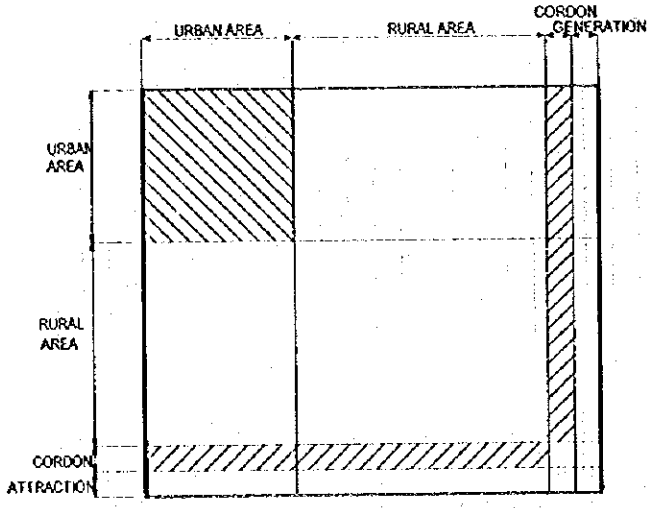


Fig. 9-1-1 Area Covered by Available Data

(3) Screen Line Survey, Road Link Counts and Intersection Traffic Counts

The screen line survey at 25 locations, road link counts at 12 locations, and the intersection traffic counts at 26 intersections gave information on the present link traffic flows. All these count results were processed to 24 hrs. base flows on links in terms of trips, to check the results of the traffic demand forecasts.

9.1.2 Demand Forecasting Process

Fig. 9-1-2 shows the demand forecasting process. Based on the limited information from the available data, the present all purpose 79x79 zones trip OD matrix was developed, synthesizing the trip movements in the rural area, and adding the truck trip movements which was estimated from the observed road side truck flows.

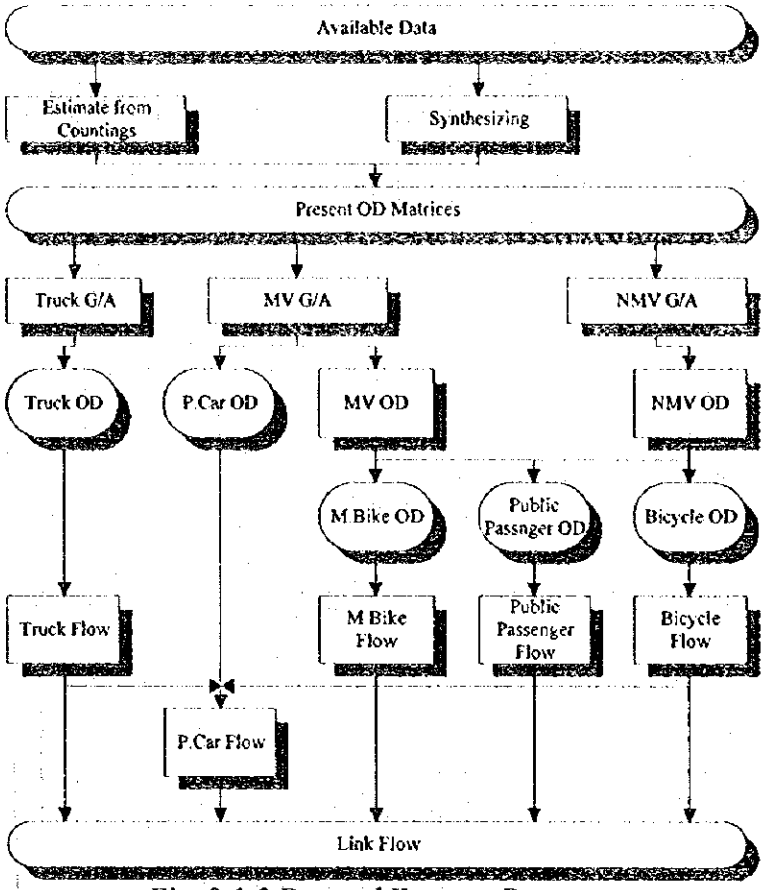


Fig. 9-1-2 Demand Forecast Process

The trip generation/attraction models were developed for Motorized (MV) and Non Motorized Vehicle (NMV) trips, and for the tree purposes of "To work/school", "Back home" and "Others". The motorized trips were split into Passenger Car and other trips, applying the relationship between passenger car trip generation and the passenger car ownership. The public transport passengers were estimated by applying the present relationship between public transport passenger share for total trips (MV+NMV) and the travel distance for the present share and the relationship in Bangkok in 1990 for future shares. Truck trips were estimated separately, based on the estimated present trip pattern and the future freight demand from the planned industrial estates.

Trips in five mode OD matrices were assigned to network links by each mode in the order of two wheelers, public transport, passenger car trips, and truck. The traffic flow on each link was estimated by combining all the mode flows.

9.2 Models

9.2.1 Generation/Attraction (G/A) Models

Trips were classified by the three purposes of "To Work/School", "Back Home" and "Other Purposes", and by the two modes of "Motorized Vehicles (MV)" and "Non Motorized Vehicles (NMV)".

Analysis of SIDA data make it clear that almost 50 % of trips were "Back Home" trips. Those justifies to consider inversion of "To Work/School" trips as "Back Home" trips. In this context, four types of generation and attraction models excluding the models for "Back Home" trips were formulated.

Followings are the formulated models. Number of employees does not include farmers and shoppers merchandising in their residences.

(1) Generation Models

To Work/School Trips by Non Motorized Vehicles (GWN)
GWN = 3892 + 0.125P
where, P = population
To Work/School Trips by Motorized Vehicles (GWM)
GWM = 1983 + 0.051P
where, P = population
Other Trips by Non Motorized Vehicles (GON)
GON = 1326 + 0.052P
where, P = population
Other Trips by Motorized Vehicles (GOM)
GOM = 176 + 0.037P
where, P = population

(2) Attraction Models

Work/School Trips by Non Motorized Vehicles (AWN)
AWN = 6715 + 0.049P +0.07E
where, P = population
E = employment
Work/School Trips by Motorized Vehicles (AWM)
AWM = 2483 + 0.033P + 0.029E
where, P = population
E = employment
Other Trips by Non Motorized Vehicles (AON)
AON = 2081 + 0.036P
where, P = population
Other Trips by Motorized Vehicles (AOM)
AOM = 646 + 0.026P + 0.006E
where, P = population
E = employment

The SIDA data shows the return trip rates (Table 9-2-1) by purpose and by mode.

Table 9-2-1 Return Trip Rates

Description	NMV	MV
To Work/School (Trips)	268,787	120,268
Others (Trips)	101,945	101,599
Total (Trips)	370,732	221,867
To Home (Trips)	379,091	180,663
Return Trip Rate	1.023	0.814

(3) Share of MV Trips

After calculation of generation/attraction trips by purpose and by mode, the total share of MV trips are adjusted by the following formula and the rates given in Table 9-2-2.

$$MV = 1.0 - \frac{1.79}{1.0 + EXP^{0.0136 \times I}} \quad (r^2=0.89)$$

Where, MV :Share of Motorized Vehicle trips

I: Private monthly income in US$

Table 9-2-2 MV Trips Share

	1994	1995	2000	2005	2015
Personal Monthly Income (US$)	30.68	32.45	42.38	55.33	94.43
MV Share(%)	0.2930	0.3033	0.3596	0.4299	0.6141

According to these formulas and rates, the generation/attraction trips for the four combinations of "With/Without New CBD" and "With/Without Control in the Built-up Area" cases as shown in Table 9-2-2.

Table 9-2-3 below shows the summary of the trip generation estimate results in the case of "With New CBD" and "With Control". The total trip end will increase by 2.67 times in 2015, and the MV trips will increase more than the NMV trips in accordance with the national economy growth.

Table 9-2-3 Trip Generation

unit: 1,000 Trips/day

MODE	PURPOSE	1995	2015	2015/1995
NM	WORK	889	1,368	1.54
	OTHERS	343	506	1.48
	HOME	1,261	1,923	1.52
	SUB TOTAL	2,493	3,797	1.52
MV	WORK	383	1,843	4.81
	OTHERS	152	1,146	7.54
	HOME	436	2,443	5.60
	SUB TOTAL	971	5,432	5.59
TOTAL		3,463	9,229	2.67

Note: With New CBD, With Control Case

Table 9-2-4 (1) Trip Generation in 1995

1995 TRIPS

ZONE	GENERATION						TOTAL	ATTRACTION						TOTAL
	NM			MV				NM			MV			
	W	O	H	W	O	H		W	O	H	W	O	H	
1	7613	2766	14136	3487	765	4289	33056	10340	3122	10571	4044	1216	3163	33056
2	10056	3799	15742	4124	1484	5178	40683	11274	4092	14152	4673	1683	4810	40684
3	12758	4941	17523	5161	2276	6161	49120	12305	4833	18116	6369	2202	6298	49123
4	16318	6447	19874	6827	3322	7457	60245	13660	5809	23311	6281	2885	8264	60246
5	19596	7831	22039	8086	4283	8550	70185	14904	6707	28158	7127	3515	10074	70485
6	8360	3082	14626	3773	984	4560	35385	10626	3626	11565	4236	1359	3874	35386
7	8914	3316	14999	3986	1148	4763	37117	10838	3778	12177	4379	1466	4180	37118
8	10294	3899	15899	4516	1553	5264	41425	11364	4156	14500	4734	1729	4910	41423
9	10758	4096	16206	4694	1689	5433	42876	11543	4284	15180	4854	1819	5196	42875
10	9875	3723	15623	4355	1431	5112	40119	11205	4042	13686	4626	1649	4710	40118
11	16251	6418	19828	6801	3302	7432	60032	13633	5790	23241	6266	2872	8227	60032
12	14488	5672	18683	6125	2784	6791	54523	12962	5306	20655	5812	2534	7253	54522
13	11447	4387	16659	4958	1892	5684	45027	11905	4473	16191	5031	1950	5576	45026
14	10791	4109	16227	4707	1699	5445	42978	11551	4293	15229	4862	1825	5214	42977
15	16793	6647	20187	7010	3150	7630	61727	13810	5939	24040	6406	2977	8526	61728
16	8754	3249	14886	3924	1100	4703	36616	10777	3731	12242	4337	1434	4090	36614
17	8807	3270	14921	3945	1116	4723	36782	10797	3749	12319	4351	1445	4121	36782
18	9031	3365	15068	4031	1182	4806	37483	10882	3811	12648	4409	1488	4245	37482
19	12024	4631	17039	5179	2062	5991	46829	12024	4631	17038	5180	2061	5895	46829
20	17506	6948	20658	7283	3670	7889	63954	14111	6134	25087	6589	3114	8919	63954
21	22112	8895	23702	9050	5021	9568	78348	15861	7397	31856	7774	3998	11462	78348
22	13463	5239	17987	5732	2481	6117	51322	12572	5025	19150	5519	2337	6688	51321
23	13569	5284	18058	5772	2514	6155	51652	12613	5054	19305	5577	2357	6745	51651
24	16324	6449	19877	6830	3323	7459	60262	13661	5810	23352	6285	2896	8267	60261
25	21697	8719	23427	8892	4899	9417	77051	15703	7283	31216	7667	3918	11234	77050
26	12929	5013	17635	5526	2327	6923	49653	12369	4979	18365	5112	2235	6392	49652
27	10759	4096	16206	4691	1689	5433	42877	11542	4284	15181	4854	1819	5196	42876
28	24642	9964	25376	10021	5763	10189	86255	16821	8091	35574	8124	4185	12860	86255
29	7905	2889	14329	3599	851	4391	33967	10453	3502	10998	4119	1271	3624	33967
30	9228	3419	15199	4107	1240	4876	38099	10958	3865	12938	4459	1525	4354	38099
31	8677	3216	14834	3896	1078	4676	36377	10747	3713	12130	4318	1420	4019	36377
32	7777	2835	14244	3550	814	4350	33570	10104	3167	10811	4087	1248	3554	33571
33	14953	6870	18971	6303	2922	6961	55980	13140	5134	21339	5933	2624	7510	55990
34	11724	4503	16810	5063	1973	5785	45888	11910	4548	16598	5102	2004	5727	45889
35	8518	3148	14731	3834	1030	4618	35879	19686	3670	11895	4272	1389	3961	35878
36	10736	4086	16189	4684	1682	5423	42799	11533	4278	15147	4847	1813	5183	42801
37	9782	3682	15561	4318	1402	5078	39823	11169	4017	13748	4603	1631	4657	39825
38	16133	6368	19749	6756	3268	7390	59664	13588	5757	23071	6237	2850	8162	59665
39	12658	4899	17456	5123	2248	6123	48807	12266	4805	17968	5342	2182	6244	48807
40	13544	5274	18041	5763	2507	6418	51577	12603	5018	19270	5571	2353	6732	51577
41	11981	4613	17011	5163	2048	5878	46691	12008	4619	16976	5169	2052	5870	46691
42	16389	6053	19269	6470	3049	7119	57339	13305	5554	21977	6045	2706	7750	57337
43	12720	4926	17497	5446	2265	6146	48999	12290	4821	18059	5357	2191	6277	48998
44	8208	3018	14527	3715	941	4505	34914	10568	3595	11411	4197	1329	3791	34914
45	11314	4330	16570	4906	1852	5635	44607	11754	4436	15995	4997	1935	5502	44609
46	8567	3169	14763	3853	1015	4636	36033	10705	3683	11967	4290	1399	3989	36033
47	9332	3493	15265	4146	1220	4915	38421	10997	3893	13099	4487	1546	4109	38422
48	14495	5675	18667	6128	2786	6791	54545	12965	6308	20664	5815	2536	7257	54545
49	16364	6466	19902	6845	3334	7474	60385	13676	5820	23110	6295	2891	8289	60381
50	9094	3392	15110	4084	1201	4827	37678	10907	3828	12740	4425	1500	4279	37679
51	12906	5003	17619	5517	2320	6214	49579	12360	4872	18332	5406	2230	6380	49580
52	15152	5954	19101	6379	2980	7033	56599	13215	5158	21630	5984	2662	7620	56599
53	7948	2907	14357	3615	863	4112	34102	10169	3514	11061	4130	1281	3646	34101
54	11776	4526	16878	5084	1958	5802	45051	11930	4563	16675	5116	2013	5756	46052
55	13822	5391	18226	5869	2589	6518	52411	12709	5124	19677	5612	2406	6885	52443
56	13580	5289	18067	5777	2518	6461	51692	12618	5058	19323	5579	2360	6753	51691
57	8751	3247	14883	3923	1160	4703	36607	10776	3733	12238	4337	1431	4089	36607
58	11187	4277	16487	4857	1816	5588	41212	11705	4402	15809	4963	1900	5432	41211
59	9567	3592	15420	4236	1340	5000	39155	11088	3957	13433	4547	1590	4539	39154
60	12456	4814	17323	5345	2188	6052	49178	12189	4750	17672	5291	2141	6132	48178
61	13898	5423	18273	5898	2611	6575	52678	12738	5141	19789	5661	2420	6927	52679
62	8115	2977	14456	3679	912	4471	34619	10532	3559	11305	4173	1312	3739	34620
63	10588	4024	16093	4628	1639	5371	42343	11478	4237	14932	4809	1786	5101	42343
64	9071	3383	15094	4047	1194	4819	37608	10897	3821	12709	4419	1494	4267	37606
65	9422	3530	15324	4181	1296	4917	38700	11031	3918	13221	4510	1563	4458	38701
66	7737	2819	14218	3535	802	4335	33446	10388	3556	10753	4076	1240	3532	33445
67	8975	3341	15031	4009	1165	4781	37305	10861	3795	12565	4391	1476	4213	37304
68	7883	2890	14312	3590	841	4388	33897	10143	3496	10966	4114	1267	3611	33897
69	7114	2554	13810	3295	618	4109	31500	10149	3286	9940	3916	1121	3168	31500
70	10411	3949	15975	4560	1587	5306	41788	11409	4188	14673	4763	1752	5003	41788
71	9130	3407	15132	4068	1210	4841	37788	10929	3837	12793	4434	1506	4297	37787
72	9176	3426	15153	4087	1226	4858	37935	10938	3859	12860	4447	1515	4326	37935
73	13499	5284	18010	5745	2491	6431	51432	12586	5035	19201	5559	2344	6707	51432
74	22566	9087	24002	9226	5154	9732	79767	16032	7522	32524	7890	4085	11714	79767
TOTAL	889756	342662	1261036	383261	152481	436156	3165352	889677	342688	1260986	383242	152550	436202	3165345

Table 9-2-4 (2) Trip Generation in 2015
With New CBD With Control Case

2015 TRIPS with New CBD with Control Case

ZONE	GENERATION						TOTAL	ATTRACTION						TOTAL
	NM			MV				NM			MV			
	W	O	H	W	O	H		W	O	H	W	O	H	
1	11330	4105	18100	16055	6889	16525	73004	12770	1782	15659	15729	5101	18961	73005
2	11925	4341	19709	16795	7590	20729	81092	11100	4931	16116	17539	8955	20018	81092
3	11651	4232	20144	16463	7241	23155	83195	14795	4839	15976	18312	9881	19391	83194
4	13024	4791	19933	18147	8934	20352	85181	14111	5273	18127	17851	7527	22261	85180
5	18861	7159	24446	25360	15935	28131	119955	17082	6996	26803	23292	11903	33873	119954
6	8330	404	17638	12368	3199	17898	59537	12815	3965	8298	14903	6767	12887	59536
7	8583	2982	22470	12697	3418	32095	82236	17009	3687	11279	20153	16777	13132	82237
8	11502	4170	22470	16288	7035	29330	90795	10613	4760	15820	20506	14370	16928	90797
9	12131	4127	22550	17906	7809	28972	92958	16586	4951	16572	20659	13993	20198	92959
10	7781	74	21710	11714	2469	30507	74258	16130	3656	7575	19211	15786	11601	74259
11	11516	10	25935	16314	7015	39673	100463	19676	4723	11291	24283	21745	18745	100463
12	16603	6242	22717	22569	13065	25190	106586	15956	6328	23145	21226	10258	29374	106586
13	13365	4927	22035	18578	9322	26267	94494	15927	5337	18184	20212	11784	22749	94193
14	15417	5755	29023	21128	11749	45160	128232	21911	5853	21156	28054	25021	26336	128231
15	7991	33	30129	11989	2671	55581	108397	23762	3669	7624	28339	33210	11792	108396
16	8604	2994	19789	12715	3504	24037	71643	14659	3919	11109	17256	11101	13299	71643
17	9531	3371	18878	13847	4560	20183	70770	13735	4212	12845	16083	8386	15210	70771
18	8026	2758	19360	12003	2796	23255	68188	14316	3749	10569	16706	10641	12179	68189
19	11676	4245	18339	16482	7310	16894	74946	12922	4886	16176	16016	6295	19650	74945
20	18876	7163	25536	25381	15999	31377	124332	18069	6975	26721	24503	14304	33760	124332
21	13398	4901	24763	18517	9218	34432	105129	18356	5275	18217	23183	17701	22398	105130
22	15627	5847	21465	21359	12093	22415	98806	15012	6051	22042	19714	8434	27491	98807
23	14740	5487	21580	20268	11007	23606	96688	15289	5772	20648	19832	9525	25631	96668
24	19683	7491	23838	26368	17002	25531	119913	16365	7268	28166	22669	9757	35687	119912
25	16886	6358	23097	22918	13607	26052	108918	16246	6408	23850	21668	10829	29916	108917
26	14664	5456	21890	20176	10911	24591	97691	15671	5742	20502	20165	10272	25139	97691
27	10472	3766	18251	16003	5931	17758	71071	13041	4512	14324	15806	6207	17161	71071
28	13757	5088	19926	19050	9830	19633	87283	13973	5501	19268	17933	6821	23787	87283
29	8618	3003	16247	12712	3578	13430	57558	11525	3976	11626	13393	3469	13570	57558
30	9884	3518	17063	14272	6126	14787	64650	12083	4352	13508	14153	4168	16086	64650
31	9355	3303	16710	13623	4482	14222	61695	11852	4196	12720	14012	3877	15037	61694
32	8495	2953	16135	12563	3428	13301	56875	11471	3938	11411	13291	3403	13328	56875
33	15350	5735	20790	21016	11765	20674	95330	14455	5982	21676	19003	7205	27005	95331
34	18617	7057	26643	25065	15672	34628	127582	19028	6971	26226	25598	16757	33100	127583
35	9463	3344	18730	13766	4581	20097	69981	13613	4195	12753	16213	8119	15089	69982
36	11321	4100	18038	16044	6879	16333	72715	12713	4782	15651	15654	4955	18959	72715
37	15124	5637	27895	20763	11403	42070	122893	20857	5780	20777	25793	22858	25828	122893
38	16493	6200	21574	22429	13148	21907	101751	14911	6321	23392	19956	7841	29296	101750
39	13159	4847	19287	18311	9112	18310	83026	13510	5328	18399	17181	5986	22621	83028
40	14220	5277	20014	19622	10400	19455	88988	13968	5645	19987	18068	6576	24746	88990
41	28523	11068	41533	37328	27571	69728	215751	30696	9646	40290	42892	40293	51937	215754
42	15821	5927	21110	21597	12337	21182	97974	14655	6120	22381	19339	7466	27919	97973
43	13246	4883	19348	18420	9216	18106	83519	13517	5356	18528	17258	6031	22796	83519
44	8907	3119	16409	13070	3933	13741	59179	11652	4061	12053	13637	3630	14145	59178
45	27193	10529	41534	35685	25960	71057	211958	30918	9239	38250	42797	41513	49210	211957
46	9250	3259	16649	13491	4352	14109	61101	11805	4161	12585	13924	3818	14826	61102
47	16155	6063	21341	22010	12741	21512	99852	14799	6220	22884	19676	7653	28618	99850
48	41531	16312	47065	63404	43277	73276	274895	33100	13553	60018	49821	40072	78332	274896
49	17164	6471	22341	23259	13957	23535	106727	15508	6513	24364	20851	8890	30602	106728
50	11737	4269	18319	16556	7383	16777	75041	12893	4905	16272	15999	5191	19777	75040
51	45517	17852	59304	58346	48032	106055	335206	43497	14537	65059	63729	63288	85091	335204
52	22077	8460	29983	29313	19843	41503	151209	21475	7876	31293	29645	21010	39881	151210
53	8739	3051	16358	12862	3726	13743	58179	11633	4010	11798	13561	3669	13806	58477
54	12323	4597	16886	17278	8092	17909	76995	13298	5076	17132	16673	5889	20927	76995
55	14902	5638	45919	20527	11019	105192	206387	39458	5555	19768	49671	67425	24511	206388
56	55939	22181	51064	71213	60659	70697	331752	33585	17996	82408	64918	34562	108293	331752
57	28165	10929	30298	36858	27228	36416	169894	20505	9775	40836	30312	15792	52613	169893
58	12070	4405	18705	16968	7787	17615	77550	13181	5000	16765	16454	5733	20126	77550
59	85093	33958	81952	107291	95697	133993	538017	55826	26349	121829	91029	74891	165095	538019
60	12972	4771	19348	18083	8881	18067	82722	13598	5268	18101	17236	6291	22225	82722
61	14353	5332	20334	19787	10556	20278	90640	14231	5679	20163	18431	7154	24982	90640
62	8820	3081	16414	12962	3826	13837	58943	11671	4033	11920	13633	3719	13906	58842
63	59145	23476	62425	75197	61475	101613	386332	43470	18696	86066	67913	56982	113205	386332
64	40261	15829	39589	51820	41791	52107	241397	26411	13315	58905	41336	24541	76827	241398
65	35565	13929	35666	46019	36141	45975	212386	23818	11968	51932	36713	20131	67493	212385
66	12574	4610	19066	17592	8100	18204	80115	13115	5150	17508	16892	6047	21433	80145
67	9677	3131	18326	14025	4851	18711	69921	13228	4265	13101	15802	7073	15552	69021
68	14527	5400	20455	20000	10765	20193	91627	14309	5729	20120	18581	7262	25325	91626
69	8670	3023	16311	12777	3640	13660	58081	11601	3989	11697	13501	3626	13667	58081
70	17451	6587	22556	23612	14302	23891	108399	15615	6593	24792	21106	9056	31172	108399
71	22517	8640	26210	29874	20419	29811	137471	17918	8101	32374	25177	12251	41318	137472
72	9836	3497	17127	14213	5067	15017	64757	12156	4337	13128	14517	4347	15982	64757
73	14083	5221	20139	19151	10227	19963	89087	14106	5598	19760	18197	6985	24441	89087
74	106921	42830	93340	134297	121910	145991	645352	61439	32930	158150	104695	78434	209705	645353
	1367695	506845	1923411	1843016	1146100	2442883	9228950	1306197	507118	1923960	1812120	1147765	2442691	9228951

Table 9-2-4 (3) Trip Generation in 2015
With New CBD Without Control Case

2015 TRIPS with New CBD W/O Control Case

ZONE	GENERATION						TOTAL	ATTRACTION						TOTAL
	NM			MV				NM			MV			
	W	O	H	W	O	H		W	O	H	W	O	H	
1	14995	5624	20634	20610	11319	20589	93771	14398	5554	21172	18860	7192	26295	93771
2	16040	6050	22647	21909	12563	25284	104393	15928	6136	22619	21053	10426	28231	104393
3	15538	5845	23111	21293	11947	27454	105188	16528	5969	21786	21638	12143	27125	105189
4	18920	6858	23395	24357	14960	25880	113370	16312	6735	25638	22130	10390	32264	113469
5	28497	11125	31156	37320	27563	38748	174399	21248	9822	41307	31405	17416	53202	174400
6	10442	101	19066	14992	5779	20243	70626	13795	4479	10526	16748	8005	17071	70624
7	10000	3590	23422	14465	5177	33682	90326	17087	4283	13351	21423	17704	15878	90326
8	15246	5723	25023	20938	11565	33458	111953	18294	5842	21182	23718	16594	26322	111952
9	16380	6165	26458	22339	12949	33650	116952	18183	6183	22892	24289	16498	28607	116952
10	9192	74	22590	13356	4083	32011	81216	17066	4025	8933	20394	16653	14146	81217
11	17743	10	30140	24035	14553	46386	132867	23167	6526	17788	29601	25492	30994	132868
12	22318	8609	26696	29677	20137	31530	138967	18154	8000	32053	26077	13548	40834	138966
13	17184	6515	24674	23330	13928	30517	116148	17630	6447	24205	23497	14023	30356	116148
14	20373	7813	32424	27294	17723	50611	156268	24024	7282	28509	32302	28031	36121	156269
15	9528	33	31142	13902	4539	57360	116501	24510	4088	9163	29723	34338	14682	116504
16	10717	3875	21214	15341	6082	26383	83612	15638	4525	14529	19100	12376	17443	83611
17	12730	4098	21057	17821	8548	24014	88868	15181	5143	17611	19134	10248	21551	88868
18	9475	3368	20323	13809	4568	24891	76434	15033	4160	12706	17990	11536	15009	76434
19	14548	5442	20327	20057	10779	20106	91259	14206	5721	20502	18488	6942	25400	91259
20	25888	10064	30424	34104	24424	39146	164050	21127	9026	37274	30447	18362	47815	164051
21	20787	7983	29980	27797	18249	42583	147279	21652	7455	29315	29618	22082	37229	147281
22	26886	10066	28604	34095	24440	33690	156781	19152	9073	37487	28105	14269	48095	156781
23	23953	9217	27975	31706	22109	33725	148745	19284	8482	31495	27597	14784	44103	148745
24	34637	13632	34287	44934	34968	41964	204422	22791	11676	50715	35210	18255	65776	204423
25	22761	8791	27194	30229	20670	32567	142212	18816	8127	32700	26655	14215	41699	142212
26	19247	7358	25072	25881	16432	29690	123680	17593	7079	27393	24076	12928	34611	123680
27	14784	5538	21211	20365	11054	22510	95452	14958	5776	20785	19480	8670	25783	95452
28	21866	8427	28656	29117	19605	28551	133125	17502	7888	31474	24774	11429	40059	133126
29	8610	3017	16230	12722	3568	13499	57646	11655	3958	11634	13445	3491	13562	57645
30	9874	3535	17079	14283	5112	14861	64744	12114	4336	13517	14508	4194	16076	64744
31	9348	3319	16726	13632	4471	14294	61790	11883	4179	12731	14067	3991	15029	61790
32	8487	2968	16150	12572	3419	13367	56963	11500	3924	11451	13313	3423	13321	56962
33	15336	5763	20810	21033	11731	20780	95456	14491	5958	21690	19079	7249	26989	95456
34	18602	7093	26568	25088	15628	34808	127787	19074	6845	26239	25691	16860	33077	127786
35	9357	3361	18747	13778	4567	20200	70110	13648	4178	12763	16274	8169	15079	70111
36	11311	4120	18052	16057	6858	16117	72815	12745	4763	15661	15715	4995	18937	72816
37	15112	5665	27927	20784	11373	42293	123151	20908	5751	20787	26892	22998	25810	123152
38	16479	6231	21596	22447	13111	22019	101883	14982	6297	23406	20030	7890	29277	101882
39	13147	4971	19306	18326	9084	18404	83138	13546	5307	18110	17249	6022	22605	83139
40	14268	5393	20034	19638	10369	19556	89108	14003	5624	19999	18138	6616	24728	89108
41	28504	11124	41579	37363	27498	70098	216166	30771	9605	40310	43047	40537	51896	216166
42	15807	5957	21133	21616	12300	21291	98104	14691	6098	22397	19471	7513	27931	98104
43	13236	4907	19365	18435	9191	18499	83633	13582	5335	18541	17323	6071	22780	83632
44	8898	3134	16426	13080	3922	13809	59268	11684	4016	12061	13688	3652	14137	59268
45	27175	10583	41581	35720	25892	71432	212383	31024	9202	38269	42951	41764	49171	212381
46	9241	3275	16653	13503	4841	14180	61193	11836	4147	12573	13977	3842	14918	61193
47	15140	6092	21363	22028	12703	21654	99980	14837	6196	22898	19750	7701	28599	99981
48	41501	16424	47117	53455	43162	73661	275320	33182	13498	60049	50003	40315	78273	275320
49	17161	6503	22362	23280	13919	23655	106870	15547	6487	24380	20929	8944	30583	106870
50	11726	4290	18332	16569	7362	16963	75142	12925	4885	16282	16059	6226	19765	75142
51	33656	13223	50877	43753	33671	92962	269142	38208	11021	47532	63731	56096	61554	268142
52	17360	6586	26644	23554	14119	36256	124518	19373	6461	24310	25681	18190	30503	124518
53	8706	3055	16366	12841	3685	13783	58426	11651	3988	11771	13592	3676	13748	58426
54	12311	4530	18900	17291	8069	18001	79105	13331	5055	17142	16736	5925	20915	79104
55	14372	5559	48961	20521	10964	106026	206903	39541	5524	19747	49828	67814	24449	206903
56	40739	16117	40083	52499	42290	53222	244950	26818	13149	59091	42022	25197	17783	244951
57	21537	8292	25541	28710	19206	28835	132121	17557	7781	30953	24739	11724	39365	132122
58	11963	4387	18654	16864	7647	17591	77109	13171	4952	16623	16433	5708	20222	77109
59	60998	24369	64572	77619	66576	106500	400634	45089	19162	88868	70594	60117	116805	400635
60	12960	4791	19365	18098	8856	18763	82835	13633	5247	18112	17300	6334	22210	82836
61	14342	6358	29355	19805	10527	20383	90770	14268	5657	20177	18501	7198	24968	90769
62	8811	3099	16430	12973	3815	13905	59033	11702	4018	11926	13684	3742	13960	59031
63	43048	17055	50852	65377	45010	83365	294707	36295	13896	62091	54283	47139	81005	294709
64	29903	11702	32126	39073	29265	40230	182298	21831	10243	43438	32660	18171	56051	182297
65	26652	10376	29246	35044	25359	31851	161528	19681	9295	38624	29166	14948	49615	161529
66	10759	3896	17802	15376	6186	16182	70201	12613	4596	14827	15385	4956	17825	70201
67	9668	3448	18344	14037	4835	18806	69138	13261	4249	13109	15861	7117	15541	69138
68	12108	4446	18758	17043	7822	17763	77940	13237	4995	16838	16560	6798	20510	77938
69	8058	2791	15906	12044	2893	13029	54721	11346	3791	10810	13025	3276	12468	54719
70	14131	5271	20203	19542	10271	20133	89551	14171	5595	19861	18316	7066	24542	89551
71	17633	6700	22720	23876	14499	24246	109674	15775	6631	25101	21355	9266	31545	109673
72	9827	3514	17139	14224	5050	15091	64845	12477	4319	13437	14570	4375	15969	64847
73	14070	5247	20161	19471	10200	20064	89213	14143	5577	19771	18265	7029	24422	89212
74	76038	30498	71001	96251	81659	110523	468970	47675	23712	111992	78470	59426	147704	468969
	1368175	504514	1920732	1846361	1145762	2443408	9228952	1367338	505638	1920931	1846008	1146209	2442627	9228951

Table 9-2-4 (4) Trip Generation in 2015
Without New CBD With Control Case

2015 TRIPS W/O New CBD with Control Case

ZONE	GENERATION						TOTAL	ATTRACTION						TOTAL
	NM			MV				NM			MV			
	W	O	H	W	O	H		W	O	H	W	O	H	
1	11634	4309	18870	16786	7124	18096	76813	13358	4957	16188	16879	5759	19673	76814
2	12274	4567	20565	17601	7863	22655	85525	14748	5123	17034	18820	8990	20809	85524
3	10229	3721	20079	15026	5418	23222	77695	14660	4189	13927	18069	9889	16662	77696
4	13456	5055	20855	19089	9271	22354	90080	14796	5491	18813	19251	8159	23226	90079
5	19735	7647	25841	27020	16682	31237	128162	18952	7371	28188	25934	13491	35726	128162
6	8412	106	18225	12735	3259	19291	62028	13300	3954	8423	15802	7422	13126	62027
7	8013	2814	22789	12291	2756	33774	82467	17331	3788	10539	20766	17889	12152	82468
8	10007	3626	23512	14762	5107	34056	91069	17706	4375	13408	21826	17774	15981	91070
9	10847	3972	24263	15821	6102	35538	96543	18234	4619	14624	22758	18690	17607	96542
10	7302	76	22045	11360	1866	32180	74829	16755	3571	7108	19819	16847	10728	74828
11	10160	10	25819	14963	5265	41067	97284	19698	4393	9915	24316	22747	16156	97284
12	17168	6588	24023	23779	13656	28292	113506	16926	6597	24341	23102	11951	30585	113505
13	11695	4323	25732	16895	7105	39236	104987	19110	4861	15824	24183	21197	19213	104988
14	17140	6572	28082	23767	13572	40898	130021	20576	6503	23939	27645	21303	30055	130021
15	7674	34	38896	11857	2223	84496	145180	31414	3608	7258	38406	50376	11118	145180
16	9286	3329	21846	13852	4261	29618	82192	16347	4174	12411	19900	14715	14645	82192
17	8525	3015	20051	12885	3366	24806	72649	14879	3964	11356	17821	11396	13231	72647
18	7880	2747	21467	12085	2573	29827	76579	16199	3752	10344	19389	15106	11889	76579
19	12007	4458	19134	17254	7664	18528	78945	13525	5070	16745	17206	5985	20414	78945
20	19751	7652	26969	27045	16688	34707	132812	19070	7349	28093	20604	16091	35605	132812
21	13765	5178	26841	19498	9574	37455	111311	19176	5493	18935	24829	19511	23366	111310
22	16255	6211	22584	22620	12587	24806	105063	15811	6341	23057	21419	9575	28861	105064
23	15300	5817	22651	21421	11418	25999	102636	16056	6036	21564	21418	10717	26855	102636
24	20616	8010	25264	28129	17739	28524	128282	17343	7667	29650	24739	11202	37679	128280
25	17609	6769	24310	24335	14176	28816	116015	12125	6730	25001	23491	12231	31467	116045
26	15220	5784	22967	21320	11347	27050	103688	16354	6004	21399	21761	11522	26647	103687
27	10712	3924	18975	15628	6016	19338	74593	13608	4663	14750	16902	6917	17752	74592
28	14243	5381	20890	20079	10213	21655	92461	14679	5741	20073	19361	7731	24869	92460
29	8566	3037	16664	12920	3475	14358	59019	11916	4031	11622	14112	3769	13570	59020
30	9827	3559	17543	14509	4978	15813	66229	12489	4414	13499	15223	4526	16079	66230
31	9303	3341	17175	13847	4352	15207	63225	12251	4253	12717	14761	4210	15933	63226
32	8443	2987	16580	12767	3329	14218	58324	11860	3995	11441	14004	3696	13328	58324
33	15276	5809	21390	21383	11439	22129	97426	14926	6060	21648	20001	7818	26972	97425
34	18541	7152	27326	25523	15248	37091	130881	19633	6956	26168	26917	18169	33036	130879
35	9416	3386	19262	14000	4451	21502	72017	14064	4251	12742	17069	8814	15077	72017
36	11262	4150	18545	16315	6684	17472	74428	13134	4847	15638	16482	5390	18936	74427
37	15067	5713	28728	21147	11097	45074	126826	21519	5850	20731	29171	24781	25774	126826
38	16416	6278	22200	22822	12785	23450	103951	15133	6402	23354	20998	8508	29255	103950
39	13094	4906	19838	18627	8956	19596	84916	13955	5400	18377	18090	6496	22598	84916
40	14151	5344	20690	19963	10108	20822	90978	14427	5720	19962	19017	7137	24716	90979
41	28154	11236	43686	38069	26869	77493	225807	32447	9748	40140	46067	45664	51751	225807
42	15745	6001	21723	21976	11993	22675	100112	15131	6202	22348	20413	8102	27912	100111
43	13181	4943	19901	18737	8958	19694	85414	13993	5427	18508	18165	6548	22773	85414
44	8855	3156	16866	13284	3919	14692	60672	12949	4120	12050	14367	3912	14144	60672
45	27107	10679	42800	36366	25280	76177	218409	31911	9315	38139	44968	44973	49072	218408
46	9195	3297	17101	13713	4228	15085	62619	12202	4221	12558	14667	4149	14823	62619
47	16078	6139	21959	22396	12386	23059	102017	16281	6301	22850	20703	8304	28579	102018
48	41426	16586	49376	54459	42169	81264	285280	34933	13698	59797	53356	45437	78058	285279
49	17086	6555	22993	23670	13573	25194	109071	16012	6598	24326	21936	9643	30557	109072
50	11675	4320	18835	16836	7175	17950	76791	13320	4971	16256	16845	5639	19761	76792
51	39789	15916	39308	52371	40303	51608	239295	25986	13442	58442	41747	23455	76223	239295
52	18796	7260	24762	25832	15582	28885	121117	17267	7098	26827	24054	11969	33903	121118
53	8687	3088	16749	13072	3619	14499	59714	11972	4068	11803	14219	3843	13810	59715
54	12253	4559	19245	17568	7650	18621	80104	13581	5145	17120	17352	5989	20918	80105
55	14718	5567	35461	20724	10631	66421	153522	27530	5670	19898	35606	40147	24670	153521
56	57477	23206	52076	74741	61096	72217	340812	33720	18775	85060	57164	31232	111861	340812
57	28818	11394	31096	38496	27400	37880	176084	20892	10145	41935	31829	16041	54168	176083
58	12015	4461	19075	17266	7576	18344	78737	13473	5073	16763	17143	5844	20440	78736
59	82646	33579	71186	106581	90669	104460	489121	45595	26331	122800	80175	51818	162403	489122
60	12900	4928	19701	18384	8627	19372	83812	13868	5341	18088	17921	6381	22213	83812
61	14277	5396	20678	20120	10255	20966	91692	14182	5758	20150	19125	7212	24965	91692
62	8766	3120	16802	13172	3712	14590	60162	12007	4092	11919	14289	3889	13965	60161
63	55898	22556	51508	72746	59235	72169	334112	33570	18281	82598	56451	34649	108564	334113
64	41296	16536	40352	54276	42074	53234	247767	26605	13899	60713	43012	24273	79265	247767
65	36458	14543	36599	49157	36387	46775	218919	24240	12419	53474	38491	20691	69571	218919
66	12722	4754	19576	18169	8416	19165	82792	13790	5287	17823	17765	6272	21856	82793
67	9607	3465	18064	14233	4704	17631	67704	12984	4333	13116	15772	6929	15570	67704
68	14737	5886	21004	20702	10801	21502	94332	14686	5896	20839	19529	7490	25891	94331
69	8659	3088	16749	13074	3622	14499	59721	11972	4068	11805	14219	3843	13814	59721
70	17757	6830	23157	24514	14368	25008	111634	16024	6807	25366	22171	9321	31946	111635
71	22987	8988	26904	31124	20534	31092	141629	18332	8385	33218	26740	12497	42455	141627
72	9776	3537	17506	14446	4920	15765	65940	12467	4398	13423	15179	4496	15978	65941
73	14008	5284	20481	19780	9937	20655	90145	14362	5676	19744	18890	7019	24427	90147
74	109989	44849	92681	141169	122788	141766	653242	59182	34514	163688	106918	72685	217164	653241
	1360175	512652	1924378	1873926	1113189	2444649	9228969	1358625	514124	1924463	1873272	1114224	2443950	9228958

Table 9-2-4 (5) Trip Generation in 2015
Without New CBD Without Control Case

2015 TRIPS W/O New CBD W/O Control Case

ZONE	GENERATION						TOTAL	ATTRACTION						TOTAL
	NM			NV				NM			NV			
	W	O	H	W	O	H		W	O	H	W	O	H	
1	17401	6692	22962	24068	13950	24791	109864	15925	6691	21832	21932	9251	31228	109865
2	18749	7247	25150	25775	15522	30138	122581	17632	7009	26717	24188	12926	33750	122582
3	10224	3722	20073	15020	5414	23216	77669	14657	4186	13922	18061	9887	16652	77668
4	21319	8306	26453	29018	18559	31475	135130	18283	7855	30629	26133	13247	38982	135129
5	34878	13903	36710	46161	31518	48836	215006	24715	11926	50936	38551	22717	66160	215005
6	10396	105	19587	15234	5630	21551	72503	14209	4550	10503	17554	8632	17055	72503
7	8039	2814	22778	12287	2754	33166	82438	17330	3784	10535	20760	17885	12145	82439
8	10002	3627	23502	14756	5103	31047	91037	17702	4369	13105	21819	17770	15973	91038
9	10941	3974	24253	15812	6100	35528	96508	18240	4616	14620	22751	16686	17596	96509
10	7299	76	22038	11351	1865	32171	74805	16753	3568	7106	19813	16843	10722	74805
11	10154	10	25808	14955	5261	41060	97248	19691	4388	9911	24369	22743	16145	97260
12	29331	11613	32725	39147	27990	42312	183218	22289	10254	42597	33723	19357	54996	183216
13	11692	4325	25721	16888	7103	39226	104955	19106	4855	15821	24475	21192	19205	104954
14	29151	11537	36614	38934	27745	54707	198688	25896	10097	41861	38137	26670	54027	198688
15	7671	34	36880	11851	2222	81180	145138	31408	3601	7256	39391	53365	11112	145139
16	12238	4552	23871	17568	7776	32924	98929	17681	5049	16741	22487	16532	20130	98929
17	8520	3015	20041	12879	3363	24802	72620	14875	3860	11352	17815	11395	13223	72620
18	7879	2748	21458	12079	2673	29819	76556	16196	3748	10342	19284	15102	11883	76555
19	18206	7022	23537	25084	14897	25727	114473	16281	6936	26038	22635	9743	32810	114473
20	34872	13901	37803	46159	34501	52251	219187	25730	11894	50785	39804	26316	65958	219487
21	21872	8531	31549	29736	19162	46704	157554	22793	7911	30972	31920	24495	39462	167553
22	27379	10810	30552	36680	25701	37739	168961	20719	9689	39766	31137	16341	51207	168859
23	25293	9948	29782	34044	23236	37586	159889	20473	9039	36538	30151	16799	46689	159889
24	36832	14709	36928	48630	36825	47411	221335	24465	12551	54042	38891	21076	70312	221337
25	30281	12005	33415	40350	29109	43534	188694	22711	10541	44024	34559	19950	56910	188695
26	25106	9869	30017	33809	23015	38506	160322	20728	8973	36214	30405	17545	46459	160321
27	15389	5858	22268	21529	11562	24739	101345	15700	6068	21735	21001	9753	27089	101346
28	23049	9019	27170	31191	20594	31878	142892	18569	8388	33278	27051	13081	42624	142891
29	8563	3038	16657	12913	3473	14353	58997	11914	4027	11019	14107	3768	13562	58997
30	9824	3559	17536	14501	4977	15810	66206	12487	4109	13196	15218	4527	16089	66206
31	9298	3342	17167	13840	4352	15204	63203	12249	4248	12712	14756	4211	15027	63203
32	8441	2987	16573	12760	3326	14214	58301	11858	3991	11439	14000	3695	13320	58303
33	15269	5811	21380	21375	11432	22123	97390	14924	6052	21643	19996	7817	26959	97391
34	18533	7155	27315	25511	15239	37084	130837	19630	6950	26162	26909	18166	33019	130836
35	9111	3386	19253	13995	4450	21496	71991	14061	4246	12738	17064	8811	15070	71990
36	11266	4152	18538	16308	6679	17468	74401	13133	4842	15634	16478	5388	18926	74401
37	15060	5716	28718	21137	11090	45065	126786	21514	5815	20726	28163	24777	25760	126785
38	16409	6280	22191	22812	12777	23444	103913	15428	6396	23350	20992	8506	29241	103913
39	13065	4909	19830	18818	8851	19591	84885	13953	5393	18373	18084	6495	22586	84884
40	14145	5346	20579	19954	10102	20817	90943	14423	5713	19957	19010	7135	24705	90943
41	28441	11239	43666	38053	26855	77471	225728	32410	9736	40129	46054	45641	51726	225729
42	15739	6004	21715	21956	11986	22666	100076	15132	6191	22345	20406	8100	27899	100076
43	13173	4945	19893	18728	8954	19691	85381	13992	5120	18502	18161	6547	22761	85383
44	8850	3156	16858	13277	3818	14687	60646	12047	4115	12046	14362	3941	14136	60647
45	27095	10684	42782	36352	25265	76159	218337	31905	9334	38130	44953	44964	49049	218335
46	9193	3297	17093	13708	4224	15082	62597	12200	4217	12556	14662	4147	14816	62598
47	16070	6142	21951	22387	12379	23054	101983	15279	6295	22814	20698	8302	28555	101983
48	41408	16593	49358	54436	42146	81245	285185	34928	13685	59785	53340	45428	78018	285184
49	17079	6557	22982	23660	13565	25187	109030	16009	6589	24321	21930	9640	30541	109030
50	11670	4323	18830	16829	7169	17946	76767	13319	4965	16253	16840	5639	19751	76767
51	27530	10872	30474	36870	25881	37313	168970	20615	9740	40016	31060	15996	51543	168970
52	16262	6220	22953	22631	12592	25919	106607	16146	6330	23037	21837	10432	28827	106609
53	8654	3076	16721	13029	3582	14161	59523	11956	4054	11755	14188	3824	13745	59522
54	12248	4562	19238	17559	7854	18615	80076	13577	5141	17117	17347	5988	20907	80077
55	14685	5658	35429	20681	10593	66377	153323	27513	5657	19852	35572	40122	24607	153323
56	38668	15467	38495	50953	38984	60311	232878	25497	13096	56769	40773	22778	73956	232879
57	20618	8018	25202	28130	17743	28339	128050	17289	7665	29668	24671	11062	37695	128050
58	11888	4413	18985	17108	7430	18200	78024	13417	5033	16578	17034	5771	20191	78024
59	54530	22010	60875	71015	57623	71710	327763	33314	11841	80502	55680	34686	105735	327761
60	12894	4829	19696	18376	8623	19365	83783	13967	5337	18083	17915	6378	22203	83783
61	14279	6398	20670	20113	10249	20962	91662	14180	6751	20145	19121	7210	24955	91662
62	8761	3120	16797	13165	3712	14585	60140	12095	4088	11915	14284	3888	13960	60140
63	37682	15060	38363	49708	37820	50962	229595	25605	12781	55204	40578	23555	71873	229596
64	28478	11262	31115	38067	26999	38316	174235	20993	10027	41447	31839	16473	53457	174236
65	25128	10005	28655	34211	23410	33937	155646	19406	9116	36898	28872	13966	47368	155646
66	10479	3831	17933	15328	5757	16569	69957	12782	4607	14475	15795	4921	17378	69958
67	9602	3467	18056	14228	4700	17627	67680	12981	4328	13113	15768	5927	15563	67680
68	11749	4355	18884	16928	7264	18037	77217	13353	4990	16370	16909	5685	19910	77217
69	7937	2779	16226	12128	2724	13635	55429	11628	3937	10691	13556	3394	12324	55330
70	13650	5142	20230	19329	9516	20244	89111	14203	5564	19216	18578	6836	23713	88110
71	16914	6502	22576	23489	13411	24068	106989	15687	6558	24154	21461	8832	30311	106989
72	9773	3539	17498	14438	4916	15754	65918	12464	4393	13421	16175	4496	15968	65917
73	14001	5286	20478	19771	9931	20650	90117	14360	5670	19740	18884	7048	24414	90116
74	71771	29122	65072	92827	77876	97259	433927	42437	22981	106191	72732	49392	140129	433926
	1360568	512486	1923189	1874199	1114348	2444161	9228951	1359506	514115	1923595	1873915	1114630	2443188	9228949

9.2.2 Distribution Models

(1) Inter Zone Distribution Models

The following Voorhees type distribution models were developed based on the analysis of the present OD matrix in the urban districts.

$$Xij = K \times Gi \times \frac{Aj \times Tij^{\alpha}}{\sum_{j \neq i} Aj \times Tij^{\alpha}}$$

where; Xij :Trip between zone i and j
K : Parameter (Table 9-2-5)
Gi : Generated trips from zone i
Aj : Attracted trips to zone j
Tij : Impedance between zone i and j
α : Parameter (Table 9-2-5)

Table 9-2-5 Parameters in Distribution Model

Mode	Purpose	K	α
NMV	Work/School	0.967174	-0.70001
	Others	0.768972	-0.66665
MV	Work/School	0.944168	-0.14004
	Others	0.762522	0.29359

(2) Intra Zone Trip Model

The following intra zone trip models were developed based on the analysis of the present OD matrix in the urban districts.

$$Xii = K \times Gi^{\alpha} \times Tii^{\beta} \times A^{\gamma}$$

where, Xii :Intra zone trips within zone i
Gi : Generated trips in zone i
Tii : Average impedance to neighboring zones
K : Parameter (Table 9-2-6)
α : Parameter (Table 9-2-6)
β : Parameter (Table 9-2-6)
γ : Parameter (Table 9-2-6)

Table 9-2-6 Parameters for Intra Zone Trip Model

Mode	Purpose	K	α	β	γ
NMV	To Work/School	0.14936	0.14480	0.77051	0.23880
	Others	2.88866	0.24164	0.83538	0.34394
MV	To Work/School	0.00288	0.06490	0.82677	0.45400
	Others	0.05129	-	0.43430	0.73768

Table 9-2-7 shows the trips between aggregated six areas of Central Hanoi (Cent), Tu Liem (T/L), Ha Dong (H/D), Thanh Tri (T/T) and Gia Lam (G/L) for one case in 1995

and the four cases in 2015. The table is shown in the triangle shaped OD matrix where the trips of the same OD pairs with the opposite directions are added.

The share of trips to/from Central Hanoi will reduce from the present 43.4% to the range between 29.9% in the case of "With New CBD With Control" and 40.8% in the case of "Without New CBD Without Control". Among the cases in 2015, the case "With New CBD With Control" will have the lowest trip share in Central Hanoi, which means the New CBD development will reduce the traffic load in the Central Hanoi.

Table 9-2-7 Trips between Areas

Unit: 1,000 Trips/day

O/D	Cent	S/S	T/L	H/D	T/T	G/L	Total	Share
1995								
Cent	1,187	182	105	130	71	98	1,772	43.4
S/S	0	555	30	25	21	31	845	20.7
T/L	0	0	300	14	12	17	479	11.7
H/D	0	0	0	164	10	14	356	8.7
T/T	0	0	0	0	197	12	322	7.9
G/L	0	0	0	0	0	308	308	7.6
2015 With CBD With Control Case								
Cent	1,566	447	627	670	289	322	3,921	29.9
S/S	0	1,076	225	179	105	115	2,147	16.4
T/L	0	0	1,929	203	117	146	3,248	24.8
H/D	0	0	0	592	90	129	1,862	14.2
T/T	0	0	0	0	625	67	1,292	9.9
G/L	0	0	0	0	0	632	632	4.8
2015 With CBD W/O Control Case								
Cent	2,346	565	603	580	269	409	4,773	37.7
S/S	0	1,075	177	131	86	112	2,147	16.9
T/L	0	0	1,477	131	85	113	2,585	20.4
H/D	0	0	0	459	58	92	1,451	11.5
T/T	0	0	0	0	529	53	1,082	8.5
G/L	0	0	0	0	0	632	632	5.0
2015 W/O CBD With Control Case								
Cent	1,641	479	724	704	333	286	4,166	31.9
S/S	0	1,089	235	193	112	111	2,220	17.0
T/L	0	0	1,504	190	104	130	2,886	22.1
H/D	0	0	0	601	93	108	1,889	14.5
T/T	0	0	0	0	562	62	1,266	9.7
G/L	0	0	0	0	0	642	642	4.9
2015 W/O CBD W/O Control Case								
Cent	2,616	632	593	579	300	370	5,090	40.8
S/S	0	1,087	167	130	88	109	2,213	17.8
T/L	0	0	1,107	102	68	94	2,131	17.1
H/D	0	0	0	436	54	73	1,374	11.0
T/T	0	0	0	0	455	49	1,013	8.1
G/L	0	0	0	0	0	641	641	5.1

The trips between Central Hanoi and Soc Son is the highest among the inter area movements in 1995, followed by Central Hanoi and Ha Dong, and Central Hanoi and Tu Liem. In 2015, the highest trips will appear between the Central Hanoi and Tu Liem and Ha Dong reflecting the future urbanization of the present sub-urban area.

9.2.3 Modal Split Model

(1) Passenger Car Share in MV Trips

The car ownership rate was estimated from Bangkok experience.. The car ownership rate was derived from the estimated GRDP per Capita in the target years using the car ownership rate vs. GRDP per Capita (current price) curve of Bangkok. The ratio of car ownership of the target year to 1995 was applied as the ratio of increase of car trips. The ratios are as follows;

Table 9-2-8 Car Trip Increase

Year	GRDP/Cap. (US$)	Ownership (Veh./1,000 Pop.)	Index of Increase
1995	346	43	1.00
2000	366	45	1.05
2005	478	59	1.33
2010	624	78	1.81
2015	1,065	131	3.05

Notes: registered vehicles in 1994 in Hanoi: 42,701
population in urban Hanoi in 1994: 1,061,777
ownership in 1994: 40
(assumed all vehicles were registered in urban Hanoi)

(2) Public Transport Passenger Share

The public passenger share to total trips were simulated by the regression analysis of *Phong/Xa* based SIDA data. The sample share and estimated results are shown in Fig. 9-2-1

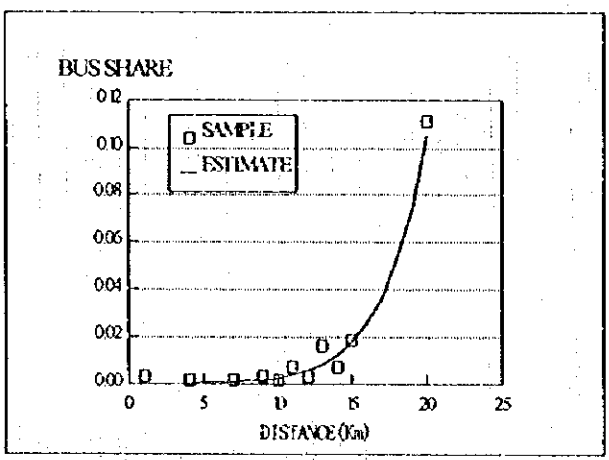


Fig. 9-2-1Present Bus Trip Share

The regression equation is;

$$Y = \frac{K}{1 + EXP(aX + b)}$$

where,
Y:public transport passenger share
X:trip distance in Km
K:parameter(1.00)
a:parameter(-0.37450)
b:parameter(9.64728)

However, the public transport passenger share at present is too low compared to other cities due to poor bus operation and resulting low availability. If public transportation operation changes to meet with the potential demand, the share will increase from the present. Therefore the public transport share model for Bangkok in 1990 developed by the JICA Study Team was assumed to be the share model in the year 2015 in Hanoi. The public passenger share model in Bangkok is;

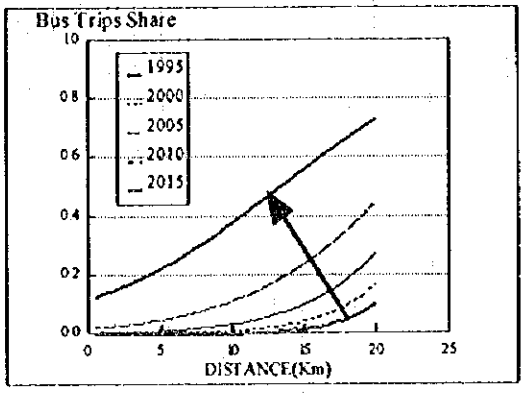


Fig. 9-2-2Public Passenger Share Increase

$$Y = 1.0 - \frac{1.0}{(1.0 + EXP(a + b \times \Delta T + c \times \Delta C))}$$

where;
Y:Public transport passenger share
ΔT :Travel time difference in min.
ΔC :Travel cost difference in Bahts
a : Parameter(-1.689)
b : Parameter(-0.073)
c : Parameter(-0.120)

Assuming the bus fare of 1,000 VND, a fuel price of 3,700 VND, a fuel consumption rate of 60Km/litter for Motorcycle, and the average operating speed of 20Km/h for public transport and 12.5Km/h for other modes, the public passenger share will change as shown in Fig. 9-2-2 The share for intermediate years was interpolated by a growth rate curve.

(3) Truck Trip Estimate

Truck trips were estimated by applying an Entropy Maximization Model based on 19 traffic counts on trunk roads and at cordon line points. They were then allocated into the 79 zone OD matrix. For the future distribution pattern, the present pattern method with new truck trip generation from the 7 planned industrial estates was applied. The assumed trip generation from these industrial estates is given below.

Table 9-2-9 Truck Trip Generation From Industrial Estates

	Name	Area (ha) Gross	Area (ha) Net	Employee	Vehicle Trip/day	Open Year
1	Thang Long North	280	197	14,300	8,600	2000
2	Thang Long South	220	164	11,900	7,100	2008
3	Dong Anh	92	68	4,900	2,900	2003
4	Gia Lam	442	302	21,900	13,100	2001
5	Soc Son	430	300	21,800	13,100	2003
6	Taiwan	63	40	2,900	1,700	1997
7	Daewoo	80	55	4,000	2,400	1996
	Total	1,607	1,126	81,600	48,900	

Notes: A half of the present employee of 72.5/ha is assumed
Freight of 0.6 trips/employee is assumed
Other source: Master Plan of Industrial Development in the Hanoi Area, 1995, JICA

(4) Trip Ends by Mode

Table 9-2-10 shows the trip ends by mode in 1995 and 2015. The share of bicycle trip in 1995 was more than half of 61.3% and will decrease to 31.8% and the share of public transport in 1995 was 5.6% and will increase 14.0% in 2015. The highest growth factor was forecast for passenger car trips of 11.64 times the present, however the share will remain to be 2.7%.

Table 9-2-10 Trips Ends by Mode

	1995		2015		2015/1995
	1,000Trips/d	%	1,000Trips/d	%	
Bicycle	2,606	61.3	4,183	31.8	1.61
M.Cycle	1,345	31.6	6,521	49.6	4.85
Bus	239	5.6	1,840	14.0	7.68
P.Car	30	0.7	351	2.7	11.64
Truck	33	0.8	264	2.0	7.90
Total	4,254	100.0	13,158	100.0	3.09

Note: Trips in 2015 is the figures in the case of "With New CBD" and "With Control"
Figures includes the intra-Zone Trips.

Table 9-2-11 shows the resulted trip ends for 1995 and 2015 by area and by mode. The overall trip growth in 2015 is 3.09 times the 1995 figure.

Table 9-2-11 Trip End by Mode and Area

	Trip End (1,000 T/D)						2015/1995					
	Central	S/S	T/L	H/D	T/T	G/L	Central	S/S	T/L	H/D	T/T	G/L
1995												
Bicycle	1,106.4	493.0	296.1	222.0	196.3	292.2						
M.Bike	559.3	234.8	166.7	112.8	106.9	164.7						
Bus	78.0	106.8	9.2	16.1	11.4	17.9						
P.Car	14.5	5.4	3.0	2.1	2.0	3.1						
Truck	14.1	4.6	4.1	3.0	5.3	2.3						
Total	1,772.3	844.6	479.1	356.0	321.9	480.2						
2015 With CBD With Control Case												
Bicycle	1,291.2	637.3	1,108.0	594.9	408.0	412.8	1.17	1.29	3.74	2.68	2.08	1.41
M.Bike	1,991.7	752.4	1,842.8	998.4	693.3	719.8	3.56	3.20	11.05	8.85	6.49	4.37
Bus	367.6	682.0	203.0	213.6	128.0	236.8	4.71	6.39	22.07	13.27	11.23	13.23
P.Car	161.2	28.5	60.2	35.0	26.8	23.7	11.12	5.28	20.07	16.67	13.40	7.65
Truck	109.0	46.3	33.6	20.5	36.0	18.5	7.73	10.07	8.20	6.83	6.79	8.04
Total	3,920.7	2,146.5	3,247.6	1,862.4	1,292.1	1,411.6	2.21	2.54	6.78	5.23	4.01	2.94
2015 With CBD Without Control Case												
Bicycle	1,531.2	638.3	875.4	468.4	339.5	417.6	1.38	1.29	2.96	2.11	1.73	1.43
M.Bike	2,460.4	761.2	1,469.9	779.5	578.4	736.1	4.40	3.24	8.82	6.91	5.41	4.47
Bus	479.1	673.2	158.5	156.1	105.8	216.2	6.14	6.30	17.23	9.70	9.28	12.08
P.Car	193.2	28.4	47.7	26.7	22.0	23.6	13.32	5.26	15.90	12.71	11.00	7.61
Truck	109.0	46.3	33.6	20.5	36.0	18.5	7.73	10.07	8.20	6.83	6.79	8.04
Total	4,772.9	2,147.4	2,585.1	1,451.2	1,081.7	1,412.0	2.69	2.54	5.40	4.08	3.36	2.94
2015 Without CBD With Control Case												
Bicycle	1,359.3	644.5	1,004.5	607.8	403.2	399.4	1.23	1.31	3.39	2.74	2.05	1.37
M.Bike	2,132.5	778.2	1,590.5	1,007.7	667.8	681.2	3.81	3.31	9.54	8.93	6.25	4.14
Bus	391.9	721.5	203.9	217.3	134.1	218.5	5.02	6.76	22.16	13.50	11.76	12.21
P.Car	173.7	29.2	53.6	35.2	25.1	22.7	11.98	5.41	17.87	16.76	12.55	7.32
Truck	109.0	46.3	33.6	20.5	36.0	18.5	7.73	10.07	8.20	6.83	6.79	8.04
Total	4,166.4	2,219.7	2,886.1	1,888.5	1,266.2	1,340.3	2.35	2.63	6.02	5.30	3.93	2.79
2015 Without CBD Without Control Case												
Bicycle	1,620.2	644.7	744.6	449.4	322.3	402.0	1.46	1.31	2.51	2.02	1.64	1.38
M.Bike	2,614.0	784.6	1,167.6	732.2	530.0	692.3	4.67	3.34	7.00	6.49	4.96	4.20
Bus	532.3	707.9	146.3	147.1	105.4	200.5	6.82	6.63	15.90	9.14	9.25	11.20
P.Car	214.6	29.2	39.2	25.1	19.7	22.7	14.80	5.41	13.07	11.95	9.85	7.32
Truck	109.0	46.3	33.6	20.5	36.0	18.5	7.73	10.07	8.20	6.83	6.79	8.04
Total	5,090.1	2,212.7	2,131.3	1,374.3	1,013.4	1,336.0	2.87	2.62	4.45	3.86	3.15	2.78

In the case of "With New CBD, With Control", the bicycle share in the central area was 62.5% in 1995 and will reduce to 32.9% in 2015, while the passenger car share was 0.8% in 1995 and will increase to 4.1% in 2015. The bus passenger (public transport passenger) share in the central area was 4.4% in 1995 and will increase to 9.4%, however the share in Soc Son/Dong Anh was 12.6% and will increase to 31.8% in 2015.

Table 9-2-12 shows the comparison of the Study team and the World Bank (WB) team estimates. The WB team estimates the traffic growth indices in 2002 based on 1995 as 1.00. The table shows the growth indices in 2002 and 2015, calculated by constant annual growth rates, for comparison purpose.

In the WB estimate, bicycle trips reduce and Motorcycle trips grow rapidly, while in our estimate, bicycle trips keep growing but at a lower rate than other modes. The public transport trips in our estimate are potential and target demand, so that the figure is higher than WB estimate. The passenger car trips in our estimate is higher than WB figures, however, passenger car ownership is not so high in 2015 even in our estimate and it may increase more depending on the establishment of foreign vehicle factories in the industrial estates surrounding Hanoi.

Table 9-2-12 Comparison of Growth Factors

Mode	1995	2002		2015	
		WB	JICA	WB	JICA
Bicycle	1.00	0.57	1.21	0.20	1.61
M.Bike	1.00	2.35	1.78	11.49	4.85
P.Car	1.00	1.62	2.33	3.97	7.68
Truck	1.00	1.71	2.06	4.63	11.64
Bus	1.00	1.23	2.04	1.81	7.90
Overall	1.00	1.68	1.51	4.40	3.09

Note:The figures of WB in 2015 and JICA in 2002 are calculated assuming the constant annual growth rates in 1995 - 2015 for the comparison purpose.
2015 JICA Estimate is for "With CBD, With Control Case"
Source: Viet Nam Urban Transport Management Study, Draft Final Report, Nov. 1995

9.2.4 Traffic Assignment Models

(1) Network Development

Prior to the traffic assignment, the road network was developed and the information from the road inventory was attached to each road link to determine the free flow speed and traffic capacity. The total number of links is about 3,000. The network is shown in Fig. 9-2-3 for urban area and for all the Study area separately.

(2) Free Flow Speeds

Free flow speeds by area and road surface types and conditions are set as shown in Table 9-2-13, based on the results of travel time survey.

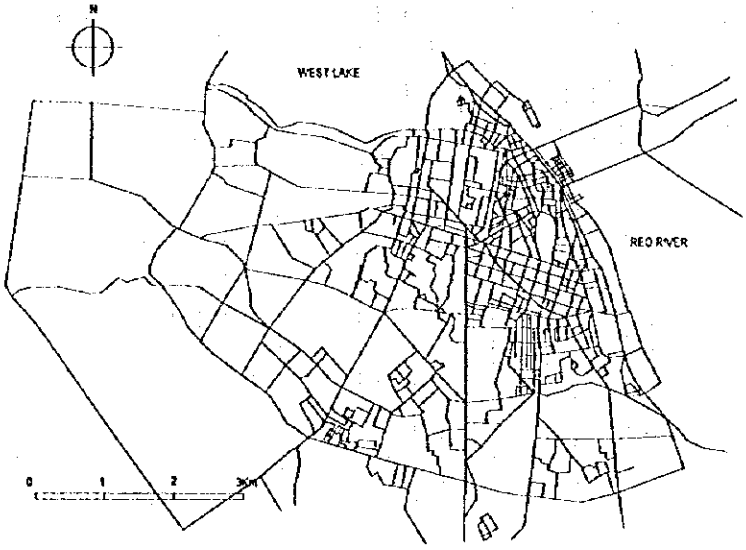


Fig. 9.2.3 1) Road Network in Urban Area

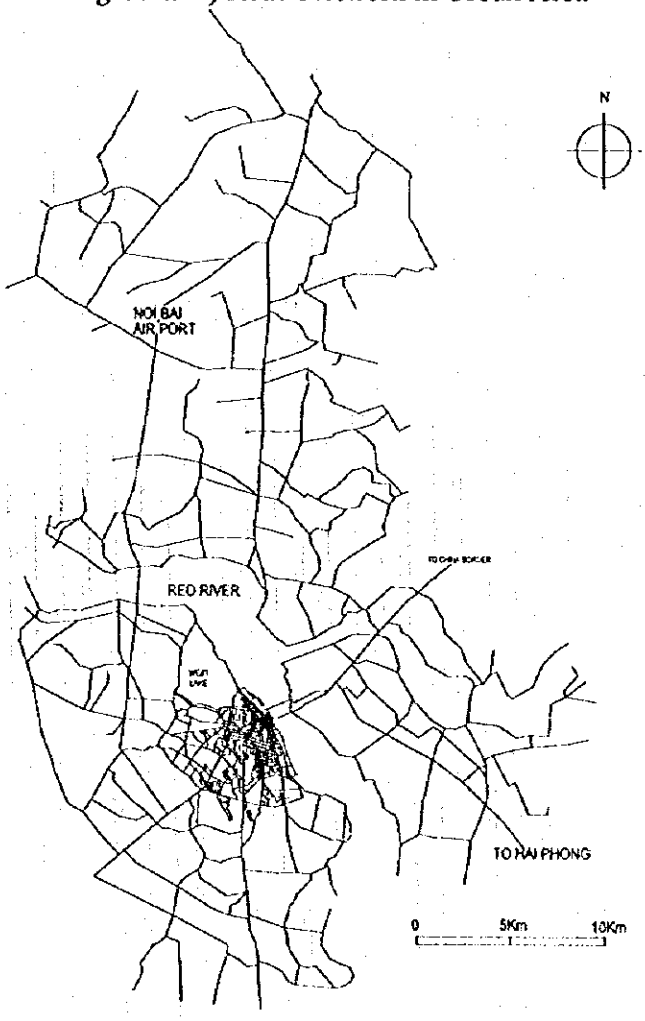


Fig. 9.2.3 (2) Road Network in all the Study Area

The carriageway widths in the Study area vary from less than 4m to more than 30m. Therefore the Study adopted the effect of carriageway width to calculate the free flow speeds. The effect of road width on free flow speed was assumed be as described in the following formulas. The maximum speed was limited to the values in the above table.

Table 9-2-13 Link Max. Speed and Reduction Factors

Item¥ Vehicle Type		Truck	P.Car	M.Bike	Bicycle
Vmax(Km/h)	Rural	80.0	80.0	25.0	12.5
	Urban	60.0	60.0	25.0	12.5
Pavement Type Adjustment Factors	Asphalt Concrete	1.0	1.0	1.0	1.0
	Bituminous Macadam	1.0	1.0	1.0	1.0
	Cement Concrete	0.8	0.8	0.8	0.8
	Gravel	0.5	0.5	0.5	0.5
	Leterite	0.5	0.5	0.5	0.5
	Earth	0.5	0.5	0.5	0.5
	Waste Coal	0.5	0.5	0.5	0.5
Surface Condition Adjustment Factors	Good	1.0	1.0	1.0	1.0
	Fair	0.8	0.8	0.9	0.9
	Bad	0.5	0.5	0.7	0.7

for Four Wheelers: $V = V\min \times A^{(W-4.0)}$ (Vmin=20.0, A=1.260 in Rural Area)
(Vmin=10.0, A=1.348 in Urban Area)

for Two Wheelers: $V = V\max \times (W + 2.0) \times 0.1$

(3) Traffic Capacity and Passenger Car Unit (PCU)

According to the reference figure in the standard for Japan, the traffic capacity of bicycle is 1,600 bicycles/hour/2m road width for two directions. The highest bicycle flow in Beijin, China is reported at 2,234 bicycles/hour/one meter width, which is almost 3 times higher than the figure in Japan, and the some trial studies to simulate bicycle flow adopted 2,200 bicycle/hour/one meter width.

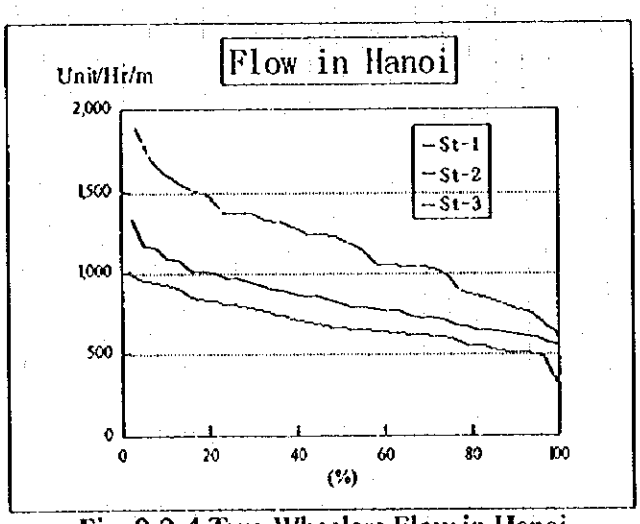


Fig. 9-2-4 Two Wheelers Flow in Hanoi

The peak one hour traffic flows on the heavily congested road links in Hanoi at present were measured using Video Cameras, and the flows were counted by one minute period. The results of one minute traffic flow count are shown in Fig. 9-2-4, where one minute counted samples at each survey station, converted to one hour flow per one meter width, are plotted in a descending order by station. The flow at station-1 reaches 2,000 two wheelers/hour/ one meter road width, while flows at the other stations remain at 1,500 two wheelers/hour/one meter road width.

Based on these results, the figure of 2,000 two wheelers/hour/one meter width was adopted as the two wheelers capacity in the Study.

The Passenger Car Units (PCUs) were assumed based on various related studies. The PCUs and the average occupancies observed at the cordon line survey stations are shown in Table 9-2-14.

Table 9-2-14 PCUs and Occupancy

Mode	PCU	Occupancy
Bicycle	0.3	1.05
Motorcycle	0.3	1.40
Bus	1.0(Micro Bus), 2.0(Standard Bus)	7.66 (Micro Bus), 24.09(Standard)
Passenger Car	1.0	1.00
Truck	2.5	1.18

(4) Speed/Capacity Restraint Formula

For the assignment of passenger cars onto the road network, the following BPR (Bureau of Public Road, USA) formula was applied as the speed/capacity restraint formula;

$$Tc = To \times (1.0 + 0.15 \times V / C^{4.0})$$

where Tc: Congested travel time
To: Travel time with free flow speed
V / C: Volume Capacity ratio

(5) Assignment Models

The route selection of two wheelers is considered not to be affected by the traffic conditions, therefore Stochastic Multi-Path assignment with five paths and loading rates in proportion to the exponential of travel time difference from the minimum path was adopted. Fig. 9-2-5 shows the traffic assignment procedure. Bicycle, Motorcycle and public passengers are converted to PCU's to calculate the pre-load volume for the passenger car and truck assignment.

(6) Assignment Results

Fig. 9-2-6 shows the present traffic flow assigned onto the present road network, where the traffic flow is shown by two wheeler unit (TWU) converted from PCU and V/C is shown by the two wheeler capacities calculated in proportion to the road width.

Fig. 9-2-7 shows the simulated passenger car speed. Despite the V/C in terms of Two Wheelers Unit not reaching to the critical point of 1.5, the passenger car speed reduces below 20.0 Km/h on many main streets because of the mixed flow with two wheelers. This situation gives a congested perception to passenger car users.

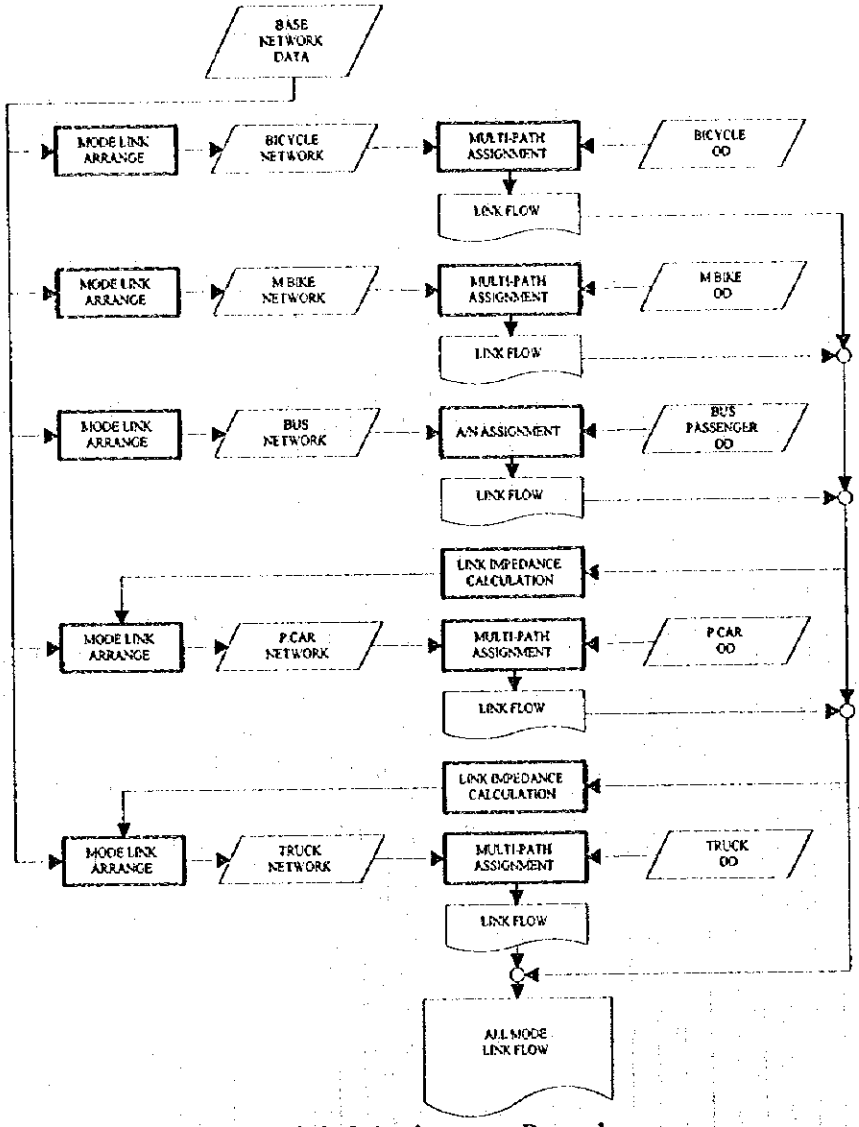


Fig. 9-2-5 Assignment Procedure

Fig. 9-2-8 shows the 2015 traffic demand assigned to the present road network (Do-Nothing Case in 2015). The most of roads will have more than 3.0 times the current traffic demand and especially the Ring Road No.2 will have a V/C of more than 1.5, which is considered as the acceptable limit, for its entire length. Also the existing Chuong Duong bridge (exclusively for MV use at present) will not be able to accommodate the traffic demand in 2015. All the entrances to the present built-up area will have V/C of more than 1.5 in line with the city expansion towards the outskirts. However, the most of the urban roads especially in French and Ancient Quarters will have some spare capacity to accommodate the future traffic demand because of the road network in these areas as relatively dense..

Table 9-2-15 shows the road length by V/C level and by areas of built-up, sub-urban and rural. The legth of roads having V/C of less than 0.5 will decrease from 92.4% in 1995 to 34.8% in 2015 and roads having V/C more than 1.5 will increase to about 20% in 2015.

Table 9-2-15 Distance by V/C Level and Area

Unit:Km

V/C	Built-up		Sub-Urban		Rural		Total	
	(Km)	(%)	(Km)	(%)	(Km)	(%)	(Km)	(%)
1995								
0.0-0.5	211.0	90.9	207.3	92.4	473.0	95.4	891.3	93.6
0.5-1.0	20.7	8.9	17.1	7.6	19.0	3.8	56.8	6.0
1.0-1.5	0.4	0.2	0.0	0.0	3.7	0.7	4.1	0.4
1.5-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	232.1	100.0	224.4	100.0	495.7	100.0	952.2	100.0
2015								
0.0-0.5	156.2	67.3	78.2	34.8	345.3	69.6	579.7	60.9
0.5-1.0	33.1	14.3	61.8	27.5	83.4	16.8	178.3	18.7
1.0-1.5	20.4	8.8	39.8	17.7	48.6	9.8	108.8	11.4
1.5-	22.3	9.6	44.6	19.9	18.6	3.8	85.5	9.0
Total	232.0	100.0	224.4	100.0	495.9	100.0	952.3	100.0

Table 9-2-16 summarizes the transportation demand indices in 1995, 2005 and 2015. The average trip distance will increase by the development of the suburban area to preserve the existing built-up area, so that the total person-Kms in the year 2015 will increase by 3.0 times the present, which requires the construction of 3.0 times of transportation infrastructures in terms of transportation capacity to accommodate the future traffic demand by the year 2015.

Table 9-2-16 1995, 2005 and 2015 Traffic Indices

ITEM	TRIP/D 1,000	PSN-KM 1,000	AV.TRIP DISTANCE(KM)
1995			
U-U	1,999.5	6,343.8	3.17
U-R	424.6	8,943.2	21.06
R-R	870.2	2,069.7	2.38
TOTAL	3,293.8	17,356.8	5.27
2005			
U-U	4,268.4	14,348.2	3.36
U-R	1,045.6	22,764.7	21.77
R-R	1,686.2	4,902.3	2.91
TOTAL	6,999.6	42,015.7	6.00
2015			
U-U	5,725.0	20,862.7	3.64
U-R	1,429.3	31,242.0	21.86
R-R	1,776.2	5,882.4	3.31
TOTAL	8,928.6	57,987.6	6.49

Note: U: Urban area. South-West of Red River
R:Rural area. North-East of Red River

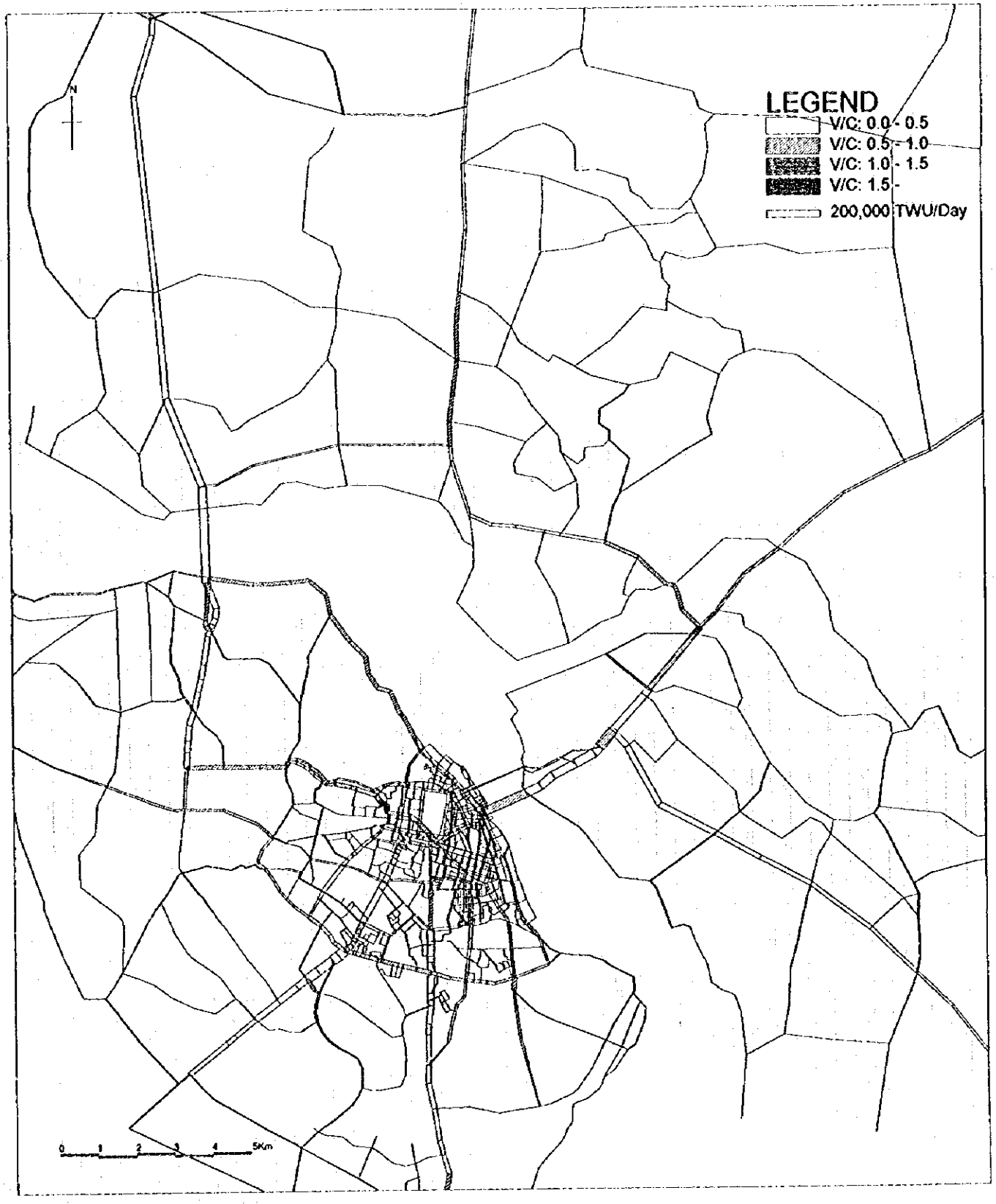


Fig. 9-2-6 Present Traffic Flow Assigned onto Present Road Network

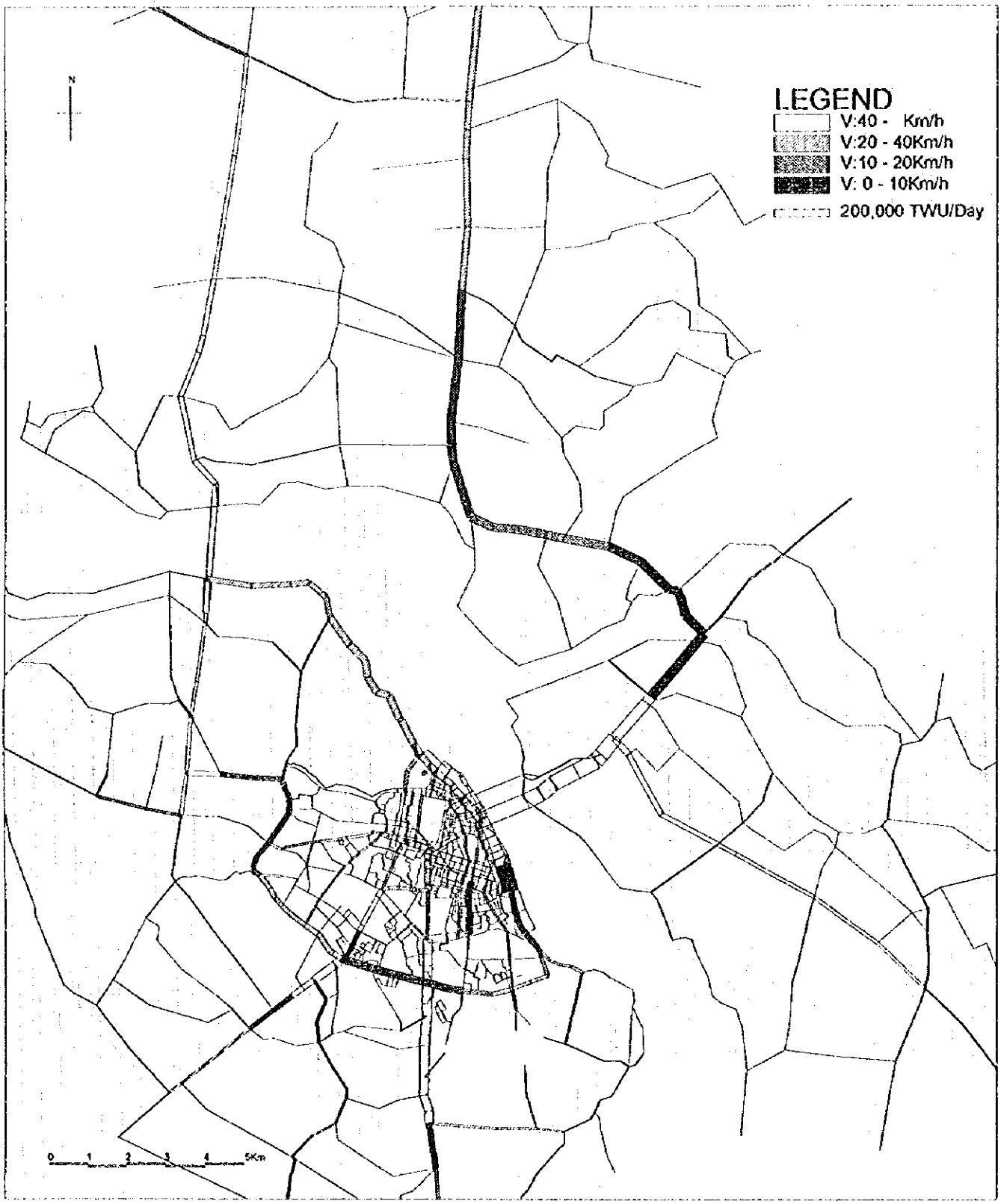


Fig. 9-2-7 Present Four Wheeler Speed on Present Road Network

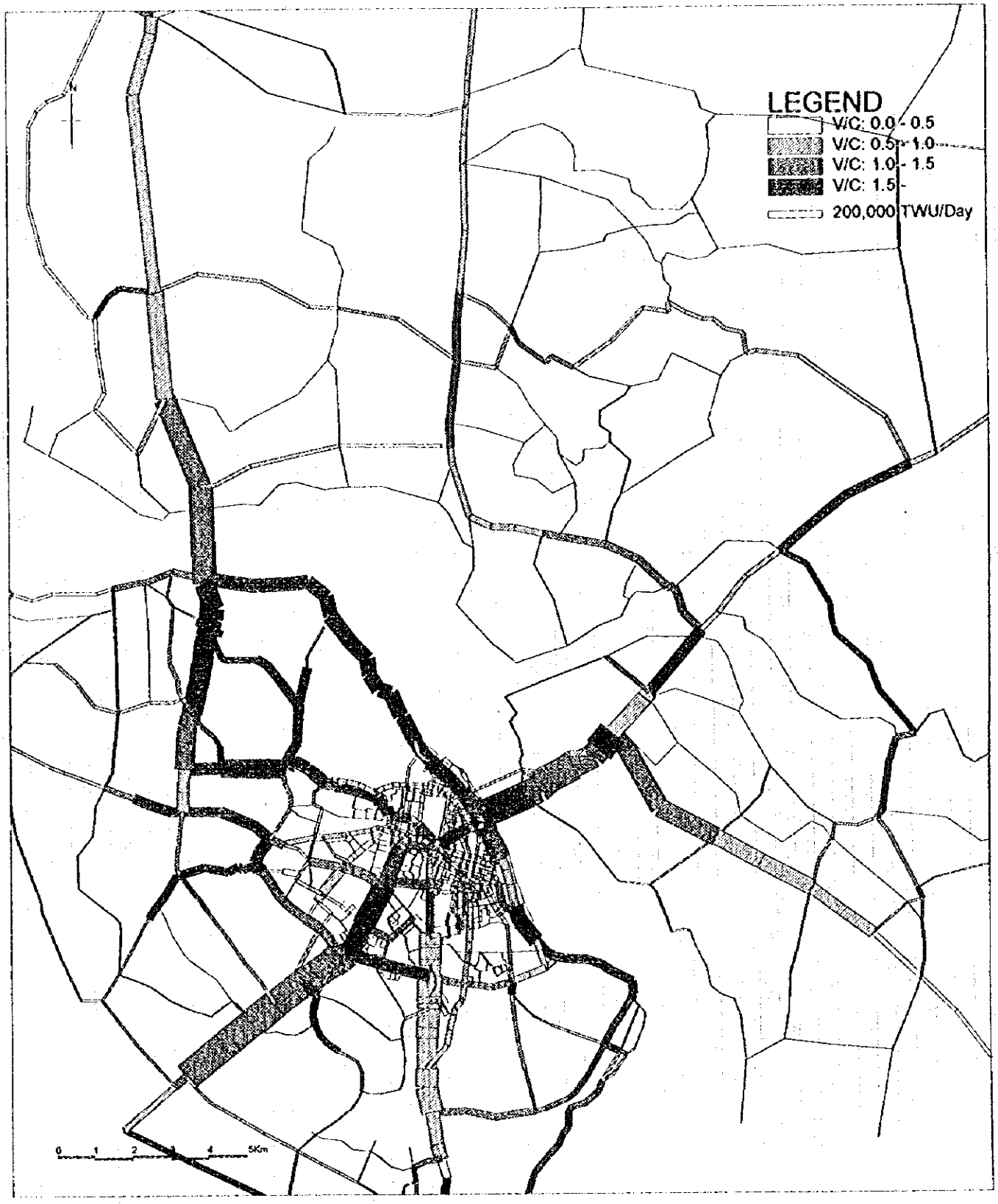


Fig. 9-2-8 2015 Traffic Flow Assigned onto Do Nothing Road Network

CHAPTER 10 TRANSPORT MASTER PLAN FORMULATION POLICY

10.1 Transportation Issues in Hanoi

10.1.1 Demand and Supply Balance

The following table 10-1-1 summarizes the demand capacity balance for 7 sections (see Fig. 10-1-1). In the year 2015, the section 7 (Hanoi North) shows the highest V/C of 2.18, followed by the section 6 (C2 West), the section 1 (Red River) and the section 5 (C2 East).

Table 10-1-1 Demand Capacity Balance under Do-Nothing Case in 1995 and 2015

Section	Capacity (1,000)	1995 Volume (1,000)	1995 V/C	2015 Volume (1,000)	2015 V/C	Volume Increase (times)
1(Red River)	1,060.0	484.0	0.46	1,475.7	1.39	3.05
2(Railway)	3,544.0	777.6	0.22	2,678.3	0.76	3.44
3(Inner Ring East)	3,300.0	475.9	0.14	1,535.4	0.47	3.23
4(Inner Ring West)	1,960.0	416.4	0.21	1,233.2	0.63	2.96
5(C2 East)	1,320.0	399.5	0.30	1,330.7	1.01	3.33
6(C2 West)	1,300.0	514.1	0.40	2,136.2	1.64	4.16
7(North)	370.0	136.0	0.37	806.3	2.18	5.93

Note: Volumes and Capacities are show in two wheelers unit

On the sections where the high V/Cs are expected in the year 2015 have a high traffic demand increase of over 3.0 times the present, and they are located at the outskirts of the present urban area. The growth on the sections inside the built-up area is lower and they will be able to accommodate the future traffic demand because of the dense road network.

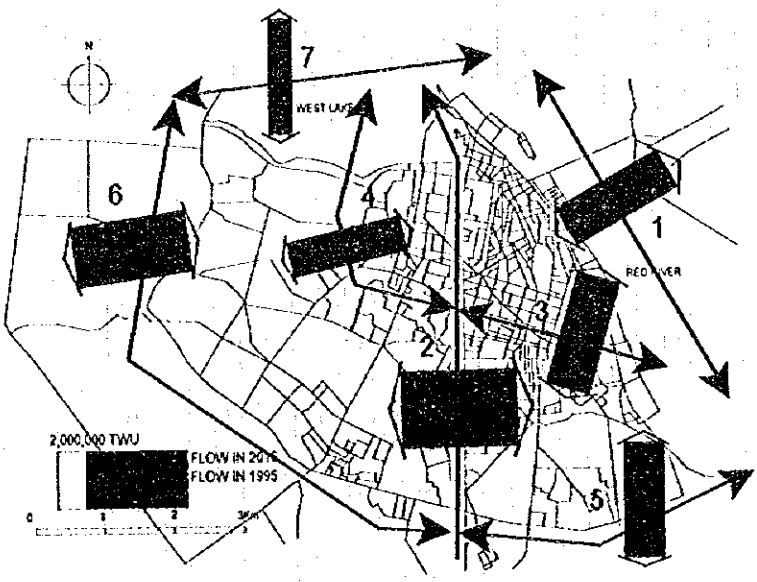


Fig. 10-1-1 Location of Sections

The one of the main issues in the future transportation network in Hanoi is to maintain at least the present level of V/C, especially in the sub-urban area, where a high traffic demand increase is expected and the road network is not developed.

10.1.2 Road Network Development

The road area rate in the present city center of Hoan Kiem district, where road network was well planned is 22.87%, which is about standard figure in various cities. In Dong Da district, the south-west district in the present built-up area, where only trunk roads were developed with about a 1 Km interval and residential area were developed along these trunk roads individually, has only 3.15% of road area rate.

The another issue of the Transportation Master Plan in Hanoi is to develop road network to reach to the sufficient road area rate to accommodate future traffic demand.

Table 10-1-2 shows the cost and performance comparison of road development in the built-up area (C-1-2) and in the sub-urban area (C-9-2). The total cost per meter for road development in the built-up area is 3.16 times higher than that in the sub-urban area because of the high right of way (ROW) cost, and the performance in terms of B/C is 19.7 times lower even when the demands on both roads are about the same level.

Table 10-1-2 Cost and Performance Comparison of Road Development

UNIT:M.VND

	C-1-2		C-9-2	
LOCATION	BUILT-UP AREA		SUB-URBAN AREA	
WIDTH(m)	32.00		40.00	
LENGTH(m)	1,300		5,000	
COST				
CONSTRUCTION COST	30,432		104,719	
ROW COST	75,335		24,184	
TOTAL	105,767		128,903	
COST PER METER				
CONSTRUCTION COST	23.41	28.8(%)	20.94	81.2(%)
ROW COST	57.95	71.2(%)	4.84	18.8(%)
TOTAL	81.36	100.0(%)	25.78	100.0(%)
ANNUAL BENEFIT	103,000		2,459,000	
B/C	0.97		19.08	
PASSENGERS VOL IN MP2015	138.3		134.7	

Therefore, from the view point of efficient investment, road network in the present sub-urban area should be developed before urbanization will expand to these areas, or at least an action and enforcement to reserve ROW should be taken urgently. While the road development in the built-up area should be implemented in the long term plan to avoid serious impact to the residents and commercial activities by the land acquisition, and traffic management measures for the effective use of the existing transportation facilities should be implemented in the short - medium term plan.

10.1.3 Organized Development of Sub-urban Area

Fig. 10-1-2 shows that 43.5% of traffic demand is generated from the existing built-up area. However in 2015, only 29.9% of demand will be generated from this area and the

highest demand generating area will shift to the existing sub-urban areas.

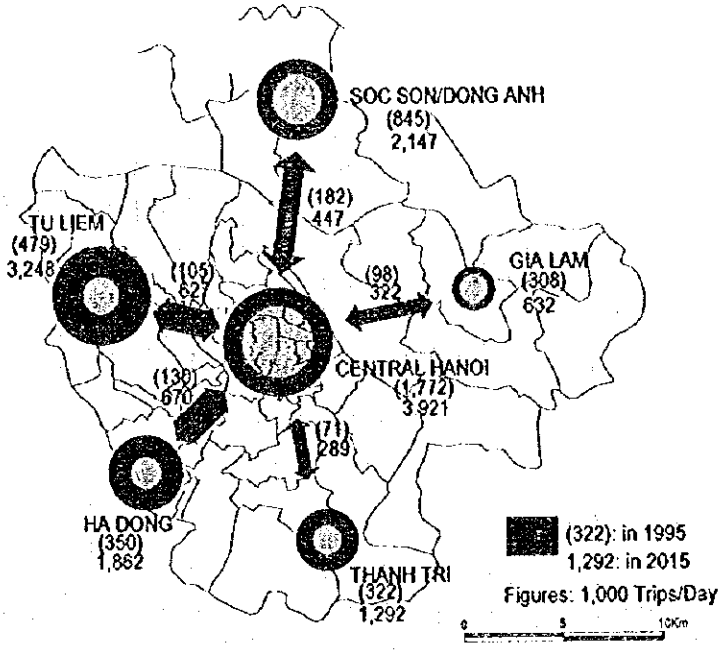


Fig. 10-1-.2 Trip End by Area

Serious traffic congestion will occur in these area caused by the high demand and the poor transportation facilities. However, the trunk road network development alone will not solve the problem. Individual land development along the trunk road will cause high road side friction due to the frequent and uncontrolled accesses of local traffic and by commercial activities, and it may reduce the traffic function of the trunk road itself.

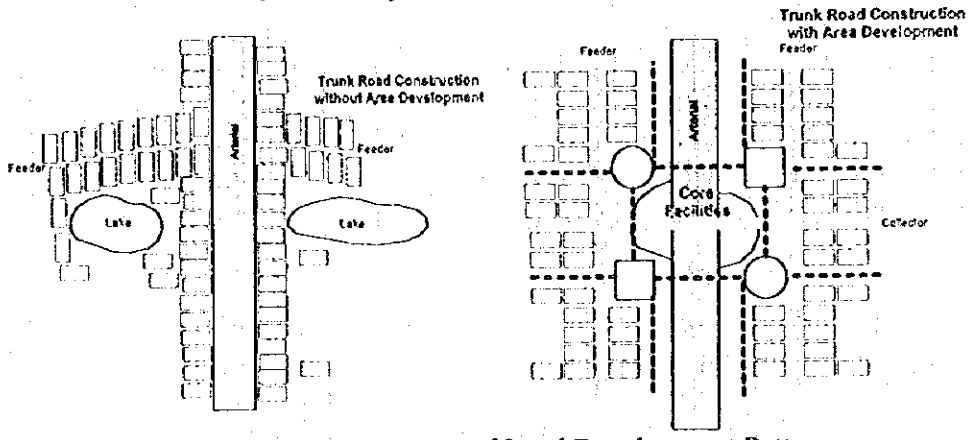


Fig. 10-1-3 Image of Land Development Patterns

The transportation network development in the sub-urban area should be planned comprehensively by providing facilities for local traffic controlling accesses to the trunk road, and public, commercial and amenity facilities to reduce the traffic demand concentration to the trunk roads.

10.2 Policies for Master Plan Formulation

10.2.1 Area Development Policy

The transportation network development will not be sufficient to meet with the future traffic demand. Lands will be developed individually along new roads and they will generate more traffic burden on the trunk road network. Paddy fields will be encroached by individual housing developments and these will create more commuters to the existing built-up area.

The individual re-development in the existing built-up area will create various problems of more dense population and labor force. This will change the city structure in the ancient and historical areas which is against the preservation policy. It will create more parking problems, traffic congestion on the existing poor road network and enforce the relocation of residents.

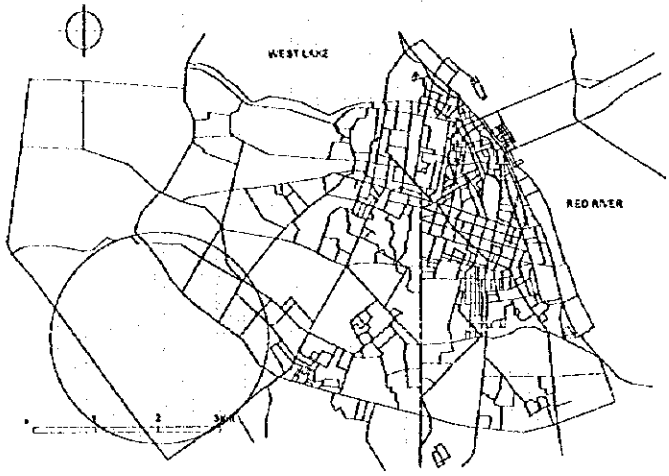
With the present characteristics and preservation policies of Hanoi central areas, it can not function as a central business district which can meet the expected economic growth of the city in the future.

An integrated area development to accommodate future population and labor force increase will absorb commuting traffic demand within the area, provide a better traffic and living environment by controlling accesses to the trunk road network, and divert the traffic demand concentration from the existing built-up area. It will be the best solution to meet with the future traffic demand.

One of the major issues of urban Hanoi road development is resettlement of shophouses occupying the right of way. The step by step improvement, firstly to improve/ develop road and land outside Ring Road No. 2, secondary to relocate those shophouses to the developed area, and then to improve roads in urban Hanoi is desirable to avoid conflicts with residents along the existing urban roads and to minimize the total investment cost which includes high compensation costs. This step by step concept is shown in Fig. 10-2-1.

In order to measure the effect of this policy on traffic load in Hanoi, especially in the existing urban area, the following four alternative land uses were prepared.

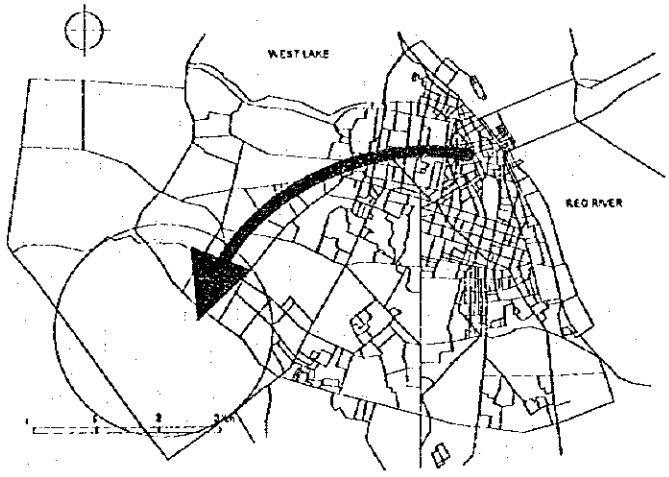
- Alternative 1: The case with sub-urban development (New CBD) and with development control in the existing built-up area.
- Alternative 2: The case with sub-urban development (New CBD) and without development control in the existing built-up area.
- Alternative 3: The case without sub-urban development (New CBD) and with development control in the existing built-up area.
- Alternative 4: The case without sub-urban development (New CBD) and without development control in the existing built-up area.



STEP-1

Development of
Sub-Urban Area

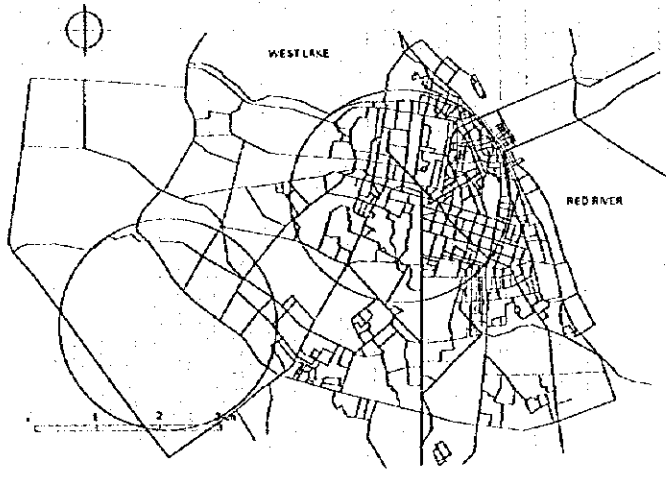
1996 - 2005



STEP-2

Relocation of Residents
from Uruban Area to
Sub-Urban Area

2005 - 2010



STEP-3

Development of
Urban Area

2010 -

Fig. 10-2-1 Land Development Pattern

Fig. 10-2-2 shows the resulting effect of New CBD Development and development control in the existing built-up area on the traffic condition in this area. The trips having their origins and destinations in the existing built-up area will increase by 1.32 - 2.20 times, and the alternative 1 "With CBD, With Control" shows the lowest of 1,566 thousands trips/day or 1.32 times the present. The alternative "Without CBD, Without Control" shows the highest of 2,616 thousands trips/day or 2.20 times the present.

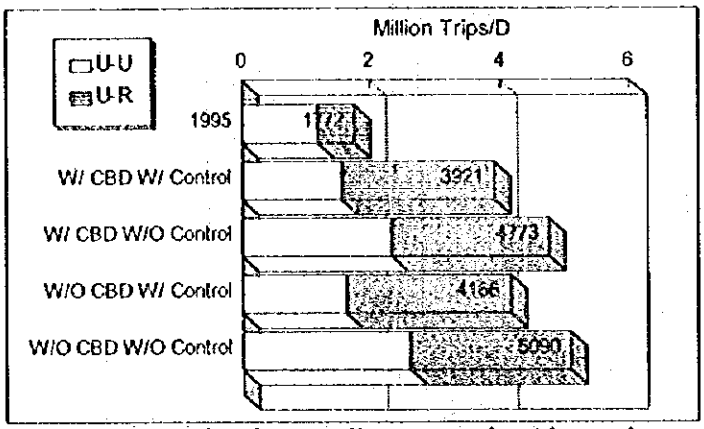


Fig. 10-2-2 Trips from Built-up Area by Alternatives

The trips between existing built-up area and other area will increase by 4.03 to 4.32 times the present. The alternative 1 "With CBD, With control" shows also the lowest of 2,355 thousand trips/d or 4.03 times, and the alternative 3 "Without CBD, with control shows the highest of 2,525 thousand trips/d or 4.32 times. The overall trips having their origin or destination in the existing built-up area shows the difference of 1,169 thousand trips or almost 30% of the lowest figure depending on the alternatives.

The development of sub urban area for the New CBD to absorb the future population and their job opportunities will decrease the traffic load in the existing built-up area. and the development control in the existing built-up area will also be effective in minimizing the traffic increase.

Table 10-2-1 Comparison of Vehicle-Km and Vehicle-Hr by Land Use Alternatives

Mode	Alt-1	Alt-2	Alt3	Alt-4
1,000 Vehicle-Km				
Bicycle	3,693.6	4,087.4	3,967.2	4,313.7
M.cycle	6,900.3	7,821.5	7,212.4	8,049.6
Bus	71.4	84.8	74.3	91.3
P.Car	181.6	224.3	202.7	251.0
Truck	278.0	271.2	273.3	263.9
Total	11,124.9	12,489.2	11,729.9	12,969.5
1,000 Vehicle-Hr				
Bicycle	313.6	349.5	336.6	370.5
M.cycle	286.5	326.5	299.8	337.5
Bus	14.4	16.3	15.9	17.2
P.Car	9.2	13.2	10.2	17.5
Truck	135.5	135.5	135.5	135.5
Total	759.2	841.0	798.0	878.2

Table 10-2-1 shows the comparison of the total vehicle-Km and vehicle-hours of five traffic modes in 28 urban zones (present built-up area). The figures show the improvement of traffic indices in the urban area caused by New CBD Development and development control in the existing built-up area. The vehicle-Km reduces by 16.5% and the vehicle-Hr 15.7% from the highest figure. Therefore, the sub-urban development as the New CBD and the development control is selected as the one of the basic transport policies.

10.2.2 Two-Wheelers Priority Policy

Table 10-2-2 shows the comparison figures of a motorcycle and a passenger car. The lane capacities of one unit based on the survey and international standard are almost the same, however the capacity of motorcycles in terms of trips is 2.33 times of that of a passenger car, which means passenger car users consume 2.33 times of road space than a motorcycle users.

Table 10-2-2 Comparison of Motorcycle, Bus and Passenger Car

Descriptions	Motorcycle	Bus	Passenger Car	M.cycle/ P.Car	Bus/ P.Car
PCU	0.3	2.0	1.0	0.30	2.0
Occupancy (Hanoi)	1.40	24.09	2.90	0.48	8.31
(Other Cities)			(2.10)	(1.50)	(11.47)
Lane (3.5m) Capacity					
Unit/Hr	7,000	1,000	2,000	3.50	0.5
PCU/Hr	2,100	2,000	2,000	1.05	1.0
Trip/Hr	9,800	24,090	4,200	2.33	5.74
Fuel Consumption Rate					
litter/100Km/Unit	3.25	35.0	10.8	0.30	3.24
litter/100Km/Trip	2.32	1.45	5.14	0.45	0.28
Economic VOC					
VND/Km/Unit	349.10	5,153.46	2,121.95	0.16	2.43
VND/Km/Trip	249.36	213.93	1,010.45	0.25	0.21

The fuel consumption of a motorcycle is 0.30 times of a passenger car in terms of units and 0.45 times in terms of trips. A passenger car user consumes almost double the volume of fuel of a motorcycle user, and hence produces air contamination. The economic vehicle operating cost (VOC) of a motorcycle/Km in terms of units is 0.16 times that of a passenger car and 0.25 times in terms of trips. A passenger car user consumes about 4 times of the economic resources than a motorcycle user, and if the initial investment for road construction is added, the difference will be greater. The use of bicycle has more benefit in terms of energy consumption, air pollution and road capacity.

Fig. 10-2-3 shows the assignment results for the case where half of motorcycle trips change to passenger car in 2015 master plan. The main roads in the urban area will turn to V/C of more than 1.5. Table 10-2-4 shows the road network length by the classification of passenger car speed. The base case is the master plan case in 2015, and mode shift case is the case where half of motorcycle shit to passenger car. The mode shift case shows the road length with the speed less than 10.0 Km/h increase by about 30% in all the network and by 14% in 10.0 - 20.0 Km/h level.

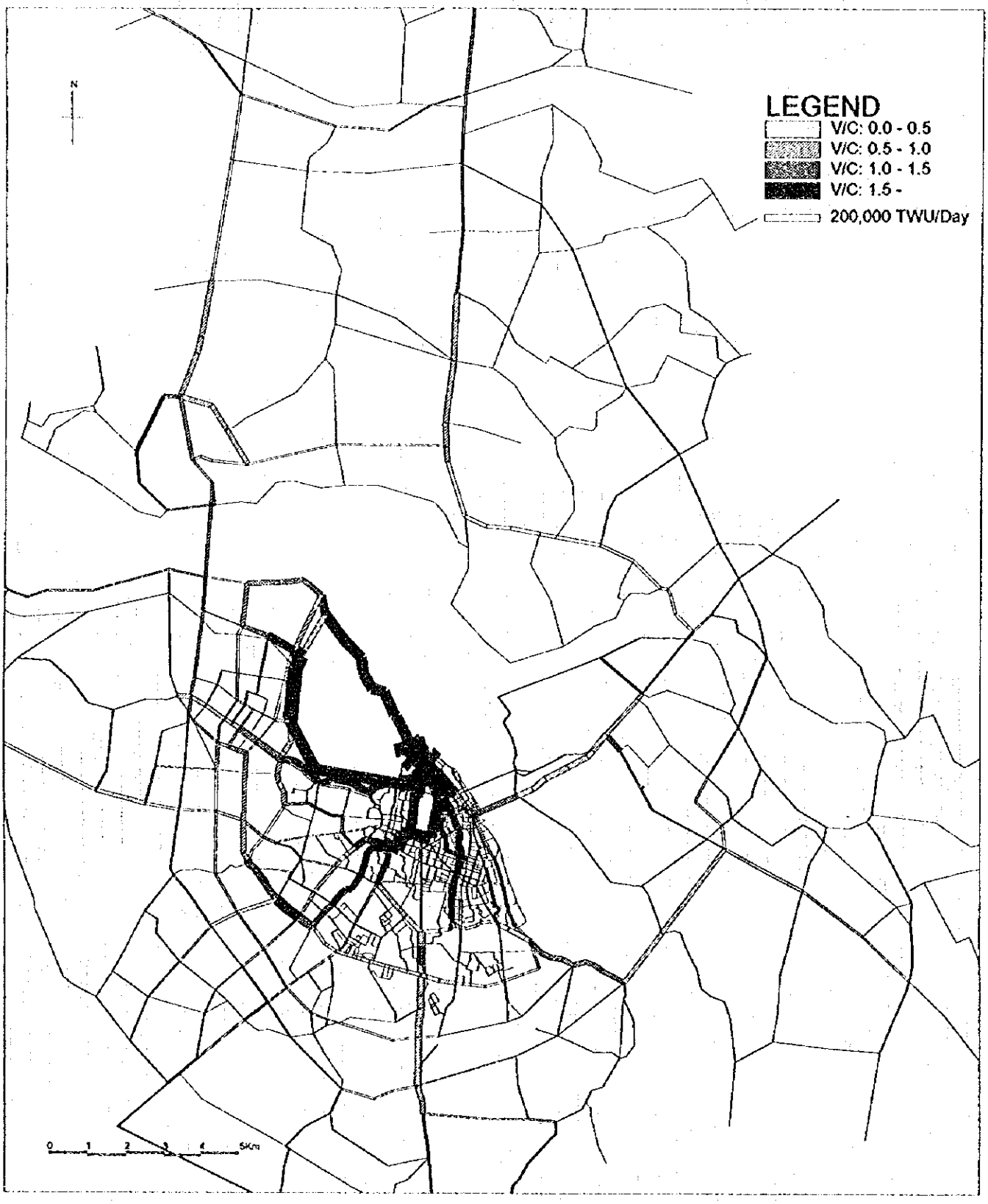


Fig. 10-2-3 2015 Traffic Flow
Mode Shift Case

However, the share of two wheelers will decrease in line with the growth of the national economy. The past records in various cities show these tendencies. Therefore, to encourage the use of two wheelers is another main issue in the Transportation Master Plan in Hanoi.

Table 10-2-3 Comparison of Road Length By Passenger Car Speed

Speed Rank(Km/h)	Urban	Rural	Total
Base Case (A)			
0.0- 9.9	69.35	45.05	114.40
10.0-19.9	66.01	27.68	93.69
20.0-39.9	45.46	480.30	525.76
40.0-	94.60	239.08	333.68
Total	275.42	792.11	1,067.53
Mode Shift Case (B)			
0.0- 9.9	76.53	70.88	147.41
10.0-19.9	63.02	43.63	106.65
20.0-39.9	51.73	439.04	490.77
40.0-	84.14	238.55	322.69
Total	275.42	792.10	1,067.52
B/A			
0.0- 9.9	1.10	1.57	1.29
10.0-19.9	0.95	1.58	1.14
20.0-39.9	1.14	0.91	0.93
40.0-	0.89	1.00	0.97
Total	1.00	1.00	1.00

Preservation of Ancient Hanoi and Old Hanoi (built-up area) is the established policy of the Vietnamese Government. Large scale improvement work of road transport infrastructure such as widening of roads can not be expected in the built up area. This means we have no counter measure to cope with the increase of four wheeler transport in these areas. The majority of the trips at present are by means of two wheeler vehicles and the existing road network in the built-up area can accommodate the traffic flow estimated for the year 2015, if the share of two wheeler trips to all trips can be maintained. It is clear that all of the improvements in the built-up area must be focused to encourage continuous use of two wheelers.

Table 10-2-4 shows the modal share of trips in various cities. Bogota in the Republic of Colombia has the highest share of bus trips, and buses are operating on bus exclusive lane with high frequency. The share of passenger car trips in Hanoi in 2015 is forecast at 2.7%, however the high share of motorcycle trips may shift to passenger car trips depend on the price balance between motorcycles and passenger cars.

Table 10-2-4 Modal Share in Various cities (%)

City	Bangkok	Manila	Beijin	Cairo	Bogota	Asncion	Hanoi
Year	1991	1971	N.A.	1988	1995	1985	2015
Bus	38.9	49.8**	35.4	36.7	71.9	58.7	14.0*
Taxi	9.9	6.1	-	8.0	5.2	0.5	-
P.Car	32.7	30.5	-	32.8	19.2	46.1	2.7
M.Cycle	18.6	-	-	-	0.5	-	49.6
Bicycle	-	-	34.7	-	-	-	31.8
Rail	-	-	-	9.0	-	-	-

Note: * including potential demand for taxi and rail
** including Gipny

Fig. 10-2-4 shows the image of modal split by travel distance. The share of two wheelers should be maintained in the urban built-up area from the view points of preservation, relocation of residents caused by the widening of existing roads in urban area and the national economy. However, the other transportation modes such as public transport and even private transport will be needed for the longer travel distance trips, especially between new development area located in suburban area and the present CBD.

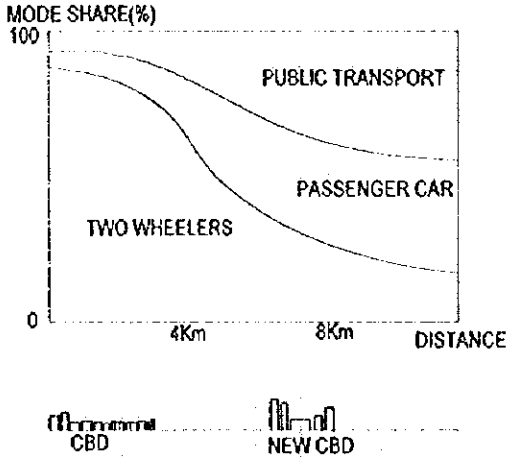


Fig. 10-2-4 Modal Split Image

As an action to realize this policy, restriction of car use in the ancient city area has beenproposed in the various studies. The synopsis of this idea is to establish the restricted zones for car use as shown in the Fig.10-2-5 below. The areas will be served only by walk or two wheel vehicles.

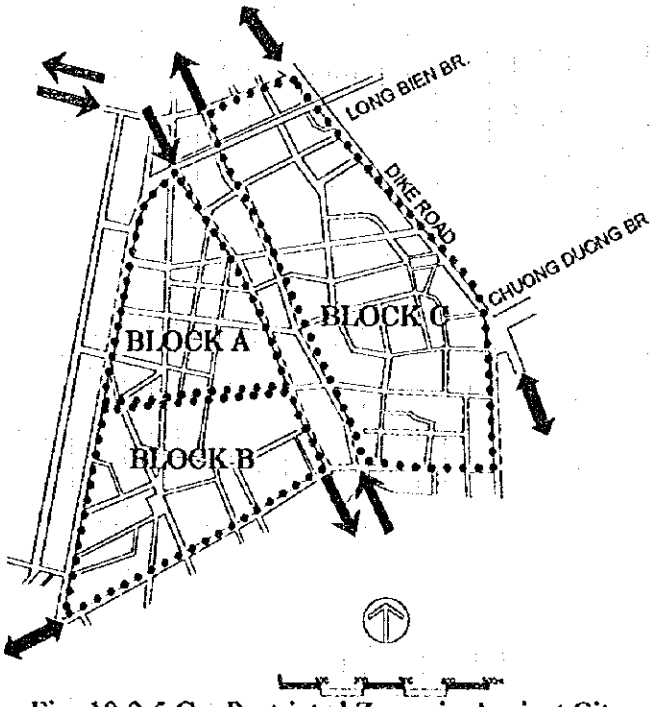


Fig. 10-2-5 Car Restricted Zones in Ancient City

10.2.3 Road Development Policy

(1) Red River Crossings

Central Hanoi is at present connected with Soc Son, Dong Anh and Gia Lam districts by three bridges over Red River, and one new bridge is under planning. One of the major policies of the road network development is to secure the sufficient capacity across the Red River section. However Long Bien bridge is basically railway bridge and the side lanes provide the only link for NMV to connect the Central Hanoi with Gia Lam area. The existing Chuong Duong bridge is served for only Mvs and can not be able to accommodate future MV demand because of high motorcycle demand.

Table 10-2-5 Existing and Planning Bridge Conditions

Name of Bridge	Descriptions
1. Chuong Duong Bridge	2 lane for 4 wheelers 2-side lanes for motorcycles
2. Long Bien Bridge	Single track railway line 2-side lanes for bicycles
3. Thang Long Bridge	4 lanes for MV on upper deck Double track railway lines (Different gages) on lower deck 2-side lanes for bicycles at lower deck
4. Than Tri Bridge	Under planning

If these bridges can not accommodate the future traffic demand, the various economic development activities located at the opposite sides of the Red River will face serious problems for commuting and freight transport. Therefore, bridge development from the view points of the traffic demand and supply balance and as a minimum requirement of the economic activities, should have the highest priority in the transportation network development.

(2) Radial Roads Development

The radial system of roads conform to the radial pattern of urban travel to reduce vehicle-km of travel for CBD oriented trips. They engender high concentrations of traffic in close-in portions of the network and funnel all traffic into system-focal points even traffic with origins or destinations outside the central area.

The radial road system in Hanoi is based on six existing national highways which connect the capital city with other regions in the country. To strengthen the radial system in the road network, other basically required radials include those to connect the city with the international airport, new industrial and residential development areas and satellite cities.

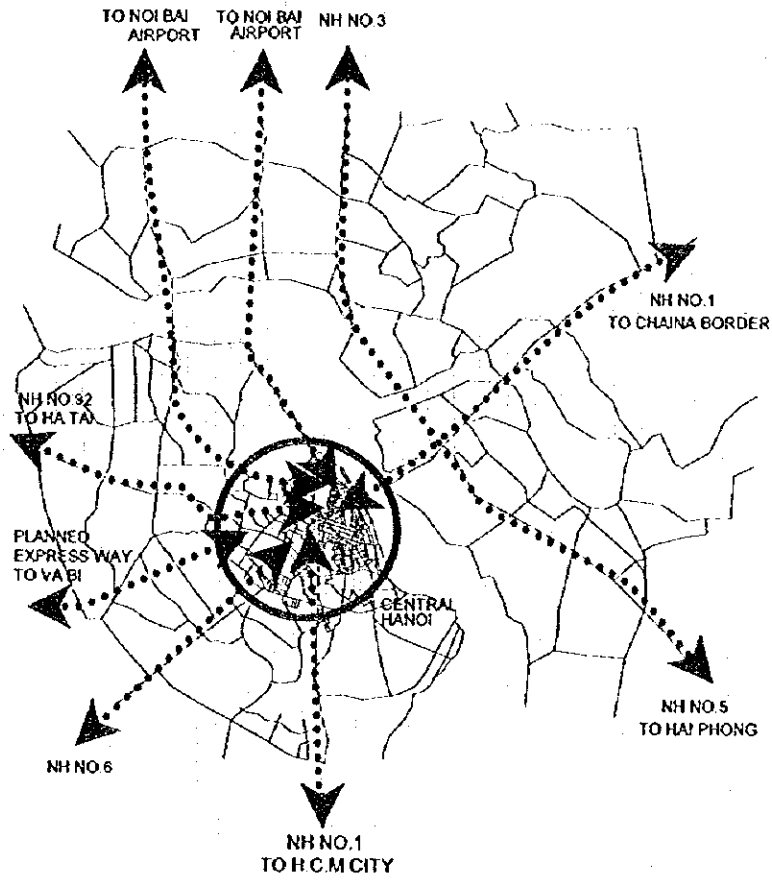


Fig. 10-2-6 Radial Roads Pattern

(3) Circular Roads Development

As the full dependence on the existing radial system concentrates the traffic at focal points of the road network, developing circular roads will improve the road network function as a radial-circular network. Existing road which may function as circular roads in Hanoi include only the RR-2 with the Dike Road and other circular roads are required to formulate a well-balanced network.

Such a system improves the accessibility and market potential as well as providing savings in vehicle operating cost and travel time. Inner loops and other circulars provide needed cross-city travel, help divert non-radial traffic and direct access to all parts of the urban area. Outer circulars encourages satellite centers development where various radials interchange, foster intensification of land use and peripheral industrialization and allows through traffic to bypass the city center.

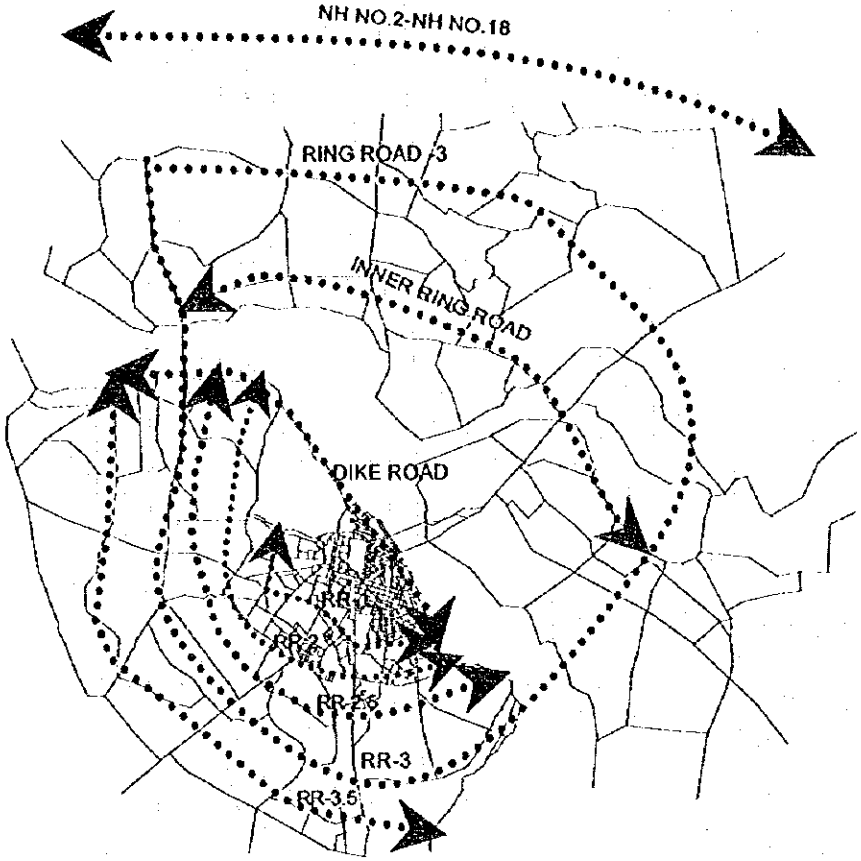


Fig. 10-2-7 Circular Road Network

(4) Urban Street Improvement Policy

Urban street development in the built-up area where road network is poor is unrealistic because of wide spread low rise and high density residents. Therefore, the plan concentrates mainly on the adjustments to the road widths in some bottle neck sections, and the effective use of existing road spaces by the traffic management measures are proposed.

Only for some trunk roads, even in the existing built-up area, desirable alignments will be proposed to reserve the space as a ROW against reconstruction of houses or building construction.

(5) Road Network Development Policy in Sub-Urban Area

Road network in the present sub-urban area will be planned to form a hierarchy, where arterial will have less accesses to maintain high traffic function, collectors will be connected to arterial, and feeders will not be connected directly to arterial to maintain the local living environment. The main intersections on arterial will be planned with about a 1Km interval, and collectors and feeders will form 200 - 500m blocks depending on land use activities.

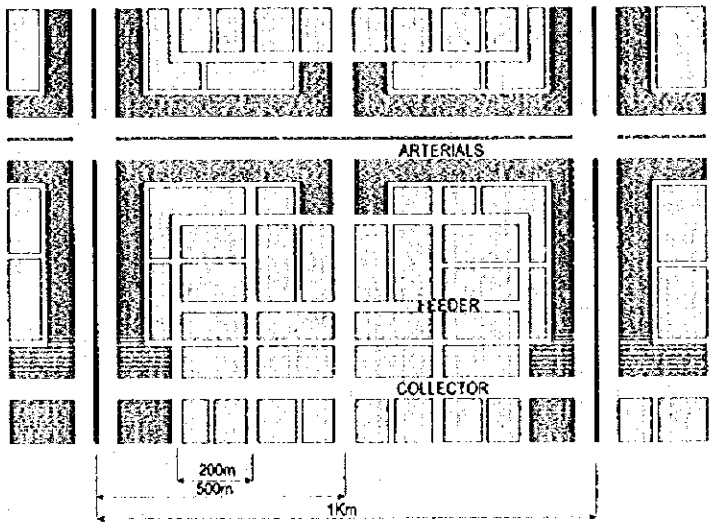


Fig. 10-2-8 Road Network Hierarchy

(6) Rural Road Improvement

In the future, the population of rural Hanoi will exceed one million. Most of the rural trunk roads (TUPWS roads) are not paved and are often closed in the rainy season. In the basic human needs respect, investment in rural road network improvement must be continued at some fixed amount even though the return on investment is poor.

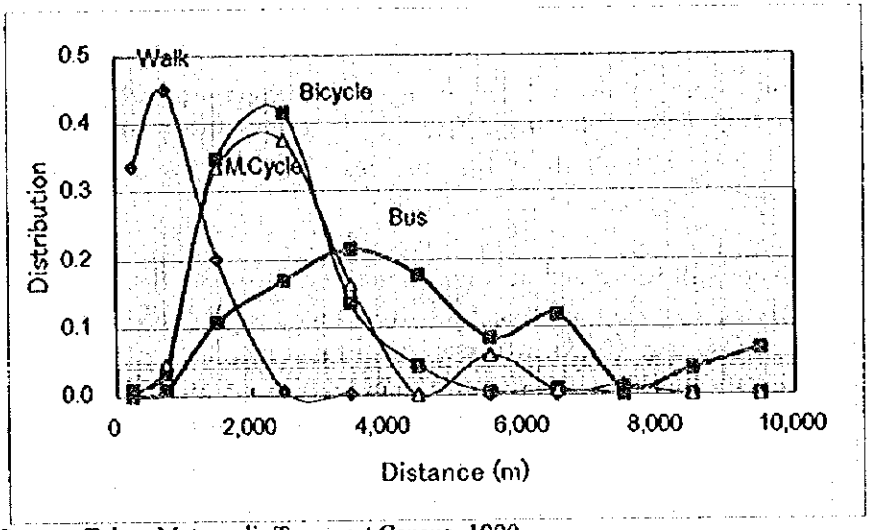
10.2.4 Public Transport Development Policy

Bus Service

Bicycle is a convenient transport mode for short distance trips but is not appropriate for long distance (more than 4 km based on the interview survey) trips. Bicycle users for long distance trip compose a portion of transport poor group. People at old age, sick, pregnant, accompanied by children, well dressed or handicapped categories belong to another group of transport poor. Several types of public transport mode should be developed to fit to every demand.

Fig. 10-2-9 shows the distribution of various modes to the railway stations in Tokyo. For the distance below 500m, almost all the trips are made by walk, and for the distance between 500m - 3.0Km, bicycles and motorcycles are prevailing modes, and buses are serving mainly for the trips beyond 3.0Km

The bus fleet should be developed in accordance with the demand increase, however the mode shift from private to the public mode should be promoted to reduce car use. Bus operation business should be financially viable and the fare should be acceptable for bus passengers. Therefore, effort should be paid to minimize the operation expenditure and to maximize the revenue. Different size of buses should be prepped for different type of services. For medium to long distance trips between the existing city center and the area beyond the border of the present built-up area, regular size buses will be suitable, while smaller size buses with more frequency will attract the short distance trip passengers within the city.



Source: Tokyo Metropolis Transport Census, 1990

Fig. 10-2-9 Mode Distribution by Trip Distance

In many cities in the South East countries, para-transit systems by smaller size and privately operated public transport systems are operating. The advantages of these systems are less operation expenditure due to less indirect cost and more revenue caused by demand response type operation.

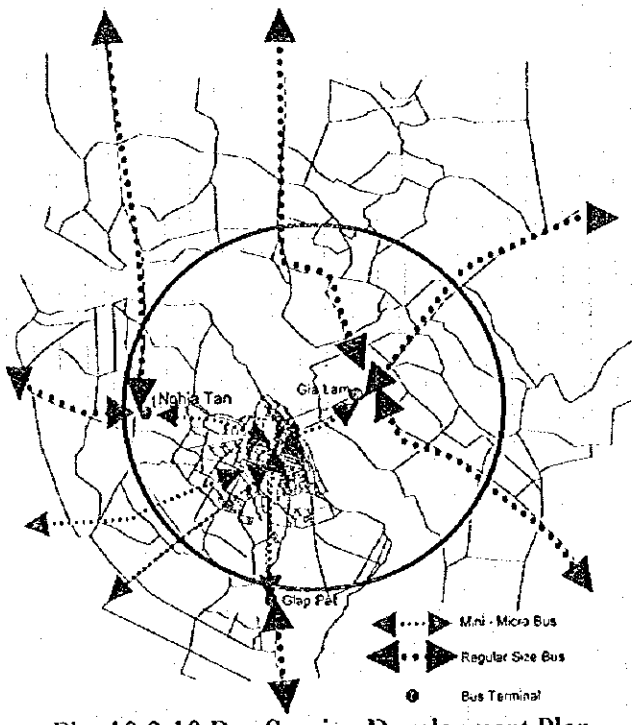


Fig. 10-2-10 Bus Service Development Plan

The potential demand based on the experiences in other countries and the possibility to introduce various types of bus operation will be studied, and bus terminals to provide transfer stations for the passengers inside and outside the urban area will be proposed.

Railway Service

The present railway line crossing the city center has various problems, among others,. the deteriorating bridge over the Red River, congested railway space occupied by houses and shops facing to the railway line, and less demand caused by limited service areas and increasing motorcycle use.

However the railway will be needed in some future when roads in the urban area will be congested by private transport modes, and even buses will not be able to provide punctual services. If railway system will start from that time, large portion of the initial investment will be spend for land purchase. To avoid this situation, the future possible railway system should be planned, even if the demand in the target year of 2015 will not be sufficient.

Railway operation business should also be financially viable. therefore, the study will focus on the clarification of the relationship between necessary cost and revenue from the forecast demand. The introduction of urban railways will be recommended if financially and economically viable.

10.2.5 Freight Transport Development Policy

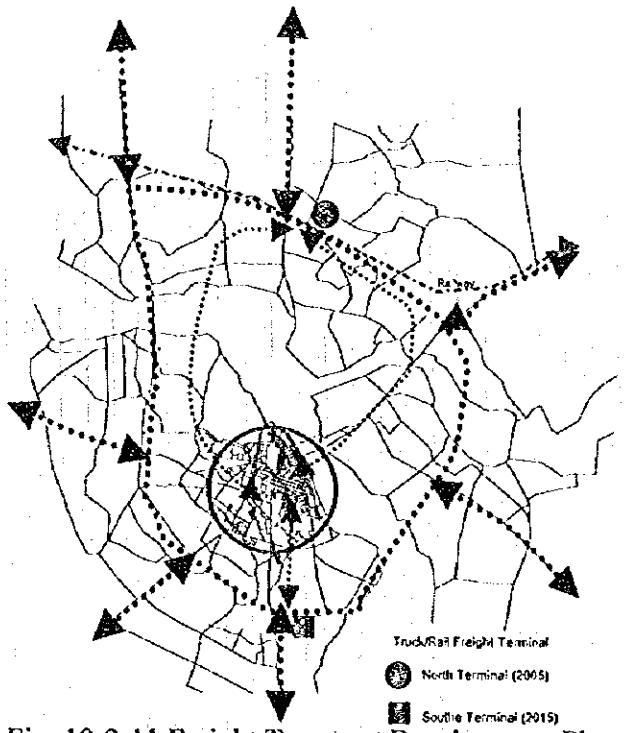


Fig. 10-2-11 Freight Transport Development Plan

Truck routes are limited on some urban streets in the built-up area. As economy grow, the freight demand from/to and via Hanoi will increase, and the truck size will shift to larger size of trailers. To prevent these trucks from the entering to the built-up area, Ring Road No.3 will provide by-pass function to the present built-up area. Along this Ring Road, truck terminals will be planned to transfer their freight to smaller size trucks.

10.3 Available Public Investment Amount

The Ministry of Transport and Construction (MOTC), Transport, Urban Public Works Services (TUPWS) of Hanoi People's Committee and District People's Committee are responsible for the public transportation facilities in the Study Area. TUPWS is responsible for the works within the future Ring Road No.3 and MOTC is responsible for National Highways and the trunk roads outside of the Ring Road No.3. The District People's Committees are responsible for the local roads within their districts.

10.3.1 MOTC Budget

Table 10-3-1 shows the state budget in 1991 - 1993 period. The budget spend to transport sector is in the range of 0.36 - 1.47% of GDP and has tendency to decrease. The "Master Plan Study on the Transport Development in the Northern Part in the Socialist Republic of Viet Nam, 1994, JICA" adopted the target share of 3% of GDP in 2010 expecting "With Policy Efforts". This share is almost same level as the share of road development investment in Japan (2.43% of GNP in 1989).

Table 10-3-1 Transport Sector Budget

Unit: Billion VND in Current Price

Item	1991	1992	1993
GDP	51,136	71,091	125,526
State Budget	9,946	17,105	36,590
Share to GDP(%)	19.5	24.1	29.1
Transport Sector Budget	753	660	449
Share to GDP(%)	1.47	0.93	0.36

Source:Key Indicators of Developing Asia and Pacific Countries 1993, ADB
Vietnam Economic Research Institute

Table 10-3-2 shows the available investment amount estimated under the assumption that 2% of GDP will be spent in the transport sector development and 10% of the national budget will be concentrated in the Hanoi Area. The same GDP growth rates as used in the socio-economic frame estimate were applied.

Table 10-3-2 MOTC Budget Estimate

Period	Transport Sector Budget(B.VND)
1996-2000	2,330.1
2001-2005	3,525.0
2006-2010	5,267.7
2011-2015	7,516.9
Total	18,639.7

The total budget for 20 years will reach to 18,640 B.VND, which is rather conservative figure than that used in the previous studies.

10.3.2 TUPWS Budget

Table 10-3-3 shows TUPWS budget record in the period of 1992 - 1995. The average annual growth rate in this period was 5.3% including local funds and the funds from ODA. According to the TUPWS Five Year Investment Program for the period of 1996 -

2000, the total investment amounts to 1,249,021 M.VND, of which 460,576 M.VND or 36.9% is allocated to road development and 192,162 M.VND or 15.4% to other transport facilities development.

Table 10-3-3 TUPWS Budget Record

Budget Item/Year	1992	1993	1994	1995
Local Fund (mil. VND)	207,265	213,937	201,215	205,492
ODA (thousand US$)	9,945	7,108	15,644	16,688
Total (million VND)	316,660	292,125	373,299	389,060

Source: TUPWS

The total investment amount in the transport sector is estimated by applying the same annual growth rate of 5.3% based on the budget in the 1996 - 2000 investment program and the same share of 52.3% to the total TUPWS budget. The 20 years total will be 4,003.9 Billion VND, which is less than the half the MOTC budget.

Table 10-3-4 TUPWS Budget Estimate

Period	Transport Sector Budget(B.VND)
1996-2000	653.0
2001-2005	844.7
2006-2010	1,092.7
2011-2015	1,413.5
Total	4,003.9

10.3.3 District People's Committee Budget

Table 10-3-5 shows District budgets for road improvement. Budgets are composed of a State budget portion and Local budget portion. Real expenditure is not available.

Table 10-3-5 District Budgets for Road Improvement (1994)

(million VND at 1994)

District	Budget		
	State	Local	Total
Thanh Tri	4,500	5,500	10,000
Gia Lam	2,600	8,000	10,600
Dong Anh	5,190	8,850	14,040
Tu Liem	2,755	468	3,223
Soc Son	2,150	0	2,150

Source:TUPWS

The following conditions were assumed to estimate the available budget.

a. for state budget, GRDP growth of Hanoi of 9 % per annum
b. for local fund, GRDP growth per Capita of Hanoi rural area,

The total investment funds available for rural road improvement is estimated as shown in Table 10-3-6 and will be 1,077 B.VND, which is almost 1/4 of TUPWS budget.

Table 10-3-6 Estimated Budgets of Districts

(at 1995 Price of Million VND)

Period/District	Thanh Tri	Gia Lam	Dong Anh	Tu Liem	Soc Son	Total
1996-2000	62,131	62,319	85,392	22,153	15,287	247,283
2001-2005	65,729	65,027	89,869	23,978	16,663	261,266
2006-2010	69,629	67,947	94,713	25,964	18,163	276,416
2011-2015	73,855	71,095	99,954	28,127	19,798	292,829
Total	271,344	266,388	369,928	100,222	69,911	1,077,794

10.3.4 Total Available Public Fund and Fund Sources

Fig. 10-3-1 shows the total available public funds for the period of 1996 - 2015. The total amount reaches to 23,721 Billion VND in 1995 prices.

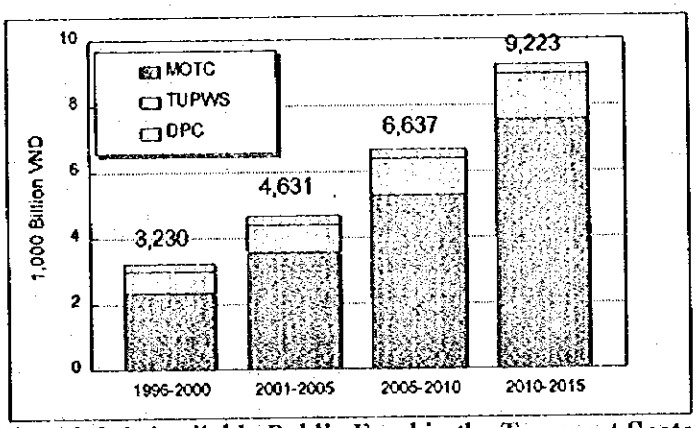


Fig. 10-3-1 Available Public Fund in the Transport Sector

However, the local funds in the previous years were decreasing, therefore various recommendations to increase the public fund or to decrease the public expenditure were made in the previous studies. They were as follows:

- Introduction of a new tax with the limited purpose to develop transport infrastructures
- Wider application of transport toll systems
- Introduction of the BOT system.

Beside these measures, a system to capture the profits to the public fund generated from the land price increase caused by the development of transport infrastructure should be taken into consideration.