AN INTEGRATED ROAD TRANSPORT NETWORK SYSTEM FOR BANDUNG (INDONESIA)

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Abstract: The population of Bandung Metropolitan Area (BMA) is over 6.5 million inhabitants in 1995 and expected to reach 11.7 million people in 2030. Due to rapid increase in population and development of business and industrial sectors, traffic problems in Bandung is becoming serious. An integrated urban and suburban public transport system is already committed to construct in the next 5 years, consisting of rail-based main corridors together with its road-based feeder systems. However, a comprehensive integrated road transport network system is also thought to be essential. This paper is based on a feasibility study project of 'Bandung Inner Ring Road' which is planned integratedly with the public transport system. The paper will mention an integrated road transport network for BMA by stressing on forecasting traffic demand and choosing the potential corridors taking into account the public transport corridors.

1. INTRODUCTION

1.1 Background

The Bandung Metropolitan Area (BMA) has an estimated population of over 6.5 million which is forecast to increase to almost 11.7 million by the year 2030 or 77% of the estimated maximum population of 15 million. The proportion of population in the inner area is estimated to decrease slightly from 80% in 1995 to 79% by 2030. The rate of growth is expected to increase as the economy builds and infrastructure becomes more developed. The peak rate of growth would have been reached by 2030 and from there on population increase would slow down as the maximum capacity is approached. The proportion of employment to population was estimated to increase from 37% in 1990 to 40% in 2000 and to 42% in the year 2010. This trend is expected to continue with employment rising to 44% of population in 2020 and to 46% in 2030. **Table 1** shows the population and employment forecasts in the BMA.

In addition, the economy of Bandung is expected to grow rapidly based on diverse industrial growth, national academics, research institutes, tourism, regional administration, shopping and commercial facilities and the close proximity to Jakarta particularly when the toll roads to Bandung and Cirebon are completed.

Table 1: Population and Employment Forecasts in the BMA

Development Area	Description	Population (1,000's)					Employment (1,000's)		
		1995	2010	2030	Max.	Max. Density (pph)	1995	2010	2030
Inner Areas :									
Kodya Bandung	Main Activity Area	2,235	2,552	2,890	3,225	200	1,152	1,563	2,342
		(35%)	(30%)	(25%)	(21%)		(48%)	(47%)	(44%)
Padalarang	Western Centre	842	1,221	1,740	2,492	84	372	588	1,052
		(13%)	(15%)	(15%)	(16%)		(16%)	(18%)	(20%)
Soreang	Southern Centre	874	1,273	2,117	1,925	71	293	435	780
		(14%)	(15%)	(18%)	(13%)		(12%)	(13%)	(14%)
Ciparay	River Plain Area	654	912	1,048	2,292	85	176	241	448
		(10%)	(11%)	(9%)	(15%)		(7%)	(7%)	(8%)
Rancaekek	Western Industrial Area	333	516	855	1,539	82	122	186	351
		(5%)	(6%)	(7%)	(10%)		(5%)	(6%)	(7%)
Tanjungsari	Education, Recreation	209	264	626	533	42	12	11	18
	& Industry	(3%)	(3%)	(5%)	(4%)		(1%)	(0%)	(0%)
		5,147	6,738	9,276	12,006	100	2,127	3,024	4,991
		(80%)	(80%)	(79%)	(79%)		(89%)	(91%)	(93%)
Outer Areas :									
Rendeh	Cities of the Future	231	281	461	965	29	53	65	81
		(4%)	(3%)	(4%)	(6%)		(2%)	(1%)	(1%)
Sindang Kerta	Forestry	220	252	433	444	13	31	40	46
		(3%)	(3%)	(4%)	(3%)		(1%)	(1%)	(1%)
Ciwidey	Southern Tourist Focus	157	189	264	389	22	42	53	62
		(2%)	(2%)	(2%)	(3%)		(2%)	(2%)	(1%)
Pacet	Plantation	251	291	606	589	8	74	90	101
		(4%)	(4%)	(5%)	(4%)		(3%)	(3%)	(2%)
Lembang	Northern Tourist Focus	450	626	660	814	21	61	74	94
		(7%)	(8%)	(6%)	(5%)		(3%)	(2%)	(2%)
		1309	1639	2424	3201		261	322	384
		(20%)	(20%)	(21%)	(21%)		(11%)	(9%)	(7%)
TOTAL		6,456	8,377	11,700	15,207	51	2,388	3,346	5,375
Increase From 1995		100%	130%	181%	236%		100%	140%	225%

Source: BMARTS (1996)

These factors emphasise Bandung's importance now and show that it will become a major urban area in the future. There is growing awareness within Central and Local Government that existing public transport services are at present far from adequate and will not be able to cope with the additional demand resulting from the rapidly expanding urban area. Some forms of actions to strengthen the capacity of transportation network in the form of a comprehensive integrated road transport network system which have to be planned integratedly with the already committed public transport system.

Bandung is connected by national roads to Jakarta in the west via Cianjur and Cikampek and to Cirebon and southern Central Java to the east. The main traffic movements are east-west either to or through Bandung from Jabotabek. The recent constructions of the Panci Toll road by passing Bandung to the south serves the main east to west movement and will increasingly relieve Jalan Soekarno-Hatta and other through-traffic routes.

The opening of the Cikampek to Padalarang toll road section, also scheduled by the year 2000, will complete the toll road between Bandung and Jakarta and will tend to generate increasing traffic and development adjacent to the route. There will also be a significant relief to the existing Padalarang to Cikampek road and on the two alternative routes to Jakarta via

Puncak and Lembang. **Figure 1** shows the road network and its classification within the BMA area.

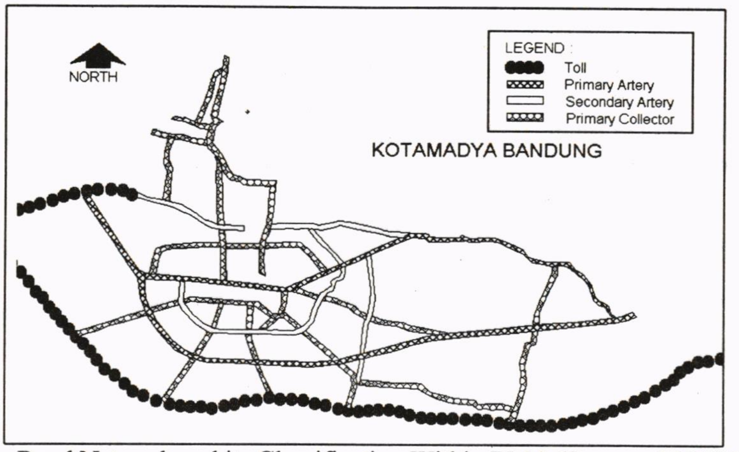

Figure 1: Road Network and its Classification Within BMA (**Source**: MBUDP, 1994)

1.2 The Urban Context

Urban transport has many particular features which do not occur in other types of transport situation. The features manifest themselves in the forms of journey to work peak hour, congestion, traffic restraint measures, public transport priorities etc. In major urban areas, rail transit systems are necessary needed to cater for the large numbers of people travelling to dense centers of attraction. Cities that have tried to cater for private transport have all come to realise that it is not possible to build enough roads and provide enough parking space for the private cars in city centers. Particular aspects that need to be understood when planning the urban transportation in the BMA are:

- Urbanisation is proceeding rapidly and population increases in the BMA are predicted to be high.

- Residential land development is spreading fast in outlying areas which do not have established transport links with the center of Bandung and other centers.

- Economic growth is high and is predicted to continue. This will encourage further land development and will also rapidly increase private vehicle ownership and use.

- The combination of population and private vehicle increase will cause increased road congestion. Therefore, transport policy will need to be focused on the control and restraint of private vehicles and the encouragement of public transport uses.

- Rail and transit systems servicing a significant proportion of transport demand must be planned carefully as they are high cost, inflexible and long lasting.

- Rail and transit system must be supported with an integrated plan with the road-based transport system to coordinate all transport modes and maximise the use of the systems.

2. ROAD-BASED TRANSPORT SYSTEM PERFORMANCE

2.1 Road Network

The road network in the BMA comprises a total of 2,052 km of classified roads of which 79.2% are Class III and below, see **Table 2**. The arterial and main collector road system covers 427.4 km and the length of all arterial roads is 177.6 km. Kabupaten Bandung has the highest proportion of roads with 1138.7 km (55.5%) and Kotamadya Bandung has 796.4 km (38.8%).

Table 2: Road Classification Inventory

Road Class/Status	Length of Roads (km)			
	Kotamadya Bandung	Kabupaten Bandung	Kabupaten Sumedang	Total BMA
CLASSIFICATION:				
Class I & II				
- Primary Arterial	38.9	90.0	17.0	145.9
- Primary Collector	58.3	106.7	2.5	167.5
- Secondary Arterial	31.7	-	-	31.7
- Secondary Collector	57.3	25.0	-	82.3
Class III & Below				
- Secondary & Local	610.2	917.0	97.0	1624.2
TOTAL	796.4	1138.7	116.5	2051.6
STATUS:				
National	38.9	90.0	17.0	145.9
Provincial	22.3	106.7	2.5	131.5
Kodya/Kabupaten	735.2	942.0	97.0	1774.2

Source: MBUDP (1994)

The BMA contains only a small part of Kabupaten Sumedang and so the length of road is low. The existing road classification is shown in **Figure 1**. Road status is related to functional classification with primary arterials as national roads, primary collectors generally as provincial roads and secondary/local roads being the responsibility of Kotamadya or Kabupaten.

2.2 Traffic System

a. **Traffic Circulation**. There is extensive use of one-way streets in Bandung. In general the existing circulation patterns are satisfactory and traffic keeps moving reasonable well. However, the one-way systems have been developed piecemeal over a period of time and result in excessive journey times and distances for many movements and particularly poor conditions for pedestrians crossing wide streams of continuously moving traffic.

b. **Volume/Capacity Ratio**. The operational performance of road links was considered in terms of volume/capacity ratios. The capacity of link is a function of the effective width of the link and roadside frictions that occur along the link. Existing peak hour volume/capacity ratios for Kotamadya Bandung roads are shown in **Figure 2**.

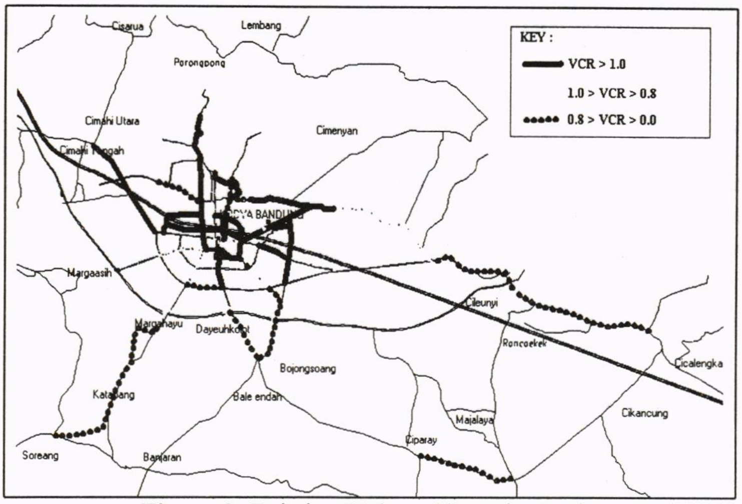

Figure 2: Existing Volume/Capacity Ratio
(**Source**: MBUDP, 1994)

Many primary and secondary roads have volume/capacity ratios greater than one, which means the roads are overloaded, the level of service is low and delays and congestion in common place. Almost all main roads in the center of Bandung are overloaded and in the outskirts of the Kotamadya are all overcapacity in the peak hours. In the Kabupatens, traffic concentration is not so extreme although roads are overloaded in town center areas.

c. <u>**Traffic Speeds**</u>. Journey time surveys were carried out in 1993 (**MBUDP, 1994**) on all main roads in the Kotamadya and Kabupatens. Average journey speeds vary considerably over the BMA, depending on the road standard, degree of urbanisation, etc. and do not correlate to road classification. Low travel speeds result from overloaded link conditions, indicated by high volume/capacity ratios and overloaded intersections. Roads with speeds less than 10 kph are regarded to have failed functionally and those with speeds less than 20 kph experience operational problems.

2.3 Public Transport Performance

A present public transportation in the Bandung is mainly provided by bus services, paratransits (angkots), taxis and minibuses. Angkots, minibuses and taxis are operated by independent private owners and comprise the majority of the transport services. Due to the operation of the various number of public transports in the crowded parts of the city, traffic congestions happen everywhere even on arterial roads.

Motorised road-based public transport has been estimated to carry over 50% of persons traveling and from between 17%-30% of vehicles on the road during an average working day. A survey of public transport carried out in the Kotamadya Bandung (**LP-ITB, 1994**) found that over a 12-hour period, the average occupancy of angkots was 8 passengers/vehicle compared with 43 passengers/vehicle for city buses. However, it is found that angkots carry almost 4 times as many passengers as Damri buses. The operation of buses and angkots are characterised by:

- High frequencies: every few minutes for angkots, 10 to 15 minutes for buses;
- Low fares: Rp 150 to about Rp 500 for long journeys out of the Kotamadya;
- Irregular picking up and setting down of angkots with no designated stops;
- Requirement to pass through designated terminal/sub-terminal to pay fee;
- Concentrations of angkots on high demand routes and around terminals;
- Irresponsible and dangerous driving of buses and angkots;
- High numbers of old, badly maintained and dangerous vehicles.

3. TRANSPORT MOVEMENT FORECASTS

3.1 Transport Needs in the Future

The future is already with us. The following trends that affect transport will continue in the future:

- **People will travel more** - Villagers who have never left the area of their kampung will let their sons and daughters travel 1,000s of kilometers to go to college in Bandung. Families will go across town to spend a day at the new zoo at Jatinangor. Students will go across town to attend university, and workers in the CBD and elsewhere will travel to and from housing throughout the BMA.

- **More women will be working** - so they will travel more.

- **More people will be students** - less children will start work early, more will stay at school, workers will continue to study part time. They will tend to travel to the CBD and main centers where continuing education will be concentrated.

- **There will be more tourism, more hotels** - more entertainment and more recreation centers. Just as people will travel more, they will also do more travel for pleasure and hence, they will need more hotels to stay in, etc.

- **Most workers will be in service industries** - by 2030, nationwide in Indonesia probably over 50% of the workforce, will be in service industries and the percentage in Bandung could be as high as 75% with only 5% in primary industries and 20% in secondary industries.

- **Industrial production will grow but industrial employment will decline** - Increasingly industries will become more mechanised even robotised. They will require less workers per unit of production but the workers will have highly specialised training for their jobs. Many factories already provide their workers with subsidised dormitory accommodation or free of charge buses to take them to and from work. As the workers get more and more specialised in their training, the factory owner will continue to provide their factory workers with accommodation or transport with accommodation or transport benefits to try to hold down labour turn over. The demand for public transport for the industrial sector will not increase significantly. Whilst public transport to the industrial areas will be needed, it usually will not be sufficient to justify special provision of public transit services.

3.2 Forecast Trips Matrices

Assuming that the moderate annual increase in household expenditure is 2.8%, total passenger trips in the morning peak hour are estimated to increase by 66% from 1995 to 2010 (3.42 % per year) and by 193% from 1995 to 2030 (3.11% per year), see **Table 3**. The effect of low household expenditure growth, 1.0% per year, was to reduce total trips (from the moderate forecast) in 2010 by 10% and in 2030 by 17%. The assumption of high household expenditure growth, 4% per year, is estimated to increase total trips (from the moderate forecast) by 6% in 2010 and by 4% in 2030.

Table 3: Forecast Passenger Trip Totals

Item	1995	2010	2030
Annual 1.0% in Income Growth (Low)			
- Total	442,662	660,846	1,071,924
- %age	100%	149%	242%
- % Increase/Year	-	2.71%	2.56%
Annual 2.8% Income Growth (Expected)			
- Total	442,662	773,149	1,249,948
- %age	100%	166%	293%
- % Increase/Year	-	3.42%	3.11%
Annual 4.0% Income Growth (High)			
- Total	442,662	775.739	1,348,587
- %age	100%	175%	305%
- % Increase/Year	-	3.81%	3.23%

Source: BMARTS (1996)

The high household expenditure growth is not shown to have a significant effect of total passengers, whereas the low growth reduces trip totals by increasing proportions with a particularly significant reduction in the 2030 forecast year. It is also estimated that over time trips will become longer with the proportion of the shorter distance trips reducing significantly and average trips distances increasing, see **Table 4**.

Table 4: Trip Matrix Distribution

Item	1995	2010	2030
Average Trips Distance (kms)	13.0	16.3	16.2
% Age of Trips : < 10 kms	60%	48%	44%
< 20 kms	77%	69%	69%

Source: BMARTS (1996)

3.3 Passenger Movement Forecasts

The total passenger O-D matrices for the forecast years were analysed to understand the pattern and magnitude of the major movements and thus the potential for the transportation corridors. In order to visualise the main movements, the BMA was divided into seven sectors and the 90 zones O-D matrix was compressed into sector movements. The seven sectors used were:

1. Old Kotamadya Bandung (plus west and south extension)
2. East Bandung (east extension of Kotamadya)
3. North Lembang-Cisarua
4. West Cimahi, Batujajar, Padalarang, Ngamprah
5. Southwest Ciwidey, Soreang, Cililin, Margahayu, dan Marga Asih
6. South and Southeast Dayeuhkolot, Banjaran, Ciparay, Majalaya
7. East Cileunyi, Jatinagor, Tanjung Sari, Rancaekek dan Cicalengka

Table 5: O-D Matrices Summary

Sector	1995		2010		2030	
	Origin	Destination	Origin	Destination	Origin	Destination
1	215,182	216,627	293,401	248,079	373,953	399,880
	100%	100%	136%	114%	173%	184%
2	69,124	59,595	140,743	94,536	339,862	162,844
	100%	100%	203%	158%	491%	273%
3	10,662	12,947	19,861	16,256	34,031	22,947
	100%	100%	186%	125%	319%	177%
4	55,895	52,737	114,630	135,004	240,648	234,395
	100%	100%	205%	255%	430%	444%
5	31,277	37,065	59,713	80,049	116,517	140,589
	100%	100%	190%	215%	372%	379%
6	41,950	47,078	77,884	116,328	140,993	241,917
	100%	100%	185%	247%	336%	513%
7	17,907%	15,948	27,222	43,202	49,107	92,539
	100%	100%	152%	270%	274%	580%
ALL	441,997	441,997	733,454	733,454	1,2295,111	1,295,111
	100%	100%	165%	165%	293%	293%

Source: BMARTS (1996)

The summary of the O-D matrix totals by sector, see **Table 5**, shows that passenger trip growth to and from the old Kotamadya area (Sector 1) will be below the average for the whloe BMA, with particular low growth on origin trips due to little or no population increase. On the other hand, East Bandung (Sector 2) shows a high increase in origin trips due to large forecast population increase. The outer areas (Sectors 3 and 7) all show above increases in trips, particularly the western and eastern areas (Sectors 4 and 7).

The sector matrices are presented in the form of desire line diagrams for the year 2030, see **Figure 3**. The existing dominance of Kotamadya Bandung in generating and attracting trips is demonstrated and this dominance is shown to increase in the future. The development of East Bandung will produce trips from a wide area and the east-west corridor will attract heavy demand.

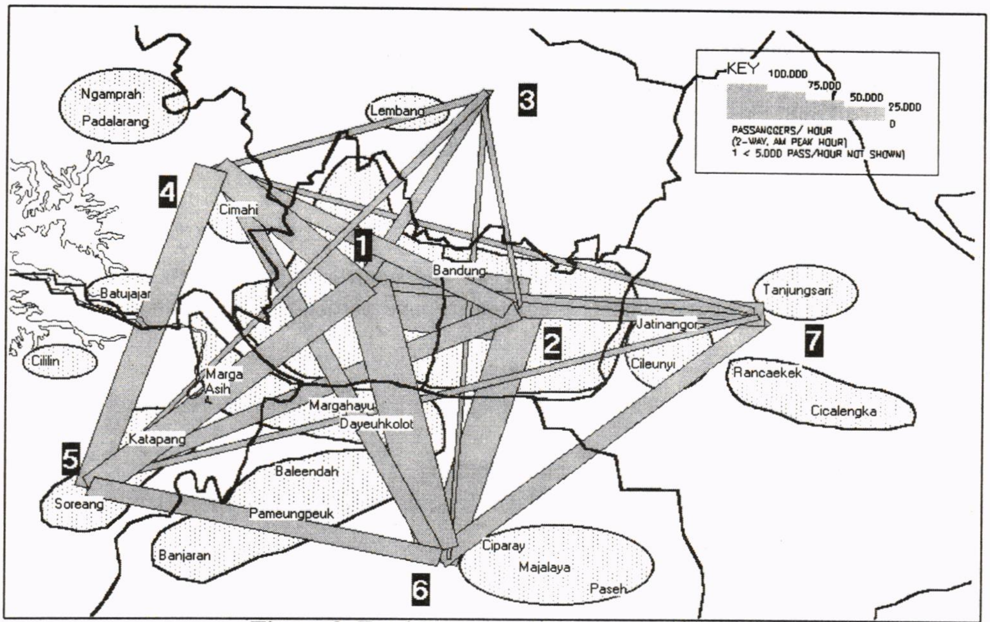

Figure 3: Total Passenger Movements (2030)
(**Source**: BMARTS, 1996)

Peripheral movements between adjacent sectors in the western, eastern and southern areas will develop strongly in the future. Intra-sector movements comprise almost 46% of total trips in 2030 and they are particularly high for the western and southern areas (Sectors 4 and 6) and for East Bandung (Sector 2), and exceptionally high for the Old Kotamadya (Sector 1) with a total of 219,500 trips in 2030 which represents 17% of total trips in the BMA.

3.4 Public Transport Requirements

The travel demand estimation model predicted that motorised public transport trips would increase by 88% from 1995 to 2030, see **Table 6**, with peak hours trips representing 9% of total daily trips. Public transport demand is much less sensitive to economic growth than private vehicle transport. Total peak hour public transport trips were estimated at 465,000 in 2030 for the moderate income growth forecast, compared with 521,000 for lower income growth and 415,000 for higher income growth.

Table 6: Public Transport Demand

Expenditure Growth	1995	2000	2010	2020	2030
1. Low (1.0% pa)	247.000	293.000	345.000	419.000	521.000
	100%	119%	140%	170%	211%
2. Expected (2.8% pa)	247.000	299.000	347.000	405.000	465.000
	100%	121%	141%	164%	188%
3. High (4.0% pa)	247.000	298.000	240.000	377.000	415.000
	100%	121%	138%	153%	168%

Source: BMARTS (1996)

There are currently over 9,000 licensed non-city bus public transport vehicles in the whole BMA. In order to satisfy demand, this number would need to increase to 18,000 vehicles by 2030. This level of microbus and minibus usage would not be efficient with such high demands. If all public transport demand were to be served using city buses about 12,000 such vehicles would be required in 2030 (50 passenger capacity).

3.5 Public Transport Corridors

The demand model has indicated substantial passenger transport movements in the future, with the following sector movements predicted to have particularly heavy demand by the year 2030:

- The East-West Corridor: Padalarang/Cimahi-Central Bandung-East Bandung-Cileunyi/ Cicalengka
- Soreang/Katapang/Margahayu-Central Bandung
- Dayeuhkolot/Banjaran/Ciparay/Majalaya-Central Bandung and East Bandung/Cileunyi/Cicalengka
- Lembang-Central Bandung
- Within Central Bandung

Based on passenger transport demand forecasts, the transport network system must be integrated in planning, implementation and operation which will combine the following elements:

- **Highway System**: an improved network of toll roads, main (arterial) and feeder (collector) roads with extensive traffic regulation and traffic management measures.

- **Primary Public Transport System**: a network of fast/high capacity transit routes.

- **Secondary Public Transport System**: an extensive rail/road based public transport network providing feeder routes to the primary transit system and a general urban public transport system.

- **Local Access System**: continuation of existing system of mini-buses, motorcycles, becak and walking.

The analysis of total public transport demand confirmed the potential heavy demand on the east-west corridor between Padalarang and Cicalengka and on radial routes into central Bandung from Lembang, Soreang, Banjaran and Majalaya. Having established that there is likely to be sufficient public transport demand over a wide area of the BMA, the next step was to define alternative corridors for urban transit routes. By considering the demand forecasts, available rights of way, development and other constrains, some possible public transit corridors were identified. The proposed long term rail and transit system for the BMA, as shown in **Figure 4**, comprises:

- the existing railway to be upgraded to provide better main line and regional services
- separate transit system to serve commuter and short distance passenger demand

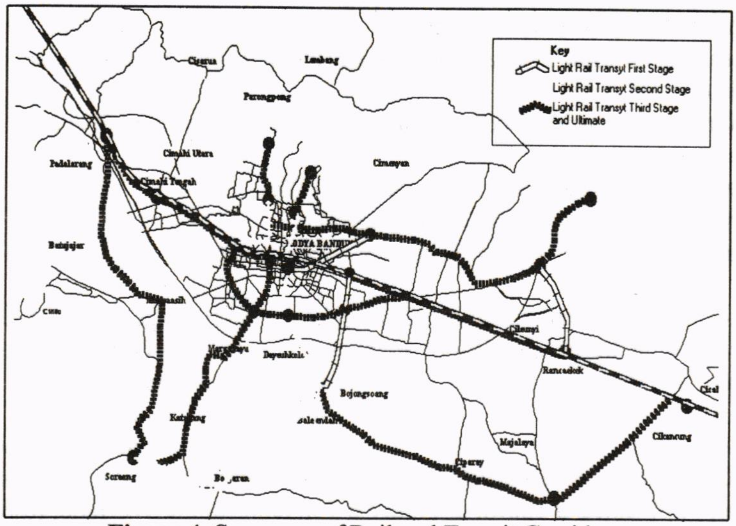

Figure 4: Summary of Rail and Transit Corridors
(**Source**: BMARTS, 1996)

4. POTENTIAL TOLL ROAD CORRIDORS

The transport demand model has indicated substantial passenger transport movements in the future. Two main stream corridors can be chosen based on passenger demand movements: East-West (E-W) and North-South (N-S) corridors, see **Figure 5**. Several aspects which have to be considered in determining the toll road corridors are: road function and classification, traffic flows, topography, landuse and implementation aspects.

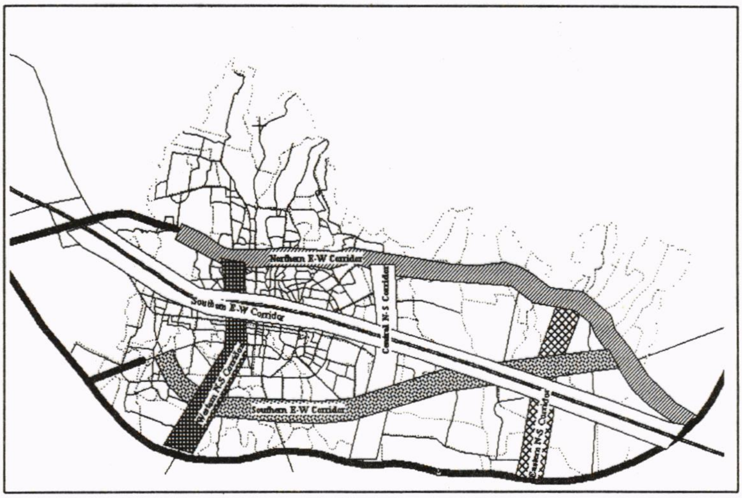

Figure 5: Summary of Toll Road Corridors for the BMA
(**Source**: BITL, 1996)

Based on those aspects, several toll road corridors for the BMA can be identified as shown in **Figure 5**:

- **Northern E-W corridor**: strecthing from Pasteur toll road-Jalan Pasteur-Jalan Surapati-Jalan Mustapha-Jalan Raya Ujung Berung-Cibiru roundabout and will end up at Padaleunyi toll road.
- **Southern E-W corridor**: corridor along Jalan Sudirman-Jalan Soekarno Hatta up to Cibiru roundabout.
- **Western N-S corridor**: Pasir Kaliki-Kopo corridor
- **Central N-S corridor**: Kiara Condong corridor
- **Eastern N-S corridor**: Rumah Sakit-Gede Bage corridor

The impact of any road construction in reliefing the transport congestion in the BMA areas can be shown using traffic simulation technique. The 2015 O-D passenger matrix was assigned onto the transport network using 'equilibrium assignment' which taking into account the cost-flow relationship of each road link. The trip assignment was carried out under two scenarios: without any new toll road construction and with new toll road construction. Having assigned the 2015 O-D passenger matrix, the traffic volumes in all main road links can be obtained as shown in **Figure 6-7** in terms of the V/C ratio, respectively for the road transport network without and with toll road construction.

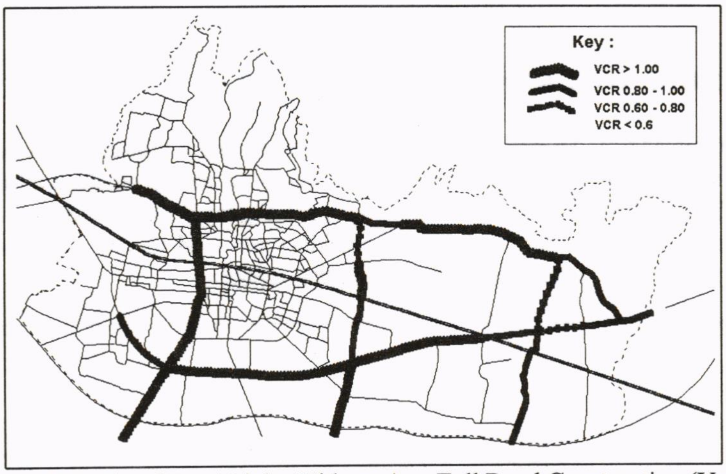

Figure 6: V/C Ratio of Road Links Without Any Toll Road Construction (Year 2015)
(**Source**: BITL, 1996)

It can be seen from **Figure 6** (without any toll road construction), in the year 2015, most of the proposed corridors for toll road have the VCR values of greater than 1 (one) indicating that heavy traffic congestion occurs on the existing network along these corridors. The congested corridors are: Northern E-W and Southern E-W corridors and Western N-S corridor. The existing road links of the proposed corridors consist of secondary arterial and secondary collector roads (see **Figure 1**).

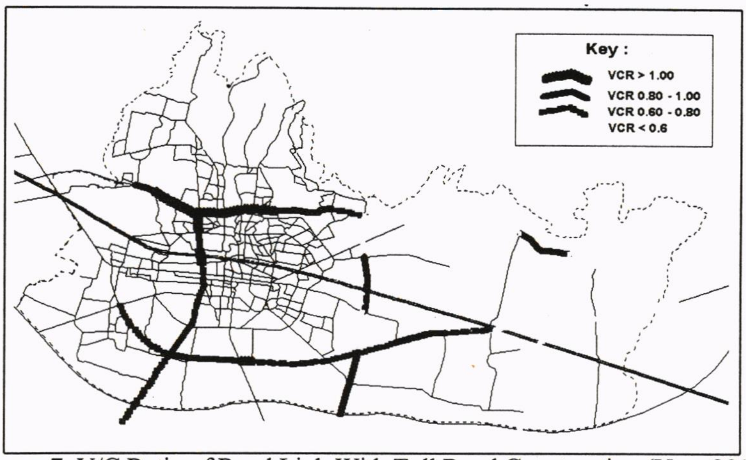

Figure 7: V/C Ratio of Road Link With Toll Road Construction (Year 2015)
(**Source**: BITL, 1996)

It can be seen from **Figure 7** (with toll road construction), in the year 2015, some of the heavity congested roads (as shown in **Figure 6**) have been relieved by the introduction of the new toll roads except some parts of the Northern corridor (i.e. Cihampelas-Surapati link). The VCR values of most road links along the proposed corridors are ranging from 0.4-0.8 indicating that there are no such heavy congested road links in the road network if compared to the situation without toll road construction.

5. CONCLUSIONS

a. Based on passenger transport demand forecasts, the transport network system must be integrated in planning, implementation and operation which will combine the following elements:

- **Highway System**: an improved network of toll roads, main (arterial) and feeder (collector) roads with extensive traffic regulation and traffic management measures.
- **Primary Public Transport System**: a network of fast/high capacity transit routes.
- **Secondary Public Transport System**: an extensive rail/road based public transport network providing feeder routes to the primary transit system and a general urban public transport system.
- **Local Access System**: continuation of existing system of mini-buses, motorcycles, becak and walking.

b. Passenger transport demand for public transport by the year 2030 forecast to be particularly heavy in the following corridors:

- Padalarang, Cimahi, Central Bandung, East Bandung, Cileunyi, Cicalengka.
- Soreang, Katapang, Margahayu, Central Bandung.
- Banjaran, Dayeuhkolot, Central and East Bandung.

- Ciparay, Majalaya, Central and East Bandung, Cileunyi, Cicalengka.
- Lembang, Central Bandung and within Central Bandung.

The urban and suburban public transport system is planned to be constructed consisting of rail-based main corridors together with road-based feeder systems.

c. The transport demand model has indicated substantial road-based passenger transport movements. Two main stream road-based corridors can be chosen based on passenger demand movements: East-West (E-W) and North-South (N-S) corridors. Several aspects which were considered in determining the toll road corridors are: road function and classification, traffic flows, topography, landuse and implementation aspects. Based on those aspects, several toll road corridors for the BMA can be identified as follows:

- **Northern E-W corridor**: strecthing from Pasteur toll road-Jalan Pasteur-Jalan Surapati-Jalan Mustapha-Jalan Raya Ujung Berung-Cibiru roundabout and will end up at Padaleunyi toll road.
- **Southern E-W corridor**: corridor along Jalan Sudirman-Jalan Soekarno Hatta up to Cibiru roundabout.
- **Western N-S corridor**: Pasir Kaliki-Kopo corridor
- **Central N-S corridor**: Kiara Condong corridor
- **Eastern N-S corridor**: Rumah Sakit-Gede Bage corridor

d. Passenger volume forecasts of 25,000-47,000 passengers/hour in the peak direction indicate that by 2030 a suburban rail service and/or a high capacity transit system would be well justified for the east-west corridor. The existing railway is recommended to be upgraded to provide better main line and regional services.

e. Land acquisition acceptability and cost could well rule out the new transport corridors (road-based and rail-based). As far as possible the strategy alternatives have to be located on the most feasible routes such as: existing and disused railway rights of way, road rights of way and underdeveloped and undeveloped land.

f. In the CBD and other inner city areas, consideration will need to be given to elevated or underground construction to overcome the problems of land acquisition. However, construction costs for elevated rail transit tracks are around twice that for at-grade construction and about four times for underground construction.

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