3) Primary Sector Worker Ratio

This indicator shows the industrial structure of a province. If this indicator shows a higher value, the province can be regarded as an agricultural province . As shown in Table 3.1-1, labor productivity of the agricultural sector is much less than that of the industry and service sectors. A province with a higher value of this indicator has less economic output in monetary terms. Sixty-three (63) out of the 73 provinces are regarded as agricultural provinces in which this indicator exceeds 50%.

National average 51.4%
Highest .....86.0% (Ifugao)
Lowest .....19.4% (Rizal)

3.2.3 Social Indicators

1) Unemployment Ratio, Underemployment Ratio and Un/Underemployment RatioGenerally, the unemployment ratio is high in the industry and service sector provinces, and the underemployment ratio is high in the agricultural provinces. Typical of the former is Laguna, in which the unemployment ratio is 9.3% (national average 6.4%) and the underemployment ratio is 20.4% (national average 35.9%), whereas Albay, typical of the latter, has an unemployment rate of 3.2% and an underemployment rate of 41.3%. Among the three indicators, the un- and underemployment ratio will most appropriately express the employment situation. A province with a high value of this indicator will be interpreted as economically not active and less developed.

National average 42.3%
Highest un- and underemployment ratio ..... 59.1% (Eastern Samar)
Lowest un- and underemployment ratio ..... 21.9% (Cavite)

2) Social Facility Ratio

The social facility ratio is a combined indicator of elementary classrooms per 1000 persons and hospital beds per 1000 persons. Generally, a province with a high value of this indicator could be considered a developed province; however, provinces near Metro Manila such as Cavite, Laguna, Rizal and Bulacan show a lower value than the national average. This is probably because development of the number of classroom and hospital beds could not keep up with the increase in population.

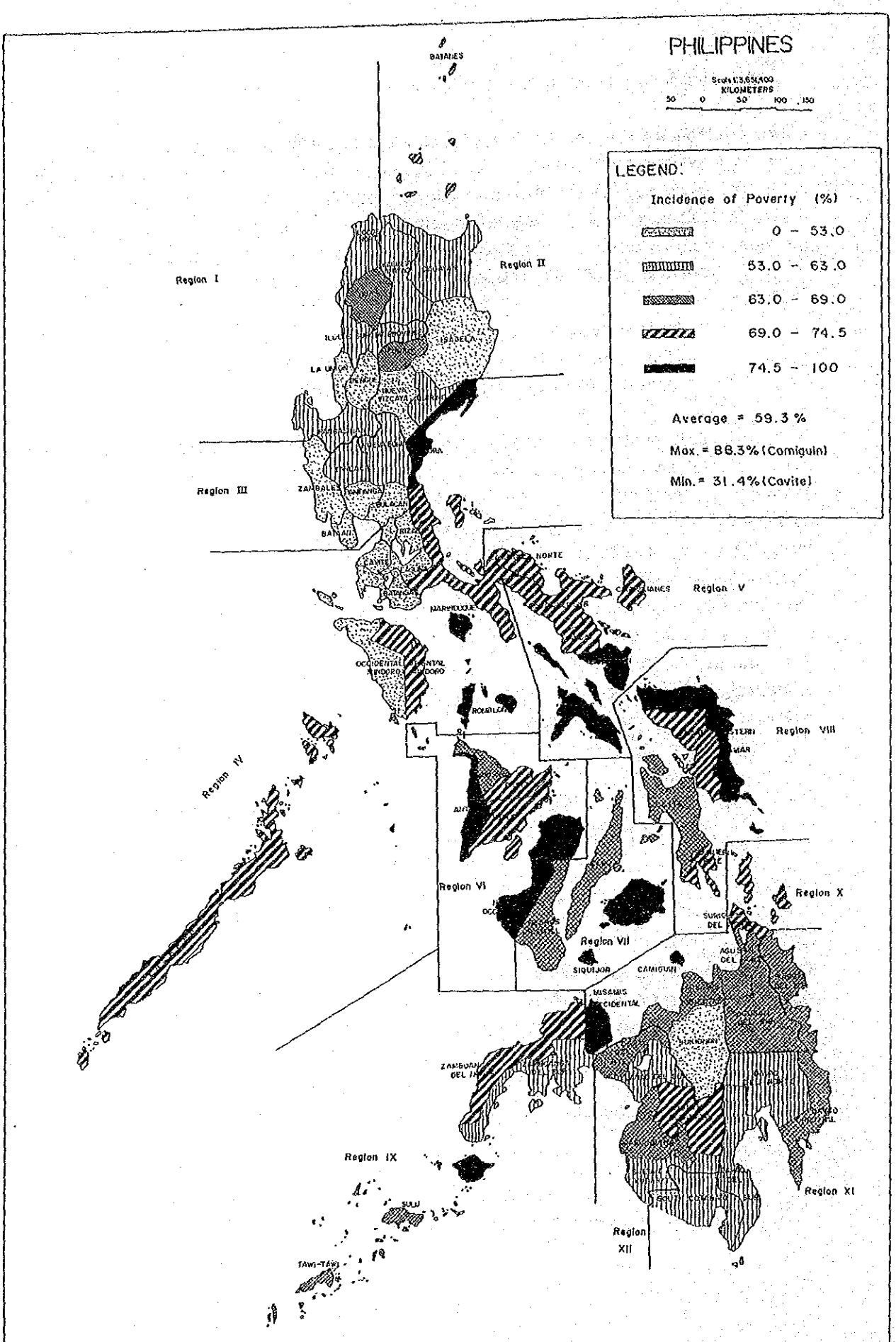
National average 1.0
Highest social facility ratio .....3.54 (Batanes)
Lowest social facility ratio .....0.45 (Rizal and Maguindanao)

3) Incidence of Poverty (See Figure 3.2-5)

This indicator is closely related to per capita income. The latter shows rather the average condition of the rich and the poor, whereas the former shows the composition of the poor. One of the national development goals is alleviation of poverty; therefore, this indicator is considered the most appropriate to assess provincial development degree. If this indicator shows a higher value, the province is regarded as economically not active and less developed.

National average 59.3%
Highest incidence of poverty .....88.3% (Camiguin)
Lowest incidence of poverty .....31.4% (Cavite)

Only eight (8) provinces show an incidence of poverty below 50%, while the remaining 65 provinces exceed 50%.



PILOT STUDY FOR THE RURAL ROAD NETWORK DEVELOPMENT PROJECT	Figure 3.2-5 INCIDENCE OF POVERTY

3.2.4 Agricultural Indicators

1) Yield of Palay, Corn, Sugarcane and Coconut

Four (4) crops: palay, corn, sugarcane and coconut, are regarded as the major crops in the Philippines. Yields (production/area harvested) of these crops are as follows:

	National Average	Highest
Palay (t/ha)	2.16	3.75 (Davao Del Sur)
Corn (t/ha)	1.15	2.56 (Tawi-Tawi)
Sugarcane (kg/ha)	48.00	73.70 (Negros Occidental)
Coconut (nuts/tree)	32.30	122.10 (Benguet)

In general, the provinces with a low yield have the potential to increase their yield to a certain extent.

2) Unutilized Agricultural Area Ratio

In general, a province with a high value of this indicator has a higher potential for cultivating presently unutilized area.

3) Accessibility to Metro Manila, Cebu City and Davao City

This is one kind of indicator to express marketability. Marketability is high if the province is located near huge consumption areas like Metro Manila, Cebu City and Davao City.

4) Agricultural Productivity (1) (See Figure 3.2-6)

This indicator shows the current level of productivity of the four (4) crops in a province. If the value of this indicator is high, it means that the productivity of a province is close to the current maximum productivity in the Philippines; therefore, potential in terms of increasing productivity (or yield) is less. It should be noted that current maximum productivity is not the absolute maximum; therefore, productivity can be raised more than the current maximum.

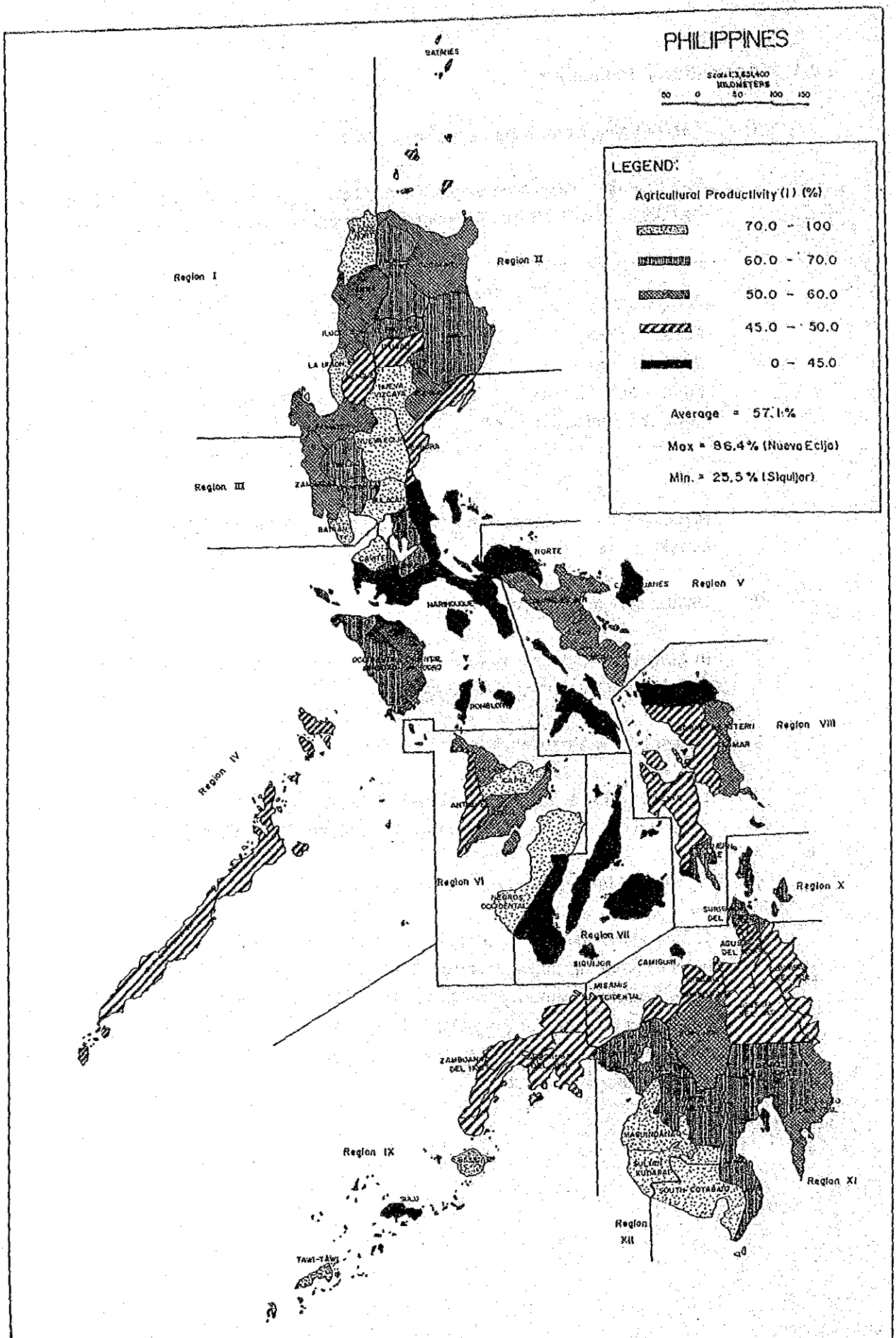


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Figure 3.2-6
AGRICULTURAL PRODUCTIVITY (I) (%)

It is not considered very difficult or impossible to raise productivity to the current maximum; therefore, a province with a lower value of this indicator is considered to have a higher agricultural potential.

National average 57.1%
Highest agricultural productivity (1) ..... 86.4% (Nueva Ecija)
Lowest agricultural productivity (1) ..... 25.5% (Siguijor)

5) Agricultural Productivity (2)

This indicator shows the potential to increase agricultural production not only by raising yield but also by expanding agricultural areas. Current productivity, unutilized are and accessibility are incorporated to develop this indicator to express this potential. A lower value shows a higher potential.

National average 43.2%
Highest agricultural productivity (2) ..... 67.3% (Tawi-Tawi)
Lowest agricultural productivity (2) ..... 12.0% (Aurora)

CHAPTER 4

REVIEW OF ADEQUACY OF ROAD NETWORK

4.1 CURRENT STATUS OF TRANSPORT SECTOR

The transport system in the Philippines consists of four (4) modes: sea, road, rail and air. Table 4.1-1 shows freight and passenger traffic by mode. Due to its geography, the Philippines depends to a great extent on interisland shipping and ferry services to link the main island of Luzon with the other islands. Nevertheless, road transport handles about 78% of the country's passenger movements and about 47% of freight movements. Sea transport handles about 9% and 49% of passenger and freight traffic, respectively. Rail and air transport handle the remaining 13% of passenger traffic and a small volume of freight (less than 5%). Therefore, the Philippine transport system is a predominantly bimodal system, with road and sea transport generally complementing, rather than competing with, each other.

TABLE 4.1-1 DOMESTIC FREIGHT AND PASSENGER TRAFFIC BY MODE: 1985

Mode	Domestic Freight Movement		Passenger Movement	
	Ton-Km (million)	Share (%)	Passenger-Km (million)	Share (%)
Road	11,200	46.5	46,000	77.7
Sea	11,900	49.4	5,080	8.6
Rail	970	4.0	3,050	5.1
Air	39	0.1	5,085	8.6
Total	24,109	100.0	59,215	100.0

Source: NEDA

As the Philippine transport system depends on road transport, priority of public investment has been placed on road development. For the period 1981 to 1985, 70% of total transport infrastructure investments was allocated to the road sector, as shown in Table 4.1-2.

TABLE 4.1-2 TRANSPORT INFRASTRUCTURE INVESTMENT

Unit: Million ₱

Mode	1981	1982	1983	1984	1985	1981-1985
Road	2,119	5,185	5,342	3,980	4,608	21,234(70.0%)
Port	589	900	462	961	956	3,868(12.7%)
Railway	111	350	1,737	1,192	610	4,000(13.2%)
Airport	197	500	81	315	151	1,244(4.1%)
Total	3,016	6,935	7,622	6,448	6,325	30,346 (100%)

Source: MPWH Infrastructure Program 1981-1985

4.2 PAST ROAD NETWORK DEVELOPMENT

4.2.1 General

The public road network system in the Philippines consists of:

- National Roads
- Provincial Roads
- City Roads
- Municipal Roads
- Barangay Roads

Provincial Roads, City Roads, Municipal Roads, Barangay Roads → Local Roads

The national roads form the main trunkline system. The provincial roads link towns and larger villages within the provinces. The city and municipal roads provide access within the urban areas. The barangay roads, the lowest tier in the road system, serve as feeder or farm-to-market roads.

Responsibility for planning, construction and maintenance of national roads and barangay roads is with the Department of Public Works and Highways (DPWH). The provincial, city and municipal government units, all under the general supervision of the Department of Local Government (DLG), are responsible for provincial, city and municipal roads in their areas, through the Provincial, City and Municipal Engineer's Offices, respectively.

4.2.2 Past Road Network Development

Major road improvement activities began in 1969 following completion of the Philippine Transport Survey conducted under UNDP financing with the World Bank as the executing agency, which recommended improvement of about 6,000 km of national roads. Also greatly impacting on the road network development was construction of the Pan-Philippine Highway (or Philippines-Japan Friendship Highway), on which construction was started in 1969 and completed in 1979 with financial assistance from Japan. As shown in Table 4.2-1 and Figure 4.2-1, national road length expanded sharply in the late 1960s and has constantly increased since then. Government efforts to improve roads is typically expressed by expansion in length of roads paved with PCC as shown in Figure 4.2-1. National road length paved with PCC greatly increased during the period between 1975 and 1980, then steadily increased in the early 1980s.

Local road expansion was also made in coordination with expansion of national roads. Figure 4.2-1 shows that local roads have been greatly expanded since 1968.

Road network in the Philippines is now generally regarded as adequate in extent.

TABLE 4.2-1 GROWTH OF ROAD NETWORK (1961-1985)

Unit: km

Year	National Roads	Local Roads				Total
		Provincial	Municipal	City	Barangay	
1961	15,143	18,777	12,238	3,447	-	49,605
1962	15,223	20,055	13,595	3,755	-	52,628
1963	15,457	20,569	14,432	3,841	-	54,299
1964	15,677	20,878	14,692	4,064	-	55,310
1965	15,922	21,363	14,309	4,184	-	55,778
1966	16,189	21,421	15,332	4,613	-	57,555
1967	16,616	22,337	14,774	4,875	-	58,602
1968	17,434	22,588	15,498	5,006	-	60,525
1969	18,540	23,312	16,176	5,232	-	63,260
1970	19,198	25,219	16,855	6,254	10,425	77,950
1971	20,066	27,879	18,781	6,805	12,069	85,601
1972	21,315	28,103	18,636	6,714	13,714	88,483
1973	21,415	28,123	19,444	7,397	16,651	93,030
1974	21,516	28,144	21,561	8,340	18,769	98,330
1975	21,665	28,175	7,512	2,680	44,399	104,430
1976	21,796	28,186	7,902	2,726	52,271	112,881
1977	22,333	28,224	9,141	3,004	56,518	119,220
1978	22,790	28,243	9,524	3,133	61,445	125,136
1979	23,552	29,034	10,657	3,406	80,960	147,609
1980	23,641	29,753	11,445	3,692	83,387	151,919
1981	23,489	29,953	11,914	3,723	84,449	153,528
1982	23,783	29,544	12,142	3,741	85,264	154,473
1983	24,140	29,725	12,240	3,718	85,847	155,671
1984	25,117	28,826	12,432	3,896	86,868	157,139
1985	26,259	28,424	12,825	3,987	90,214	161,709
	(16.2%)	(17.6%)	(7.9%)	(2.5%)	(55.8%)	(100%)

Source: 1. Monitoring and Statistics Division, PES, MPWH
2. Bureau of Maintenance, MPWH

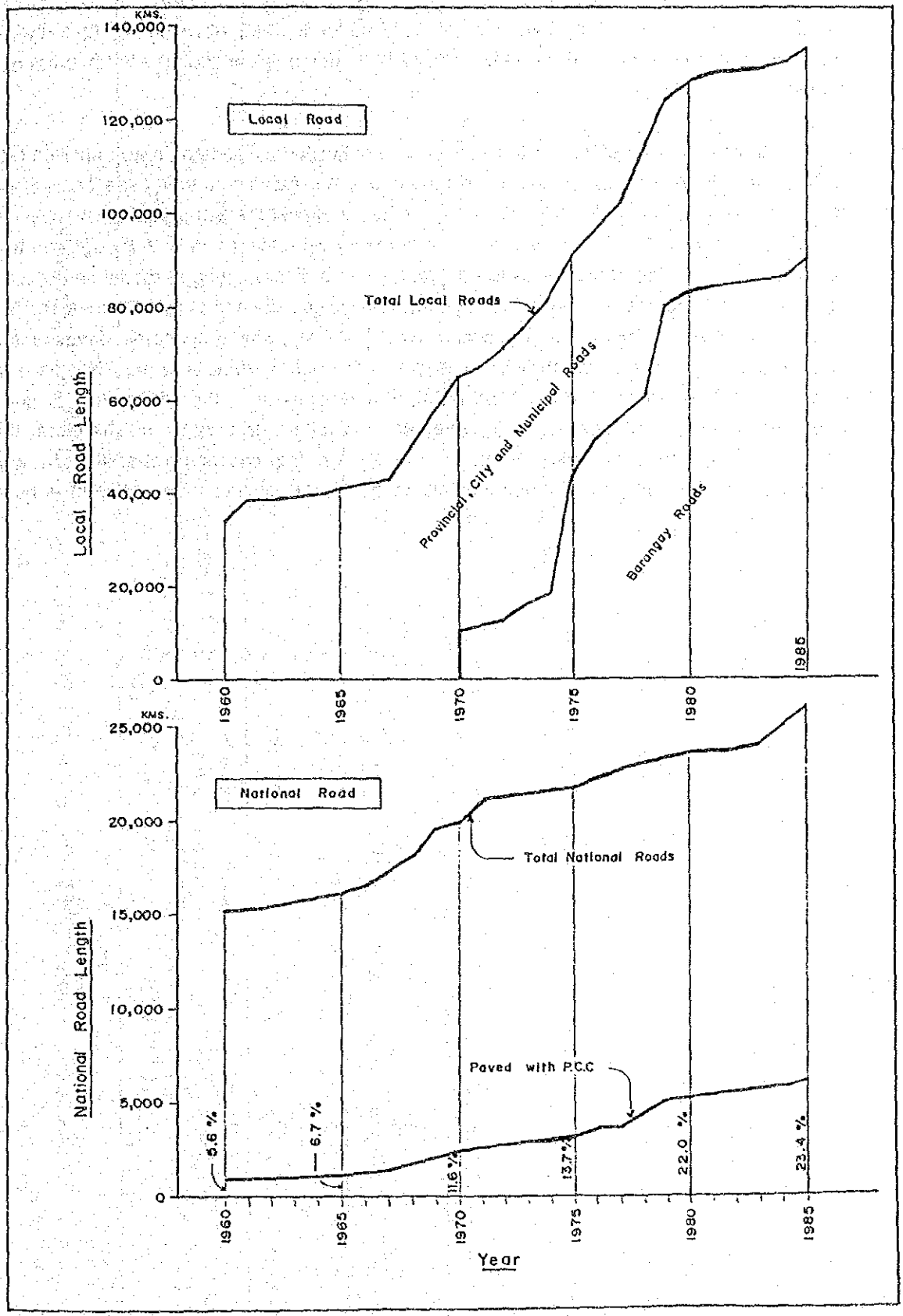


FIGURE 4.2-1 ROAD DEVELOPEMENT IN THE PHILIPPINES

4.2.3 Current Level of Road Network Development

The Philippines had a road network of some 161,700 km in 1985, of which 26,300 km were national, 28,400 km provincial, 4,000 km city, 12,800 km municipal and 90,200 km barangay roads.

In order to have an idea of the current level of road network development, road densities ($=L/\sqrt{PA}$) of the Philippines are compared with those of other Asian countries (See Table 4.2-2 and Figure 4.2-2). Per capita GDP of the Philippines is almost the same as that of Thailand; therefore, the two countries have similar economic development levels. Although the two countries have a different type of transport system, i.e., a different type of modal share, road densities of national roads and rural roads in the Philippines are higher by 2.3 times and 3.0 times, respectively, compared with Thailand. West Malaysia, whose economic development level is higher than that of the Philippines, has similar road densities with the Philippines. It can be said that current level of road network development in the Philippines is quite adequate as far as road extension (quantity of road length) is concerned.Therefore, the Philippine government's policy to place priority on improvement/rehabilitation and maintenance of existing roads (improvement of quality of existing road network) is quite rational and adequate.

TABLE 4.2-2 COMPARISON OF ROAD DENSITY WITH SELECTED ASIAN COUNTRIES

Country	Land Area (A: km^2)	Population: 1985 1) (P: 1000 persons)	Road Length: 1985 (L: km) 2)			PA	Road Density = $L/\sqrt{PA}$			Per Capita GDP, 1980 (US$)
			National Roads	Rural Roads	Total	(1000 person*km^2)	National Roads	Rural Roads	Total	
Philippines	300,000	54,670	26,260	135,450	161,710	128,070	0.205	1.058	1.263	728
							(1.00)	(1.00)	(1.00)	
Thailand	514,000	57,730	15,220	61,100	76,320	172,260	0.088	0.355	0.443	741
							(0.43)	(0.34)	(0.35)	
Indonesia	1,905,000	180,330	12,240	165,700	177,940	586,110	0.021	0.283	0.304	492
							(0.10)	(0.27)	(0.24)	
West Malaysia	130,000	6,600	6,170	24,600	30,770	29,290	0.211	0.840	1.051	1,703
							(1.03)	(0.79)	(0.83)	
Singapore	600	2,960	435	2,210	2,645	1,330	0.327	1.662	1.989	4,790
							(1.60)	(1.57)	(1.57)	

Source : 1) Philippine Statistical Year Book, 1986
2) IRF World Road Statistics 1981-1985

Note : Population and road length of Indonesia are 1984 data

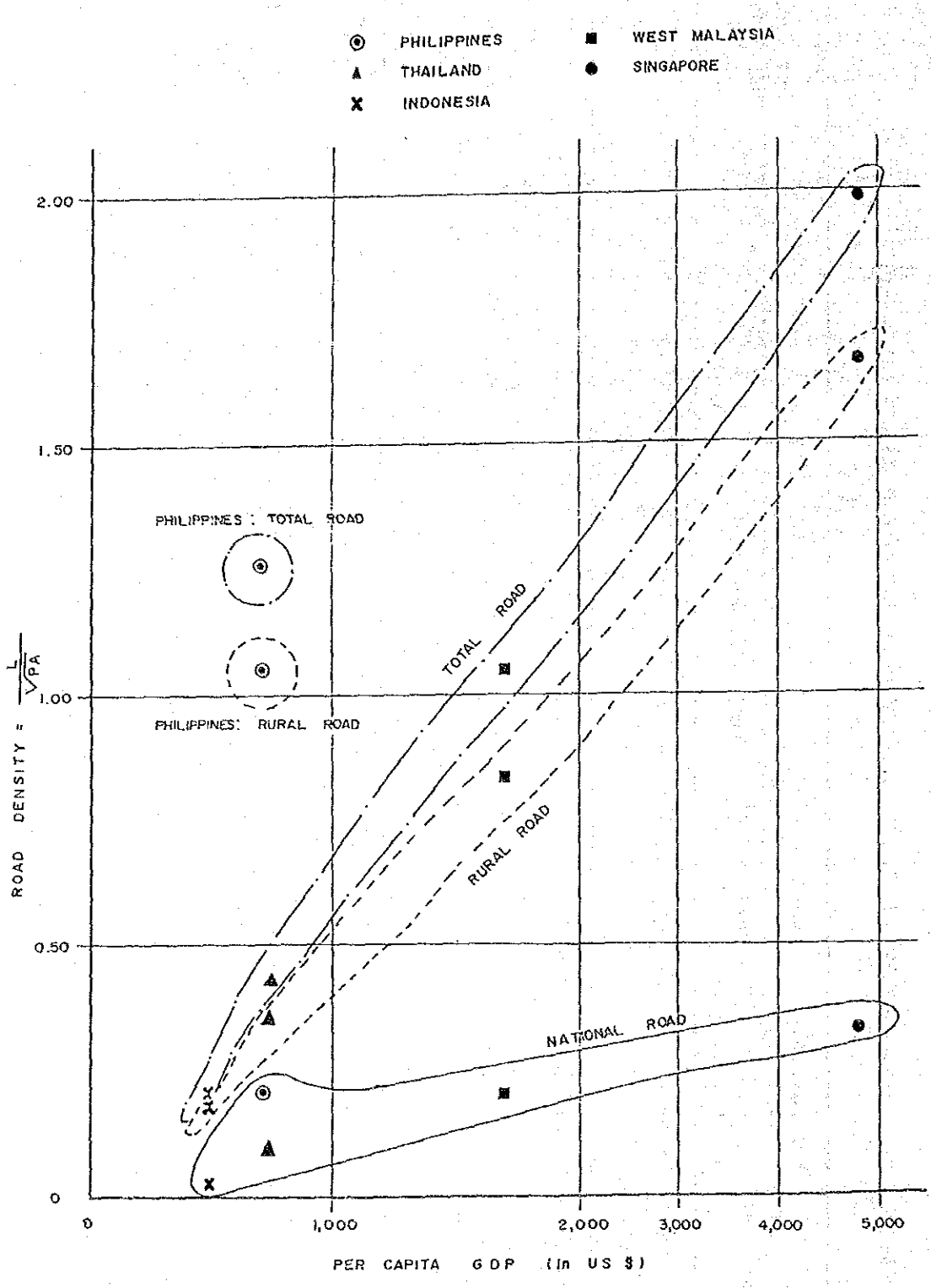


FIGURE 4.2-2 ROAD DENSITIES OF SELECTED ASIAN COUNTRIES

4.3 REVIEW OF ADEQUACY OF ROAD NETWORK

4.3.1 Basic Considerations

Various kinds of indicators were developed as shown in Appendix 2-2. The main purpose of having developed many indicators was to find out what indicator expresses adequacy of road network most appropriately.

In general, road network requirement is basically determined in accordance with the following rules:

i) The wider the area, the more roads are needed.

ii) The more people inhabit the area, the more roads are needed.

iii) The more intensive economic activities are, the higher traffic demands are, thus requiring more roads.

iv) Even though traffic demands are lighter, roads are needed to maintain inhabitants' daily lives as a basic human need.

As an indicator to express i) above, a road density (1): road length/area is commonly used. A road density (2): road length / PA is an indicator to explain i) and ii) combined. A road density (3): road length/ I PA is developed as an indicator to express i), ii) and iii) combined. It is assumed that, although there may be some exceptional cases, roads to support inhabitants' daily lives already exist in good or bad conditions; therefore, iv) above could be expressed by any of the three road densities.

4.3.2 Road Network Pattern

Steep mountainous terrain and rivers are usually two (2) major obstructions for road construction; therefore, road network development is closely related to topographic characteristics. In Chapter 3, provinces are classified by topography. The present road network pattern is related to topography as follows (also refer to Table 5.2-3 in Chapter 5):

a) Inland Province with mostly mountainous terrain

Generally, one or two primary or secondary roads penetrate the province, and a specific road network pattern is not formed yet. Typical of this group is Mountain Province.

b) Inland Province with relatively flat plain

Due to favorable topographic conditions, the basic road network is relatively well-developed and the pattern is more or less a grid type pattern. Nueva Ecija is a typical province of this group.

c) Seaside province with narrow plain along the sea and with mountainous hinterland

There are many provinces of this type. Generally there is one (1) primary road in the narrow plain along the coast and secondary or feeder roads branch off from the primary road towards the mountainous area, thus forming a comb type pattern of road network. Zambales is a typical province of this group.

d) Seaside province with relatively flat plain

A similar road network pattern to b) above is formed. Iloilo is a typical province.

e) province composed of round-shape island(s)

The road network consists of a circumferential road along the coast and one or two cross-island roads. Typical of this group is Bohol.

f) province composed of narrow and long island(s)

One primary road along the coast or center of the island with secondary or feeder roads branching off from it penetrate the province, thus forming a comb type or a fish-bone type pattern. Typical of this group is Masbate.

4.3.3 Adequacy of Road Network

1) Appropriate Indicators

Three (3) kinds of road length were examined:

L : Total road length
L' : Fair condition road length
L" : Road length paved with PCC and AC

L and L" are considered not appropriate to assess adequacy of road network. L includes all roads regardless of condition or whether they are functioning or not. L" does not include gravel surface roads which are in good condition, especially rural roads which usually carry light traffic. Therefore, gravel surface roads can be regarded as an appropriate surface type in many sections of road. It is concluded that L' is the appropriate road length to be used for assessment of adequacy of road network. Factors to determine L' are assumed by the Study Team as follows:

PCC Pavement	:	100% in fair condition
AC Pavement	:	60% in fair condition
Gravel Surface	:	15% of barangay roads and 30% of remaining roads in fair condition
Earth Surface	:	0% (no earth surface roads in fair condition)

To find an appropriate indicator, relations between L' and total land area, arable area, $\sqrt{PA}$ and $I\sqrt{PA}$ are analyzed. As shown in Figure 5.2-1 in Chapter 5, L' is strongly related with $\sqrt{PA}$; in other words, roads seems to have been developed in proportion to the size of land area and population of a province. The degree of economic activity seems to have been less related to road development, because some provinces with a high value of $I\sqrt{PA}$ have less road length than some provinces with a low value of $I\sqrt{PA}$. In this Study, road density (2): $L'/\sqrt{PA}$ was selected as a representative indicator to express adequacy of road network.

2) Adequacy of Road Network

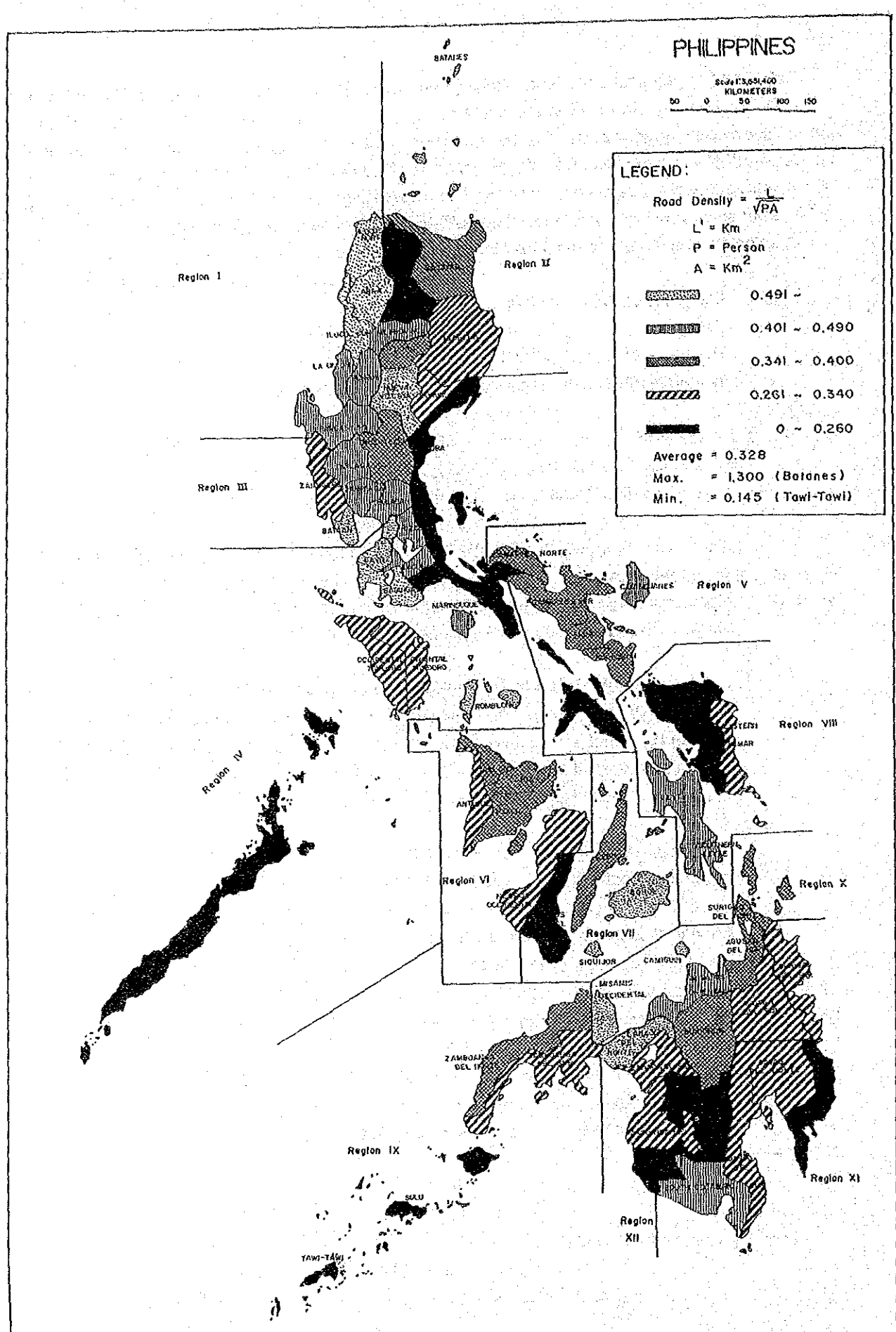
The value of road density (2) of each province is presented in Appendix 2.2: Various Indicators (5), and also shown in Figure 4.3-1.

National Average 0.328
Highest Road Density (2) .....1.300 (Batanes)
Lowest Road Density (2) .....0.145 (Tawi-Tawi)

Those provinces which have the lower road density are most provinces in Region II, island provinces and Quezon in Region IV, Masbate in Region V, Antique and Negros Occidental in Region VI, Negros Oriental in Region VII, all provinces in Samar Island in Region VIII and most provinces in Regions IX, XI and XII.

provinces which have a higher road density are provinces in Region I, provinces near Metro Manila in Region III and IV, small island provinces of Marinduque and Romblon in Region IV, Bohol and Siquijor in Region VII, provinces in Leyte Island in Region VIII, Misamis Occidental and Misamis Oriental in Region X, south Cotabato in Region XI and Lanao Del Norte in Region XII.

Provincial disparity in road density is quite notable. Excluding very small island provinces, Ilocos Norte has the highest road density (0.668) and Masbate the lowest (0.163), whose road density is only one fourth (1/4) that of Ilocos Norte. Mitigation of provincial disparity in road density should be considered.



PILOT STUDY FOR THE RURAL ROAD NETWORK DEVELOPMENT PROJECT	Figure 4.3-1	ROAD DENSITY = $\frac{L'}{\sqrt{PA}}$ (All Roads)

4.3.4 Adequacy of Road Network by Class of Road

In Section 4.3.3, all classes of roads are dealt with as one class to assess adequacy of roads in general. In this section, roads are classified into two (2): primary and secondary roads and feeder roads to identify which class of roads is adequate or not. Roads are classified as follows:

Primary and Secondary Roads .....National, provincial and city roads

Feeder Roads .....Municipal and barangay roads

The road density (2) of each class of roads was computed and plotted as shown in Figure 4.3-2. provinces are classified into five (5) as follows:

Code	Primary and Secondary Roads	Feeder Roads
LL	Relatively good	Relatively good
LS	Relatively good	Relatively poor
MM	Average	Average
SL	Relatively poor	Relatively good
SS	Relatively poor	Relatively poor

Table 4.3-1 shows provinces under each category, also shown graphically in Figure 4.3-3.

Ten (10) provinces were classified under LL, 12 under LS, 18 under MM, 7 under SL and 26 under SS.

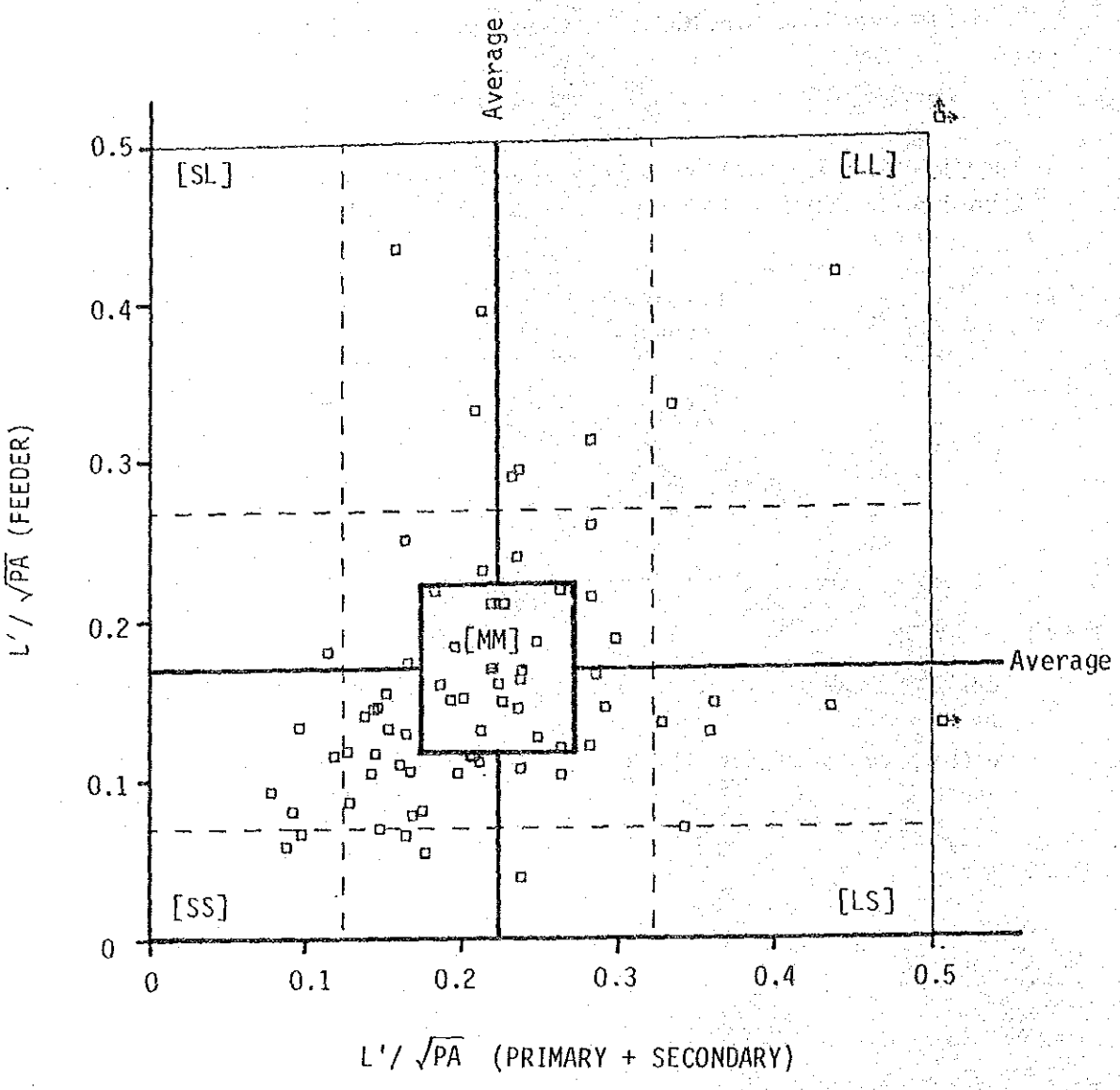


FIGURE 4.3-2 RELATION OF ROAD DENSITY BETWEEN PRIMARY AND SECONDARY ROADS AND FEEDER ROADS

TABLE 4.3-1 PROVINCES UNDER EACH CATEGORY

[SL]

- Primary and Secondary Roads: Relatively Poor
- Feeder Roads: Relatively Good

(1) Abra
(4) Rizal
(1) Ilocos Sur
(6) Antique
(11) South Cotabato
(12) Lanao del Norte
(8) Eastern Samar

[LL]

- Primary and Secondary Roads: Relatively Good
- Feeder Roads: Relatively Good

(2) Batanes
(10) Camiguin
(1) Ilocos Norte
(8) Southern Leyte
(4) Romblon
(7) Bohol
(4) Batangas
(10) Misamis Occidental
(3) Bulacan
(2) Nueva Vizcaya

[MM]

- Primary and Secondary Roads: Average
- Feeder Roads: Average

(5) Albay
(10) Misamis Oriental
(8) Leyte
(10) Agusan del Norte
(3) Pampanga
(10) Surigao del Norte
(5) Camarines Sur
(3) Tarlac
(3) Nueva Ecija
(2) Ifugao
(6) Iloilo
(1) Pangasinan
(7) Cebu
(6) Capiz
(6) Aklan
(2) Cagayan
(9) Zamboanga del Norte
(10) Bukidnon

[SS]

- Primary and Secondary Roads: Relatively Poor
- Feeder Roads: Relatively Poor

(2) Quirino
(6) Negros Occidental
(3) Zambales
(8) Samar
(9) Sulu
(4) Aurora
(12) Maguindanao
(11) Davao Oriental
(4) Occidental Mindoro
(10) Agusan del Sur
(11) Davao del Norte
(11) Davao del Sur
(4) Quezon
(12) Lanao del Sur
(11) Surigao del Sur
(2) Isabela
(7) Negros Oriental
(9) Zamboanga del Sur
(2) Kalinga-Apayao
(9) Basilan
(4) Palawan
(5) Masbate
(12) Sultan Kudarat
(8) Northern Samar
(9) Tawi-Tawi
(12) North Cotabato

[LS]

- Primary and Secondary Roads: Relatively Good
- Feeder Roads: Relatively Poor

(7) Siquijor
(3) Bataan
(4) Cavite
(1) Benguet
(1) Mountain Province
(4) Marinduque
(4) Laguna
(1) La Union
(5) Catanduanes
(5) Sorsogon
(4) Oriental Mindoro
(5) Camarines Norte

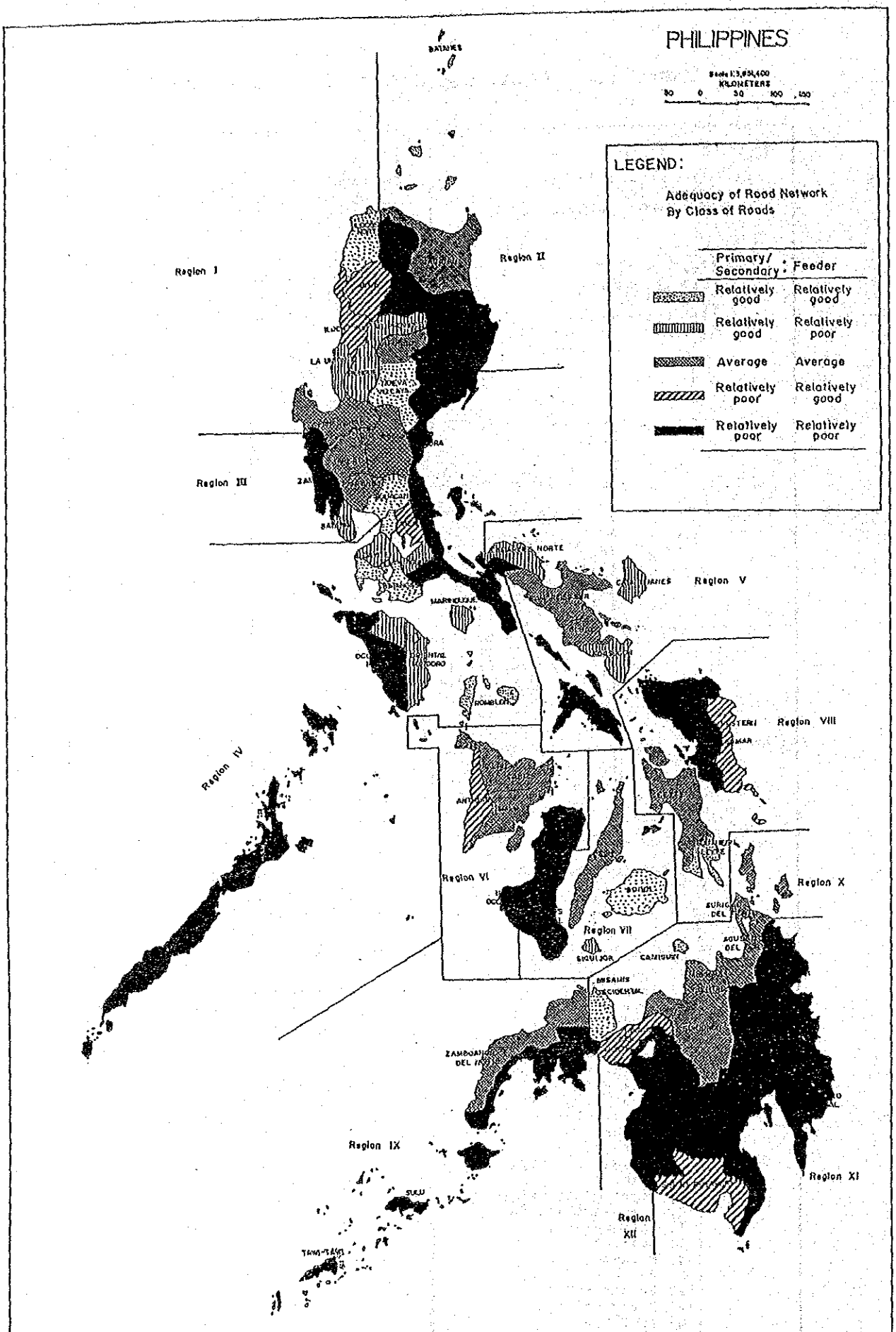


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Figure 4.3-3
ADEQUACY OF ROAD NETWORK BY CLASS OF ROADS

CHAPTER 5

CLASSIFICATION OF PROVINCES

5.1 CLASSIFICATION ACCORDING TO SOCIO-ECONOMIC DEVELOPMENT

5.1.1 Approach

1) Selection of Indicators

Various indicators related to socio-economic development are divided into three major factors. Table 5.1-1 shows the indicators to be used in the classification of provinces under each factor.

TABLE 5.1-1 INDICATORS USED IN CLASSIFICATION OF PROVINCES

Factor	Indicators
Demographic Characteristics	Arable Area Ratio Population Density Urban Population Ratio Population Growth Rate
Socio-Economic Characteristics	Per Capita GRDP Land Productivity (GRDP/Area) Per Capita Income Un-/Underemployment Ratio Social Facility Ratio Incidence of Poverty
Agricultural Productivity	Agricultural Productivity (1) Agricultural Productivity (2)

2) Classification Procedures

The classification procedures are illustrated in Figure 5.1-1.

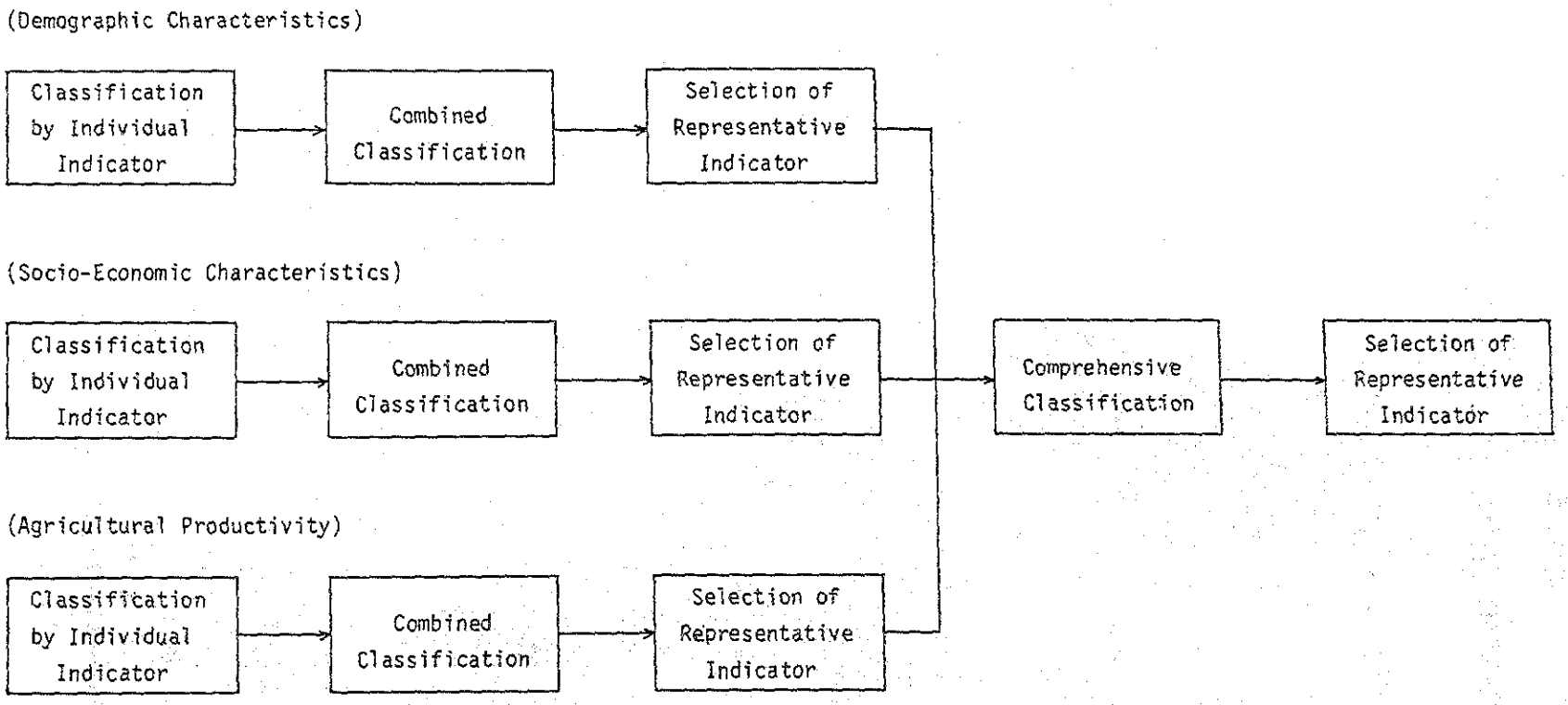


FIGURE 5.1-1 PROCEDURES FOR CLASSIFICATION OF PROVINCES

a) Classification by Individual Indicator

Provinces are classified into A to E as follows in descending order of indicator, except for ascending order for "un-/underemployment ratio" and "incidence of poverty":

First	14 Provinces: A
Second	15 Provinces: B
Third	15 Provinces: C
Fourth	15 Provinces: D
Last	14 Provinces: E

The classification of each province may vary depending on the indicator.

b) Combined Classification

A combined value of several indicators is calculated for each province and, based on this value, a combined classification is made. The combined value is calculated as the weighted total of several indicators:

$$Z=\sum Wi.Xi^*$$

where, Z : Combined value
wi : Weight given to indicator, i
xi^* : Standardized value of indicator, i

$$xi^* = \frac{xi - \bar{xi}}{\sigma i}$$

xi : Value of indicator, i
$\bar{xi}$: Mean value of indicator, i
σi : Standard deviation of indicator, i

Standardization is made for adjustment of different ranges of value between indicators.

The combined classification is considered a sort of compromise classification in several indicators of similar nature. In this classification, a peculiar value in a certain indicator may be neutralized.

c) Selection of Representative Indicator

Since a combined classification is somewhat time-consuming, a simplified method was developed. If a certain indicator can be considered representative of all indicators concerned, in other words, if the classification by that indicator is not unacceptably different from the combined classification, it is regarded as a representative indicator to be used in classification instead of the combined classification.

Comprehensive Classification

Comprehensive classification is made in the same way as combined classification described above, using representative indicators of demographic characteristics, socio-economic characteristics and agricultural productivity. Then, the representative indicator of all indicators concern is searched for.

5.1.2 Classification according to Demographic Characteristics

1) Correlation between Indicators

The coefficients of correlation between indicators used in the analysis are shown in Table 5.1-2. Population density is found to correlate with arable area ratio and urban population ratio.

TABLE 5.1-2 COEFFICIENTS OF CORRELATION BETWEEN INDICATORS (DEMOGRAPHIC CHARACTERISTICS)

	Arable Area Ratio	Population Density	Urban Population Ratio	Population Growth Rate
Arable Area Ratio	-	0.618	0.213	-0.056
Population Density		-	0.663	0.142
Urban Population Ratio			-	0.355
Population Growth Rate				-

2) Classification by Individual Indicator

Classification by individual indicator is shown in Table 5.1-3.

3) Combined Classification

The combined values are calculated giving the following weights to each indicator and, according to the combined values, provinces are classified into A to E as shown in Table 5.1-3:

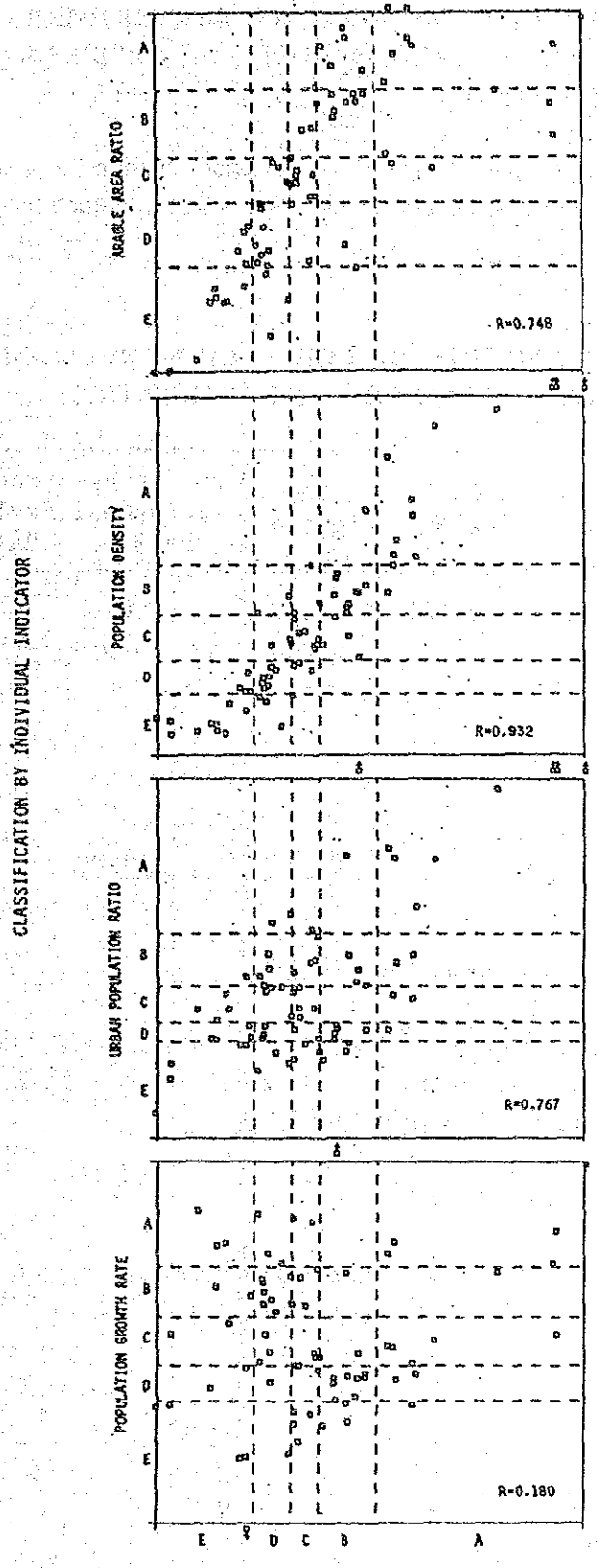
Indicator	Weight
Arable Area Ratio	1/3
Population Density	1/3
Urban Population Ratio	1/3
Population Growth Rate	0

4) Selection of Representative Indicator

Figure 5.1-2 shows the relationship between classification by individual indicator and combined classification. From this figure, the difference between classification by population density and combined classification was found to be acceptably small. As a result, population density is recognized as the representative indicator of demographic characteristics.

TABLE 5.1-3 CLASSIFICATION BY INDIVUDUAL INDICATOR AND COMBINED CLASSIFICATION (DEMOGRAPHIC CHARACTERISTICS)

	Classification by Individual Indicator				Combined Classification (Demographic Charact)
	Arable Area Ratio (%)	Population Density (/km2)	Urban Population Ratio (%)	Population Growth Rate (% p.a.)	
Weight for Combined Classification	.3333	.3333	.3333	-	
(4) Rizal	A	A	A	A	A
(3) Pampanga	A	A	A	C	A
(4) Cavite	B	A	A	A	A
(4) Laguna	B	A	A	A	A
(3) Bulacan	B	A	A	B	A
(7) Cebu	C	A	A	C	A
(6) Negros Occidental	A	A	A	D	A
(1) Pangasinan	A	A	B	E	A
(5) Albay	A	A	C	C	A
(6) Iloilo	A	A	B	D	A
(3) Bataan	C	A	A	A	A
(5) Sorsogon	A	B	C	C	A
(4) Batangas	A	A	D	C	A
(10) Misamis Oriental	B	B	A	A	A
Average	66.8	421	45.5	2.96	1.295
Standard Deviation	10.8	153	18.2	.94	.685
(5) Camarines Sur	A	B	B	D	B
(1) La Union	B	A	D	D	B
(3) Zambales	E	C	A	D	B
(3) Nueva Ecija	B	B	B	C	B
(8) Leyte	B	B	B	D	B
(7) Bohol	A	B	E	E	B
(5) Camarines Norte	B	C	B	D	B
(11) Davao del Sur	D	B	A	B	B
(4) Marinduque	A	B	E	E	B
(9) Sulu	B	B	D	A	B
(3) Tarlac	B	B	D	D	B
(8) Southern Leyte	A	C	D	D	B
(10) Misamis Occidental	B	B	D	D	B
(4) Romblon	A	C	E	E	B
(6) Capiz	B	B	E	C	B
Average	61.8	216	24.6	2.21	.257
Standard Deviation	12.6	46	13.3	.97	.127
(5) Masbate	A	C	D	D	C
(10) Surigao del Norte	C	C	B	B	C
(4) Quezon	C	C	B	C	C
(6) Antique	B	C	C	C	C
(11) South Cotabato	C	D	A	A	C
(10) Camiguin	D	A	B	E	C
(9) Basilan	B	C	E	B	C
(12) Lanao del Norte	C	C	C	B	C
(5) Catanduanes	C	D	C	E	C
(7) Negros Oriental	C	C	C	C	C
(1) Ilocos Sur	C	C	D	E	C
(6) Aklan	B	B	E	D	C
(1) Ilocos Norte	D	D	B	E	C
(12) Sultan Kudarat	C	E	C	A	C
(9) Zamboanga del Sur	C	C	C	B	C
Average	48.8	160	23.6	2.52	-.129
Standard Deviation	7.4	40	6.3	.95	.090
(10) Agusan del Norte	E	C	A	B	D
(7) Siquijor	C	B	E	E	D
(4) Aurora	C	E	C	A	D
(4) Oriental Mindoro	C	D	E	B	D
(1) Benguet	E	C	A	B	D
(8) Northern Samar	D	D	C	D	D
(12) Maguindanao	D	D	B	C	D
(11) Surigao del Sur	E	D	B	A	D
(11) Davao Oriental	D	E	C	C	D
(2) Isabela	D	D	D	B	D
(9) Zamboanga del Norte	D	D	D	B	D
(11) Davao del Norte	D	D	B	B	D
(12) North Cotabato	C	D	D	B	D
(8) Eastern Samar	D	E	B	C	D
(9) Tawi-Tawi	D	B	E	A	D
Average	36.4	119	23.6	2.93	-.446
Standard Deviation	9.3	46	7.8	.79	.091
(10) Bukidnon	D	D	D	B	E
(12) Lanao del Sur	D	D	D	E	E
(2) Batanes	E	E	B	E	E
(2) Cagayan	D	D	E	D	E
(8) Samar	D	D	E	E	E
(2) Nueva Vizcaya	E	E	C	C	E
(4) Palawan	E	E	C	A	E
(10) Agusan del Sur	E	E	C	A	E
(4) Occidental Mindoro	E	E	D	B	E
(1) Abra	E	E	D	D	E
(2) Quirino	E	E	C	A	E
(2) Kalinga-Apayao	E	E	E	C	E
(2) Ifugao	E	E	E	E	E
(1) Mountain Province	E	E	E	E	E
Average	23.6	60	17.2	2.26	-.953
Standard Deviation	9.4	26	5.6	1.41	.281
All Average	47.5	194	26.7	2.57	.000
Standard Deviation	18.7	144	14.7	1.08	.816



R: Coefficient of correlation between individual indicator and combined value

FIGURE 5.1-2 RELATIONSHIP BETWEEN CLASSIFICATION BY INDIVIDUAL INDICATOR AND COMBINED CLASSIFICATION (DEMOGRAPHIC CHARACTERISTICS)

5.1.3 Classification according to Socio-Economic Characteristics

1) Correlation between Indicators

The coefficients of correlation between indicators used in the analysis are shown in Table 5.1-4. These indicators have some correlation with each other, except for social facility ratio.

TABLE 5.1-4 COEFFICIENTS OF CORRELATION BETWEEN INDICATORS (SOCIO-ECONOMIC CHARACTERISTICS)

	Per Capita GRDP	GRDP/ Area	Per Capita Income	Un-/Under-employment Ratio	Social Facility Ratio	Incidence of Poverty
Per Capita GRDP	-	0.738	0.453	-0.507	-0.095	-0.394
GRDP/Area		-	0.400	-0.549	-0.195	-0.489
Per Capita Income			-	-0.295	0.072	-0.853
Un-/Underemployment Ratio				-	0.037	0.543
Social Facility Ratio					-	0.146
Incidence of Poverty						-

2) Classification by Individual Indicator

Classifications by un-/underemployment ratio and incidence of poverty are made in ascending order, while classifications by other indicators are in descending order. These classifications are shown in Table 5.1-5.

3) Combined Classification

The combined values are calculated giving the following weights to each indicator and, according to the combined values, provinces are classified into A to E as shown in Table 5.1-5.

Indicator	Weight
Per Capita GRDP	0.25
GRDP/Area	0
Per Capita Income	0.25
Un-/Underemployment Ratio	-0.25
Social Facility Ratio	0
Incidence of Poverty	-0.25

TABLE 5.1-5 CLASSIFICATION BY INDIVIDUAL INDICATOR AND COMBINED CLASSIFICATION (SOCIO-ECONOMIC CHARACTERISTICS)

	Classification by Individual Indicator						Combined Classification (Socio-Economic Charact)
	Per Capita GRDP (p)	GRDP/ Area (Tp/km2)	Per Capita Income (p)	Un- & Under-employ't Ratio (%)	Social Facility Ratio	Incidence of Poverty (%)	
Weight for Combined Classification	.2500	-	.2500	-.2500	-	-.2500	
(4) Cavite	A	A	A	A	E	A	A
(4) Laguna	A	A	A	A	D	A	A
(3) Zambales	A	C	A	B	C	A	A
(4) Rizal	A	A	A	E	E	A	A
(3) Bulacan	A	A	A	B	D	A	A
(1) Benguet	C	C	A	A	A	A	A
(3) Pampanga	A	A	A	C	B	A	A
(3) Bataan	A	A	A	B	C	A	A
(4) Batangas	A	A	B	A	C	A	A
(4) Occidental Mindoro	B	E	A	A	C	A	A
(7) Cebu	A	A	C	A	C	C	A
(3) Tarlac	B	A	B	A	D	B	A
(11) Davao del Sur	A	A	B	D	B	B	A
(1) La Union	D	B	A	C	B	A	A
Average	11981	4844	6913	36.6	.94	46.2	1.275
Standard Deviation	2605	3211	1648	7.2	.24	10.3	.581
(3) Nueva Ecija	C	B	B	A	E	B	B
(9) Zamboanga del Sur	C	C	C	A	D	B	B
(12) Lanao del Sur	B	C	B	B	D	B	B
(2) Quirino	E	E	A	C	A	B	B
(2) Nueva Vizcaya	D	E	A	C	C	A	B
(1) Ilocos Norte	D	D	A	C	B	B	B
(1) Pangasinan	D	B	B	B	B	B	B
(10) Misamis Oriental	A	A	A	E	B	C	B
(11) Davao del Norte	B	D	B	D	B	B	B
(11) South Cotabato	B	C	B	E	D	B	B
(10) Bukidnon	C	D	B	D	E	A	B
(2) Cagayan	D	D	C	B	C	B	B
(10) Agusan del Norte	A	B	C	D	A	C	B
(4) Palawan	B	E	D	A	A	D	B
(12) Sultan Kudarat	C	D	C	C	A	B	B
Average	8516	1128	5297	43.2	1.04	57.9	.213
Standard Deviation	1639	696	843	4.8	.19	5.8	.106
(2) Isabela	D	D	B	C	D	A	C
(12) Maguindanao	C	D	D	A	E	C	C
(10) Agusan del Sur	D	E	C	A	C	C	C
(6) Aklan	B	B	B	D	B	C	C
(2) Batanes	D	E	B	C	A	D	C
(12) Lanao del Norte	B	B	D	D	B	C	C
(4) Quezon	A	B	D	B	E	D	C
(1) Mountain Province	C	E	B	E	A	B	C
(9) Tawi-Tawi	E	C	C	B	E	C	C
(4) Oriental Mindoro	C	C	C	B	E	D	C
(10) Surigao del Norte	C	C	C	C	B	D	C
(4) Marinduque	B	B	D	B	B	E	C
(6) Iloilo	C	A	B	D	C	D	C
(9) Zamboanga del Norte	D	D	D	B	D	D	C
(2) Ifugao	B	E	C	E	D	C	C
Average	8601	1178	4379	43.3	1.12	68.2	-.128
Standard Deviation	1394	692	584	4.3	.72	6.8	.096
(11) Surigao del Sur	B	D	D	E	B	C	D
(1) Ilocos Sur	D	C	C	C	B	B	D
(4) Romblon	A	B	E	B	A	E	D
(9) Sulu	D	B	D	D	E	C	D
(4) Aurora	B	E	E	A	D	E	D
(10) Misamis Occidental	B	B	E	B	A	E	D
(2) Kalinga-Apayao	D	E	B	E	A	B	D
(6) Capiz	C	B	D	D	E	D	D
(7) Negros Oriental	D	C	C	D	E	C	D
(12) North Cotabato	C	D	D	C	C	D	D
(7) Bohol	C	B	E	C	B	E	D
(5) Albay	E	B	D	C	B	D	D
(11) Davao Oriental	C	D	C	E	D	C	D
(9) Basilan	D	C	E	B	D	E	D
(1) Abra	E	E	C	E	A	C	D
Average	8181	1245	3760	45.8	1.05	71.3	-.419
Standard Deviation	1594	662	701	4.8	.30	6.9	.104
(6) Antique	C	C	E	C	C	E	E
(6) Negros Occidental	B	A	C	E	E	E	E
(8) Leyte	E	C	D	C	D	C	E
(7) Siquijor	D	B	D	B	A	E	E
(5) Camarines Norte	E	D	E	D	C	D	E
(10) Camiguin	B	A	E	D	A	E	E
(5) Camarines Sur	E	C	D	D	C	D	E
(5) Catanduanes	E	D	E	D	A	D	E
(8) Samar	E	E	D	E	E	D	E
(8) Southern Leyte	E	D	E	E	E	D	E
(8) Northern Samar	E	E	E	D	D	E	E
(5) Masbate	E	D	E	E	D	E	E
(5) Sorsogon	E	C	E	E	C	E	E
(8) Eastern Samar	E	E	E	E	C	E	E
Average	5867	1163	3292	48.9	1.03	75.8	-.917
Standard Deviation	1957	693	412	4.5	.29	6.1	.273
All Average	8621	1880	4718	43.6	1.04	64.0	.000
Standard Deviation	2678	2108	1578	6.6	.40	12.8	.779

4) Selection of Representative Indicator

Figure 5.1-3 shows the relationship between classification by individual indicator and combined classification. It is found that socio-economic characteristics are represented by either per capita income or incidence of poverty. The choice between the two will be made in consideration of availability and reliability of data and conformability to study purpose. Taking into account the facts that per capita income depends on total income in the province while incidence of poverty on income distribution and that alleviation of poverty is one of the purposes in rural development, incidence of poverty is used in this Study as the representative indicator of socio-economic characteristics. However, it can be replaced with per capita income as the case may be.

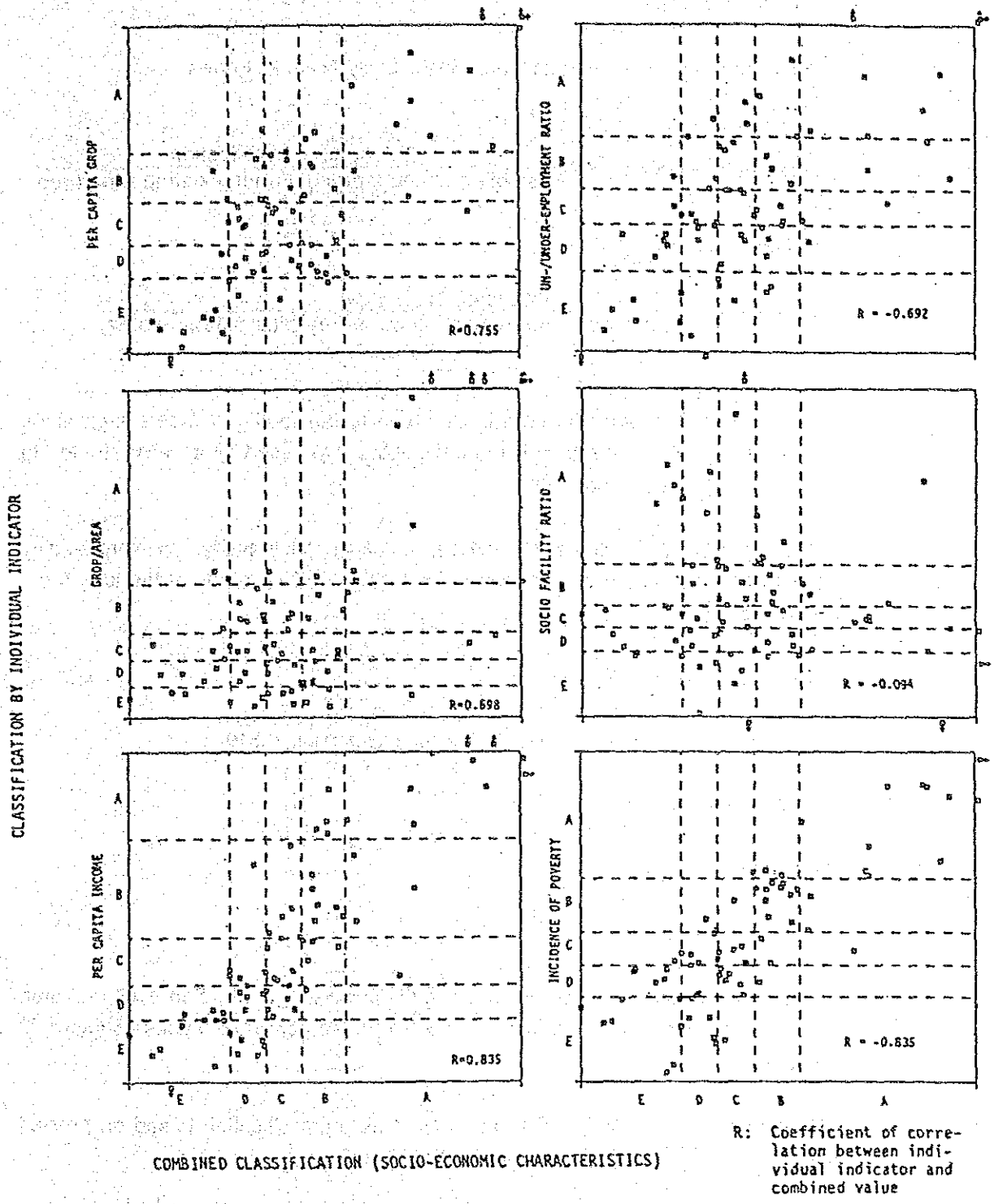


FIGURE 5.1-3 RELATIONSHIP BETWEEN CLASSIFICATION BY INDIVUDUAL INDICATOR AND COMBINED CLASSIFICATION (SOCIO-ECONOMIC CHARACTERISTICS)

5.1.4 Classification according to Agricultural Productivity

1) Meanings of Indicators

The meanings of the two indicators used in the analysis are as follows:

$$\text{Agricultural Productivity (1)} = \frac{\text{Present actual production}}{\text{Possible maximum production in existing farm area}}$$

$$\text{Agricultural Productivity (2)} = \frac{\text{Present actual production}}{\text{Possible maximum production in existing farm area plus potential area}}$$

where, The potential area is assumed to be unutilized arable area times discount rate due to marketability expressed by accessibility to big consuming cities.

Thus, agricultural productivities (1) and (2), as defined in this Study, are interpreted as accomplishment to productive potentialities in the short term and in the long term, respectively.

2) Correlation between Indicators

The coefficient of correlation between the two indicators is 0.519.

3) Classification by Individual Indicator

See Table 5.1-6.

4) Combined Classification

The combined values are calculated giving the same weight of 0.5 to each indicator. The combined classification is made according to the combined values as shown in Table 5.1-6.

This classification is, as a result, considered as a classification based on present performance to productive potentiality in the medium term.

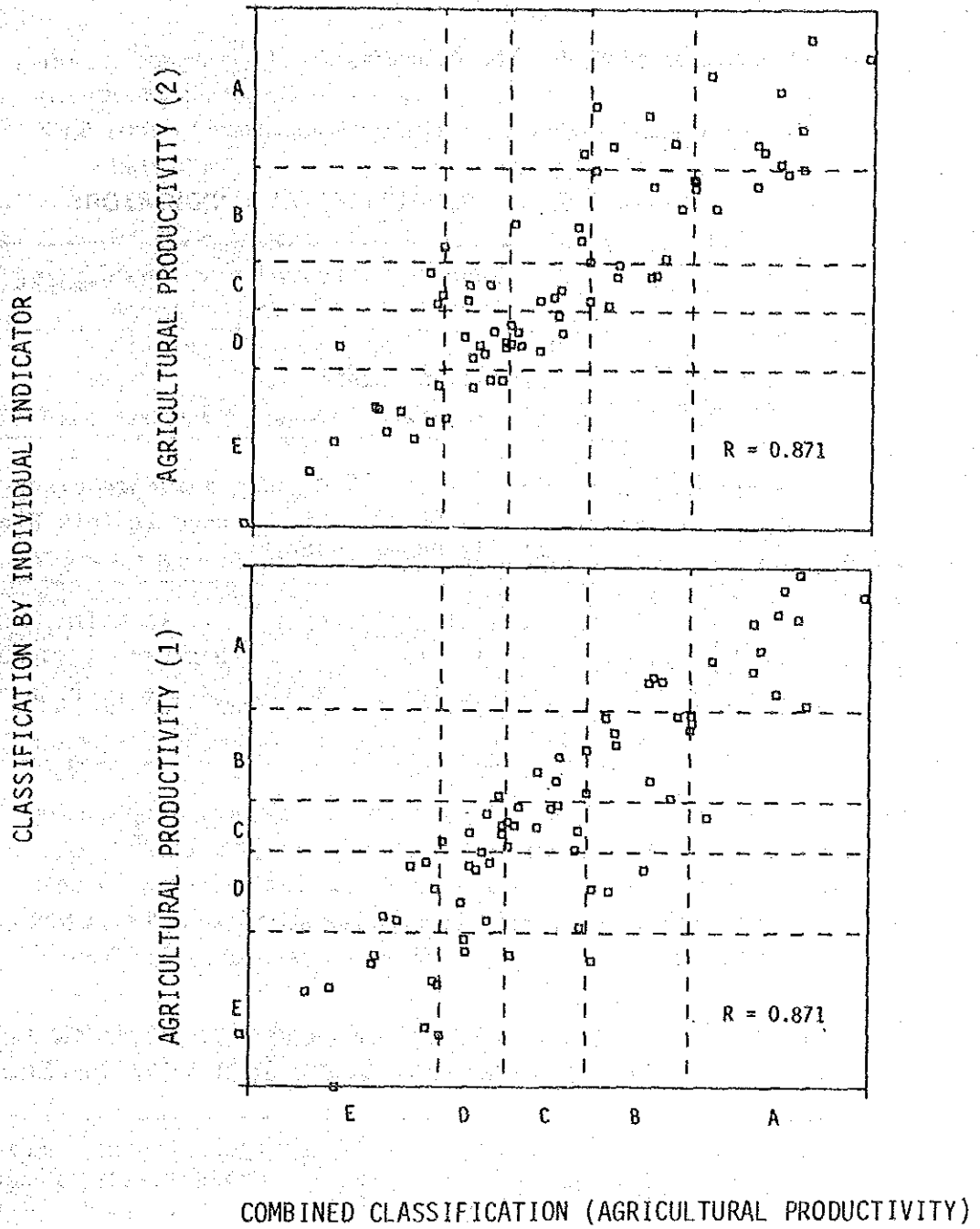
TABLE 5.1-6 CLASSIFICATION BY INDIVIDUAL INDICATOR AND COMBINED CLASSIFICATION (AGRICULTURAL PRODUCTIVITY)

	Classification by Individual Indicator		Combined Classification
	Agric. Productivity (1) (%)	Agric. Productivity (2) (%)	(Agric. Productivity)
Weight for Combined Classification	.5000	.5000	
(12) Maguindanao	A	A	A
(3) Nueva Ecija	A	A	A
(9) Tawi-Tawi	A	A	A
(11) South Cotabato	A	A	A
(11) Davao del Norte	B	A	A
(9) Basilan	A	A	A
(4) Cavite	A	A	A
(6) Capiz	A	A	A
(11) Davao del Sur	B	A	A
(6) Negros Occidental	A	A	A
(12) Lanao del Sur	B	A	A
(1) Ilocos Norte	A	C	A
(2) Kalinga-Apayao	B	B	A
(4) Occidental Mindoro	B	B	A
Average	73.7	57.9	1.314
Standard Deviation	6.5	6.9	.306
(8) Southern Leyte	B	B	B
(10) Surigao del Norte	B	B	B
(1) La Union	A	B	B
(1) Mountain Province	B	A	B
(5) Sorsogon	C	A	B
(4) Laguna	B	B	B
(5) Albay	C	A	B
(12) Sultan Kudarat	A	D	B
(11) Davao Oriental	C	B	B
(10) Bukidnon	C	B	B
(2) Nueva Vizcaya	A	D	B
(5) Camarines Sur	C	B	B
(3) Pampanga	B	D	B
(3) Bataan	A	E	B
(12) Lanao del Norte	B	B	B
Average	54.6	46.3	.484
Standard Deviation	8.1	9.2	.211
(6) Iloilo	C	B	C
(3) Bulacan	A	D	C
(12) North Cotabato	B	C	C
(3) Tarlac	B	C	C
(1) Benguet	D	B	C
(8) Eastern Samar	C	C	C
(9) Zamboanga del Norte	D	B	C
(6) Aklan	C	C	C
(4) Oriental Mindoro	C	C	C
(11) Surigao del Sur	D	B	C
(8) Leyte	D	C	C
(10) Agusan del Norte	D	C	C
(2) Isabela	B	E	C
(4) Palawan	D	C	C
(8) Samar	D	C	C
Average	54.5	40.2	-.092
Standard Deviation	6.9	5.8	.176
(9) Zamboanga del Sur	D	C	D
(2) Ifugao	D	C	D
(7) Negros Oriental	E	B	D
(10) Misamis Occidental	D	D	D
(9) Sulu	E	C	D
(1) Ilocos Sur	C	D	D
(10) Misamis Oriental	D	D	D
(2) Batanes	D	D	D
(8) Northern Samar	E	C	D
(6) Antique	D	D	D
(2) Quirino	C	E	D
(1) Pangasinan	C	E	D
(10) Agusan del Sur	D	D	D
(5) Camarines Norte	E	C	D
(4) Rizal	B	E	D
Average	48.5	34.6	-.535
Standard Deviation	5.5	6.6	.121
(2) Cagayan	C	E	E
(10) Camiguin	E	D	E
(1) Abra	C	E	E
(3) Zambales	C	E	E
(5) Catanduanes	E	D	E
(5) Masbate	E	D	E
(7) Cebu	E	D	E
(4) Quezon	E	D	E
(4) Batangas	E	E	E
(7) Bohol	E	E	E
(4) Aurora	D	E	E
(4) Marinduque	E	E	E
(4) Romblon	E	E	E
(7) Siquijor	E	E	E
Average	41.3	25.4	-1.160
Standard Deviation	8.5	6.8	.363
All Average	56.5	40.6	.000
Standard Deviation	13.4	12.8	.871

5) Representative Indicator

Figure 5.1-4 shows the relationship between classification by individual indicator and combined classification.

Since each indicator has an independent meaning, the selection of a representative indicator based on similarity between classification by individual indicator and combined classification is not performed here.



R: Coefficient of correlation between individual indicator and combined value

FIGURE 5.1-4 RELATIONSHIP BETWEEN CLASSIFICATION BY INDIVIDUAL INDICATOR AND COMBINED CLASSIFICATION (AGRICULTURAL PRODUCTIVITY)

5.1.5 Comprehensive Classification

1) Representative Indicator of Each Factor

The representative indicator of each factor is summarized in Table 5.1-7.

TABLE 5.1-7 REPRESENTATIVE INDICATORS

Factor	Representative Indicator	Remarks
Demographic Characteristics	Population Density	
Socio-Economic Characteristics	Per Capita Income or Incidence of Poverty	Incidence of Poverty is used in this Study
Agricultural Productivity	Agricultural Productivity (1) Agricultural Productivity (2)	(1) is mainly used because it is more indicative of present situation

2) Correlation between Indicators

The coefficients of correlation between indicators used in the analysis are shown in Table 5.1-8.

TABLE 5.1-8 COEFFICIENTS OF CORRELATION BETWEEN INDICATORS (COMPREHENSIVE SOCIO-ECONOMIC DEVELOPMENT)

	Population Density	Incidence of Poverty	Agricultural Productivity (1)	Agricultural Productivity (2)
Population Density	-	-0.410	0.160	-0.036
Incidence of Poverty		-	-0.532	-0.018
Agric. Productivity (1)			-	0.519
Agric. Productivity (2)				-

3) Comprehensive Classification

The comprehensive classification is made according to the combined values which are calculated giving the following weights to each indicator:

Indicator	Weight
Population Density	1/3
Incidence of Poverty	-1/3
Agricultural Productivity (1)	1/3
Agricultural Productivity (2)	0

The comprehensive classification is shown in Table 5.1-9.

4) Selection of Representative Indicator

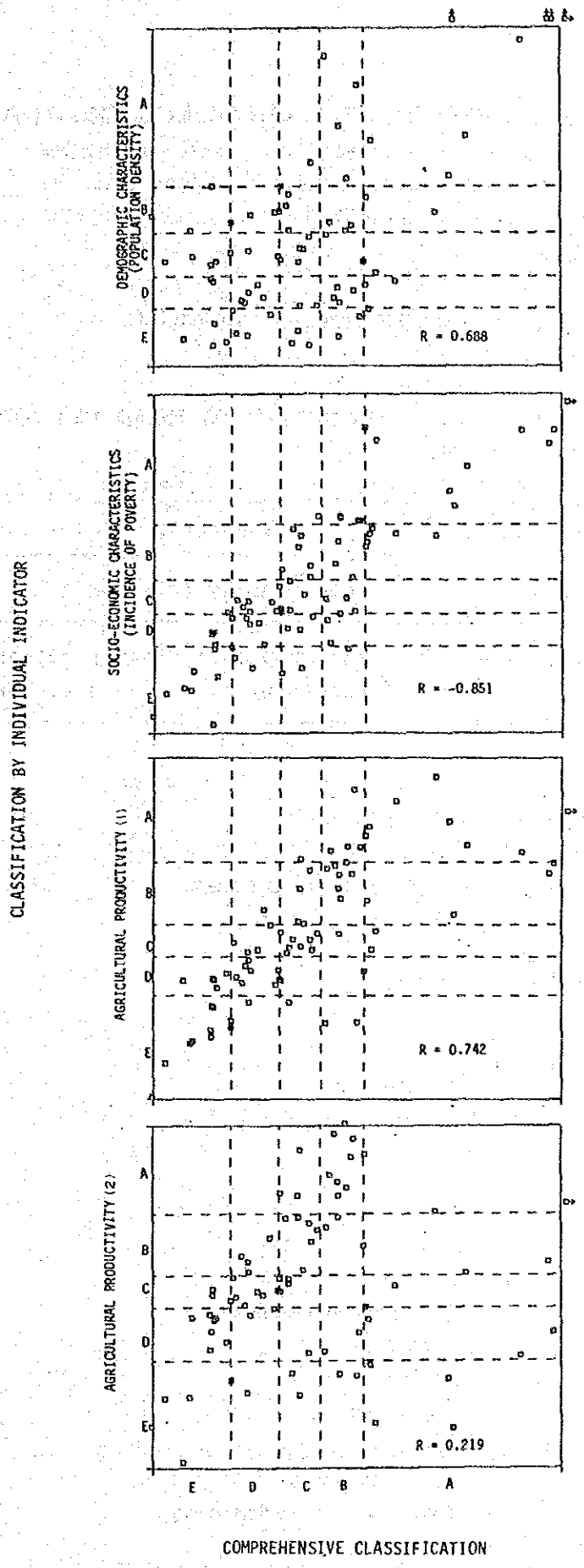
Figure 5.1-5 shows the relationship between classification by individual indicator and comprehensive classification. From this figure, the difference between classification by incidence of poverty and comprehensive classification is found to be acceptably small. Hence, incidence of poverty may be employed as the representative indicator of comprehensive provincial characteristics including demographic characteristics, socio-economic characteristics and agricultural productivity.

In addition to approach described above, there is a mathematical analysis method called principal component analysis. This method analyzse multiple factors in certain mutual correlations and extracts the principal characteristics of the samples. For supplemental purposes, principal component analysis was applied to the classification of provinces as described in Appendix 5-1.

The results of the analysis verify that the incidence of poverty is the principal indicator representing the characteristics of provinces.

TABLE 5.1-9 COMPREHENSIVE CLASSIFICATION

	Classification by Individual Indicator				
	Population Density (/km2)	Incidence of Poverty (%)	Agric. Productivity (1) (%)	Agric. Productivity (2) (%)	Comprehensive Classification
Weight for Comprehensive Classification	.3333	-.3333	.3333	-	
(4) Cavite	A	A	A	A	A
(3) Pampanga	A	A	B	D	A
(4) Laguna	A	A	B	B	A
(3) Bulacan	A	A	A	D	A
(1) La Union	A	A	A	B	A
(4) Rizal	A	A	B	E	A
(3) Bataan	A	A	A	E	A
(3) Nueva Ecija	B	B	A	A	A
(1) Ilocos Norte	D	B	A	C	A
(3) Zambales	C	A	C	E	A
(1) Pangasinan	A	B	C	E	A
(12) Sultan Kudarat	E	B	A	D	A
(3) Tarlac	B	B	B	C	A
(11) South Cotabato	D	B	A	A	A
Average	349	46.6	71.0	37.3	1.171
Standard Deviation	207	8.6	9.4	12.9	.681
(1) Benguet	C	A	D	B	B
(2) Nueva Vizcaya	E	A	A	D	B
(4) Batangas	A	A	E	E	B
(12) Maguindanao	D	C	A	A	B
(11) Davao del Sur	B	B	B	A	B
(6) Negros Occidental	A	E	A	A	B
(9) Tawi-Tawi	B	C	A	A	B
(2) Isabela	D	A	B	E	B
(4) Occidental Mindoro	E	A	B	B	B
(5) Albay	A	D	C	A	B
(12) Lanao del Sur	D	B	B	A	B
(11) Davao del Norte	D	B	B	A	B
(6) Capiz	B	D	A	A	B
(8) Southern Leyte	C	D	B	B	B
(7) Cebu	A	C	E	D	B
Average	200	60.7	63.9	50.3	.284
Standard Deviation	122	10.3	12.1	14.0	.097
(10) Bukidnon	D	A	C	B	C
(6) Iloilo	A	D	C	B	C
(2) Kalinga-Apayao	E	B	D	B	C
(1) Ilocos Sur	C	B	C	D	C
(12) Lanao del Norte	C	C	B	B	C
(9) Basilan	C	E	A	A	C
(2) Cagayan	D	B	C	E	C
(10) Surigao del Norte	C	D	B	B	C
(1) Mountain Province	E	B	B	A	C
(2) Quirino	E	B	C	E	C
(9) Sulu	B	C	E	C	C
(6) Aklan	B	C	C	C	C
(5) Camarines Sur	B	D	C	B	C
(9) Zamboanga del Sur	C	B	D	C	C
(5) Sorsogon	B	E	C	A	C
Average	159	64.6	56.7	44.9	-.091
Standard Deviation	83	8.2	6.9	11.1	.091
(8) Leyte	B	C	D	C	D
(10) Agusan del Norte	C	C	D	C	D
(10) Misamis Oriental	B	C	D	D	D
(11) Davao Oriental	E	C	C	B	D
(12) North Cotabato	D	D	B	C	D
(4) Oriental Mindoro	D	D	C	C	D
(10) Misamis Occidental	B	E	D	D	D
(9) Zamboanga del Norte	D	D	D	B	D
(7) Negros Oriental	C	C	E	B	D
(1) Abra	E	C	C	E	D
(8) Samar	D	D	D	C	D
(11) Surigao del Sur	D	C	D	B	D
(2) Ifugao	E	C	D	C	D
(8) Eastern Samar	E	E	C	C	D
(7) Bohol	B	E	E	E	D
Average	133	70.1	50.3	39.0	-.456
Standard Deviation	63	4.0	5.1	6.6	.131
(5) Camarines Norte	C	D	E	C	E
(10) Agusan del Sur	E	C	D	D	E
(6) Antique	C	E	D	D	E
(2) Batanes	E	D	D	D	E
(8) Northern Samar	D	E	E	C	E
(4) Palawan	E	D	D	C	E
(10) Camiguin	A	E	E	D	E
(4) Quezon	C	D	E	D	E
(5) Catanduanes	D	D	E	D	E
(5) Masbate	C	E	E	D	E
(4) Marinduque	B	E	E	E	E
(4) Aurora	E	E	D	E	E
(4) Romblon	C	E	E	E	E
(7) Siquijor	B	E	E	E	E
Average	135	77.6	40.5	30.8	-.889
Standard Deviation	69	6.2	6.7	8.4	.182
All Average	194	64.0	56.5	40.6	.000
Standard Deviation	144	12.8	13.4	12.8	.760



R: Coefficient of correlation between individual indicator and combined value

FIGURE 5.1-5 RELATIONSHIP BETWEEN CLASSIFICATION BY INDIVIDUAL INDICATOR AND COMPREHENSIVE CLASSIFICAION

5.2 CLASSIFICATION ACCORDING TO ADEQUACY OF ROAD

5.2.1 Approach

1) Kind of Classification

Two kinds of classifications are made as shown in Table 5.2-1

TABLE 5.2-1 CLASSIFICATIONS ACCORDING TO ROAD NETWORK DEVELOPMENT

Kind of Classification	Indicators Used
Adequacy of Road	Road Density (all roads)
Geographic/Topographical Classification	Topographical Classification Road Density by Class of Road

2) Selection of Indicator for Road Density

The indicators expressive of road density are as follows:

i) $\frac{L'}{A}$ or $\frac{L'}{Aar}$

ii) $\frac{L'}{\sqrt{P.A}}$

iii) $\frac{L'}{\alpha.I\sqrt{P.A}}$

iv) $\frac{L'}{L}$

where, L' : Fair condition road length
A : Land area
Aar : Arable area
P : Population
α : Parameter
I : Per capita income
L : Total length of existing roads

In every indicator, the denominator expresses the necessary length of roads or its proportional value. These indicators are examined on appropriateness in indicating the adequacy of roads. L' is plotted in Figures 5.2-1 against A, Aar, PA, I PA and L. Major considerations on these indicators are as follows:

- $\frac{L'}{A}$ and $\frac{L'}{Aar}$: For mountainous provinces, L'/A shows too low a value and L'/Aar too high. Thus, neither indicator is considered suitable for direct comparison among provinces, since some are mountainous and others are flat.

- $\frac{L'}{\sqrt{PA}}$: In general, the necessary road length is considered to be a function of both population and land area.

  The points on the graph plotting $\sqrt{PA}$ vs. L' (Figure 5.2-1) are distributed on and around a straight line drawn through the origin. From this fact, $\sqrt{PA}$ is considered to be indicative of transport demand or necessary road length.

- $\frac{L'}{\alpha.I\sqrt{PA}}$: This indicator makes sense on the assumption that transport demand is proportional to per capita income as well as $\sqrt{PA}$.

  The relation between road improvement and resulting change in per capita income is needed for this indicator, but it is complicated and ambiguous.

- $\frac{L'}{L}$: Existing road length, L is, on the other hand, expressive of necessary length, assuming that a road exists by necessity and that existing roads are good enough in terms of length as described in Chapter 4. Thus, L'/L is also considered to indicate the ratio of length of existing road in acceptable condition to necessary road length. However, the correlation between L'/ $\sqrt{PA}$ and L'/L is not found at all as shown in Figure 5.2-2 (coefficient of correlation = 0.008). L'/L is, therefore, not so commonly used as L'/ $\sqrt{PA}$.

Based on the above considerations, L'/ $\sqrt{PA}$ is selected as indicator for road density.

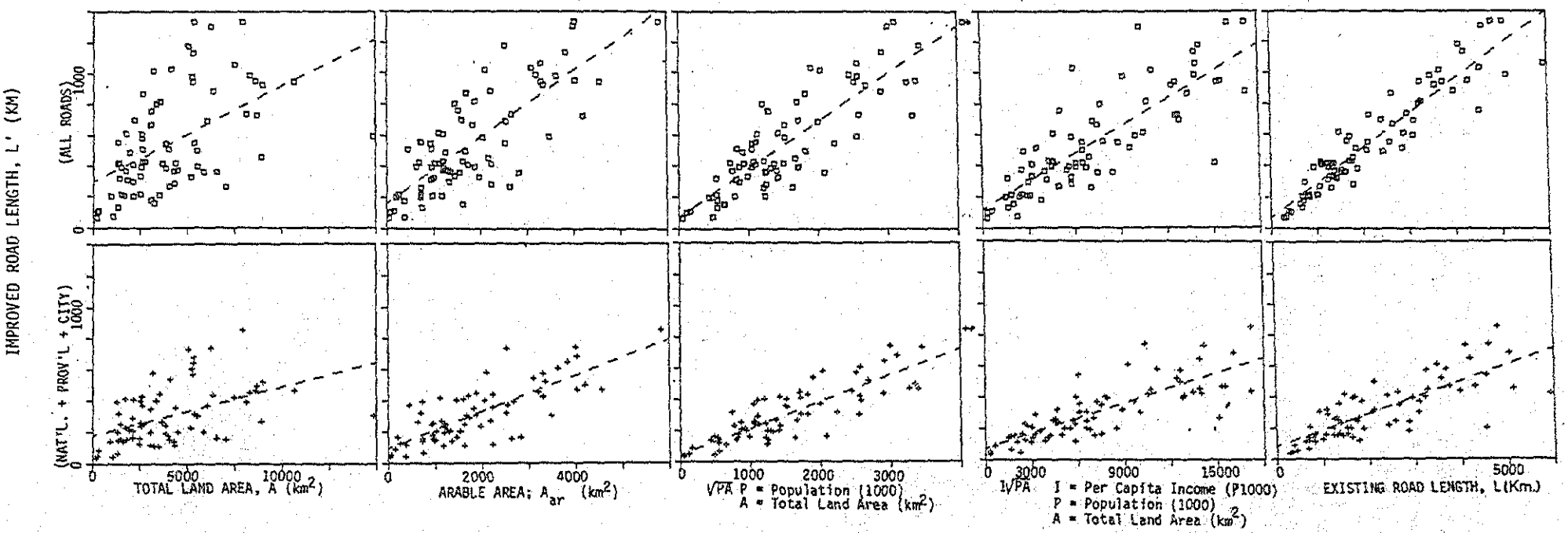
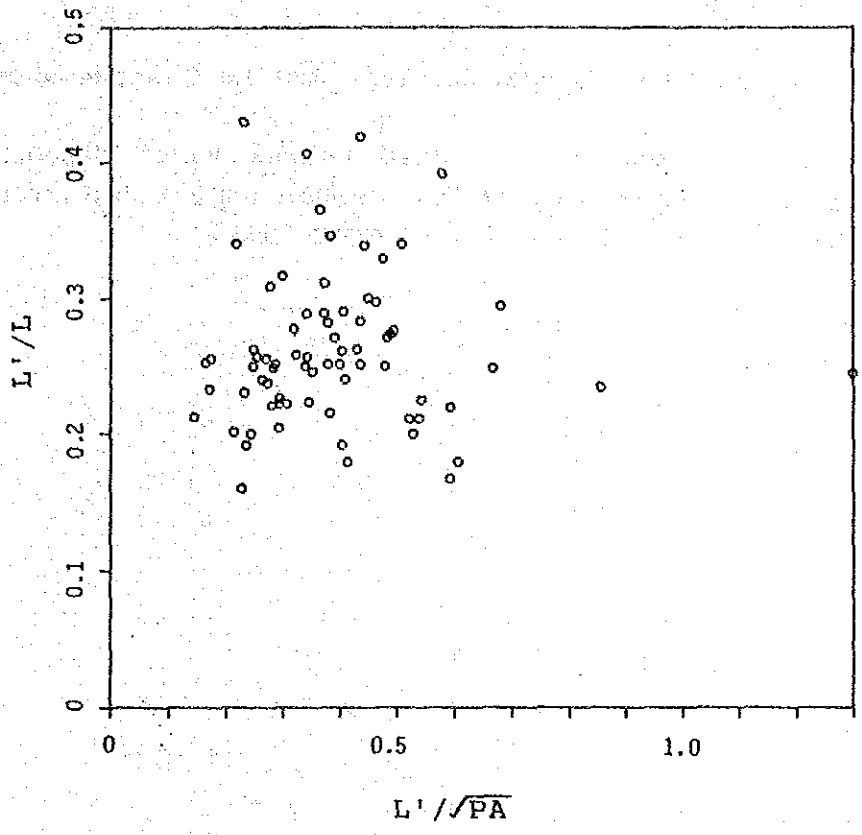


FIGURE 5.2-1 IMPROVED ROAD LENGTH, L' VS.A,Aar, $\sqrt{PA}$, $I\sqrt{PA}$ AND L



L = Existing road length(km)
L' = Assumed improved road length(km)
P = Population(10^3)
A = Land Area(km^2)

FIGURE 5.2-2 RELATIONSHIP BETWEEN L' / $\sqrt{PA}$ AND L' / L

5.2.2 Classification according to Adequacy of Road

Table 5.2-2 shows the classification by road density, $L'/\sqrt{PA}$, as well as by other indicators for reference.

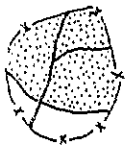
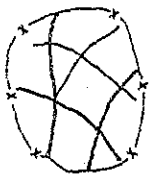
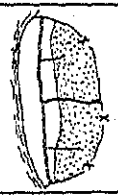
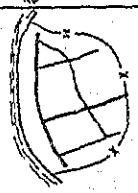
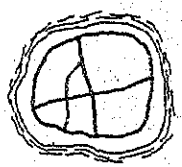
5.2.3 Classification according to Geographical/Topographical Characteristics

Generally, the formation of a road network varies depending on geographic/topographical characteristics. Provinces are classified according to geographic/topographical characteristics as shown in Table 5.2-3.

TABLE 5.2-2 CLASSIFICATION BY ROAD DENSITY, L' / $\sqrt{P \cdot A}$ (ALL ROADS AND OTHER INDICATORS)

	Road Density L'/$\sqrt{P \cdot A}$ (All Roads)	Road Density L'/$\sqrt{P \cdot A}$ (km/Tp·$\sqrt{ppp \cdot km2}$)	L'/L Ratio (All Roads)	Road Density L'/$\sqrt{P \cdot A}$ (Nat'l, Prov,City)	Road Density L'/$\sqrt{P \cdot A}$ (Mun'l, Bar'y)
(2) Batanes	A	A	D	A	A
(10) Camiguin	A	A	D	A	A
(7) Siquijor	A	A	B	A	C
(1) Ilocos Norte	A	B	C	A	A
(1) Abra	A	A	E	C	A
(4) Romblon	A	A	D	A	A
(12) Lanao del Norte	A	A	E	D	A
(3) Bataan	A	B	A	A	C
(7) Bohol	A	A	D	A	A
(1) Ilocos Sur	A	A	E	C	A
(10) Misamis Occidental	A	A	E	B	A
(2) Nueva Vizcaya	A	C	E	B	A
(4) Cavite	A	C	A	A	C
(4) Batangas	A	B	B	B	B
Average	.644	.1520	.25	.334	.310
Standard Deviation	.203	.0631	.06	.136	.132
(1) Benguet	B	E	B	A	D
(8) Southern Leyte	B	A	B	A	B
(10) Misamis Oriental	B	C	C	B	B
(3) Bulacan	B	D	A	B	A
(4) Marinduque	B	A	B	A	C
(1) La Union	B	D	A	A	B
(4) Rizal	B	D	A	C	A
(3) Tarlac	B	B	C	C	B
(4) Laguna	B	D	A	A	C
(8) Leyte	B	A	B	B	B
(1) Pangasinan	B	C	B	C	B
(11) South Cotabato	B	C	E	D	A
(1) Mountain Province	B	C	D	A	E
(3) Pampanga	B	B	B	B	B
(5) Catanduanes	B	A	B	B	D
Average	.444	.0859	.28	.267	.177
Standard Deviation	.028	.0287	.05	.051	.049
(10) Bukidnon	C	D	E	D	A
(10) Surigao del Norte	C	B	C	B	B
(6) Iloilo	C	C	B	C	B
(5) Albay	C	B	A	B	D
(2) Ifugao	C	B	E	C	B
(5) Camarines Sur	C	B	B	B	C
(6) Aklan	C	C	C	C	B
(3) Nueva Ecija	C	C	B	C	C
(10) Agusan del Norte	C	B	A	B	D
(5) Sorsogon	C	A	A	B	E
(6) Capiz	C	B	D	C	C
(9) Zamboanga del Norte	C	B	D	D	B
(5) Camarines Norte	C	B	A	B	D
(2) Cagayan	C	C	C	C	C
(7) Cebu	C	C	B	C	D
Average	.371	.0898	.28	.222	.149
Standard Deviation	.020	.0143	.06	.025	.029
(6) Antique	D	B	C	D	B
(2) Quirino	D	E	C	C	D
(6) Negros Occidental	D	C	B	C	D
(11) Davao del Sur	D	E	D	D	C
(3) Zambales	D	E	A	C	E
(8) Eastern Samar	D	B	D	E	B
(12) Lanao del Sur	D	E	E	E	C
(4) Occidental Mindoro	D	E	D	D	D
(2) Isabela	D	D	C	E	C
(11) Davao del Norte	D	E	C	D	C
(9) Zamboanga del Sur	D	D	D	E	C
(4) Oriental Mindoro	D	D	A	B	E
(12) Maguindanao	D	C	D	D	D
(10) Agusan del Sur	D	D	C	D	D
(11) Surigao del Sur	D	D	D	E	D
Average	.293	.0635	.25	.166	.127
Standard Deviation	.021	.0184	.03	.032	.033
(9) Sulu	E	D	C	D	E
(7) Negros Oriental	E	D	B	E	D
(4) Aurora	E	C	C	D	E
(9) Basilan	E	B	E	E	D
(4) Palawan	E	D	E	E	D
(8) Samar	E	D	A	D	E
(11) Davao Oriental	E	E	D	D	E
(12) Sultan Kudarat	E	E	E	E	C
(4) Quezon	E	D	A	D	E
(2) Kalinga-Apayao	E	E	E	E	E
(8) Northern Samar	E	C	C	E	E
(12) North Cotabato	E	E	D	E	E
(5) Masbate	E	E	C	E	E
(9) Tawi-Tawi	E	E	E	E	E
Average	.214	.0585	.25	.128	.086
Standard Deviation	.035	.0141	.07	.034	.023
All Average	.392	.0895	.26	.223	.169
Standard Deviation	.171	.0464	.06	.099	.100

TABLE 5.2-3 CLASSIFICATION OF PROVINCE BY GEOGRAPHICAL / TOPOGRAPHICAL CHARACTERISTICS

Geographical/Topographical Characteristics		Present Formation of Primary Road Network	Adequacy of Road Development by Class of Roads				
		Primary & Secondary / Feeder	Relatively Good / Relatively Good	Relatively Good / Relatively Poor	Average / Average	Relatively Poor / Relatively Good	Relatively Poor / Relatively Poor
In-land Province	• With mostly mountainous terrain	 • Only one or two primary roads penetrate the Province.	(2) Nueva Vizcaya	(1) Benguet (1) Mt. Province	(2) Ifugao (10) Bukidnon	(1) Abra	(2) Quirino (2) Kalinga Apayao
	• With vast flat plain	 • More or less, mesh type network formed.			(3) Tarlac (3) Nueva Ecija		(2) Isabela (10) Agusan del Sur (12) North Cotabato
Sea-side Province	• With narrow plain along the sea and with mountainous hinterland	 • One primary road along the coast. . (Comb type network)	(1) Ilocos Norte (8) Southern Leyte (10) Misamis Occidental	(1) La Union (3) Bataan (4) Oriental Mindoro (5) Camarines Norte	(2) Cagayan (6) Aklan (9) Zamboanga del Norte (10) Surigao del Norte (10) Misamis Oriental (10) Agusan del Norte	(1) Ilocos Sur (6) Antique (8) Eastern Samar (11) South Cotabato (12) Lanao del Norte	(3) Zambales (4) Aurora (4) Occidental Mindoro (4) Quezon (7) Negros Oriental (8) Northern Samar (8) Samar (9) Zamboanga del Sur (11) Davao Oriental (11) Davao del Sur (11) Surigao del Sur (12) Lanao del Sur (12) Sultan Kudarat
	• With relatively flat plain	 • More or less, mesh type network formed.	(3) Bulacan (4) Batangas	(4) Cavite (4) Laguna (5) Sorsogon	(1) Pangasinan (3) Pampanga (5) Albay (5) Camarines Sur (6) Iloilo (6) Capiz (8) Leyte	(4) Rizal	(6) Negros Occidental (11) Davao del Norte (12) Maguindanao
Island Province	• Round island	 • Circumferential road along the coast plus cross-island roads	(2) Batanes (4) Romblon (7) Bohol (10) Camiguin	(4) Marinduque (5) Catanduanes (7) Siquijor			(9) Sulu (9) Basilan
	• Narrow and long island	 • Comb type or fish-bone type network			(7) Cebu		(4) Palawan (5) Masbate (9) Tawi-Tawi

Legends:

—x—x— Provincial Boundary

Mountainous Area

Primary Road

Secondary Road

5.3 CLASSIFICATION ACCORDING TO TWO FACTORS: SOCIO-ECONOMIC DEVELOPMENT AND ADEQUACY OF ROAD

As described in 5.1 and 5.2, representative indicators of the two factors were selected as follows:

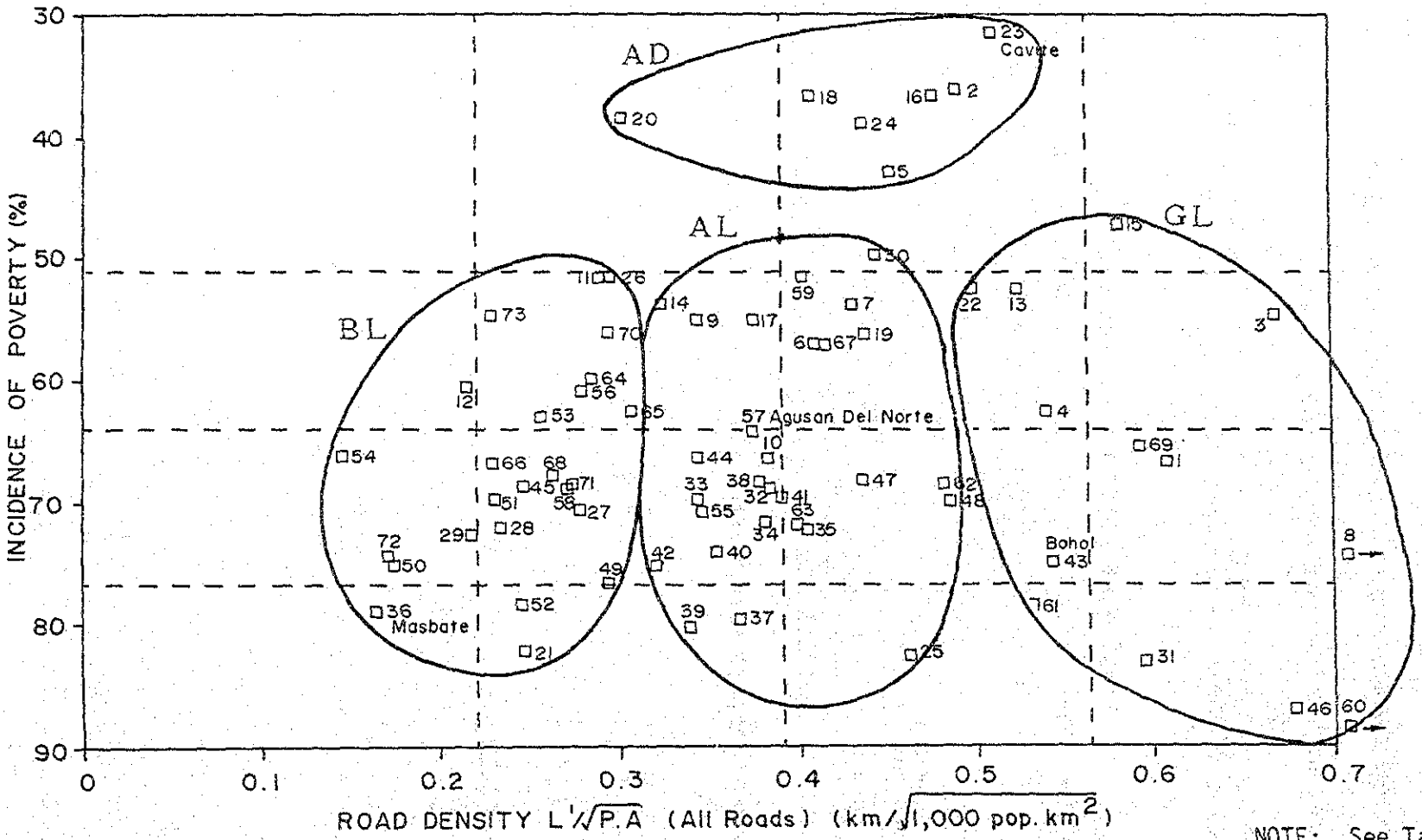
- Incidence of poverty as representative of socio-economic development
- Road density, $L'/\sqrt{PA}$, as representative of adequacy of road

Incidence of poverty vs. road density, $L'/\sqrt{PA}$, are plotted in Figure 5.3-1. Based on this figure, the overall classification of provinces is made as shown in Table 5.3-1.

TABLE 5.3-1 OVERALL CLASSIFICATION

		Adequacy of Road (represented by road density, $L'//\sqrt{PA}$)		
		Bad	Average	Good
Socio-Economic Development (represented by incidence of poverty)	Developed	-	AD	-
	Less developed	BL	AL	GL

The provinces belonging to each group are listed in Table 5.3-2 and shown on the map in Figure 5.3-2.



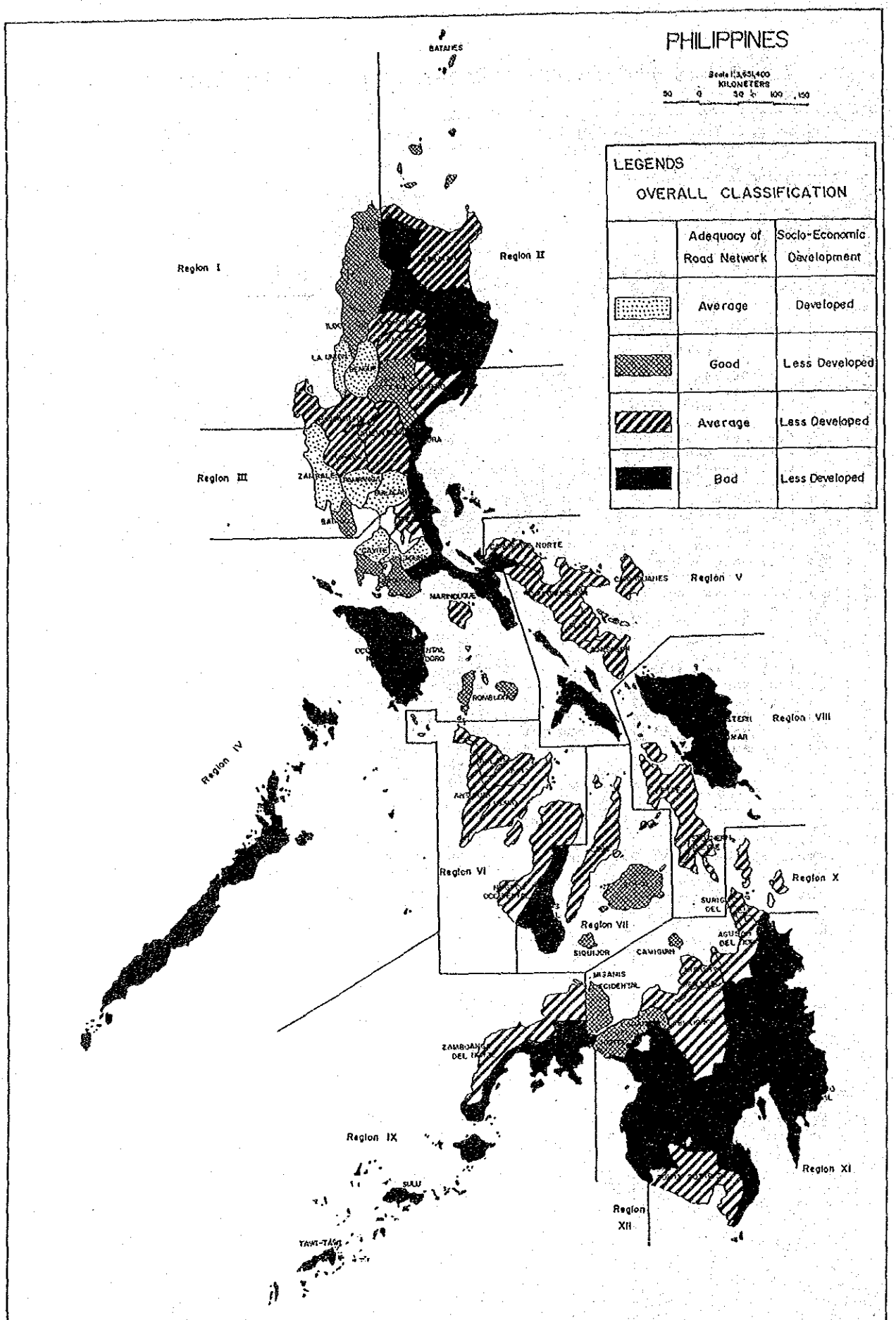
NOTE: See Table 5.3-3 as to province name corresponding to number indicated here.

FIGURE 5.3-1 INCIDENCE OF POVERTY VS. ROAD DENSITY L'/ √P A

TABLE 5.3-2 OVERALL CLASSIFICATION OF PROVINCES

Socio-economic Development (Represented by Incidence of Poverty)	Adequacy of Road (Represented by Road Density , $L'/\sqrt{P \cdot A}$)		
	Bad	Average	Good
Developed	——	(AD) (4) Cavite 23 (1) Benguet 2 (3) Pampanga 18 (3) Bulacan 16 (3) Zambales 20 (4) Laguna 24 (1) La Union 5	——
Less Developed	(BL) (4) Occidental Mindoro 26 (2) Isabela 11 (12) Sultan Kudarat 73 (12) Lanao del Sur 70 (11) Davao del Norte 64 (2) Kalinga-Apayao 12 (9) Zamboanga del Sur 56 (11) Davao del Sur 65 (9) Sulu 53 (9) Tawi-Tawi 54 (11) Davao Oriental 66 (11) Surigao del Sur 68 (12) Maguindanao 71 (7) Negros Oriental 45 (10) Agusan del Sur 58 (8) Samar 51 (4) Oriental Mindoro 27 (4) Palawan 28 (4) Quezon 29 (12) North Cotabato 72 (8) Northern Samar 50 (8) Eastern Samar 49 (9) Basilan 52 (5) Masbate 36 (4) Aurora 21	(AL) (4) Rizal 30 (10) Bukidnon 59 (1) Pangasinan 7 (2) Quirino 14 (2) Cagayan 9 (3) Nueva Ecija 17 (3) Tarlac 19 (11) South Cotabato 67 (1) Mountain Province 6 (10) Agusan del Norte 57 (7) Cebu 44 (2) Ifugao 10 (8) Leyte 47 (6) Aklan 38 (10) Misamis Oriental 62 (5) Albay 32 (6) Iloilo 41 (5) Camarines Norte 33 (8) Southern Leyte 48 (9) Zamboanga del Norte 55 (5) Camarines Sur 34 (10) Surigao del Norte 63 (5) Catanduanes 35 (6) Capiz 40 (6) Negros Occidental 42 (5) Sorsogon 37 (6) Antique 39 (4) Marinduque 25	(GL) (3) Bataan 15 (4) Batangas 22 (2) Nueva Vizcaya 13 (1) Ilocos Norte 3 (1) Ilocos Sur 4 (12) Lanao del Norte 69 (1) Abra 1 (2) Batanes 8 (7) Bohol 43 (10) Misamis Occidental 61 (4) Romblon 31 (7) Siquijor 46 (10) Camiguin 60

Note : ( ):Region Number
Number at the end of province name corresponds to number in Fig.5.3-1.



PILOT STUDY
FOR
THE RURAL ROAD NETWORK DEVELOPMENT PROJECT

Figure 5.3-2
OVERALL CLASSIFICATION

CHAPTER 6

SELECTION OF PILOT PROVINCES

6.1 SELECTION CRITERIA

The considerations in selecting pilot provinces were as follows:

- In Chapter 5, provinces were classified into four groups according to socio-economic development and adequacy of road as shown in Table 6.2-1. One province should be selected from each group, taking the one considered typical of the group.

- The classification of provinces according to geographic/topographical characteristics were made in Section 5.2.3. The pilot provinces should be selected so as to cover a variety of geography/topography.

- Pilot provinces should be widely distributed over the country, specifically choosing at least one each from Luzon, Visayas and Mindanao.

- Provinces with ongoing/committed road projects of considerable length should be excluded (provinces that have more than 50 km of ongoing/committed projects under IBRD/ADB assistance are marked in Table 6.2-1).

6.2 SELECTION OF PILOT PROVINCES

Based on the above considerations, the following four provinces were selected (See Table 6.2-1):

Cavite
Masbate
Bohol
Agusan del Norte

The characteristics of the selected provinces are summarized in Table 6.2-2.

TABLE 6.2-1 SELECTION OF PILOT PROVINCES

Socio-economic Development (Represented by Incidence of Poverty)	Adequacy of Road (Represented by Road Density , $L'/\sqrt{P \cdot A}$)		
	Bad	Average	Good
Developed	—	(AD) (4) Cavite (1) Benguet (3) Pampanga (3) Bulacan *(3) Zambales (4) Laguna (1) La Union	—
Less Developed	(BL) (4) Occidental Mindoro *(2) Isabela (12) Sultan Kudarat (12) Lanao del Sur (11) Davao del Norte (2) Kalinga-Apayao (9) Zamboanga del Sur *(11) Davao del Sur (9) Sulu (9) Tawi-Tawi (11) Davao Oriental (11) Surigao del Sur (12) Maguindanao *(7) Negros Oriental *(10) Agusan del Sur *(8) Samar (4) Oriental Mindoro (4) Palawan *(4) Quezon (12) North Cotabato (8) Northern Samar (8) Eastern Samar (9) Basilan (5) Masbate *(4) Aurora	(AL) (4) Rizal (10) Bukidnon (1) Pangasinan *(2) Quirino *(2) Cagayan (3) Nueva Ecija (3) Tarlac (11) South Cotabato (1) Mountain Province (10) Agusan del Norte *(7) Cebu *(2) Ifugao (8) Leyte *(6) Aklan *(10) Misamis Oriental (5) Albay *(6) Iloilo (5) Camarines Norte (8) Southern Leyte *(9) Zamboanga del Norte (5) Camarines Sur (10) Surigao del Norte *(5) Catanduanes *(6) Capiz *(6) Negros Occidental (5) Sorsogon *(6) Antique (4) Marinduque	(GL) (3) Bataan (4) Batangas *(2) Nueva Vizcaya (1) Ilocos Norte (1) Ilocos Sur (12) Lanao del Norte (1) Abra (2) Batanes (7) Bohol *(10) Misamis Occidental (4) Romblon (7) Siquijor (10) Camiguin

Note : [ ] Pilot province
* Province with more than 50 km of ongoing/committed road projects under IBRD/ADB assistance

TABLE 6.2-2 CHARACTERISTICS OF PILOT PROVINCES

Pilot Province	Region	Overall Classification Code[1]	Major Indicator[2]				Geographic/ Topographic Classification
			Population Density ($/km^2$)	Incidence of Poverty (%)	Agricultural Productivity (1) (%)	Road Density $L'/\sqrt{P.A}$ ($km/\sqrt{pop.km^2}$)	
Cavite	IV	AD	725 A	31.4 A	79.8 A	0.509 A	Seaside, Flat
Masbate	V	BL	162 C	78.9 E	36.1 E	0.163 E	Island, Narrow
Bohol	VII	GL	212 B	74.8 E	40.0 E	0.543 A	Island, Round
Agusan del Norte	X	AL	162 C	64.1 C	49.4 D	0.374 C	Seaside, Mountainous

Note: 1)

Code	Adequacy of Roads	Socio-Economic Development
AD	Average	Developed
GL	Good	Less developed
AL	Average	Less developed
BL	Bad	Less developed

2) A: Highest 14 provinces
B: Second highest 15 provinces
C: Middle 15 provinces
D: Second lowest 15 provinces
E: Lowest 15 provinces

PART III PROJECT IDENTIFICATION AND SCREENING

CHAPTER 7

PROJECT IDENTIFICATION AND SCREENING METHODOLOGY

7.1 GENERAL PROCEDURE

Figure 7.1-1 shows the procedure for project identification and screening. Since the Study covers all roads except national primary roads defined in Executive Order No. 113, it deals with various classes of roads with different functions. In order to systematically identify, prioritize and select road links for feasibility studies, roads are functionally classified into two (2) broad categories. Major and minor roads. Major roads are defined as major inter-provincial roads or major intra-provincial roads linking municipal towns with each other or to the provincial capital, while minor roads are roads linking barangays to the municipal towns or to the major road network or farm- to-market roads. Different identification and screening criteria were established for major and minor roads.

Data/Information Collection and Road Condition Survey

Socio-economic and transport data collection and road condition surveys were conducted. Road conditions of all major roads and some minor roads were investigated by field survey. Information on road conditions of minor roads not covered by the field survey were obtained through interviews with local officials.

Assessment of Present Road Network

Based on the field survey results as well as each province's socio-economic and topographical characteristics, the present road network was assessed in terms of road development level and network characteristics.

Formulation of Basic Road Network Requirement

Based on an assessment of the present road network, a major road network was formulated, whose appropriateness was examined by network value and accessibility.

Identification of Road Links

The roads which are substandard in surface type, surface condition and/or carriageway width, based on proposed engineering standards, were identified as road projects.

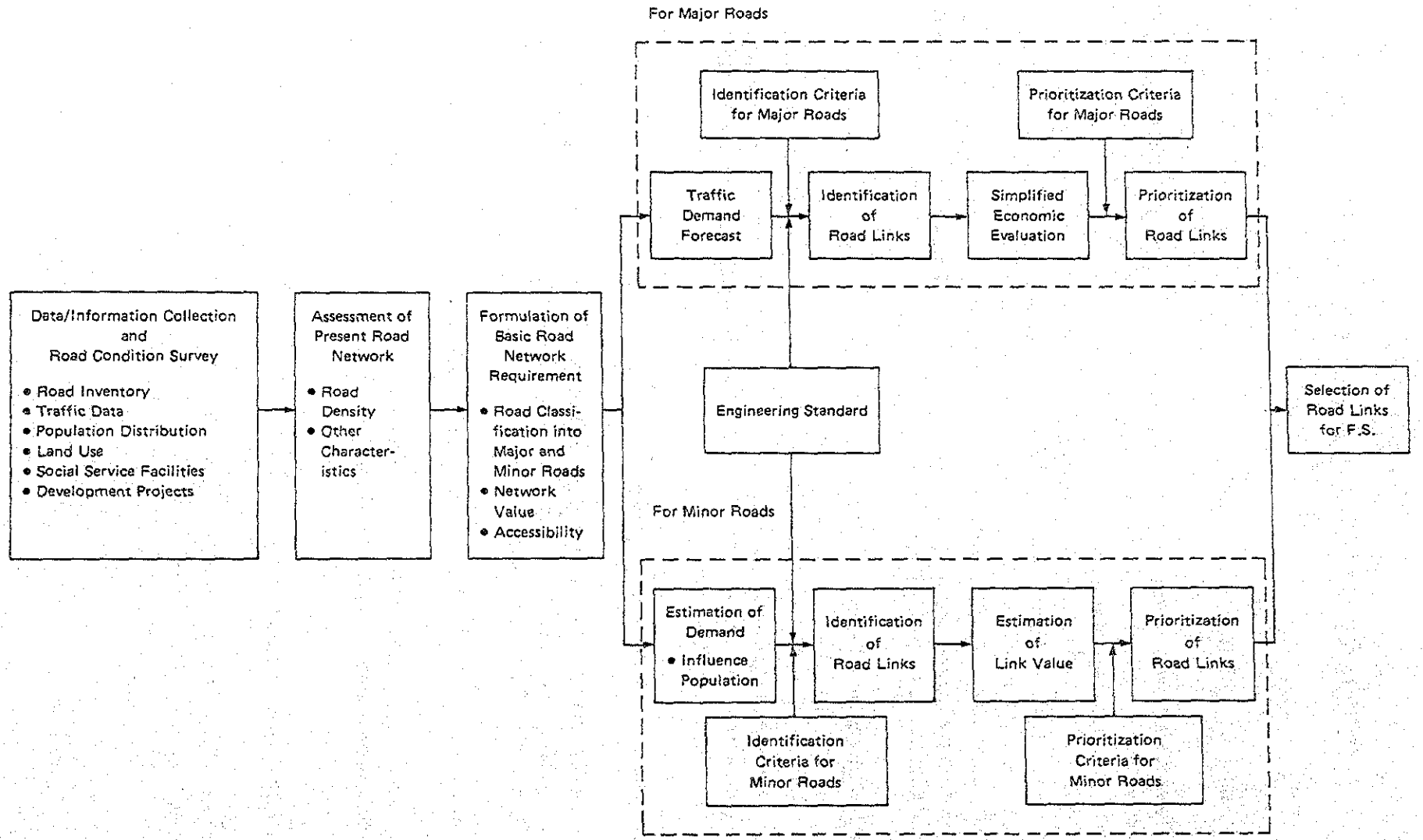


FIGURE 7.1-1 PROCEDURE FOR PROJECT IDENTIFICATION AND SCREENING

Prioritization of Road Links

Prioritization was carried out in accordance with the proposed prioritization criteria which was determined by road class, type of improvement, economic viability (for major roads) and population served (for minor roads).

Selection of Road Links For Feasibility Study

In due consideration of the overall objectives of the Study, selection criteria were proposed. In accordance therewith, road links to be subjected for the Feasibility Study were selected.

7.2 DATA/INFORMATION COLLECTION AND ROAD CONDITION SURVEY

7.2.1 Data/Information Collection

The collected data/information are listed in Table 7.2-1.

Maps

Since 1:50,000 and 1:250,000 topographical maps are most reliable, those maps were utilized as base maps for road maps, population distribution maps, etc.

Population

Census population figures by barangay were available for all provinces for 1980. Population in 1988 by barangay were estimated using the proportional rate of change at the municipality level.

Traffic Data

Traffic survey data were available from DPWH counts for national roads and from previous studies. Based on those data, a traffic demand forecast was carried out.

TABLE 7.2-1 LIST OF COLLECTED DATA

Data/Information	Source
1. Maps	
(1) Topographical Map (1:50,000)	BCGS
(2) Topographical Map (1:250,000)	BCGS
(3) Road Map	
- Cavite (1:75,000)	
- Masbate (1:200,000)	
- Bohol (1:100,000)	
- Agusan del Norte (1:100,000)	
(4) Municipal Map (no scale) (showing location of barangay)	Municipalities
(5) Road Map by Municipality (no scale) (showing barangay roads)	Municipalities
(6) Slope Map	BOS
(7) Land Use Map	BOS
2. Road Inventories	
(1) Inventory of National Roads (road name, length, surface type, etc.)	PEO
(2) Inventory of Provincial Roads (road name, length, surface type, etc.)	PEO
(3) Inventory of City Roads (road name, length, surface type, etc.)	CEO
(4) Inventory of Barangay Roads (road name, length, surface type, etc.)	DEO
3. Socio-Economic Data	
(1) 1980 Census of Population (population by barangay)	NCSO
(2) Philippine Population Projections 1980-2030 (projected population by municipality)	NEDA
(3) Provincial Profile (land use, list of social service facilities, production, etc.)	PPDO

(Table 7.2-1 Continued)

Data/Information	Source
4. Traffic Data	
(1) Nationwide Traffic Count Project (AADT in 1985 and 1986)	DPWH
(2) Rural Roads Development Program II, 1982 (Bohol and Agusan del Norte)	DLG
(3) Philippine Islands Road Feasibility Study, 1980 (Masbate)	DPWH
5. Road Project Lists	
(1) List of Ongoing Road Projects	DEO, PEO, CEO
(2) List of Proposed Road Projects	DEO, PEO, CEO
6. Provincial Development Plan	
(1) Development Plan	PPDO
(2) Infrastructure Investment Program	PPDO

7.2.2 Road Condition Survey

The road condition survey was conducted covering all major roads and minor roads proposed by provincial and municipal officials.

The survey was composed of 'field survey' and 'hearing survey'. The field survey was applied for all road links which were classified as major roads. It was also applied to most national and provincial roads and to some typical barangay roads which were classified as minor roads. The hearing survey was conducted for the rest of the minor roads which were mostly barangay roads.

1) Field Survey

In the field survey, measured/assessed were location, road length, road width, surface type and condition, terrain, alignment, average travel speed, level of motorized access and bridge length.

The data were recorded in the field sheet shown in Table 7.2-2.

2) Hearing Survey

For some of the minor roads, the data were obtained by hearing survey. The survey team visited each municipality where survey roads are located, and inquired of the Municipal Engineer or other personnel familiar with the conditions of the roads. The data obtained were recorded in the same form as the field survey sheet.

TABLE 7.2-2 ROAD INVENTORY SURVEY FIELD SHEET

THE RURAL ROAD NETWORK DEVELOPMENT PROJECT

- Road Inventory Survey Field Sheet -

Link No.(Major Road) / Block No.(Minor Road) ;			
Name of Road;			
Road Number;			
Road Length (Km); (Km .) - (Km .)			
Road Width (m)	Carriageway;		
	Shoulders;		
Surface Type	(P) PCC, (A) AC, (G) Gravel, (E) Earth		
Surface Condition	(1) Good, (2) Fair, (3) Bad, (4) Very Bad (5) Abandoned / Non-existing		
Terrain	(1) Flat, (2) Rolling, (3) Mountainous		
Steep Gradient	(1) None, (2) Existing		
Sharp Curves	(1) None, (2) Existing		
Average Speed (Km/hr);			
Level of Motorised Access	(1) Open at all time, (2) Seldom impassable, (3) Often impassable		
	If "seldom/often impassable", what is cause? (1) Flood, (2) Muddy, (3) Others( )		
Bridges	Ford Crossing	Number	
		Total Length (m)	
	Timber Bridges	Number	
		Total Length (m)	
	Bailey Bridges	Number	
		Total Length (m)	
	Steel/Concrete Bridges needing Rehabilitation	Number	
		Total Length (m)	
Survey Method	(1) Field Investigation, (2) Hearing		
Remarks;			
Date of Survey; ,1988		Surveyor;	

7.3 ROAD CLASSIFICATION

7.3.1 Administrative Road Classification

Road classification in the Philippines has been established by a series of Executives Orders, Republic Acts and/or Presidential Decrees, of which the most fundamental one was Republic Act No. 917 (the Philippine Highway Act) and classified as follows:

- National Primary and Secondary Roads
- "National Aid" Roads
- Provincial and City Roads
- Municipal Roads

This classification was more clearly defined by Executive Order No. 113 in 1955. Since then, various amendments have been made such as the following:

- "National Aid" roads no longer appear in the Revised Philippine Highway Act, 1972 (Presidential Decree No. 17)
- A new class of roads known as Barangay Roads was introduced by Presidential Decree No. 702, 1975.

Today, the Department of Public Works and Highways (DPWH) classifies roads into the following five (5) classes:

- National Roads (possibly subclassified into national primary and national secondary)
- Provincial Roads
- City Roads
- Municipal Roads
- Barangay Roads

These classes are defined as follows and shown conceptually in Figure 7.3-1:

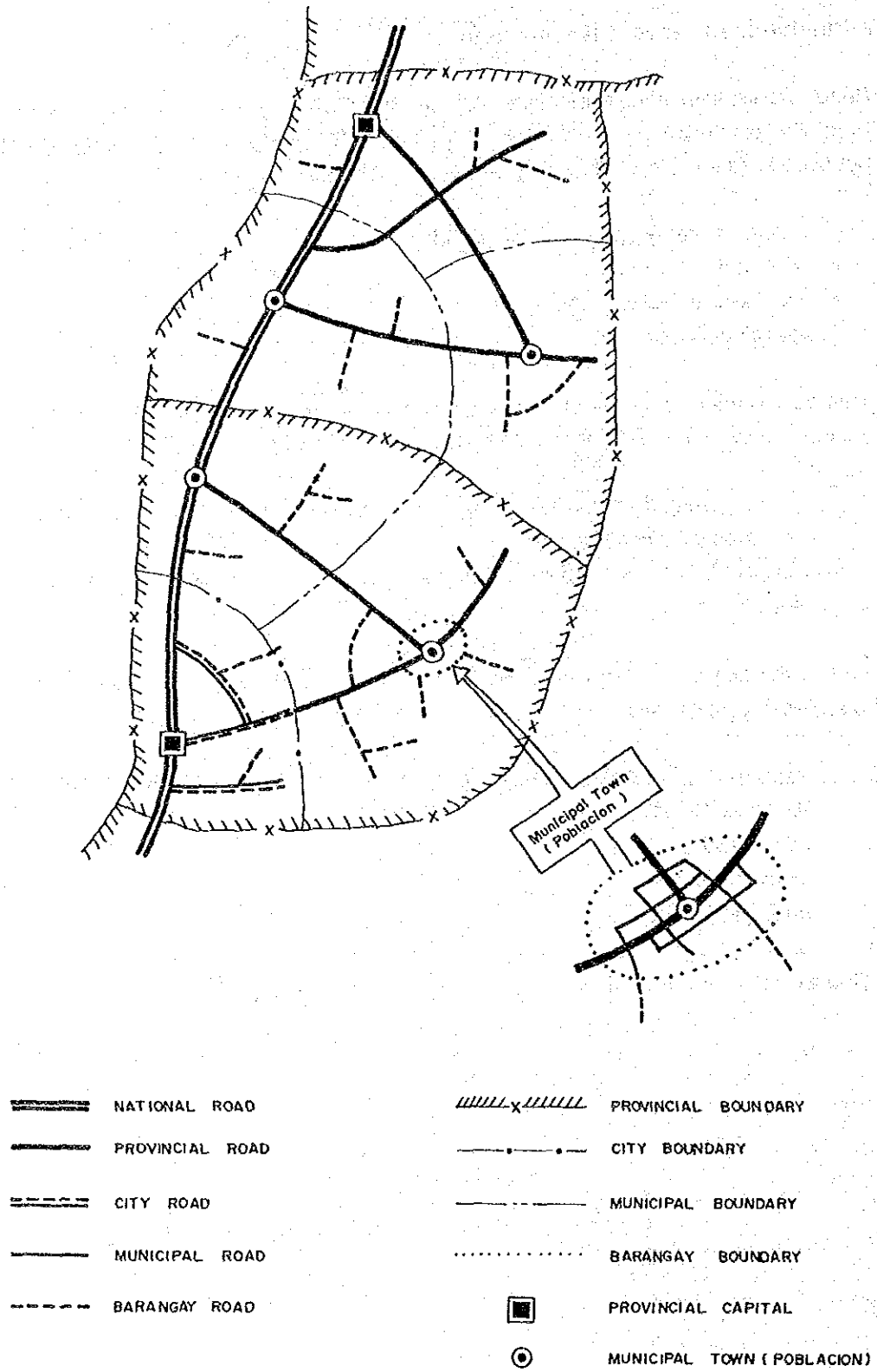


FIGURE 7.3-1 CONCEPTUAL ROAD NETWORK BY ADMINISTRATIVE CLASSIFICATION

National Roads - are all roads that form part of the main trunkline system continuous in extent; all roads leading to national airports, national seaports, national parks or coast-to-coast roads.

Provincial Roads - are those roads connecting one municipality with another municipality, the termini to be public plazas; all roads extending from a municipality or from a provincial or national road to a public wharf or railway station; and any other road to be designated as such by the Sangguniang Panlalawigan.

City Roads - are those roads/streets within the urban area of the city to be designated as such by the Sangguniang Panglungsod.

Minicipal Roads - are those roads/streets within the poblacion area of a municipality to be designated as such by the Sangguniang Bayan.

Barangay Roads - are rural roads located either outside the urban area of a city or outside industrial, commercial or residential subdivisions which act as feeder or farm-to-market roads, and which are not otherwise classified as national, provincial, city or municipal roads. Roads located outside the poblacion area of a municipality and those roads located outside the urban area of a city are to be designated as such by the Barangay Council concerned.

7.3.2 Functional Road Classification

1) Needs of Functional Road Classification

Road classification by the DPWH is mainly based on the administrative responsibilities and jurisdiction of the agencies concerned in the funding, planning, construction/improvement and maintenance, rather than functions, of roads. National and provincial roads or provincial and barangay roads are often indistinguishable, because some provincial roads have comparable functions with national roads, while some function only as feeder roads which is the main function of barangay roads. Sometimes, classification of a road is changed at a provincial or a municipal boundary, for instance, from a provincial road to a barangay road.

For planning and developing an efficient road network, functional classification is essential. Functional classification groups roads according to importance and the character of services they are intended to provide. Individual road links of similar importance and quality of services are organized into systems so that a road network in accordance with the hierarchy of functions can be planned and formed. Thus they can be efficiently managed with consistent policies, design and operation.

2) Previous Studies

Functional road classification of rural roads was made by two (2) studies. In 1982, IBRD Assisted Rural Roads Development Program II classified roads into the following five (5) classes:

- Primary Roads
- Secondary Roads
- Tertiary Roads
- Farm-to-market Roads
- Streets

Definition for classification used by that study is presented in Table 7.3-1.

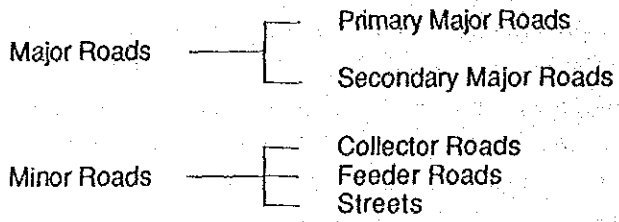
IBRD Assisted Functional Road Classification Study was undertaken in 1986, and classified rural roads as follows:

- National Primary Roads
- National Secondary Roads
- National Tertiary Roads
- Provincial Roads
- Feeder Roads

Definition for classification is presented in Table 7.3-1. The focus of that study was placed more on classification of national roads.

3) Proposed Functional Classification

Based on a review of previous two (2) studies, functional classification criteria similar to IBRD Assisted Rural Roads Development Program II Study were proposed as shown in Table 7.3-2 and conceptually in Figure 7.3-2. Roads are classified into the following five (5) classes:



Functional classification is related to administrative classification. National roads are mostly classified as either primary or secondary major roads and provincial roads as either secondary major or collector roads. Since city roads under administrative classification have a variety of functions, they are , classified as either secondary major, collector or feeder roads or streets. Minicipal roads are those within urban centers (poblacion)and are therefore classified as streets. Barangay roads are classified as either collector or feeder roads.

TABLE 7.3-1 PREVIOUS FUNCTIONAL ROAD CLASSIFICATION OF RURAL ROADS

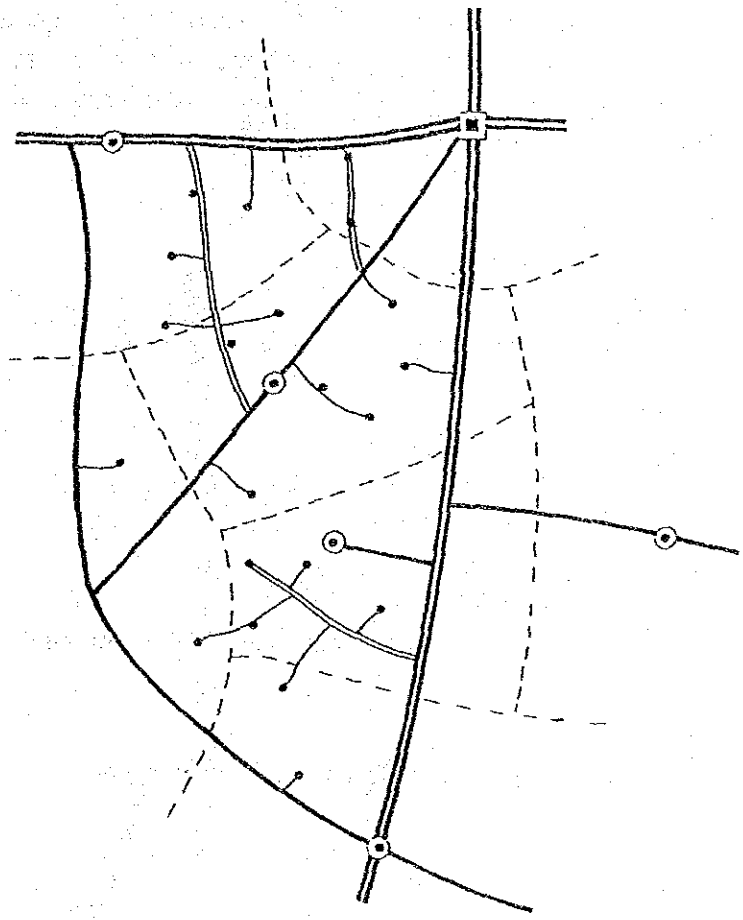
IBRD Assisted Functional Road Classification Study (DPWH), 1986	IBRD Assisted Rural Roads Development Program II (DLG), 1982
(1) National Primary Road Connect primary centers	(a) Primary Road Major inter-provincial roads or major intra-provincial trunk roads linking one or more municipal towns to the Provincial Capital
(2) National Secondary Road Connect secondary centers to one another and to National Primary roads	
(3) National Tertiary Road Connect tertiary centers to one another to a National Primary or National Secondary road	(b) Secondary Road Roads (other than above) linking municipalities with each other or to the provincial capital or to the primary network
(4) Provincial Road Connect cities and municipalities not classified as primary/secondary/tertiary center to a national road.	(c) Tertiary Road Roads linking barangays to the municipal towns and to the primary or secodary network
(5) Feeder Road Connect barangays, outside urban development areas of a city or municipality, to one another and roads not classified as national or provincial	(d) Farm-to-market road Roads linking farm areas to their respective barangay centers or to the higher level network
	(e) Street Roads within built-up population centers with essentially urban rather than rural functions

- Primary Center (28)
  - either a national or regional capital
  - or base for a national base seaport
  - or base for an international airport
  - or having a rating of 9 or less
- Secondary Center (58)
  - either a provincial capital
  - or base for a national sub-base port
  - or having a rating of 10 to 13 inclusive
- Tertiary Center (14)
  - either a sub-provincial capital
  - or having a rating of 14 to 16

Rating	
National/Regional Capital	1
Provincial Capital	2
If combined	0
Sub-provincial Capital	3
National Base Seaport	1
International Airport	1
National Sub-base Seaport	2
National Trunkline Airport	2
National Seaport/Secondary Airport	3
Feeder Port	4
Population over 100,000	1
75,000 - 100,000	2
50,000 - 75,000	3
If None	5

TABLE 7.3-2 PROPOSED FUNCTIONAL CLASSIFICATION OF RURAL ROAD NETWORK

Functional Classification		General Definition	General Characteristics and Services Provided	Relationship with Administrative Classification				
				National Road	Provincial Road	City Road	Municipal Road	Barangay Road
Major Road	Primary Major Road	• Major inter-provincial roads • Intra-provincial roads linking two (2) or more municipal towns to the Provincial Capital • Intra-provincial roads which form a skelton road network of a province	• Provides the highest level of service at the high speed for the long uninterrupted distance • Serves for long distance trips • Mobility is given the highest consideration	●				
	Secondary Major Road	• Roads linking municipal towns each other • Roads linking a municipal town to the Provincial Capital • Roads linking one (1) or more municipal towns to the primary major road network	• Provides high level of service • Serves for medium distance trips • Mobility is given high consideration	●	●	●		
Minor Road	Collector Road	• Roads linking secondary major roads each other or a primary road with a secondary road • Roads linking two (2) or more barangays to the municipal town or to the higher level network	• Provides rather low level of mobility • Serves for short distance trips • Collects traffic from feeder roads and connects them with major roads • Mobility and land access functions be harmonized		●	●		●
	Feeder Road	• Roads linking one or more barangay centers to the higher level network • Roads linking farm areas to their respective barangay centers or to the higher level network	• Primarily provides access to abutting land with little or no through traffic • Serves for local traffic • Land access is given high consideration			●		●
Street		• Roads within built-up population centers (Poblacion) with essentially urban rather than rural functions	• Primarily provides access to abutting land in urban areas • Through traffic usage discouraged			●	●	



Legends :

- Primary Major Road
- Secondary Major Road
- Collector / Distributor Road
- Feeder Road
- Municipal Boundary
- Provincial Capital
- Municipal Town
- Barangay

FIGURE 7.3-2 CONCEPTUAL ROAD NETWORK BY FUNCTIONAL CLASSIFICATION

4) Application of Proposed Functional Classification to Pilot Provinces

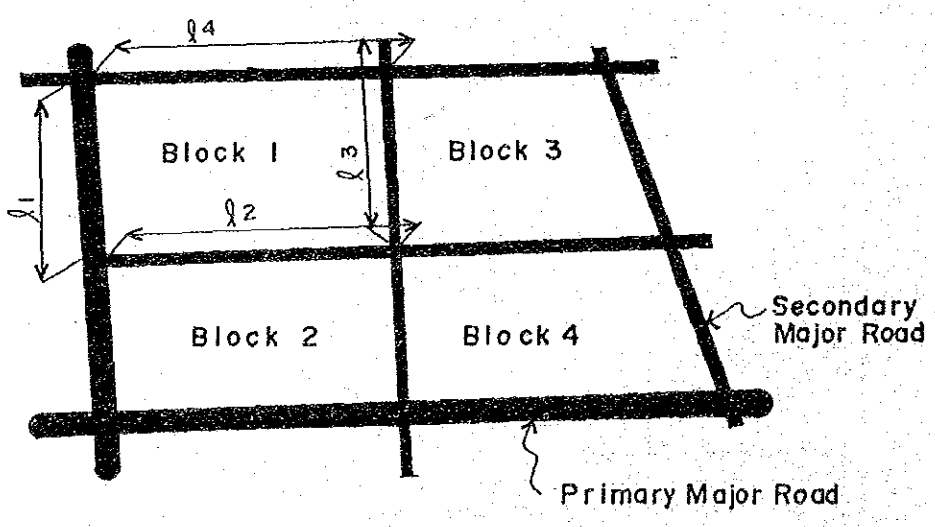
According to the proposed functional classification criteria, major roads (primary and secondary) are basically determined in accordance with their linkages with municipal towns. Some provinces are composed of many small sized municipalities (as in Bohol Province) and some are, on the contrary, composed of a few large sized municipalities (as in Masbate Province). In a province, municipality sizes in terms of land area and population range widely. In order to establish a well-balanced major road network, two (2) indicators were developed to check the balance of network size and, if indicators showed imbalanced values, additions or deletion of major road links were made. Two (2) indicators were as follows:

a) Network Value

$$Nv = \frac{L}{\sqrt{PA}}$$

where:

Nv	=	Network value
L	=	Road length delineating a block (= $l_1 + l_2 + l_3 + l_4$, in case of Block 1 of the figure below)
P	=	Population in a block
A	=	Land area in a block
Block	=	Area delineated by primary and/or secondary major roads



b) Accessibility

Accessibility $Ac = \sum p.l$

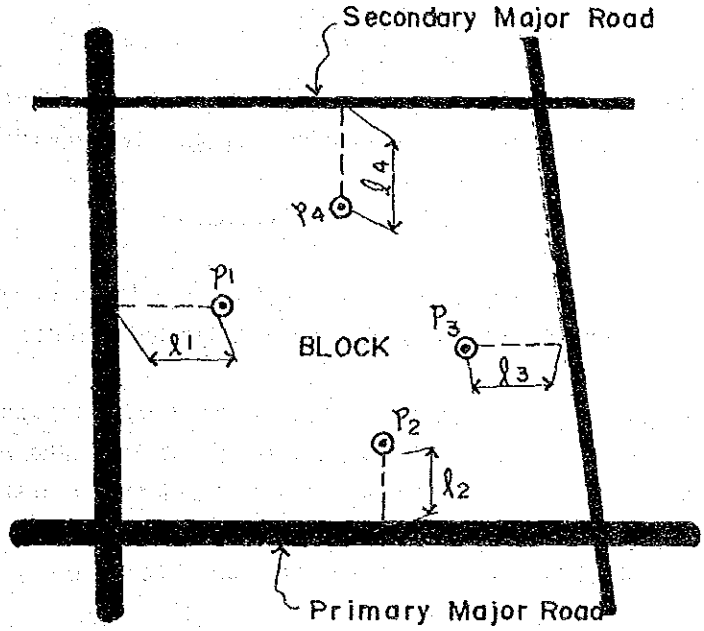
Average Accessibility $A\ ave = \frac{\sum p.l}{P}$

where:

p = Population of a barangay

l = Distance from a barangay center to respective primary or secondary major road

P = Total population in a block



⊙: Barangay Center

$Accessibility = p_1 \cdot l_1 + p_2 \cdot l_2 + p_3 \cdot l_3 + p_4 \cdot l_4$

$Average\ Accessibility = \frac{Accessibility}{p_1 + p_2 + p_3 + p_4}$

7.4 ENGINEERING STANDARDS

7.4.1 Present Engineering Standards in the Philippines

The Department of Public Works and Highways (DPWH) established the Highway Design Guideline in 1984 and issued the Barangay Road Design Criteria as Ministry Order No. 4 in 1987. Separately the Department of Local Government (DLG) published the Interim Design Guideline in 1981. The main provisions for engineering standards of these Guidelines are summarized in Table 7.4-1.

Since this Study involves roads under the jurisdiction of two Departments, DPWH and DLG, these standards should be unified for the project implementation.

7.4.2 Proposed Engineering Standards

The existing guidelines mentioned above were reviewed. Based thereupon, the engineering standards were proposed for this project as shown in Table 7.4-2.

1) Road Classification and Design Traffic Volume

The DPWH is responsible for national roads and barangay roads, while the DLG is the competent authority for provincial, city and municipal roads.

To properly harmonize the present design standards under the two Departments, the principal consideration was given to the design traffic volumes classified by both design guidelines which were used as the element in unifying both. In consequence of this consideration, functional classification precedence over administrative classification not only in the discussion of basic road network but in the study of engineering standards.

In the proposed standards, AADT of primary and secondary major roads were classified into six (6) and five (5) groups, respectively, basically following DPWH standards, while AADT of collector and feeder roads were grouped into four (4) in accordance with DLG standards.

TABLE 7.4-1 DESIGN STANDARDS

	DPWH: Highway Design Guidelines (1984) AADT In Opening Year					DLG: Interim Design Guidelines (1981) AADT in Opening Year				DPWH: Ministry Order No. 4 (1987) Barangay Road Design Criteria A A D T			
	Under 200	200-400	400-1,000	1,000-2,000	More than 2,000	Under 50	50-150	150-400	Over 400	Less than 50	51-150	151-300	More than 300
a) Design Speed (km/hr)													
Flat	60	70	70	80	90	-	60	60	60				
Rolling	40	50	60	60	70	-	40/50	40/50	40/50				
Mountainous	30	40	40	50	60	-	30	30	30				
b) Pavement Width (m)	4.0	5.5-6.0	6.10	6.70	6.70-7.30	4.0	5.5-6.0	5.5-6.0	6.0	4.0	5.0-6.0	6.0	6.0-6.7
c) Shoulder Width (m)													
Flat	0.5	1.0	1.5-2.0	2.5-3.0	3.0	-	0.5	1.0	1.5	Optional	0.5	0.5-1.0	1.0-1.5
Rolling						-	0.5	1.0	1.25				
Mountainous						-	0.5	1.0	1.0				
d) Radius (m)													
Flat	120	160	160	220	280	-	120	120	120				
Rolling	55	85	120	120	160	-	55/85	55/85	55/85				
Mountainous	30	50	50	80	120	-	30	30	30				
e) Grade (%)													
Flat	6.0	6.0	5.0	4.0	4.0	6.0	6.0	5.0	5.0				
Rolling	8.0	7.0	6.0	5.0	5.0	9.0	8.0	7.0	6.0				
Mountainous	10.0	9.0	8.0	7.0	7.0	12.0	10.0	9.0	8.0				
f) ROW Width (m)	20	30	30	30	60					10.0	10.0	15.0	15.0
g) Surface Type	. Graved, Cr. Gr. or Cr. Stone . Bit. Preservative Treatment . Single or Double Bit. Surf. Treatment . Bit. Macadam Pavement	. Gr. Cr.Gr. or Cr. Stone . Bit. Preservative Treatment . Single or Double Bit. Surf. Treatment . Bit. Macadam Pavement	. Bit. Macadam Pavement . Dense or Open Graded Plant Mix Surf. Course . Bit. Conc. Surf. Course	. Bituminous Conc. Surface Course	. Bituminous Conc. Surf. Course . Portland Cement Concrete Pavement	. Nutural Gravel	. Crushed Gravel	. Crushed Gravel	. Surface Treatment	. Gravel	. Gravel with light Asph. at Population centers	. Gravel . Bituminous Macadam	. Bituminous Macadam . Asphaltic Conc.

TABLE 7.4-2 PROPOSED ENGINEERING STANDARDS

Functional Classification	Major Road										Minor Road							
	Primary Major Road					Secondary Major Road					Collector Road				Feeder Road			
Administrative Classification	National Road					National/Provincial City Road					Provincial/City/ Barangay Road				City/Barangay Road			
AADT in Opening Year	Under 100	100-200	200-400	400-1,000	1000-2,000	Over 2,000	Under 200	200-400	400-1,000	1000-2,000	Over 2,000	Under 50	50-200	200-400	Over 400	Under 50	50-200	200-400	Over 400
1) Design speed (km/hr.)																			
Flat		60	70	70	80	90	50	60	60	70	80	40	50	60	60	40	40	50	50
Rolling		40	50	60	60	70	40	50	50	50	60	30	40	40	50	30	30	40	40
Mountainous		30	40	40	50	60	30	40	40	40	50	30	30	30	30	30	30	30	30
2) Carriageway Width (m)		6.0	6.0	6.7-6.0	6.7	6.7	6.0	6.0	6.0	6.0	6.7	5.5[2]	5.5-6.0	5.5-6.0	6.0	4.0	4.0-5.5	5.5 6.0	6.0
3) Shoulder Width (m)																			
Flat		1.5	2.0	2.0	2.5	3.0	1.0	1.5	2.0	2.5	2.5	1.0	1.0	1.5	1.5	0.5	1.0	1.0	1.5
Rolling		1.0	1.5	1.5	1.5	2.0	0.5	1.0	1.5	1.5	1.5	0.5	0.5	1.0	1.0	0.5	0.5	0.5	1.0
Mountainous		0.5	1.0	1.0	1.0	1.5	0.5	1.0	1.0	1.0	1.0	0.5	0.5	1.0	1.0	0.5	0.5	0.5	0.5
4) ROW Width (m)		20	30	30	30	30	20	20	30	30	30	20	20	20	20	10	10	15	15
5) Radius (m)																			
Flat		120	160	160	220	280	85	120	120	160	220	55	85	120	120	55	55	85	85
Rolling		55	85	120	120	160	55	85	85	85	120	30	55	55	85	25	30	55	55
Mountainous		30	50	50	80	120	30	50	50	50	80	30	30	30	30	25	30	30	30
6) Grade (%)																			
Flat		6.0	6.0	5.0	4.0	4.0	7.0	6.0	6.0	5.0	4.0	8.0	7.0	6.0	6.0	8.0	8.0	7.0	7.0
Rolling		8.0	7.0	6.0	5.0	5.0	8.0	7.0	7.0	7.0	5.0	10.0	8.0	8.0	7.0	10.0	10.0	8.0	8.0
Mountainous		10.0	9.0	8.0	7.0	7.0	10.0	9.0	8.0	8.0	7.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
7) Acceptable Pavement Type	.S or DBST .BMP .BPT .Cr. Gr.		.AC .DBST	.PCC .AC	.PCC .AC	.PCC .AC	.S or DBST .BMP .BPT .Cr. Gr.		.AC .DBST	.PCC .AC	.PCC .AC	.Cr. .Gr.	.BPT .Cr. Gr.	.S or DBST .BMP	.AC .DBST	.Nat or Cr. Gr.	.Nat or Cr. Gr. .BPT	.S or DBST .BMP	AC DBST
8) Pavement Type Recommended In This Study	Gr.	1) BMP/ DBST	1) BMP/ DBST	.AC	.PCC	.PCC	.Gr.	1) BMP/ DBST	.AC	.PCC	.PCC	.Gr.	.Gr.	1) BMP/ DBST	.AC	.Gr.	.Gr.	1) BMP/ DBST	.AC

Pavement Type
- S or DBST.....Single or double bituminous treatment
- BMP.....Bituminous macadam pavement
- BPT.....Bituminous preservative treatment
- Nat. or Cr. Gr. .....Natural or crushed gravel
- AC.....Asphalt concrete pavement
- PCC.....Portland cement concrete pavement

NOTE:
1) Choice of BMP/DBST depends on the conditions of subgrade, traffic loading, drainage, etc.

2) 4.0 m in case of less than 25 AADT.

2) Design Speed

In conjunction with the AADT classification, the design speeds for the major roads (primary and secondary) and the minor roads (collector and feeder) were proposed based on DPWH and DLG standards, respectively, with minor adjustments.

3) Carriageway Width

The carriageway widths prescribed in the present design guidelines vary from 4.0 to 7.3 m. Taking into consideration the fact that the width of the Pan-Philippine Highway is 6.7 m, 7.3 m was deemed to be a little too wide even for the major roads. On the other hand, 4.0 m might be as narrow as a two-lane road even in rural areas, except for collector roads with AADT less than 25 and feeder roads with AADT less than 200. Based on these facts and the level of services to be assigned to each class of road, the standard widths were proposed as follows:

- High Class Road. 6.7 m (3.35 m x 2)
  - Primary major roads with AADT more than 400
  - Secondary major roads with AADT more than 2000
- Average Class Roads. 6.0 m (3.0 m x 2)
  - Primary major roads with AADT less than 400
  - Secondary major roads with AADT less than 2000
  - Minor roads, both collector and feeder roads with AADT more than 200
- Low Class Roads. 5.5 m (2.75 m x 2)
  - Collector roads with AADT between 200 and 25
- Low Class Roads. 4.0 m (1-lane)
  - Collector roads with AADT less than 25
  - Feeder roads with AADT less than 200

4) Shoulder Width and ROW Width

The shoulder widths were proposed in accordance with the present guidelines of DPWH and DLG. However, the R.O.W. width of 60m which is used for roads with AADT more than 2000 in the DPWH Guideline was not recommended.

5) Radius and Grade

As for the radius and grade, which are basic elements of highway geometric design, no change was proposed because almost the same values are adopted in both design guidelines.

6) Pavement Type

The pavement types commonly used in the Philippines are as follows:

- Crushed gravel surfacing (Gravel)
- Double bituminous surface treatment (DBST)
- Bituminous macadam pavement (BMP)
- Asphalt concrete pavement (AC)
- Portland cement concrete pavement (PCC)

For each type, the standard pavement structure was prepared as shown in Figure 7.4-1, and the performance period was estimated according to the design equations shown in "AASHTO Guide for Design of Pavement Structures, 1986", under the conditions shown in Table 7.4-3 which were assumed to be average conditions in the project roads. (The performance period refers to the period of time that an initial pavement structure will last before it needs rehabilitation. The performance period of a gravel road is defined as the period which will elapse until the thickness of gravel is reduced by 10 cm). Figure 7.4-2 shows the relationship between AADT and performance period.

The minimum performance period was selected as shown in Table 7.4-4. The AADT corresponding thereto was derived from Figure 7.4-2 and is shown in Table 7.4-4. Based on this Table, the recommended pavement type depending on AADT was determined.

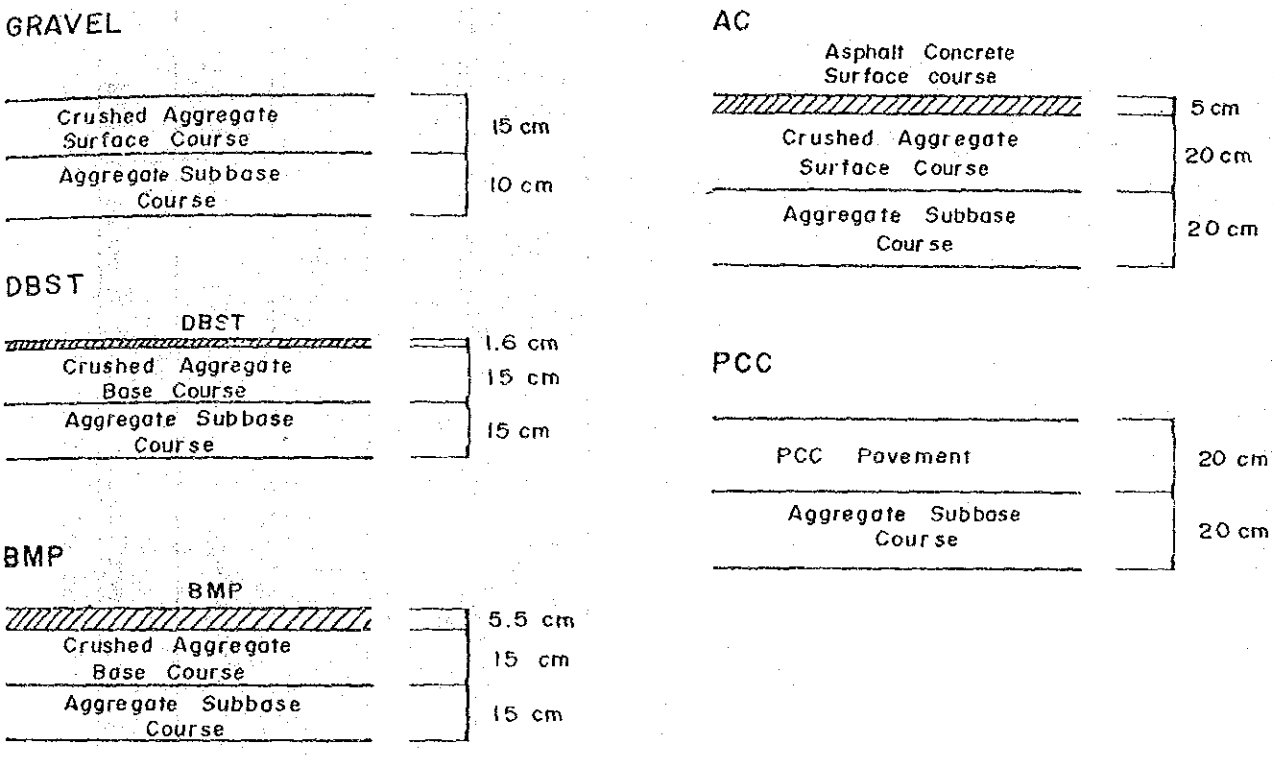


FIGURE 7.4-1 STANDARD PAVEMENT STRUCTURE

TABLE 7.4-3 CONDITIONS ASSUMED IN ESTIMATING PERFORMANCE PERIOD

	G r a v e l	DBST/BMP/AC	P C C
Traffic			
Heavy Vehicle Composition			
AADT 400		20%	
AADT 1000		25%	
Relative Damaging Factor[1] of Heavy Vehicle			
AADT 400		1.2	
AADT 1000		1.4	
Traffic Growth Rate		3% p.a.	
Reliability		Not Considered	
Serviceability			
Initial (po)		4.2	4.5
Terminal (pt)		2.0	2.0
Subgrade CBR	6	6	6
Resilient Modulus (M_R)/ Modulus of Subgrade Reaction (k)		MR = 9,000 psi	k = 210 pci
Layer Coefficient		AC 0.38 DBST/BMP 0.20 Crushed Base 0.14 Subbase 0.10	
Modulus of Rupture for PCC (S'c)			S'c = 580 psi
Load Transfer Coefficient (J)			J = 4
Modulus of Elasticity for PCC (Ec)			Ec = 3.28×10^6 psi
Drainage Condition			
Layer Drainage Coefficient (m)		m = 0.9	
Drainage Coefficient (Cd)			Cd = 0.9
Gravel Loss	1.5 cm annually from rainfall and 1.5 cm every 100,000 vehicles		

Note: 1) Relative Damaging Factor = $\frac{\text{Number of 18-kip equivalent single axle loads}}{\text{Number of vehicles}}$

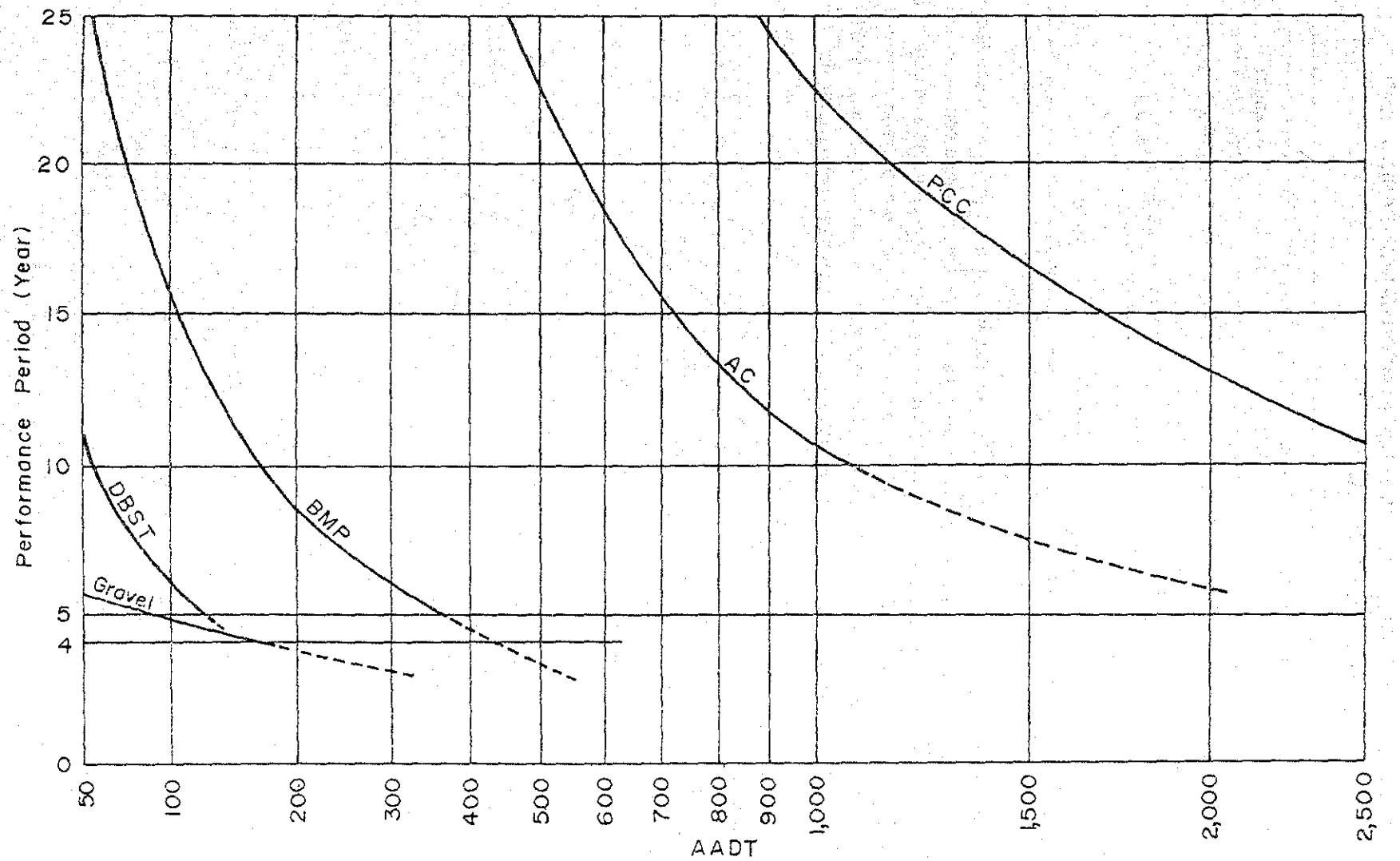


FIGURE 7.4-2 RELATIONSHIP BETWEEN AADT AND PERFORMANCE PERIOD UNDER THE CONDITIONS SHOWN IN TABLE 7.4-3

TABLE 7.4-4 RECOMMENDED MINIMUM PERFORMANCE PERIOD AND CORRESPONDING AADT

	Minimum Performance Period (Years)	Corresponding AADT	Range of AADT recommended in Design Standards
Gravel	4	180	0 - 200
DBST	5	125	-
BMP	5	370	200 - 400
AC	10	1,080	400 - 1000
PCC	10	2,600	1000 -

It should be noted that performance period depends very much on the various conditions such as traffic loading, material properties, roadbed soil properties, drainage conditions, etc., as exemplified in Figure 7.4-3, showing how pavement performance changes with subgrade strength and drainage condition, wherein pavement performance is expressed in terms of total 18-kip equivalent single axle load applications during the performance period. From this figure, it is found that DBST can be applied instead of BMP where conditions warrant it.

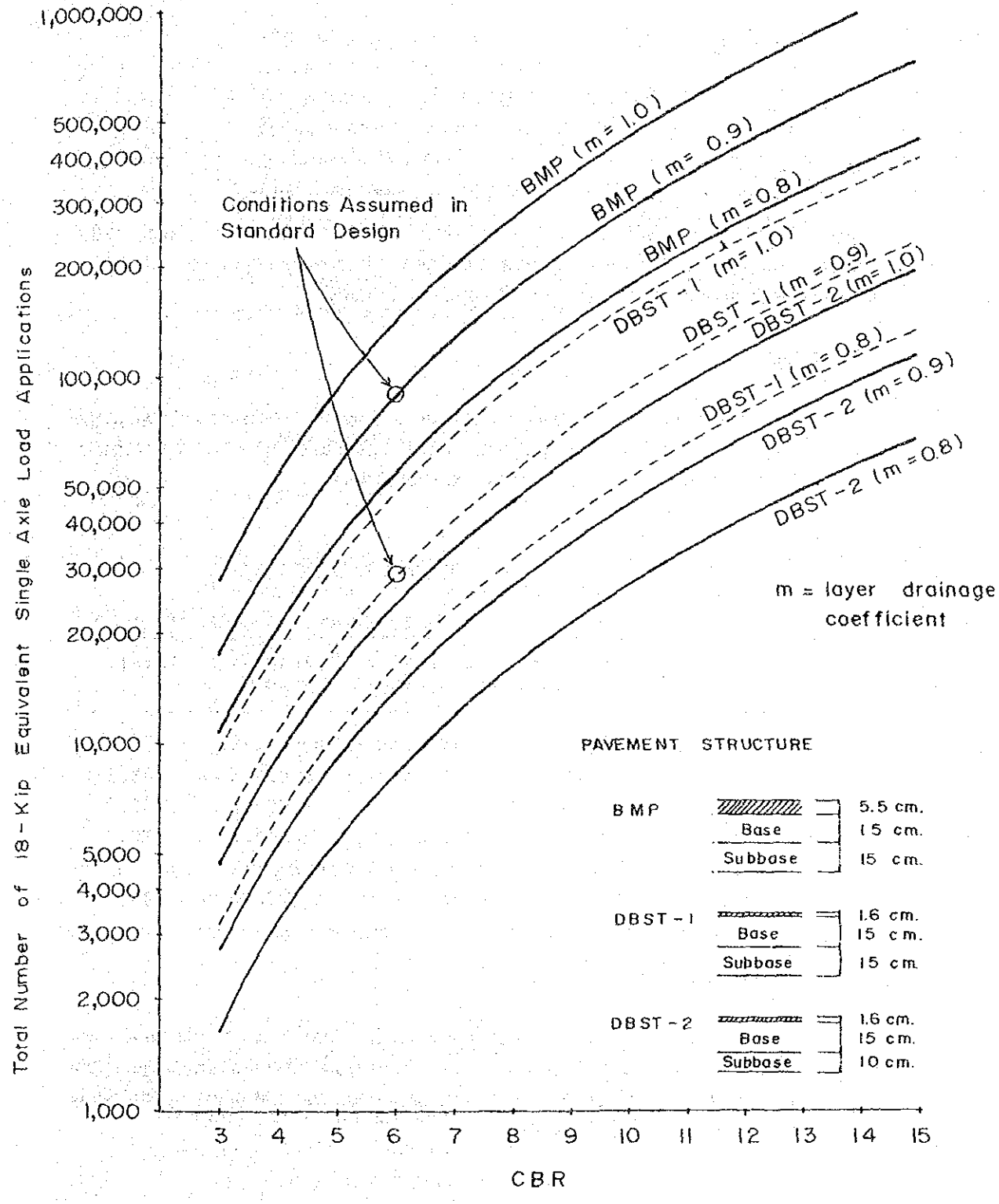


FIGURE 7.4-3 CHANGE OF PAVEMENT PERFORMANCE WITH SUBGRADE STRENGTH AND DRAINAGE CONDITION