CHAPTER 7 TRAFFIC ANALYSIS

7.1 Traffic Surveys Conducted

7.1.1 Survey Objective

In order to collect up-to-date information, traffic surveys have been conducted by the JICA study team from January to April, 2007 in various places of Sulawesi. They are traffic count and interview surveys on road, port and ferry.

The objectives of the traffic count survey and roadside interview survey are 1) to obtain latest information/data on road traffic situation in Sulawesi Island, 2) to analyze traffic characteristics through interview to road users, and 3) to create a basis for transport demand forecast to be carried out in the next phase of the study.

7.1.2 Survey Coverage

(1) Survey on Road

The traffic count survey and the roadside interview survey were carried out at 77 stations on road. 13 survey stations are located in Maminasata and 64 survey stations are mainly on the border of Kabupaten and Kota, and near major ports. The survey locations are shown in the following Figure 7.1.1 and Table 7.1.1.

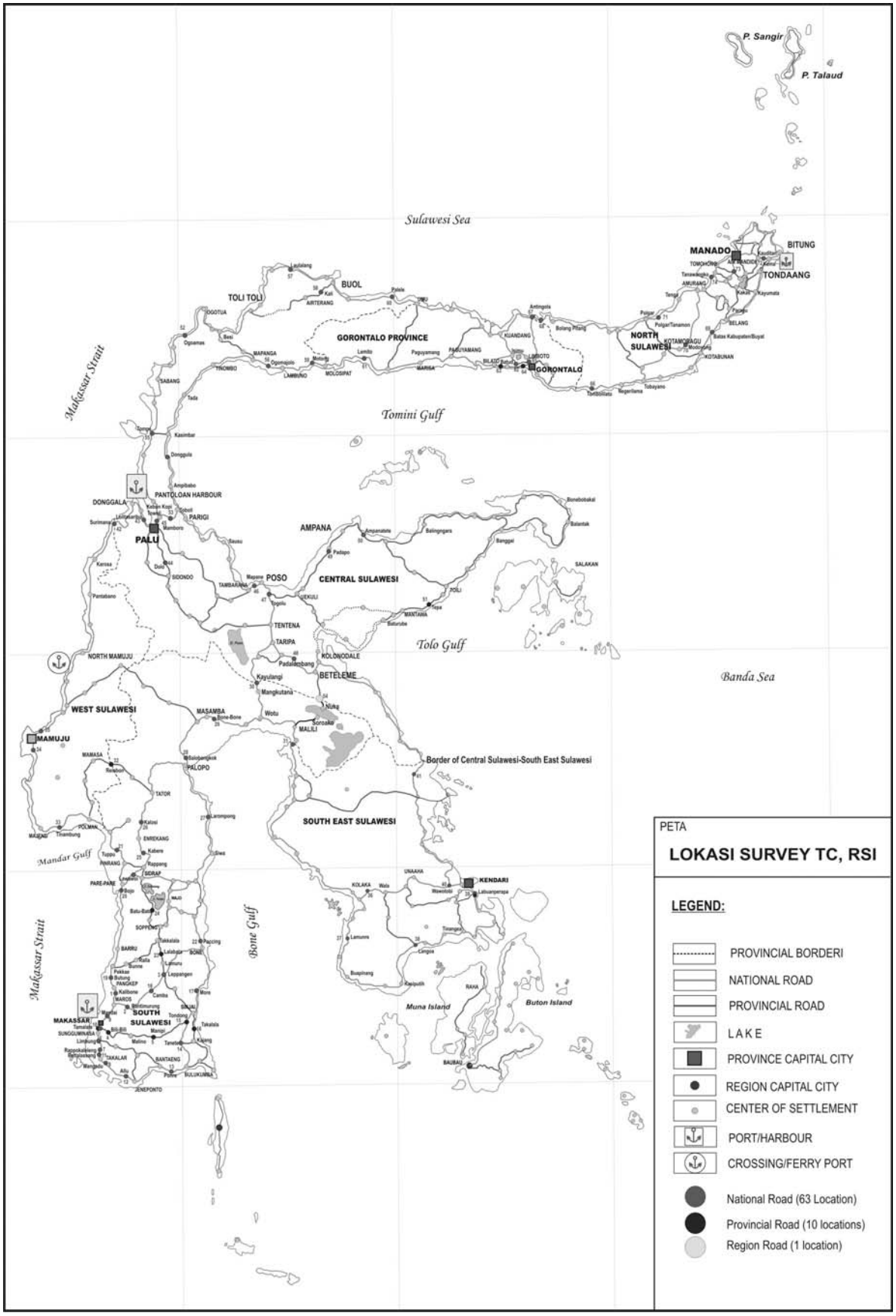
24-hour surveys were conducted from 06:00 in the morning to 06:00 in the next morning. 18-hour surveys were conducted from 06:00 in the morning to 22:00 in the evening.

Table 7.1.1 Survey Locations on Road

Province	Post No.	Road Status	Road Section	Survey Station	Survey Duration	Type of Survey
South Sulawesi	01	N	Maros – Pangkep	Kali Bone	1 day, 16 Hours	TC, RSI
	02	N	Maros – Camba	Bantimurung	1 day, 16 Hours	TC, RSI
	03	N	Maros – Bone	Perbatasan Bone Maros	1 day, 16 Hours	TC, RSI
	04	P	Sungguminasa – Malino	Bili-Bili	1 day, 16 Hours	TC, RSI
	05	P	Malino – Sinjai	Manipi	1 day, 16 Hours	TC, RSI
	06	N	Sungguminasa – Limbung	Limbung	1 day, 16 Hours	TC, RSI
	07	N	Limbung – Takalar	Rappokaleleng	1 day, 16 Hours	TC, RSI
	08	N	Takalar – Jeneponto	Mangadu	1 day, 16 Hours	TC, RSI
	09	N	Makassar – Maros	Mandai POM Bensin	2 days, 24 Hours	TC, RSI
	10	N	Makassar– Sungguminasa	Tamalate	2 days, 24 Hours	TC, RSI
	10A	R	Barombong - Sagebongga	Resantern Goppi/Kalimantan	1 day 16 hours	TC RSI
	10B	R	Barungburung-Sawgi	Patalassang (Bontomarannu)	1 day 16 hours	TC, RSI
	10C	R	Samala-Burungburung	Resanteran Guppi/Kalimantan	1 day, 16 hours	TC RSI
	11	N	Sungguminasa – Takalar	Pattalasang	1 day, 16 Hours	TC, RSI
	12	N	Takalar – Jeneponto	Allu	1 day, 16 Hours	TC, RSI
	13	N	Bantaeng - Bulukumba	Ponre	1 day, 16 Hours	TC, RSI
	14	N	Bulukumba – Sinjai	Tanete	1 day, 16 Hours	TC, RSI
	15	P	Malino – Sinjai	Tondong	1 day, 16 Hours	TC, RSI
	16	P	Kajang – Sinjai	Takalala	1 day, 16 Hours	TC, RSI
	17	N	Sinjai – Bone	Mare	1 day, 16 Hours	TC, RSI
	18	N	Maros – Bone	Camba	1 day, 16 Hours	TC, RSI
	19	N	Pangkajene – Barru	Butung	1 day, 16 Hours	TC, RSI
	20	N	Barru – Parepare	Bojo	1 day, 16 Hours	TC, RSI
	21	N	Pinrang - Polmas	Tuppu	1 day, 16 Hours	TC, RSI
	22	N	Bone – Sengkang	Paccing	1 day, 16 Hours	TC, RSI

Province	Post No.	Road Status	Road Section	Survey Station	Survey Duration	Type of Survey
	23	P	Lamuru – Takalala	Lalabata	1 day, 16 Hours	TC, RSI
	24	P	Soppeng – Pangkajene	Batu-Batu	1 day, 16 Hours	TC, RSI
	25	N	Rappang – Enrekang	Kabere	1 day, 16 Hours	TC, RSI
	26	N	Enrekang – Makale	Kalosi	1 day, 16 Hours	TC, RSI
	27	N	Siwa – Palopo	Larompong	1 day, 16 Hours	TC, RSI
	28	N	Palopo – Masamba	Km. 10 Salobongkok	1 day, 16 Hours	TC, RSI
	29	N	Masamba – Wotu	10 Kilo meters Before Bone-Bone	1 day, 16 Hours	TC, RSI
	30	N	Wotu – Frontier of Central Sulawesi	Frontier of Central Sulawesi (Kayu Langi)	1 day, 16 Hours	TC, RSI
	31	N	Malili – Frontier of East North Sulawesi	Frontier of East North Sulawesi	1 day, 16 Hours	TC, RSI
West Sulawesi	32	P	Mamasa - Makale	Frontier of Mamasa – Makale Rembon	1 day, 16 Hours	TC, RSI
	33	N	Polewali – Majene	Tinambung	1 day, 16 Hours	TC, RSI
	34	N	Majene – Mamuju	Kilo meter 10 Before Mamuju	1 day, 16 Hours	TC, RSI
	35	N	Mamuju – Tasing	5 Km Before Mamuju	1 day, 16 Hours	TC, RSI
East South Sulawesi	36	N	Kolaka – Wala	± 10 kilo meters from Kolaka	1 day, 16 Hours	TC, RSI
	37	P	Pomalaa – Buapinang	Lamunre	2 days, 24 Hours	TC, RSI
	38	N	Kasiputih – Tinangea	Langoa	1 day, 16 Hours	TC, RSI
	39	N	Kendari – Kalano	Labuanperapa	2 days, 24 Hours	TC
	40	N	Kendari – Unahaa	Wawotobi	1 day, 16 Hours	TC, RSI
	41	N	Frontier East Cross of North Sulawesi – Central Sulawesi	Frontier of North Sulawesi – Central Sulawesi	1 days, 16 Hours	TC, RSI
Central Sulawesi	42	N	Frontier Central Sulawesi and West Sulawesi	Surimana	1 day, 16 Hours	TC, RSI
	43	N	Palu - Donggala	Lotisari Buri	1 day, 16 Hours	TC, RSI
	44	N	Palu - Sidondo	Dolo	1 day, 16 Hours	TC, RSI
	45	N	Tawa Eli - Palu	Mamboro	1 day, 16 Hours	TC, RSI
	46	N	Poso - Tambarana	Mapane	1 day, 16 Hours	TC, RSI
	47	N	Tentena - Poso	Tongolo	2 days, 24 Hours	TC
	48	N	Taripa - Beteleme	Padalembang	1 day, 16 Hours	TC, RSI
	49	N	Uwekali – Ampana	Padapo	1 day, 16 Hours	TC, RSI
	50	N	Ampana - Balingara	Ampanatete	2 days, 24 Hours	TC, RSI
	51	P	Toili - Mantawa	Tepa	1 day, 16 Hours	TC, RSI
	52	N	Sabang - Ogotua	Ogoamas	1 day, 16 Hours	TC
	53	P	Towaeli - Toboli	Kebun Kopi	1 day, 16 Hours	TC, RSI
	54	R	Beteleme - Nuha	Frontier Central Sulawesi – South Sulawesi	1 days, 16 Hours	TC, RSI
	55	N	Pantoloan – Sabang	Tompe	1 day, 16 Hours	TC, RSI
	56	N	Tinombo - Lambuno	Ogomajoko	2 days, 24 Hours	TC,
	57	N	Toli-toli – Buoll	Laulang	1 day, 16 Hours	TC, RSI
	58	N	Airterang – Buol	Kali	1 day, 16 Hours	TC, RSI
	59	N	Lambunu – Molosifat	Motong	2 days, 24 Hours	TC
	60	P	Buol - Umu	Palele	1 day, 16 Hours	TC, RSI
Gorontalo	61	P	Frontier Central Sulawesi and Marisa	Lemito	1 day, 16 Hours	TC, RSI
	62	N	Gorontalo – Isimu	Batuk	1 day, 16 Hours	TC, RSI
	63	N	Gorontalo – Panguyaman	Bilato	1 day, 16 Hours	TC, RSI
	64	N	Gorontalo - Bilato	± 10 kilo meters From Gorontalo	1 day, 16 Hours	TC, RSI
	65	N	Gorontalo - Limboto	± 5 KM from Gorontalo	1 day, 16 Hours	TC, RSI
North Sulawesi	66	N	Gorontalo – Negeri Lama	Tombolilato	1 day, 16 Hours	TC, RSI
	67	N	Limboto - Panguyaman	Antingola	1 day, 16 Hours	TC, RSI
	68	N	Kuandang - Bolangpitang	The east of Antingola	1 day, 16 Hours	TC, RSI
	69	N	Kota Bunang - Belang	Frontier Buyat Regency	1 day, 16 Hours	TC, RSI
	70	N	Kotamobagu – Amurag	Motoyang	1 day, 16 Hours	TC, RSI
	71	N	Polgar - Tenga	Polgar/Tanamon	1 day, 16 Hours	TC, RSI
	72	N	Airmalili - Kema	Paragu	1 day, 16 Hours	TC, RSI
	73	N	Manado - Tomohon	Before Tomohon	1 day, 16 Hours	TC, RSI
	74	N	Amurang - Manado	Tanawangko	1 day, 16 Hours	TC, RSI

Source: JICA Study Team Note : N: National Road, P: Provincial Road, R: Regional(Kabupaten) Road



Source: JICA Study Team

Figure 7.1.1 Survey Location on Road

(2) Survey at Port

Traffic count survey and roadside interview were conducted as well at four(4) major ports illustrated in Figure 7.1.2.

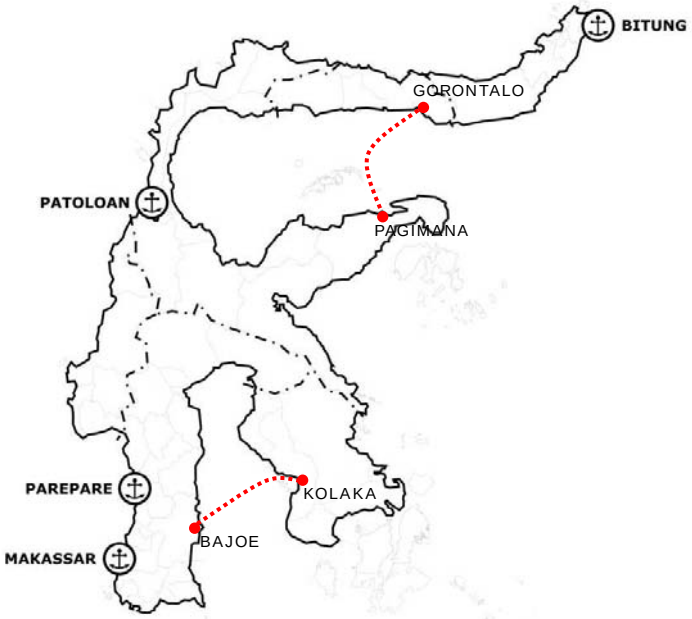


Figure 7.1.2 Survey Location at Port

(3) Survey on Ferry

In order to grasp the complementary mutual relation between road and ferry, interview surveys were conducted in a limited scale. The ferry routes covered were:

* Bajoe – Kolaka
* Gorontalo – Pagimana

7.1.3 Scope of Survey

(1) Traffic Count Survey

Vehicular traffic count was conducted by direction, by hour and by vehicle type on major roads and at major ports.

The vehicle type was classified as follows:

- Motorcycle
- Private Car (Sedan)
- Small Bus
- Medium & Large Bus
- Pick Up
- Small Truck (2 axles)
- Large Truck (3 axles or more)

The survey forms are shown in Appendix 3.

(2) Roadside Interview Survey

The questionnaire includes the following:

- Type of Vehicle (the same as traffic count survey)
- Number of Passengers
- Trip Purpose
- Origin & Destination
- Travel Time
- Usage of Ship and Airplane
- Loading Capacity & Load Factor (For Truck)
- Major Commodity (For Truck)

These were interviewed to the sampled vehicle drivers at roadside. The survey forms are shown in Appendix 3.

(3) Interview Survey on Ferry

The questionnaire includes the following:

- Type of Vehicle (the same as traffic count survey) traveling with the passenger
- Access/egress Mode of Transport to/from the Port if not traveling with vehicle
- Number of Passengers traveling with
- Trip Purpose
- Origin & Destination
- Travel Time
- Reason of Selecting Ferry

The survey forms are shown in Appendix 3.

7.2 Survey Result and Major Findings

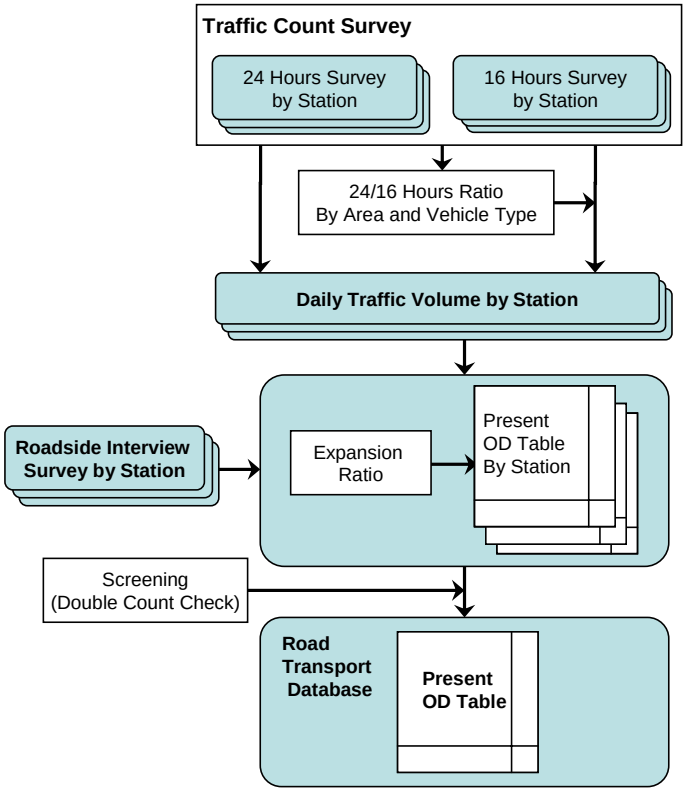
7.2.1 Methodology

(1) General

Figure 7.2.1 illustrates the process of creating road traffic database. Firstly, hourly fluctuation of road traffic was analyzed using the result of traffic count survey. After that, 24/16 hour ratio was calculated, then daily traffic volume was estimated for 77 stations.

Furthermore, the existing OD tables of each station were estimated by the daily traffic volume and the result of roadside interview survey. However, those OD tables were including double counts, and, therefore, a screening check was conducted for each OD pair to create the present (2007) OD tables.

Finally, road transport database was created to analyze road traffic characteristics.



Source: JICA Study Team

Figure 7.2.1 Process of Creating Road Traffic Database

(2) Preparation of Present OD Tables

OD tables of vehicle trips across zone borders excluding intra zone trips by 83 zone system was estimated by roadside interview survey and traffic count survey. The number of total trips is not so large, because most traffic demands of daily life can be supported inside the zone (Kabupaten and Kota).

Table 7.2.1 Present OD Table – Summarized (2007)

PCU in Year 2007	Sulawesi Utara	Gorontalo	Sulawesi Tengah	Sulawesi Tenggara	Sulawesi Barat	Sulawesi Selatan
Sulawesi Utara	31,314	1,530	95	0	0	103
Gorontalo	1,530	4,998	429	6	0	12
Sulawesi Tengah	95	429	6,609	52	583	435
Sulawesi Tenggara	0	6	52	2,360	0	338
Sulawesi Barat	0	0	583	0	4,548	2,367
Sulawesi Selatan	103	12	435	338	2,367	117,233
Major Airports in Mainland	0	0	6	0	0	498
Major Ports in Mainland	0	2	1,070	78	67	8,747
Total	33,041	6,975	9,280	2,834	7,565	129,732

PCU in Year 2007	Major Airports in Mainland	Major Ports in Mainland	Total
Sulawesi Utara	0	0	33,041
Gorontalo	0	2	6,975
Sulawesi Tengah	6	1,070	9,280
Sulawesi Tenggara	0	78	2,834
Sulawesi Barat	0	67	7,565
Sulawesi Selatan	498	8,747	129,732
Major Airports in Mainland	0	0	504
Major Ports in Mainland	0	0	9,964
Total	504	9,964	199,895

**) Symmetric matrix excluding intra zone trips*
**) Data in major airports and ports is only samples interviewed by traffic survey.*

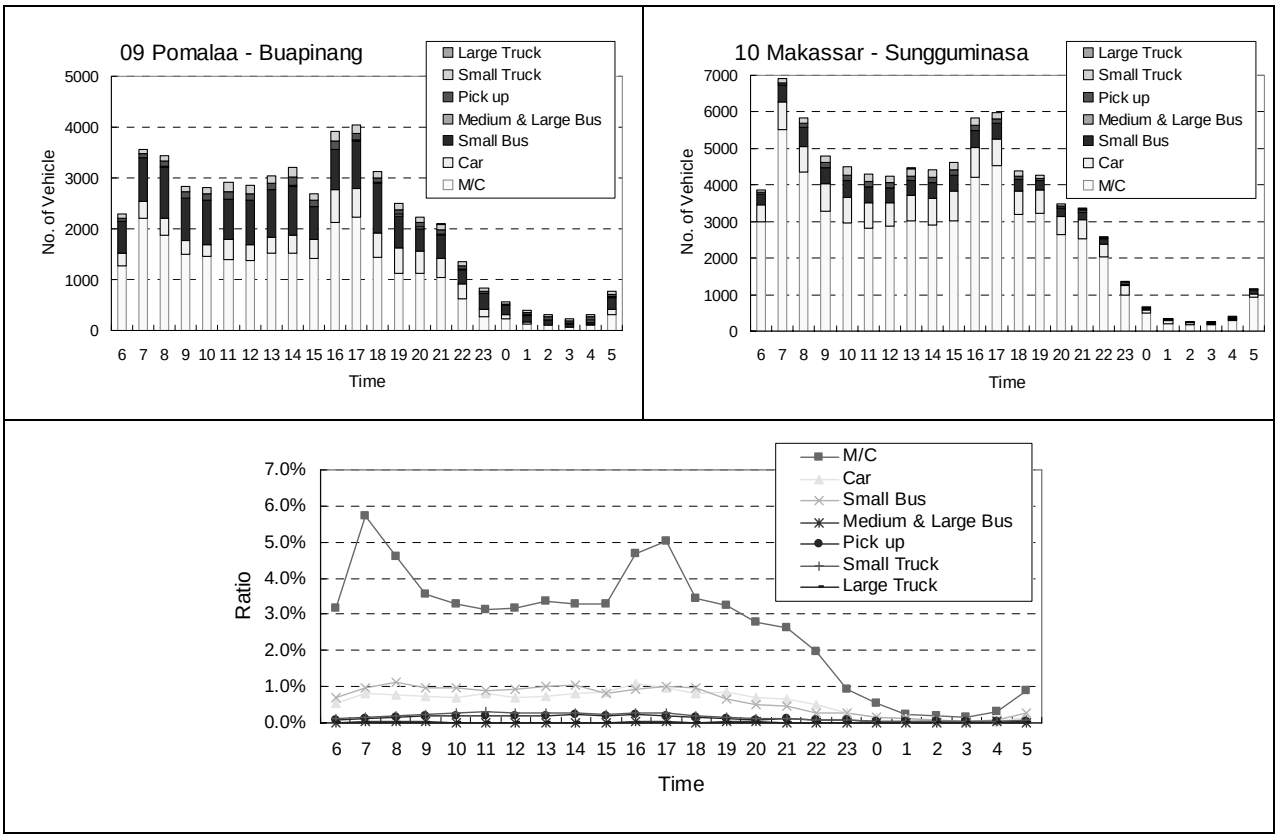
In Sulawesi most trips are closed in the province. Some trips reach to neighboring provinces, and only few trips go beyond provincial boundary. The trip length of motorcycle is comparatively long because the motorization is still in an earlier stage in Sulawesi. Trips by passenger car are not so numerous. This can be observed by the OD tables.

7.2.2 Road Traffic Characteristics

(1) Hourly Fluctuation by Area

1) Urban Area

The following Figure 7.2.2 illustrates hourly fluctuation of traffic based on the results of 24-hour surveys conducted near Makassar city. The peak hours are observed between 7:00 and 8:00 in the morning and between 16:00 and 17:00 in the evening. Motorcycle has the highest share in the traffic, and it concentrates at peak hours.

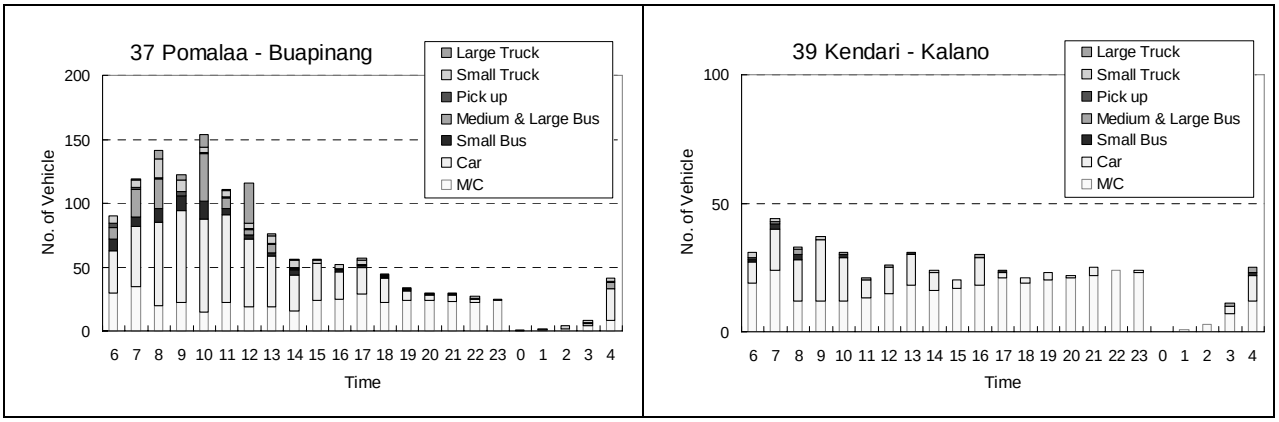


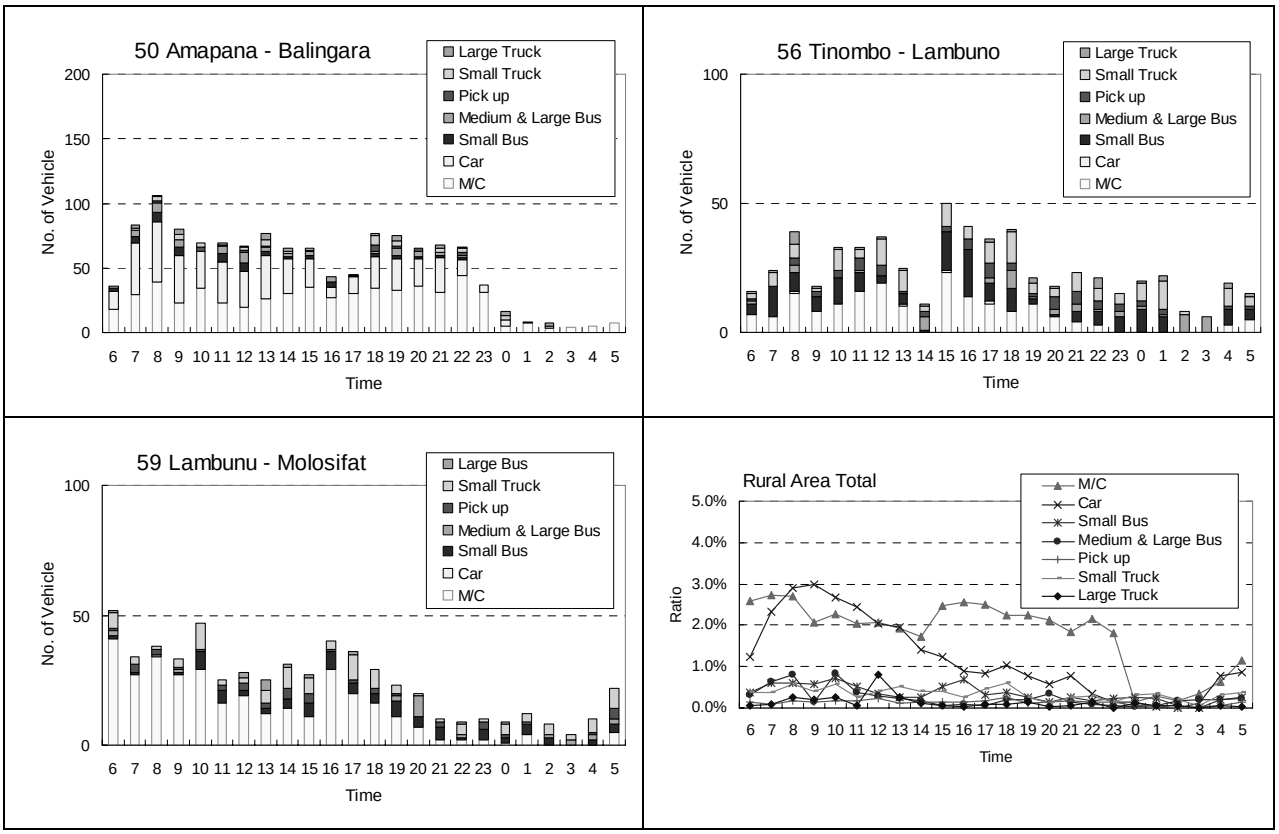
Source: JICA Study Team

Figure 7.2.2 Hourly Fluctuation by Survey Point (Urban Area)

2) Rural Area

Figure 7.2.3 illustrates hourly fluctuation of traffic based on the results of 24-hour traffic count surveys conducted in rural area. It has no significant peak hours compared with the urban area. Motorcycle and private car have higher shares than other vehicles. The pattern of hourly fluctuation, however, is different by area and vehicle type.





Source: JICA Study Team

Figure 7.2.3 Hourly Fluctuation by Survey Point (Rural Area)

(2) 24hour/16hour Ratio

Traffic count survey was carried out at 77 stations in Sulawesi Island. 24-hour survey, however, was conducted only in seven (7) of them. In other stations, 16-hour survey (6:00-22:00) was conducted instead. These 16-hour traffic volume should therefore be converted into 24-hour (i.e. daily) traffic volume using 24hour/16hour ratios. The following Table 7.2.2 shows 24hour/16hour ratios by area and by vehicle type. The ratio is higher in urban area than in rural area, and the ratio of bus and truck is high compared to private vehicles. Especially, the ratio of bus and truck in rural area is significantly high, presumably because long-distance trips of bus and truck are included in the night time.

Table 7.2.2 24hour/16hour Ratio by Area and by Vehicle Type

Urban/Rural	Station No.	No. of Vehicles	Private Vehicle (M/C & Car)	Bus & Truck
Urban	9	47,600	1.08	1.14
	10	75,500	1.10	1.07
	Ave.	-	**1.09**	**1.11**
Rural	37	1,300	1.15	1.10
	39	400	1.26	1.32
	50	4,800	1.01	1.01
	56	1,100	1.15	1.10
	59	500	1.06	1.39
	Ave.	-	**1.15**	**1.24**

Source: JICA Study Team

(3) Daily Traffic Volume on Road

The daily traffic volume was estimated using the result of traffic count survey and 24hour/16hour ratio. In the cities and its suburbs, such as Makassar, Palu, Poso and Manado, 24hour/16hour ratio of urban area was applied. The following Tables 7.2.3 through 7.2.8 show daily traffic volume by province.

Table 7.2.3 Daily Traffic Volume in South Sulawesi Province (Unit: Vehicle)

Area	Station	No. of Vehicle	M/C	Car	Small Bus	M & L Bus	Pick up	Small Truck	Large Truck
Mamminasata Area	1	13,797	5,450	625	4,751	171	777	1,916	107
	2	11,484	6,515	1,378	2,261	56	617	651	6
	3	3,467	1,587	91	1,212	45	235	294	3
	4	8,765	4,471	163	1,897	9	314	1,903	8
	5	547	390	2	79	-	48	28	-
	6	30,815	19,547	4,320	3,630	115	899	2,295	9
	7	16,459	10,135	1,748	3,255	35	382	839	65
	8	8,869	4,776	768	2,486	16	301	518	4
	9	57,736	30,877	14,233	5,391	457	2,375	4,333	70
	10	58,861	29,958	13,128	8,557	397	1,956	4,733	132
	101	9,337	7,816	385	729	7	245	153	2
	102	2,943	2,573	52	108	-	94	104	12
	103	2,564	2,295	15	141	-	59	54	-
Out of Mamminasata Area	11	19,158	12,834	2,009	3,238	42	402	598	35
	12	9,127	5,113	486	2,629	42	322	529	6
	13	8,909	5,449	131	2,413	29	415	472	-
	14	2,905	1,498	310	725	15	183	169	5
	15	573	312	28	123	5	69	36	-
	16	435	412	-	12	-	7	4	-
	17	8,052	5,642	137	1,485	23	360	402	3
	18	3,021	1,290	89	1,113	34	211	281	3
	19	7,677	2,415	356	3,256	136	365	1,095	54
	20	13,919	5,558	3,054	3,030	330	656	1,276	15
	21	4,264	2,085	65	1,315	66	313	417	3
	22	4,240	2,429	98	1,322	56	180	148	7
	23	1,390	684	43	448	25	85	93	12
	24	1,538	648	36	552	19	87	183	13
	25	3,218	1,740	72	841	59	169	337	-
	26	1,563	588	196	361	113	72	190	43
	27	5,009	2,448	74	1,807	98	186	360	36
	28	5,149	2,483	82	1,687	98	199	592	8
	29	5,154	2,752	74	1,352	112	208	638	18
	30	154	23	-	13	14	23	81	-
	31	731	328	10	183	33	70	85	22

Source: JICA Study Team

Table 7.2.4 Daily Traffic Volume in West Sulawesi Province (Unit: Vehicle)

Station	No. of Vehicle	M/C	Car	Small Bus	M & L Bus	Pick up	Small Truck	Large Truck
32	92	71	19	-	-	-	2	-
33	5,695	2,992	398	1,786	31	168	279	41
34	3,245	1,431	251	530	102	350	501	80
35	2,098	795	173	477	75	222	310	46

Source: JICA Study Team

Table 7.2.5 Daily Traffic Volume in South East Sulawesi Province (Unit: Vehicle)

Station	No. of Vehicle	M/C	Car	Small Bus	M & L Bus	Pick up	Small Truck	Large Truck
36	1,895	991	642	49	35	85	93	-
37	1,263	837	61	179	3	71	112	-
38	271	199	5	17	-	18	23	9
39	265	235	4	14	-	5	7	-
40	3,533	1,268	523	904	148	582	108	-
41	169	115	12	3	2	13	24	-

Source: JICA Study Team

Table 7.2.6 Daily Traffic Volume in Central Sulawesi Province (Unit: Vehicle)

Station	No. of Vehicle	M/C	Car	Small Bus	M & L Bus	Pick up	Small Truck	Large Truck
42	1,636	1,006	9	299	33	155	131	3
43	4,669	2,809	329	727	43	245	501	15
44	7,467	6,040	353	752	7	216	99	-
45	17,499	11,291	408	3,804	94	731	1,043	128
46	5,154	3,709	810	79	65	198	251	42
47	5,108	3,590	964	68	56	195	177	58
48	313	170	3	51	12	20	53	4
49	474	290	3	82	35	25	35	4
50	1,027	781	-	137	13	33	60	3
51	203	166	-	8	-	-	29	-
52	520	390	-	50	25	25	30	-
53	2,161	930	12	643	70	168	231	107
54	76	42	3	15	7	5	4	-
55	964	685	2	124	23	51	71	8
56	565	195	5	137	31	59	115	23
57	1,159	938	23	91	41	-	66	-
58	613	509	4	65	15	-	13	7
59	593	363	-	72	18	38	89	13
60	53	35	-	3	5	-	10	-

Source: JICA Study Team

Table 7.2.7 Daily Traffic Volume in Gorontalo Province (Unit: Vehicle)

Station	No. of Vehicle	M/C	Car	Small Bus	M & L Bus	Pick up	Small Truck	Large Truck
61	1,513	1,010	115	97	25	112	151	3
62	5,422	4,367	147	564	53	115	143	33
63	513	463	12	18	-	13	7	-
64	660	402	15	175	33	13	22	-
65	4,655	4,031	217	97	18	146	143	3

Source: JICA Study Team

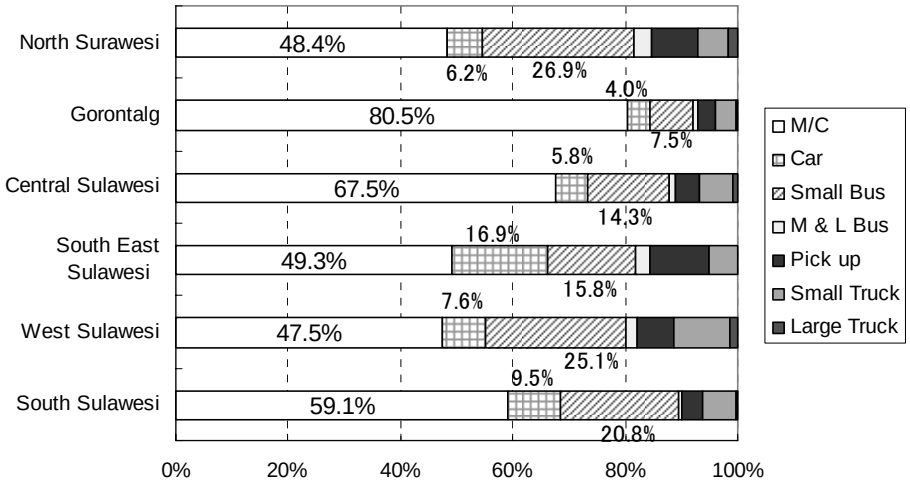
Table 7.2.8 Daily Traffic Volume in North Sulawesi Province (Unit: Vehicle)

Station	No. of Vehicle	M/C	Car	Small Bus	M & L Bus	Pick up	Small Truck	Large Truck
66	1,712	995	87	330	27	189	84	-
67	5,338	3,081	710	902	232	170	146	97
68	1,631	1,193	147	48	39	92	85	27
69	1,016	505	132	137	-	183	44	15
70	7,029	4,237	241	1,803	46	457	204	41
71	2,908	1,116	87	908	113	322	298	64
72	10,426	4,225	472	2,577	339	1,107	1,168	538
73	18,170	7,188	950	6,877	795	1,532	622	206
74	8,832	5,084	721	1,747	224	609	437	10

Source: JICA Study Team

(4) Vehicle Composition by Province

Figure 7.2.4 shows the vehicle composition of road traffic by province. On the whole, the vehicle composition is slightly different from one province to another. The percentage of motorcycle is the largest in all provinces, followed by small bus (such as Petepete).



Source: JICA Study Team

Figure 7.2.4 Vehicle Composition by Province

(5) Traffic Volume at Major Port

Traffic volume at major ports is summarized in the following Table 7.2.9. Makassar Port shows a remarkably larger traffic than other ports. It is noted that the share of trucks is considerably lower in Parepare than in other ports.

Table 7.2.9 Traffic Volume at Major Port (Unit: Vehicle)

Name of Port	M/C	Car	Small Bus	M&L Bus	Pick up	Small Truck	Large Truck
Makassar Port	17,040	2,024	1,232	20	440	3,923	438
Pare-Pare Port	2,708	100	319	9	77	250	0
Pantoloan Port	2,377	119	293	25	70	329	90
Bitung Port	3,852	443	608	7	346	815	131

Note: These surveys were conducted from 6:00 to 23:00.
Source: JICA Study Team

(6) Average Trip Distance by Vehicle Type

Table 7.2.10 shows the average trip distance by vehicle type. The average travel distances of M/C, car and small bus are shorter than other vehicle types. It seems that these vehicles are used for citizen's daily life such as commuting. On the other hand, medium & large bus has significantly long trip distance, since they are used mainly as provincial bus serving intercity travel.

About freight transport, the average trip distance of large truck is longer than pickup and small truck. Note that trucks are mainly for medium-distance transport perhaps leaving long-distance freight transport for coastal shipping.

Table 7.2.10 Average Trip Distance by Vehicle Type

	Vehicle Type	Ave. Travel Distance (km)	Ave. Travel Speed (km/h)*	Ave. Travel Time (hour)	Total Travel Time (hour)	No. of Samples
Passenger Transport	M/C	17.7	18.3	0.97	26,578	27,467
	Car	25.6	17.7	1.45	7,023	4,850
	Small Bus	39.9	20.5	1.95	13,587	6,982
	M&L Bus	178.8	30.2	5.92	4,056	685
Freight Transport	Pick up	47.7	23.4	2.04	2,737	1,343
	Small Truck	62.3	24.7	2.52	5,553	2,201
	Large Truck	74.2	32.3	2.30	473	206

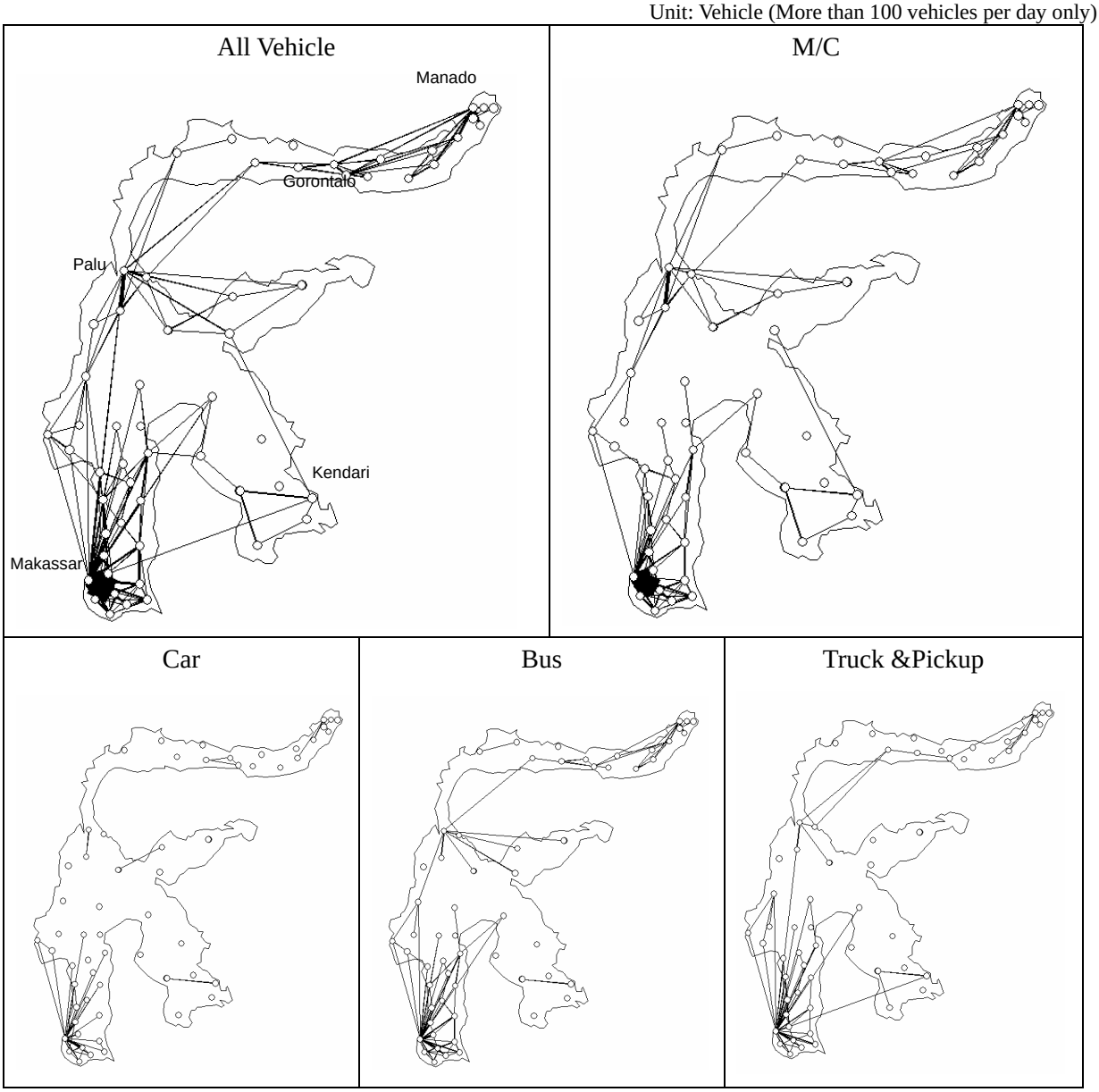
Note: * Average travel speed is estimated using the result of traffic assignment.
Source: JICA Study Team

7.2.3 Trip Distribution

(1) Trip Distribution in Sulawesi Island

The estimated trip distribution based on road traffic database is illustrated in Figure 7.2.5. Overall, most of trips concentrate to city areas such as Makassar, Manado, Palu, Gorongtalo and Kendari. Especially, the trip to/from Makassar City is outstanding. Long-distance interprovincial trips, e.g. from Makassar City to Manado City, are very few.

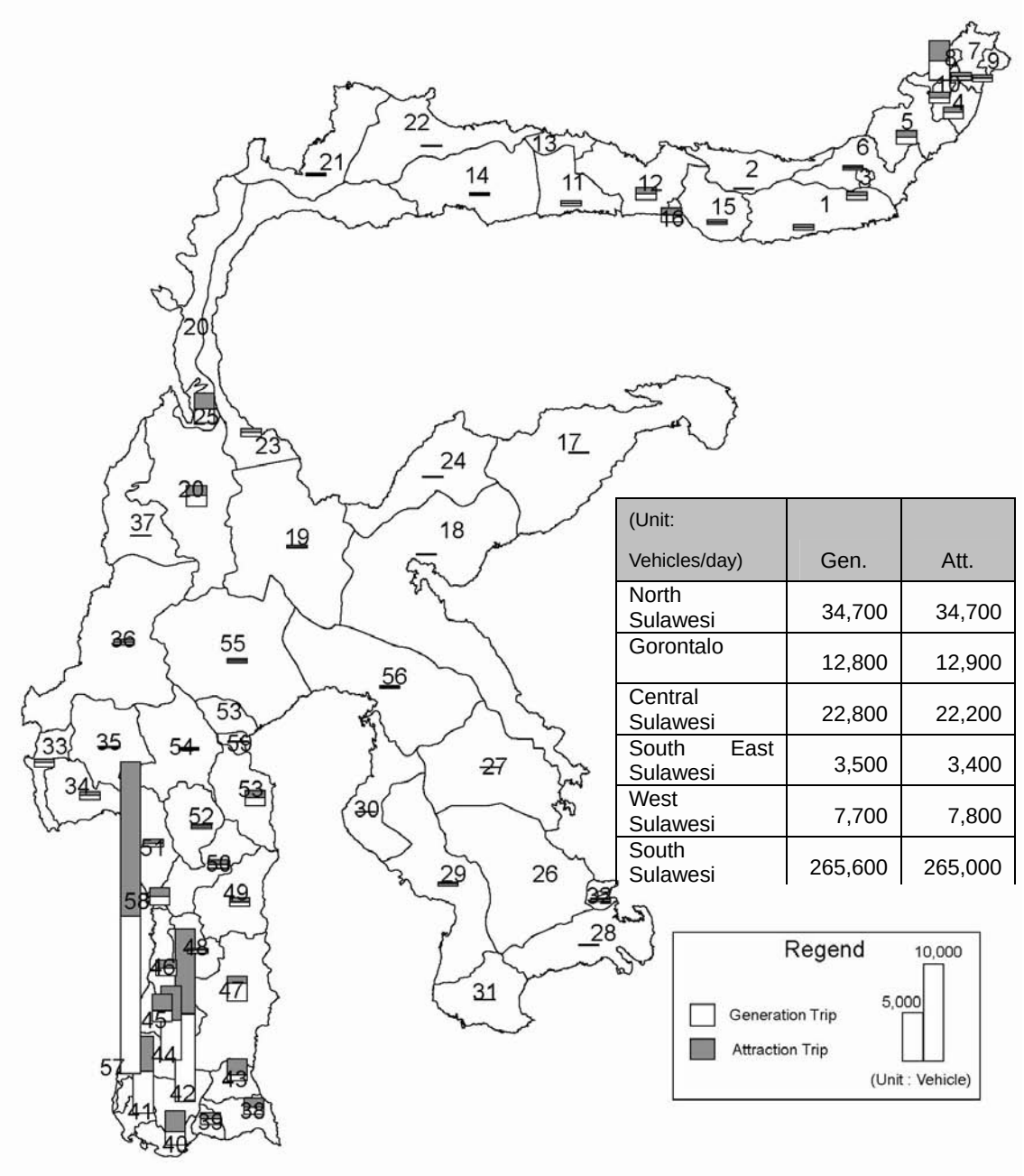
Unit: Vehicle (More than 100 vehicles per day only)



Source: JICA Study Team

Figure 7.2.5 Trip Distribution in Sulawesi Island

Estimated traffic generation/attraction is illustrated by zone in Figure 7.2.6. The result shows that Makassar City (No.57) is the highest. Kab. Gowa (No.42), which is adjacent to Makassar city is the second highest. In the provincial level, the traffic generation/attraction in South Sulawesi Province including Makassar City is the highest.



(Unit: Vehicles/day)	Gen.	Att.
North Sulawesi	34,700	34,700
Gorontalo	12,800	12,900
Central Sulawesi	22,800	22,200
South East Sulawesi	3,500	3,400
West Sulawesi	7,700	7,800
South Sulawesi	265,600	265,000

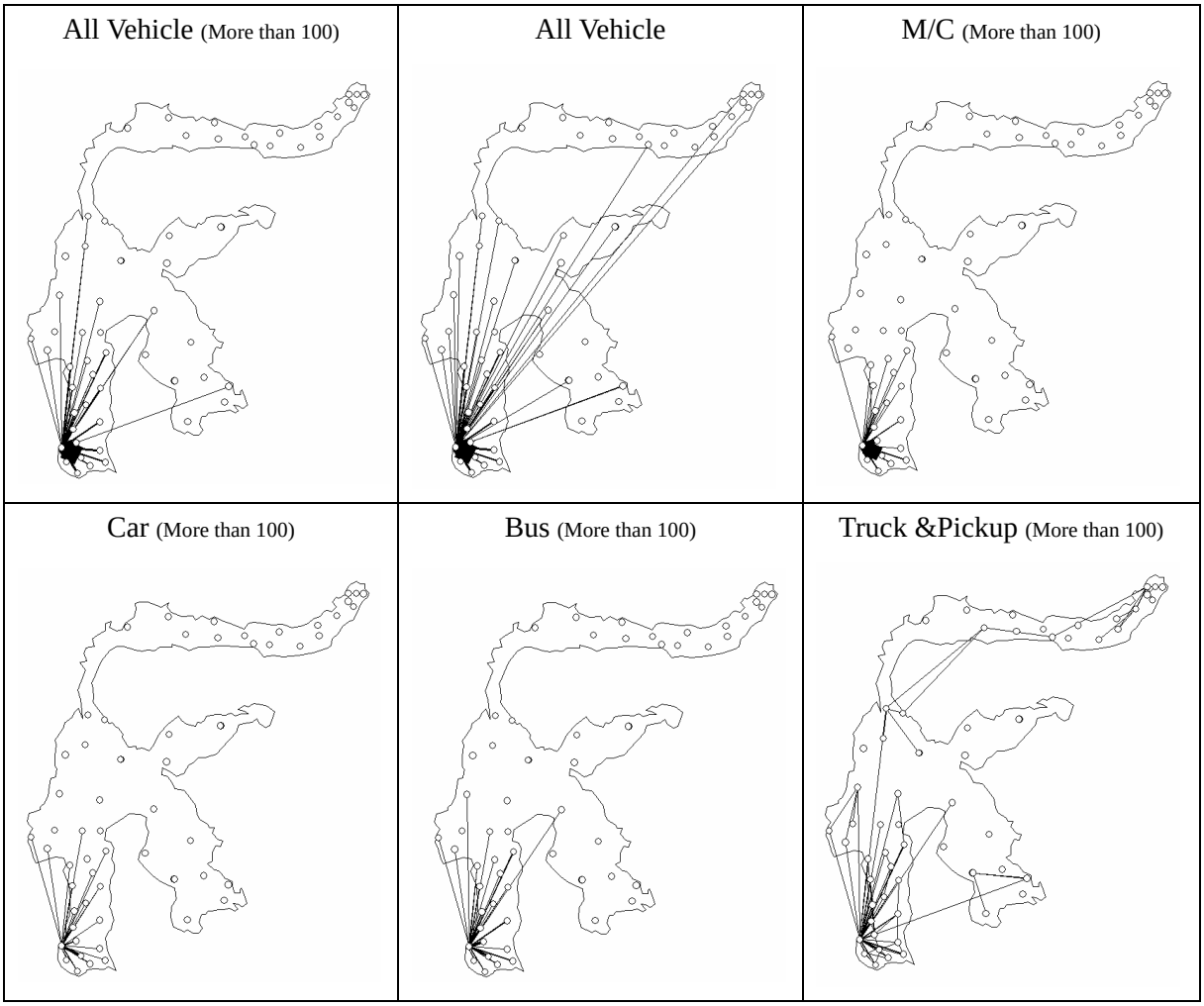
Source: JICA Study Team

Figure 7.2.6 Generation/Attraction Traffic Volumes by Kabupaten

(2) Trip Distribution to/from Makassar

Estimated trip distribution to/from Makassar City is shown in Figure 7.2.7. As a whole, most of trips to/from Makassar are concentrated in the nearby areas such as various Kabupatens of South Sulawesi Province and southern part of West Sulawesi Province.

Unit: Vehicles per day



Source: JICA Study Team

Figure 7.2.7 Trip Distribution to/from Makassar

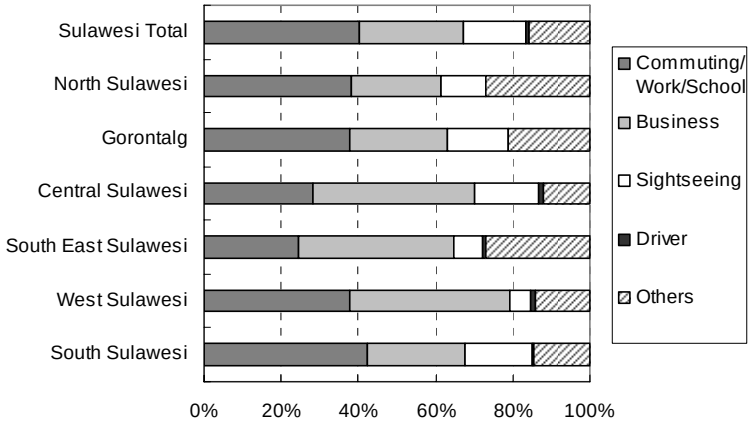
7.2.4 Passenger Travel Characteristics

(1) Trip Purpose

The following table and figure show the share of trip purpose by province in the study area. On the whole, commuting/work/school and business trips account for more than 60% of all trip purpose.

Table 7.2.11 Trip Purpose Composition by Province

	Commuting/ Work/School	Business	Sightseeing	Driver	Others
South Sulawesi	42.2%	25.6%	17.1%	0.8%	14.4%
West Sulawesi	37.6%	41.6%	5.3%	1.5%	13.9%
South East Sulawesi	24.6%	40.1%	7.4%	0.7%	27.1%
Central Sulawesi	28.1%	42.2%	16.5%	1.2%	12.0%
Gorontalg	37.9%	25.0%	15.7%	0.0%	21.3%
North Sulawesi	38.2%	23.3%	11.5%	0.1%	26.9%
Sulawesi Total	40.4%	26.8%	16.1%	0.7%	15.9%



Source: JICA Study Team

Figure 7.2.8 Trip Purpose Composition by Province

(2) Passenger Occupancy

The passenger occupancy by vehicle type is presented in theTable 7.2.12. Overall, there are not significant difference between Makassar City and its outside. However, the occupancy is generally higher inside Makassar City than in the rest of Sulawesi.

Table 7.2.12 Passenger Occupancy by Vehicle Type

	M/C	Private Car	Small Bus	M & L Bus	Pick Up	Small Truck (2 axis)	Large Truck (3 axis more)
Inside of Makassar City	1.35	2.36	6.85	21.10	1.99	2.08	2.22
Outside of Makassar City	1.41	2.81	6.55	21.77	2.12	2.34	2.53
Sulawesi Island Total	1.38	2.51	6.69	21.61	2.06	2.21	2.44

Source: JICA Study Team

7.2.5 Freight Transport Characteristics

(1) Average Freight Tonnage

Table 7.2.13 shows the average freight tonnage by vehicle type.

Table 7.2.13 Average Freight Tonnage by Vehicle Type

	Pick Up	Small Truck (2 axis)	Large Truck (3 axis more)
Inside of Makassar City	1.03	3.63	5.62
Outside of Makassar City	0.87	3.70	4.73
Sulawesi Island Total	0.94	3.67	4.90

(2) Major Commodity

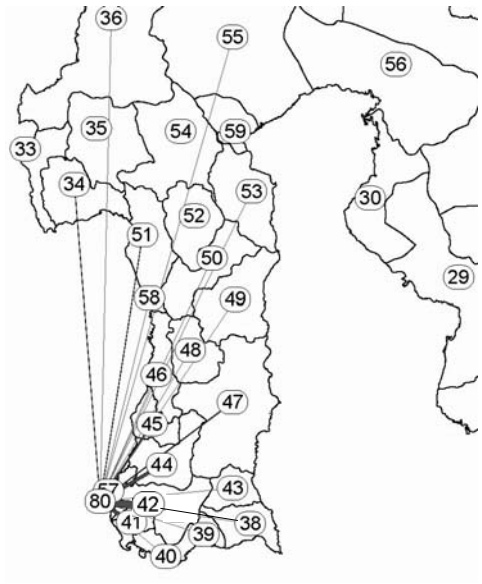
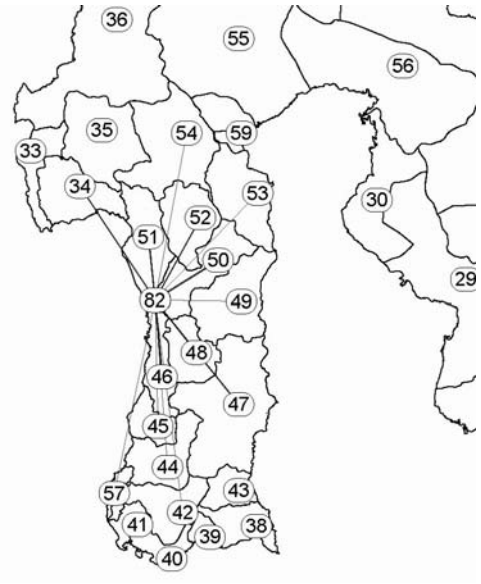
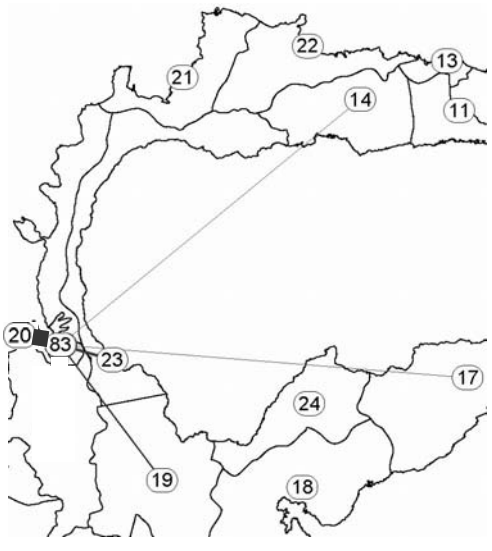
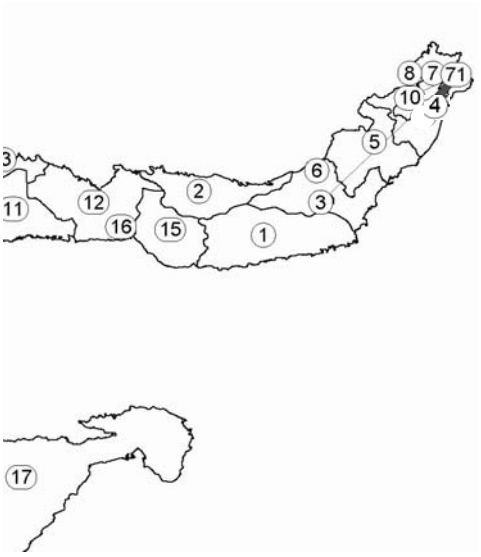
Table 7.2.14 shows major commodities carried by trucks at the survey stations. The commodity was classified into ten(10) types: agriculture, plantation product, forest product, fishery product, mineral, metal & machine, chemical industry/electronics, construction material and others. The types of commodity carried are different between inside Makassar City and outside Makassar City. Inside Makassar City, the percentage of agriculture and construction are higher than other commodities. On the other hand, outside Makassar City, the percentage of plantation product and industry/electronics are high.

Table 7.2.14 Major Commodity of Freight Transport

	Inside of Makassar City	Outside of Makassar City	Sulawesi Island Total
Agriculture	18.4%	15.8%	16.4%
Plantation Product	8.6%	19.4%	17.0%
Forest	1.2%	5.6%	4.6%
Fishery	9.2%	5.0%	5.9%
Mineral	3.2%	1.6%	1.9%
Metal & Machine	0.2%	0.5%	0.4%
Chemical	0.0%	1.6%	1.3%
Industry / Electronics	11.1%	16.2%	15.1%
Construction	16.5%	9.0%	10.6%
Others	31.5%	25.5%	26.8%

(3) Port Related Traffic

Estimated trip distribution to/from the four (4) major ports is presented in Figure 7.2.9. Overall, most trips are distributed to/from neighboring Kabupatens. The territory of Makassar Port is extensive compared with other ports.

Makassar Port (No.80)	Parepare Port (No.82)
Daily Traffic Volume: 25,100	Daily Traffic Volume: 3,500
	
Patoloan Port (No.83)	**Bitung (No.71)**
Daily Traffic Volume: 3,300	Daily Traffic Volume: 6,200
	

Source: JICA Study Team

Figure 7.2.9 Trip Distribution of Port OD

7.3 Traffic Assignment for Present network

7.3.1 Zoning and Road Network

(1) Zoning

The zoning for traffic analysis and demand forecast in Sulawesi Island is presented in Figure 7.3.1 and Table 7.3.1. In addition to these zones (Kabupaten 1-59), ports and airports were identified as strategic zones important for planning the linkage with air and maritime transport as shown in Figure 7.3.2 and Table 7.3.2.

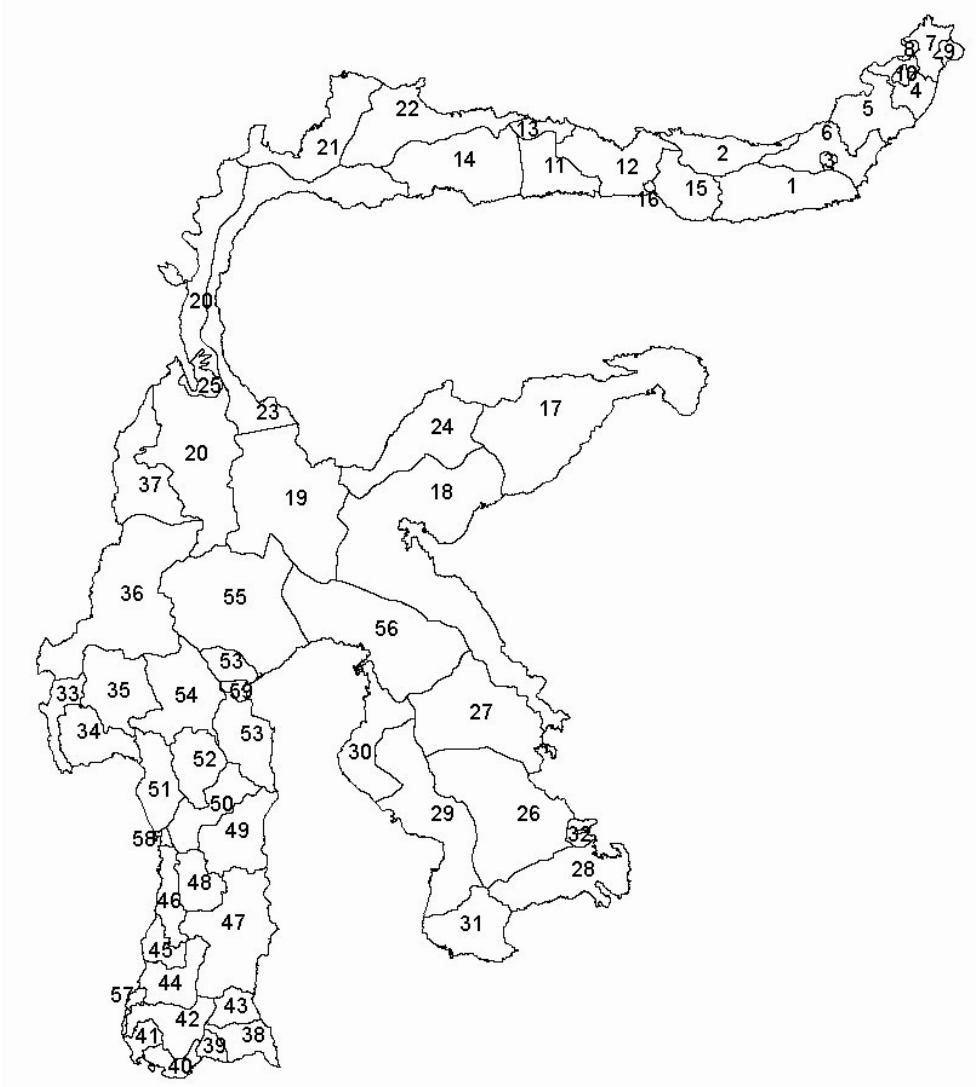


Figure 7.3.1 Zoning Map in Sulawesi Island (Kabupaten 1 - 59)

Table 7.3.1 Zoning Table in Sulawesi Island

No.	Province	Kabupaten	No.	Province	Kabupaten
1	North Sulawesi	Bolaang Mongondow	33	West Sulawesi	Majene
2		Bolaang Mongondow Utara	34		Polewali Mamasa
3		Kota Kotamobagu	35		Mamasa
4		Minahasa	36		Mamuju
5		Minahasa Selatan	37		Mamuju Utara
6		Minahasa Tenggara	38	South Sulawesi	Bulukumba
7		Minahasa Utara	39		Bantaeng
8		Kota Manado	40		Jeneponto
9		Kota Bitung	41		Takalar
10		Kota Tomohon	42		Gowa
11	Gorontalo	Boalemo	43		Sinjai
12		Gorontalo	44		Maros
13		Gorontalo Utara	45		Pangkajene Kepulauan
14		Pohuwato	46		Barru
15		Bone Bolango	47		Bone
16		Kota Gorontalo	48		Soppeng
17	Central Sulawesi	Banggai	49		Wajo
18		Morowali	50		Sidenreng Rappang
19		Poso	51		Pinrang
20		Donggala	52		Enrekang
21		Toli-Toli	53		Luwu
22		Buol	54		Tana Toraja
23		Parigi Moutong	55		Luwu Utara
24		Tojo Una-Una	56		Luwu Timur
25		Kota Palu	57		Kota Makassar
26	South East Sulawesi	Konawe	58		Kota Pare-Pare
27		Konawe Utara	59		Kota Palopo
28		Konawe Selatan			
29		Kolaka			
30		Kolaka Utara			
31		Bombana			
32		Kota Kendari			

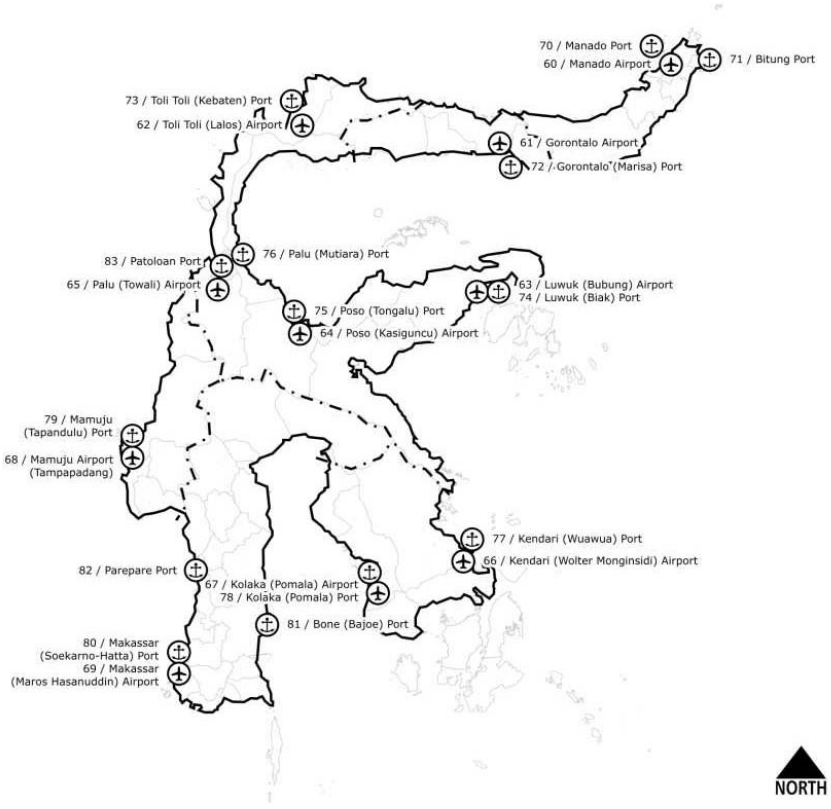


Figure 7.3.2 Zoning Map in Sulawesi Island (Port & Airport 60 - 83)

Table 7.3.2 Zoning Table of Airport/Port in Sulawesi Island

No.	Province	Airport/ Port	No.	Province	Airport/ Port
60	North Sulawesi	Manado Airport	72	Gorontalo	Marisa Port
61	Gorontalo	Gorontalo Airport	73	Central Sulawesi	Kebaten Port
62	Central Sulawesi	Lalos Airport	74		Biak Port
63		Bubung Airport	75		Tongalu Port
64		Kasiguncu Airport	76		Mutiara Port
65		Towali Airport	77	South East Sulawesi	Wuawua Port
66	South East Sulawesi	Wolter Monginsidi Airport	78		Pomala Port
67		Pomala Airport	79	West Sulawesi	Tapandulu Port
68	West Sulawesi	Tampapadang Airport	80	South Sulawesi	Soekarno-Hatta Port
69	South Sulawesi	Maros Hasanuddin Airport	81		Bajoe Port
70	North Sulawesi	Manado Port	82		Parepare Port
71	North Sulawesi	Bitung Port	83	Central Sulawesi	Patoloan Port

(2) Road Network

1) Road Network in Sulawesi Island

The existing road network in Sulawesi Island is illustrated in Figure 7.3.3. For details, see Chapter 3.2.

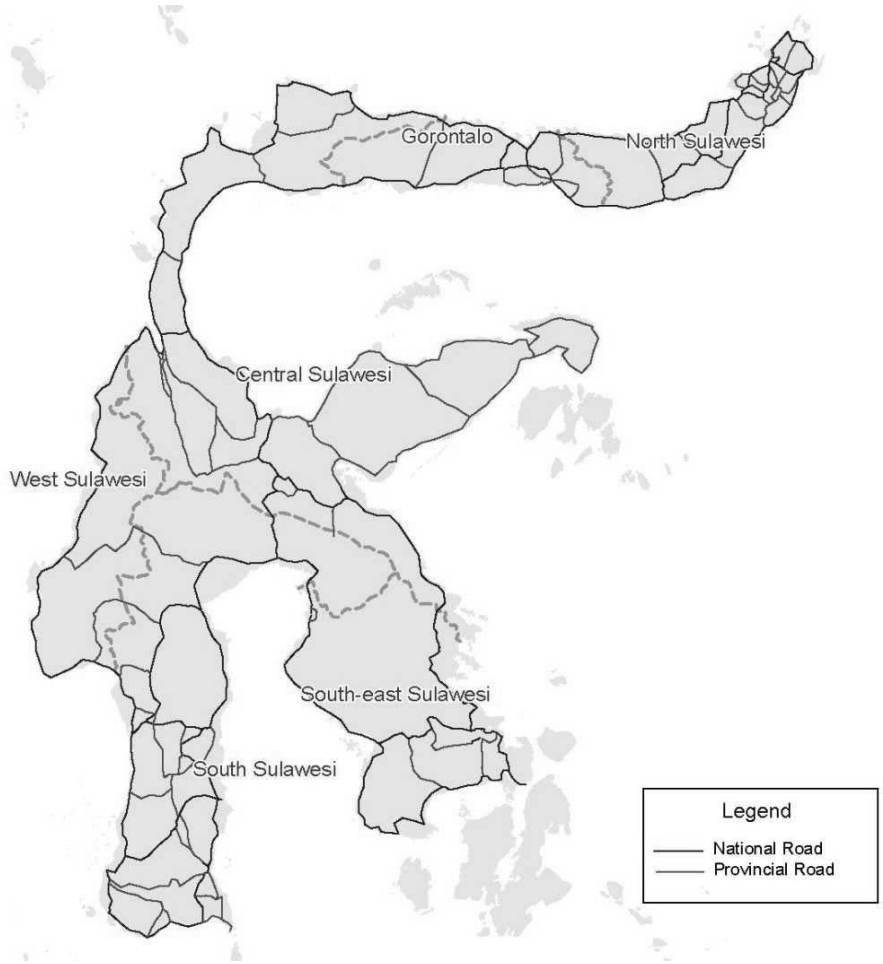


Figure 7.3.3 Road Network in Sulawesi Island (Administrative Classification)

(2) Compiled Information by Link

The detailed link attributes compiled in this study is shown in Table 7.3.3.

Table 7.3.3 Link Attributes Compiled in STRADA

STRADA	IRMS	Conversion
Distance	PANJANG	Length on GIS Map (km)
Vmax (km/h)	SPEED	10-20 => 20 20-40 => 40 40-60 => 60 NoData/Blank If User2 =< 2 => 20 Others => 15 Additional New Link (default) => 20
Capacity (PCUs/Day)		IF LEBAR_ >= 10.5 => 39,000 7.0-8.0 => 20,000 6.0-6.25 => 8,000 5.0-5.25 => 5,000 <=4.5 => 3,000 Additional New Link (default) => 3,000
Delay Function No.		IF LEBAR_ >= 10.5 => 5 7.0-8.0 => 4 6.0-6.25 => 3 5.0-5.25 => 2 <=4.5 => 1 Additional New Link (default) => 1
Fare		(not used)
Dir		(not used)
RoadType		= 0 (non toll road)
Evaluation		= 0 (normal link) = 1 (centroid connection)
Display	STATUS	N (National Road) = 1 P(Provincial Road) = 2 K (Road) = 3 S/No Data/Blank = 4 Additional New Link = 4 Centroid connection = 9
User1		=STATUS Centroid connection = 9
User2	KONDISI	Baik => 1 Sedang => 2 Rusak Ringan => 3 Rusak Berat => 4 No Data/Others => 5 Additional New Link (default) => 5 Centroid connection => 9
User3	SUM_SURF	Surface Condition (1-11 and unknown 0) = Pavement
User4		1. North Sulawesi 2. Gorontalo 3. Central Sulawesi 4. South East Sulawesi 5. West Sulawesi 6. South Sulawesi
User5	LEBAR	Road width (m)
Color	FUNGSI	A (Arterial) => 4 (red) K1 (Collector 1) => 5 (purple) K2 (Collector 2) => 2 (green) K3 (Collector 3) => 3 (yellow) K4/No Data/Others => 0 (black) Additional New Link (default) => 0 (black) Dummy Link for Centroid => 1 (Blue)

(3) Setting of PCU

The PCU (Passenger Car Unit) for traffic assignment is shown in Table 7.3.4. These values were set based on experience in Indonesia and neighboring countries.

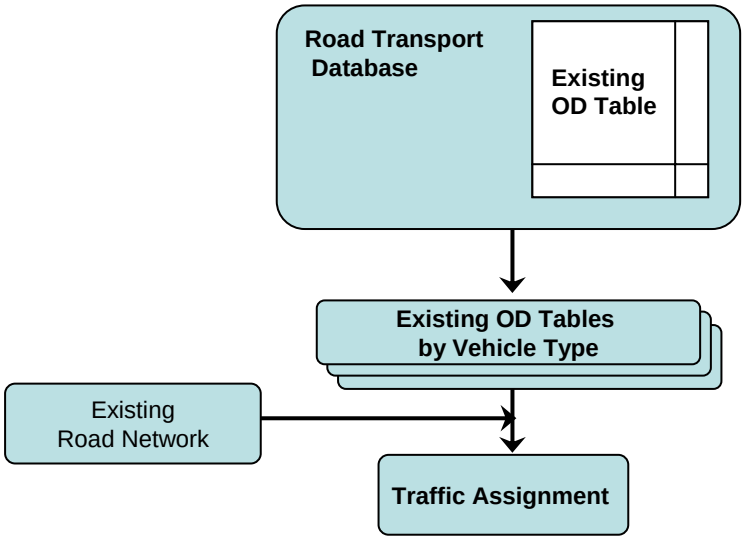
Table 7.3.4 PCU by Vehicle Type for Traffic Assignment

Vehicle Type	Motorcycle	Private Car	Small Bus	Medium & Large Bus	Pickup	Small Truck	Large Truck
PCU	0.25	1.00	2.00	2.50	1.00	2.00	2.50

7.3.2 Traffic Assignment for 2007

(1) Methodology

The methodology of traffic assignment is shown in Figure 7.3.4. The present OD tables by vehicle type were estimated based on the road traffic database. After that, the OD tables have been loaded onto the road network using STRADA.

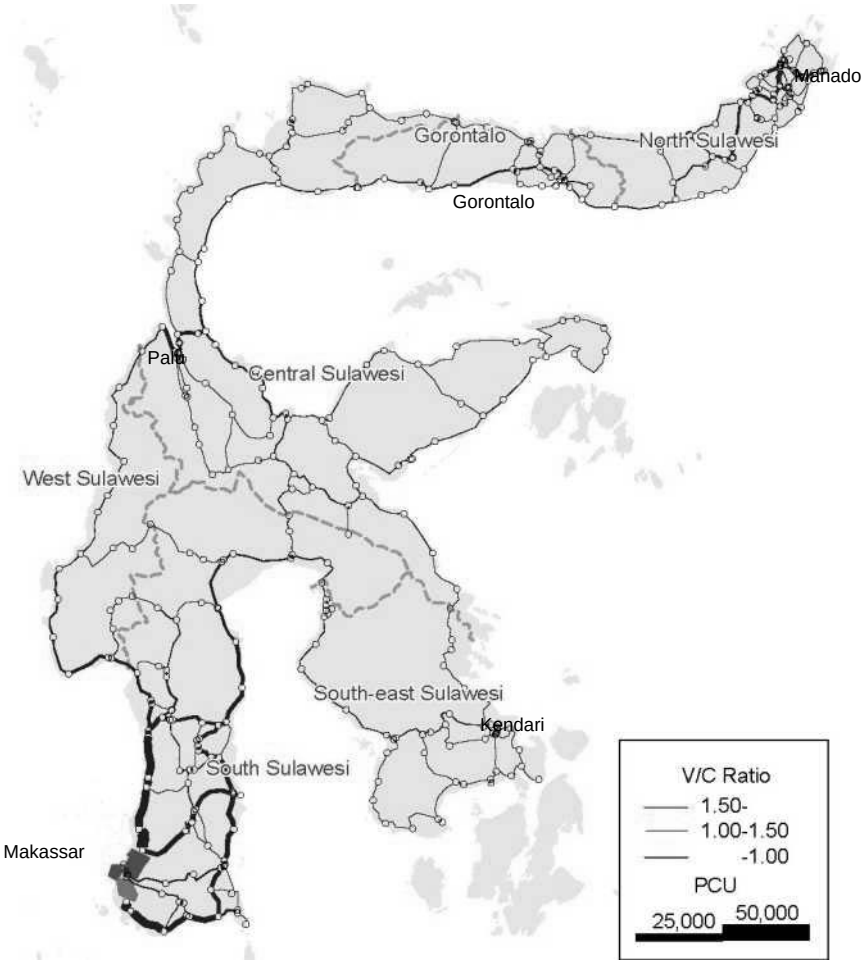


Source: JICA Study Team

Figure 7.3.4 Methodology of Traffic Assignment

(2) Result of Traffic Assignment for 2007 (Calibration)

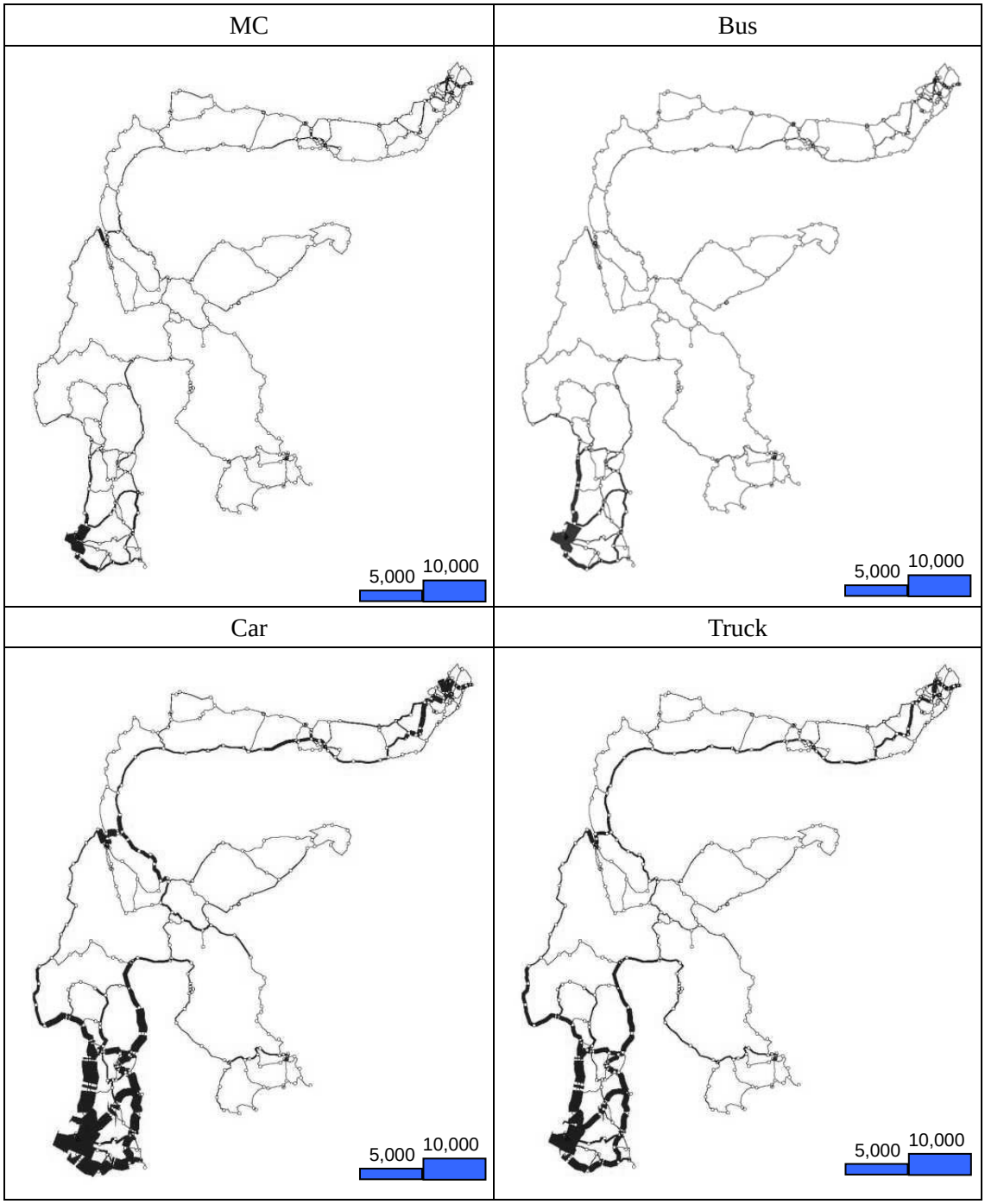
The result of traffic assignment is illustrated in Figure 7.3.5 through 7.3.8. Large traffic volume is seen only in and around Kota areas particularly Makassar. Traffic volume reaches road capacity only around Makassar (needs examination separately).



Source: JICA Study Team

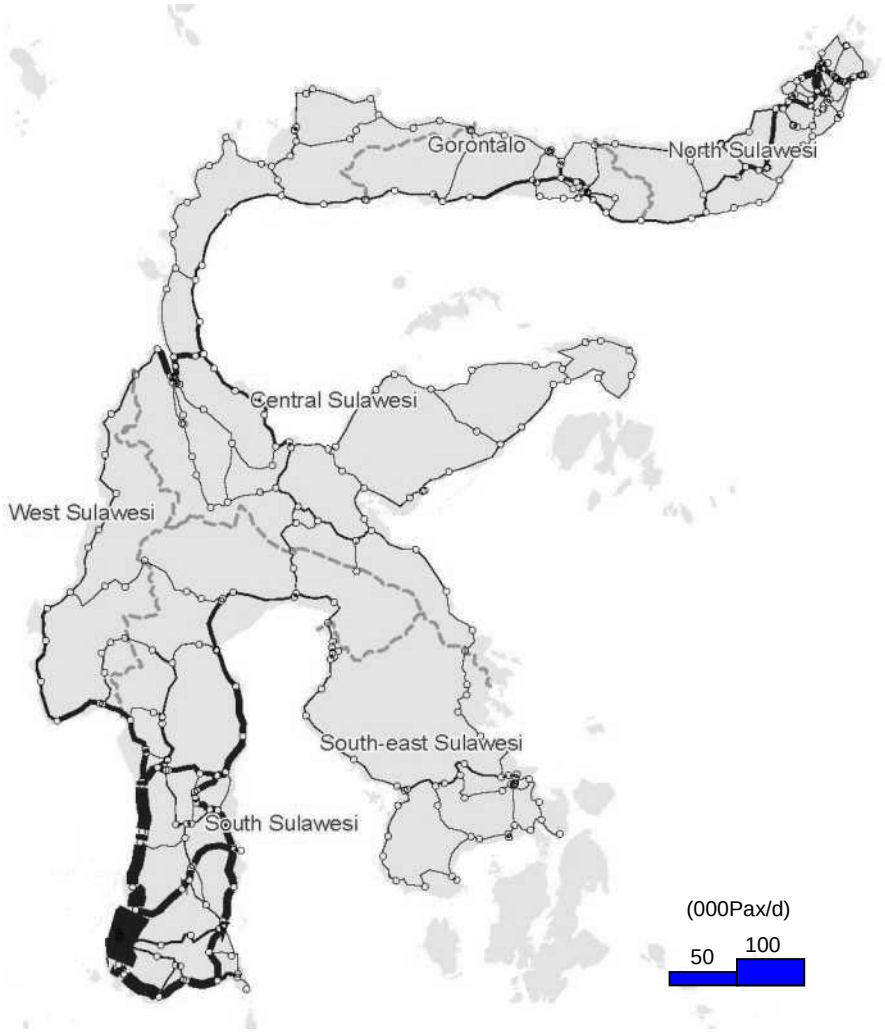
Figure 7.3.5 Result of Traffic Assignment in 2007 (All Vehicles)

Unit: PCU/day



Source: JICA Study Team

Figure 7.3.6 Result of Traffic Assignment by Vehicle Type in 2007



Source: JICA Study Team

Figure 7.3.7 Result of Traffic Assignment in 2007 (Passenger)

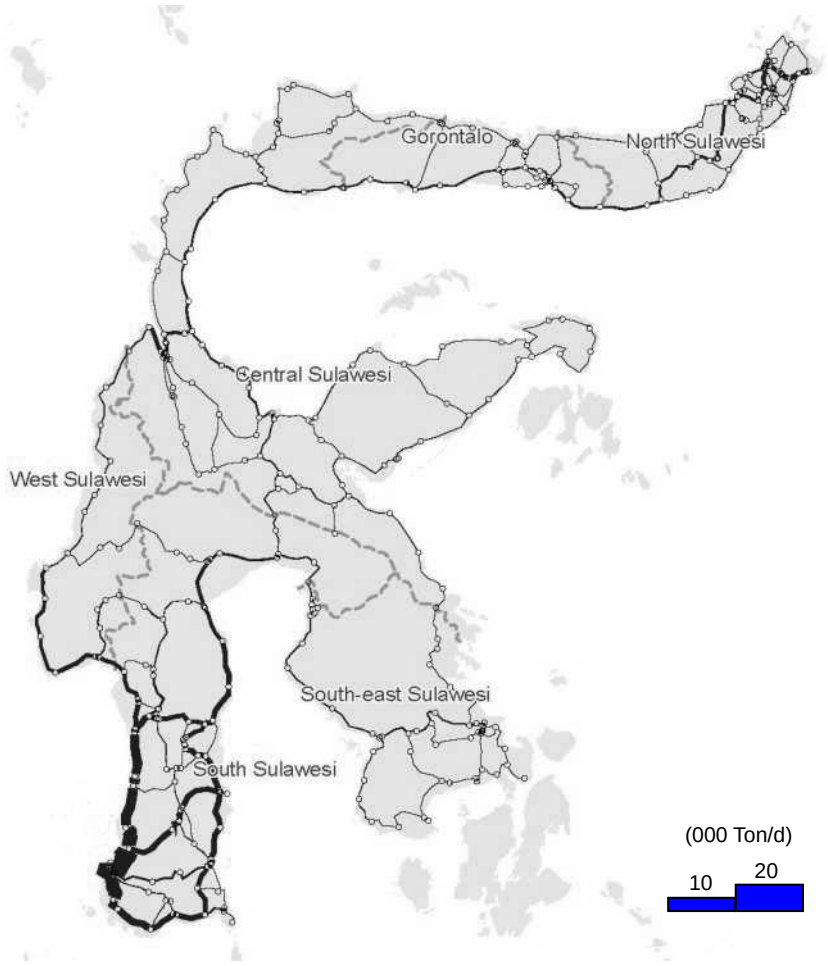


Figure 7.3.8 Result of Traffic Assignment in 2007 (Freight Tonnage)

(3) Suitability of Traffic Assignment

The result of traffic count surveys was compared with the traffic assignment results as shown in Figure 7.3.9 in order to justify the created database as well as the assignment methodology. Although the correlation is fairly good, assigned volume tends to be a little larger than the actual traffic. This may be attributed to the intra-zonal traffic (counted, but not assigned as intrazonal trips).

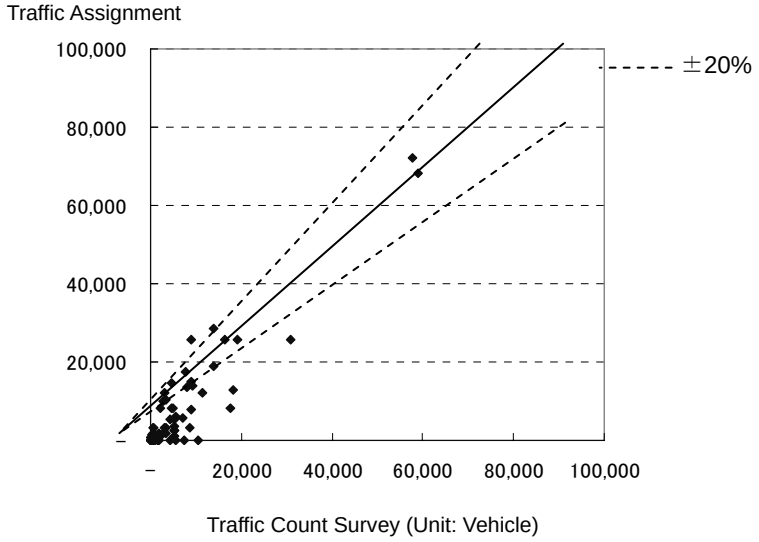


Figure 7.3.9 Comparison Traffic Count Survey and Traffic Assignment

7.4 Analysis on Current Traffic Situation

7.4.1 Intermodal Relations among Road, Maritime and Air Transport

It is a difficult task to analyze the intermodal relations and to extract meaningful results regarding the transportation in and around Sulawesi. Firstly, air and maritime traffic in Sulawesi includes a significant percentage of inter-island and international movement. Therefore the overall modal choice by Sulawesi residents is hardly grasped in the limited availability of data and information. Secondly, large-scale surveys could not be afforded in this study due to time and budgetary constraints. Using the best available data, however, some analysis was conducted as explained below:

(1) Passenger Transport

Table 7.4.1 presents the intermodal relation of passenger transport between Makassar and other provincial capital cities. Since the origin-destination data of maritime passengers is not available, this table compares the modal shares among air, provincial bus and other road traffic.

- For long-distance travel such as Makassar-Manado and Makassar- Gorontalo, air shares about 2/3 of the total traffic demand of passengers.
- In contrast, the share of air traffic decreases to below 1/4 for medium-distance travel.
- Provincial bus shoulders a certain role in inter-provincial travel with a share of 3-15%. As the travel distance becomes longer, the share tends to diminish.
- Other road traffic, mostly of private cars, becomes predominant in medium- to short-distance travel with a share of 2/3 or more.

However, the air fare listed in the table is "normal". Considering the recent tendency of lowering air fare level such as "promo" and newly appearing LCCs (Low-Cost Carrier), air transport will become more and more popular in the near future. This tendency will further be strengthened if people's income level is pulled up by economic development.

Table 7.4.1 Intermodal Relation of Passenger Transport to/from Makassar

Makassar	Distance (km)		Air 2005			Provincial Bus 2006			Road 2007		Total	
to/from:	Road	Crow-fly	pass./day	%	fare (Rp.)	pass./day	%	fare (Rp.)	pass./day	%	pass./day	%
Manado	1,800	949	245	66	769,000	12	3	250,000	116	31	373	100
Gorontalo	1,454	746	85	66	739,000	13	10	200,000	31	24	129	100
Palu	837	468	189	23	639,000	71	8	175,000	576	69	836	100
Kendari	1,057	361	208	22	509,000	108	12	160,000	620	66	936	100
Mamuju	444	276	17	1	222,300	428	15	78,854	2,458	85	2903	100

Note 1) Maritime passenger OD data is not available.
2) Provincial bus between Makassar and Kendari uses ferry for Bajoe-Kolaka section.
Source: Air - JICA Study Team based on AP1 & AP2 information.
Provincial bus: JICA Study Team based on the data from Terminal Regional Daya.
Road: Traffic surveys conducted in this study.

(2) Cargo Transport

Table 7.4.2 summarizes the intermodal relation of cargo traffic for the same route as Table 7.4.1. Air transport was not considered in this table due to the negligibly small quantity of air cargoes.

- Maritime transport plays a dominant role in Makassar-Manado, Makassar-Gorontalo and Makassar-Kendari. This may be attributed to the transport distance and road condition.
- In Makassar-Palu and Makassar-Mamuju, most of the inter-provincial cargo is carried by road transport (trucks). In the case of Mamuju, cargo handling facilities at port may be insufficient.

Although the intermodal relation cannot be clearly determined in this limited analysis, maritime transport seems to be dominant when road distance becomes longer than 1,000 km.

Table 7.4.2 Intermodal Relation of Cargo Transport to/from Makassar

Makassar	Distance (km)		Maritime 2006		Road 2007		Total	
to/from:	Road	Crow-fly	ton/day	%	ton/day	%	ton/day	%
Manado	1,800	949	137	66	70	33	207	100
Gorontalo	1,454	746	151	100	0	0	151	100
Palu	837	468	68	17	312	82	380	100
Kendari	1,057	361	1,260	76	385	23	1645	100
Mamuju	444	276	0	0	465	100	465	100

Note: Air cargo volume is negligibly small.
Source: Maritime - JICA Study Team based on PELINDO data.
Road: Traffic surveys conducted in this study.

(3) Role of Ferry

Based on the interview survey on ferry, the role of existing ferry was analyzed.

Bajoe-Kolaka

The following table shows the modal share of inter-provincial transport between Sulawesi Selatan and Sulawesi Tenggara. The modal share of the ferry (Bajoe – Kolaka) is approximately 12.4%, being one of the main transport modes between Sulawesi Selatan and Sulawesi Tenggara. Especially, more than half of private car uses the ferry service from Bajoe Port to Kolaka Port.

Table 7.4.3 Modal Share of Inter-Provincial Transport

Sulawesi Selatan ⇔ Sulawesi Tenggara		
Total Traffic Volume		767 (PCUs/day)
Traffic Volume by Ferry (Bajoe – Kolaka)		96 (PCUs/day)
Modal Share of Ferry	All	12.4%
	M/C	8.5%
	Car	57.1%
	Mini-Bus	5.0%
	Bus	11.0%
	Pickup	20.9%
	Small Truck	15.9%
	Large Truck	0%

Note: Total traffic volume is that of the present OD table.
Source: JICA Study Team

The distribution of inter-provincial trips of both road user and ferry user are shown in the following figure. The OD pairs of ferry user are not only Bajoe (No.47) and Kolaka (No.29) which have the port but also Makassar (No.57) and Kendari (No.32).

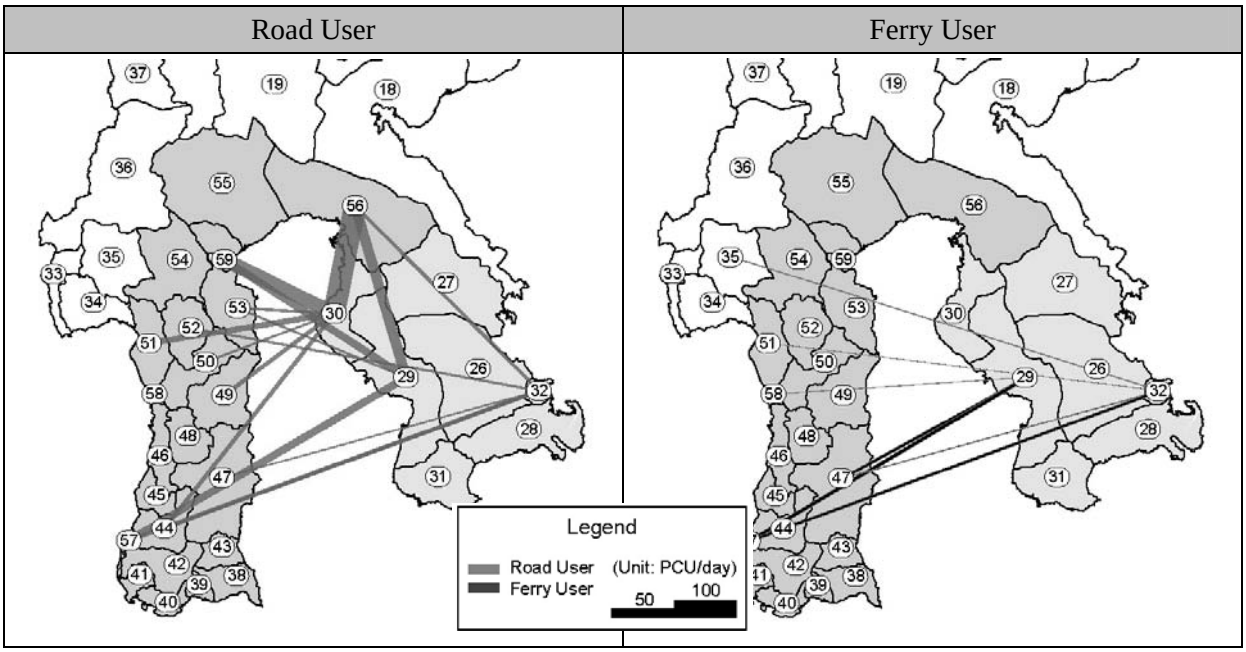


Figure 7.4.1 Distribution of Inter-provincial Trips by Road and by Ferry betweenSulawesi Selatan and Sulawesi Tenggara

Table 7.4.4 shows the modal share between Makassar and Kendari. The majority of this OD pair uses the ferry service between Bajoe Port and Kolaka Port. In particular, the ferry's share is significantly high for car compared with other vehicle types.

Table 7.4.4 Modal Shares between Makassar (Zone No.57) and Kendari (Zone No.32)

No.	Vehicle Type	Ferry User (PCU/day)	Road User (PCU/day)	Modal Share of Ferry
1	Motorcycle	-	-	-
2	Car	8	2	80.0%
3	Mini Bus	0	2	0.0%
4	Bus	3	4	42.9%
5	Pickup	2	2	50.0%
6	Small Truck	12	8	60.0%
7	Large Truck	-	-	-

Source: Study Team

The conclusion of this analysis can be summarized as follows:

- The use of ferry is not so far significant between remote zones unless travel distance can be remarkably shortened by ferry to about 1/2 to1/3. This is presumably due to the ferry tariff amounting to Rp.115,000 for motorcycle, Rp.832,000 for car, Rp.2,560,000 for bus and Rp.1,925,000-3,466,000 for truck. This is costly, being equivalent to the vehicle operating cost for 400 to 1,000 km.
- However, the role of ferry becomes significant between larger cities such as Makassar – Kendari, and particularly for car that is considered to have more cost-shouldering power than other vehicles.

Pagimana-Gorontalo

The Pagimana-Gorontalo ferry plays a significant role in linking Central Sulawesi Province with Gorontalo and North Sulawesi Province. However its traffic volume is small at only 32PCUs per day (as of October 2007), and the connection of Central Sulawesi Province is stronger with North Sulawesi Province rather than Gorontalo Province. Figure 7.4.2 shows this trip distribution.

Table 7.4.5 Modal Share of Inter-Provincial Transport

		Gorontalo ⇔ Central Sulawesi	North Sulawesi ⇔ Central Sulawesi
Traffic Volume		984 (PCU/day)	156 (PCU/day)
Traffic Volume by Ferry (Pagimana - Gorontalo)		14 (PCU/day)	18 (PCU/day)
Modal Share of Ferry	All	1.4%	11.5%
	M/C	2.0%	5.9%
	Car	0.0%	33.3%
	Mini-Bus	2.5%	2.7%
	Bus	0.0%	0.0%
	Pickup	0.8%	0.0%
	Small Truck	0.9%	29.6%
	Large Truck	2.0%	5.9%

Note: Total traffic volume is that of the present OD table.
Source: JICA Study Team

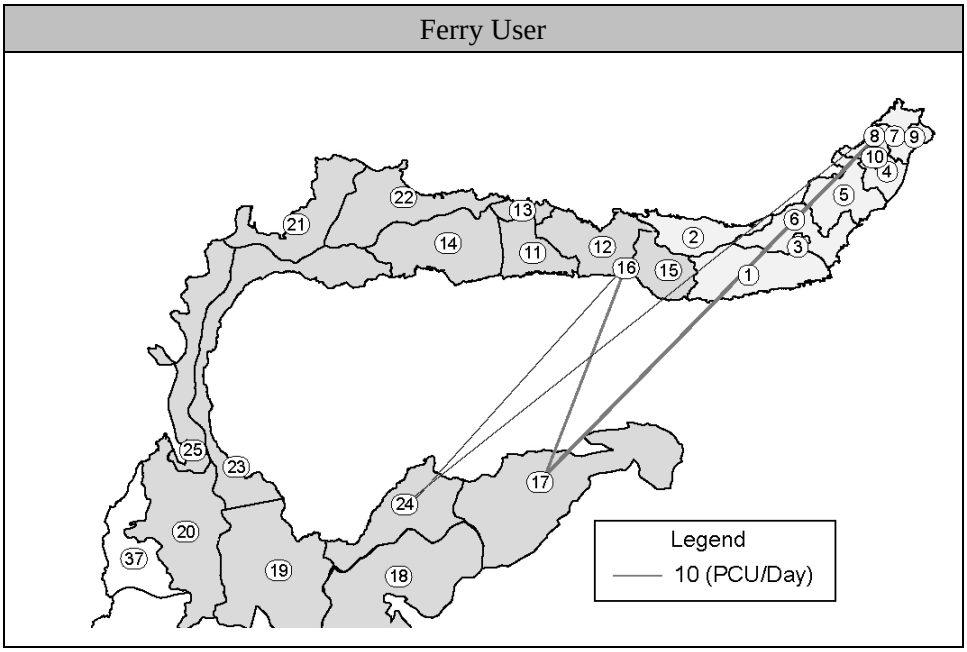


Figure 7.4.2 Distribution of Inter-Provincial Ferry Trips (North Sulawesi and Gorontalo, with Central Sulawesi)

7.4.2 Cargo Traffic by Land Transport in Sulawesi

(1) Demand and Supply of Goods in Sulawesi

The demand and supply situation of goods by each province composing Sulawesi is compiled and analyzed. One product of which production or supply surpasses its consumption in the province is assumed to be transported to the other province where subject product is in short to meet with the demand of such province. Based on such analysis a probable movement of cargo by land transport in Sulawesi by commodity and by direction is estimated as illustrated in **Figure 7.4.3.**

The total volume of freight by land transport in Sulawesi in 2006 is estimated at 14.4 million tons of which around 3.1 million tons was fuel transport.

Figure 7.4.4 illustrates the volume of cargo movement in Sulawesi in total in year 2005.

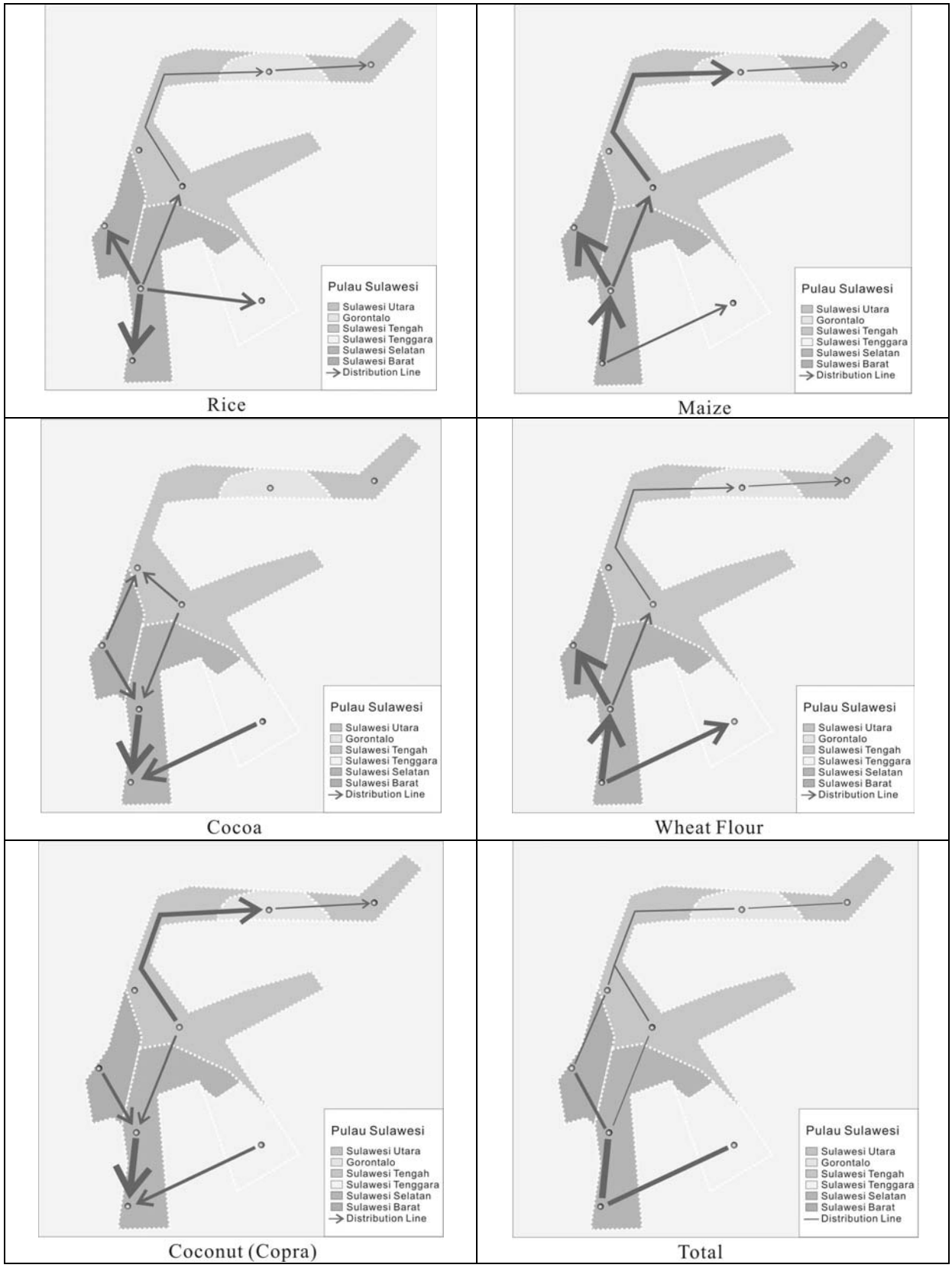
(2) Estimated Average Number of Trip of Cargo Truck per Day

Based on the estimation of demand and supply condition of agriculture products and fuel by province and by commodity as discussed in the preceding section, the total number of trips by cargo trucks in year 2006 is estimated as shown in **Table 7.4.5**. **Figure 7.4.5** illustrates the distribution of number of trips by cargo truck in 2006.

Table 7.4.6 Estimation of Number of Trucks per Day by Province, 2006

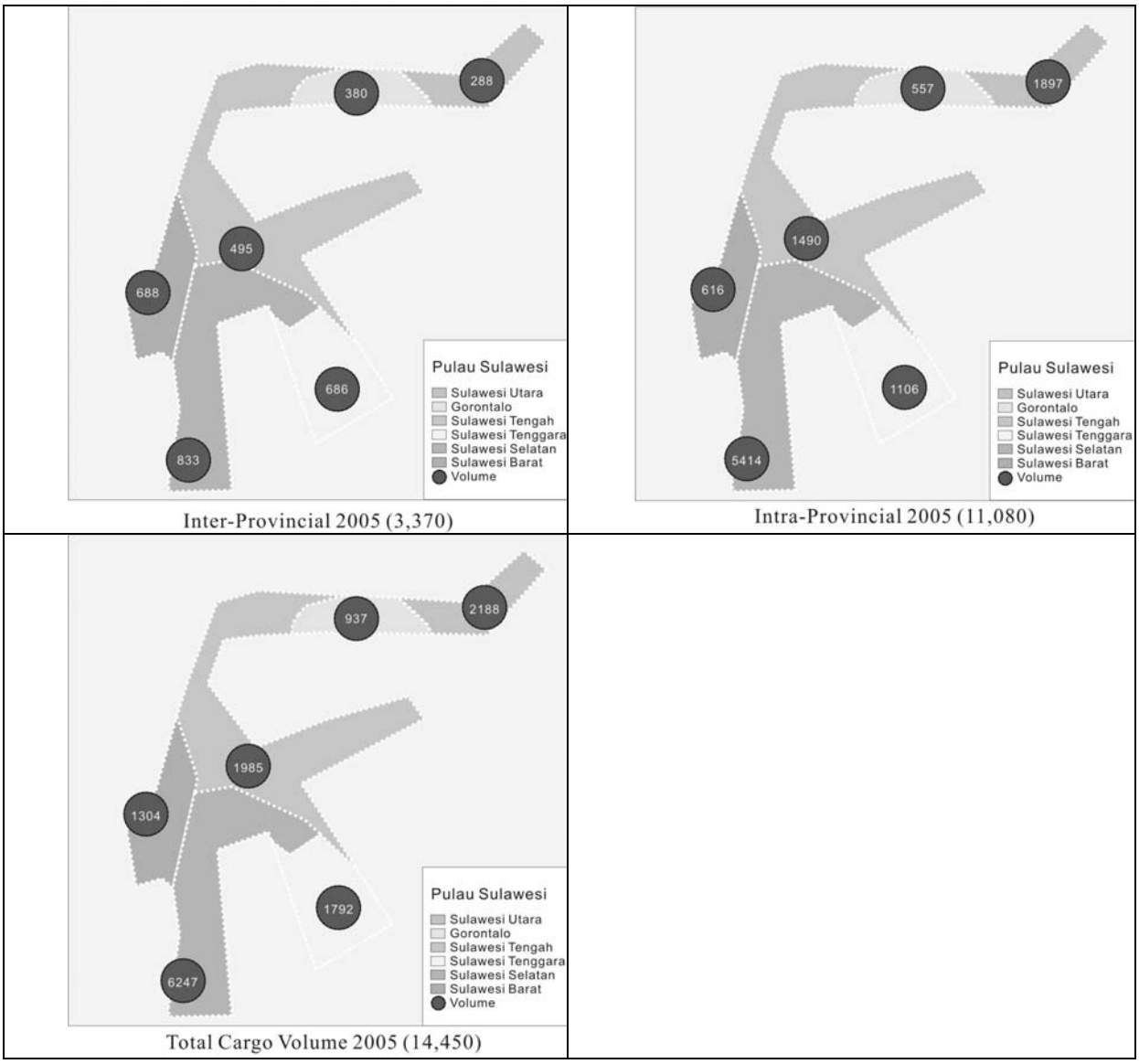
Average Daily Trip	Sulawesi South	Sulawesi West	Sulawesi Southeast	Sulawesi Central	Gorontalo	Sulawesi North
Total Movement in 2006	7,758	2,184	2,716	2,718	1,442	2,771

Note:
1) Assumed the cargo is transported by 5-tons truck with a loading ratio 0.5.
2) Intra-provincial cargo movement is included.
Source: JICA Study Team



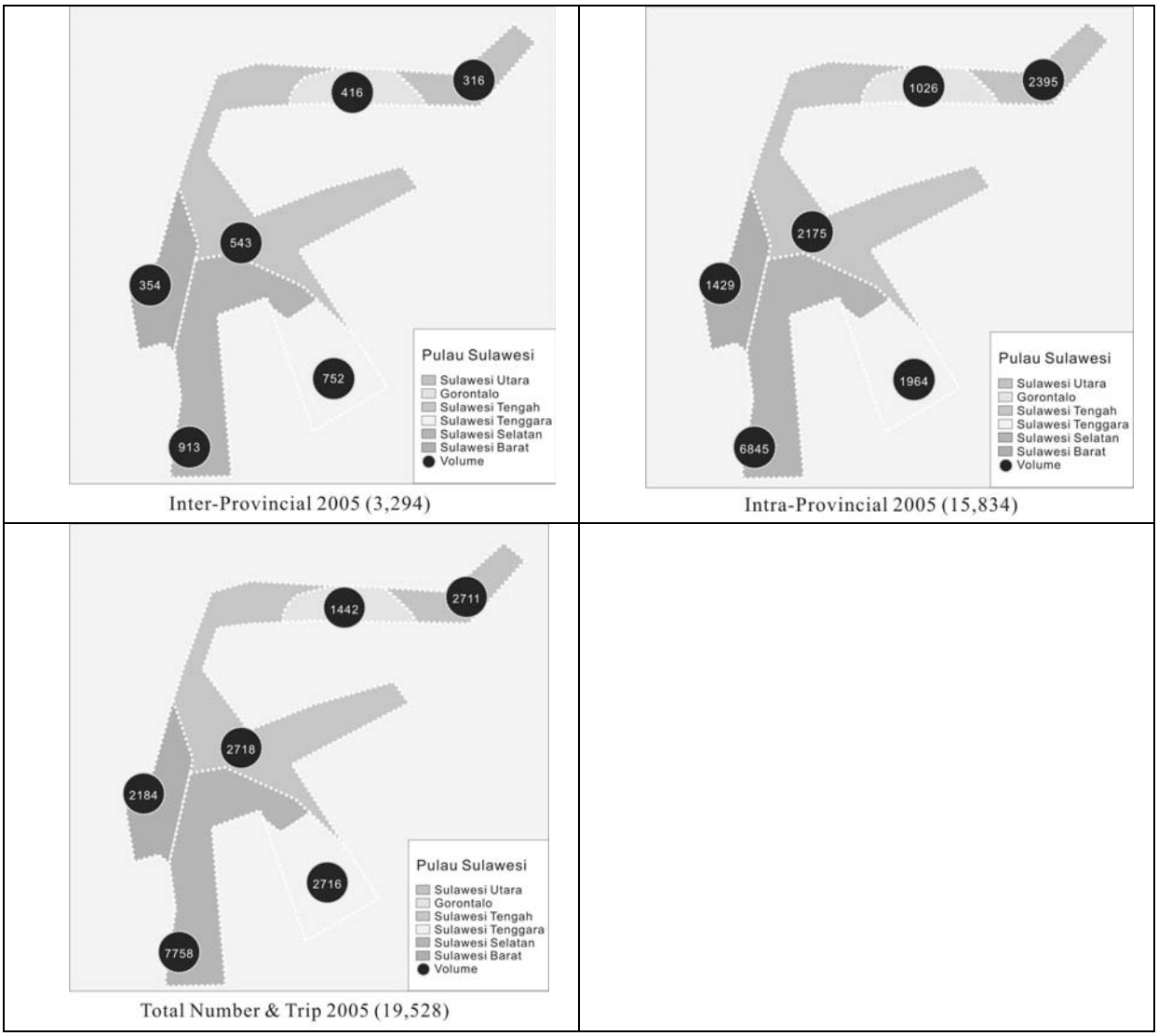
Source: JST estimation

Figure 7.4.3 Intra Island Land Transport by Commodity (2006)



Unit: 1,000 tons/year Source: JST

Figure 7.4.4 Cargo Movement Volume in Sulawesi (2006)



Unit: trucks/day Source: JST

Figure 7.4.5 Number and Trip per Day by Cargo Truck (2006)

7.5 Assignment of Future Traffic Demand onto Present Road Network (Do-Nothing Situation)

7.5.1 Future Traffic Demand in terms of Trip Generation/Attraction

(1) Forecast Methodology

1) Total Inter Zonal Person Trips

With regard to the inter-relation between estimated traffic demand and socio-economic indices as shown in the next table, the inter zonal trip has the highest correlation with the labor force of the non-agriculture sector. It has also a high correlation with GRDP of non-agriculture sector. The reason is that non-agriculture sector needs employees attracted from surrounding residential areas and their products should be transported to consumption areas. These sectors are usually located in urban area. Because high correlation between trips and population is caused by their socio-economic activities in proportion to the population, urbanized area generates larger trips.

On the other hand the slightly inverse proportion between trips and employees in agriculture sector comes from the low density of population and the low traffic activities to other zones. Even though agriculture products have higher shares in cargo trips, they are concentrated to urban area, therefore the correlation factor is affected more strongly by urbanization.

Table 7.5.1 Correlation between Inter Zonal Trips (PCU) and Socio-economic Indices

Non-Agriculture Sector Labor Force	0.912
GRDP (Non-Agriculture)	0.851
GRDP (2000 Constant Prices)	0.831
Population	0.785
Total Labor Force	0.779
Urbanization Rate (%)	0.476
Agri. Sector Labor Force	-0.049
GRDP (Agriculture)	-0.094
Area	-0.279

Source: Traffic Survey by JICA Study Team

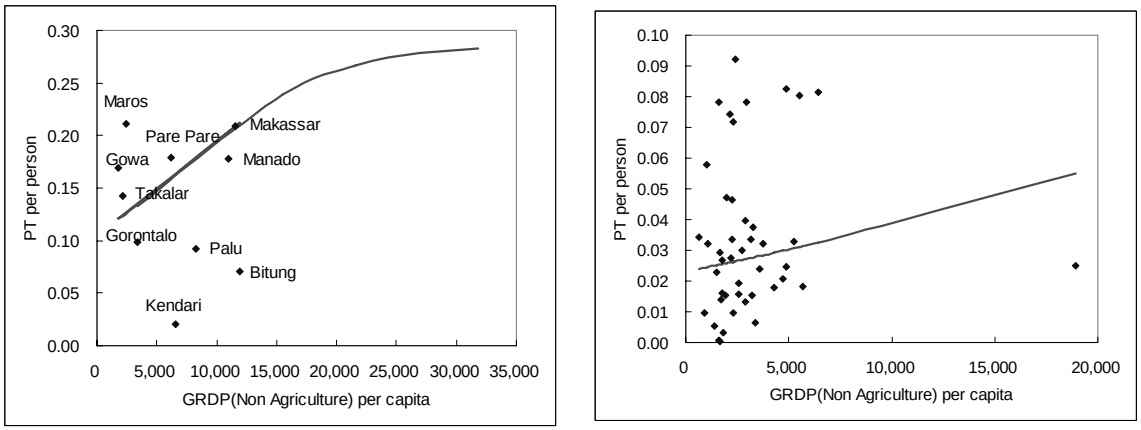
Urban zones of which urbanization rate exceeds 50% generate and attract trips more than other zones The result of correlation analysis shows high correlation between inter zonal trips and GRDP of non-agriculture sector as presented in the following figure. In this figure, horizontal axis represents per capita GRDP of non-agriculture sector, and vertical axis, generation of inter zonal trips per person.

In urban area both GRDP per capita of non-agriculture sector and inter zonal trips per person are high because of large number of commuting trips from surrounding zones, business trips, commodities for urban residents from outside zones and cargo trips for distribution.

In rural areas inter zonal trips do not spread widely because most trips are made on daily necessities for living and primary products. Therefore the number of trips per person is lower than

urban area.

However, in neighboring zones of large cities as Gowa, Maros, Takalar next to Makassar, inter zonal trips become large in number though the urbanization ratio is low. For model preparation of this study, these neighboring zones were classified as urban area.



Generated PT in Urban Area Generated PT in Rural Area

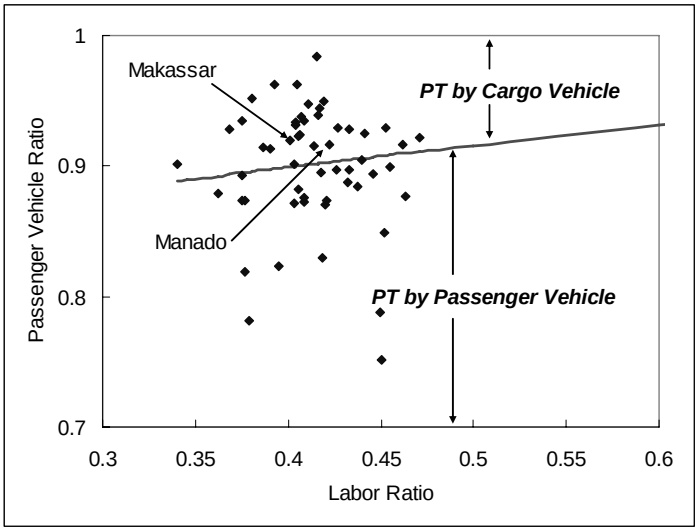
Source: Traffic Survey by JICA Study Team

Figure 7.5.1 Correlation between Per Capita GRDP and Trip Generation per Person

At present person trips by zone cannot be estimated correctly because home interview survey has not been carried out yet in Sulawesi. However, only inter zonal trips per person (excluding intra zonal trips) can be estimated by GRDP per person of non-agriculture sector for urban area and rural area separately as explained above. Although the correlation coefficient of each model is not so high because of the OD tables estimated only by roadside interview, future demand will be forecasted assuming that present deviation of each zone remains within a certain range in the future.

2) Modal Shares of Passenger and Cargo Vehicles

As the next step for modeling, the total person trips per person are divided into person trips by passenger vehicles like passenger car and bus, and by cargo vehicles like pickup and truck. Although there is a tendency that as the ratio of labor population becomes higher the ratio of PT (person trips) by passenger vehicles increases according to the survey result, the ratio of labor population is about 40% and the PT ratio of passenger vehicle is about 90%. Consequently, the relation becomes almost a flat line as the following figure. Therefore the ratio is assumed to remain the same even in the future. But if the ratio is extremely small at present, it is assumed to increase along with the output of the model, because the number of samples interviewed in the survey is too small to ensure the accuracy.



Source: Traffic Survey by JICA Study Team

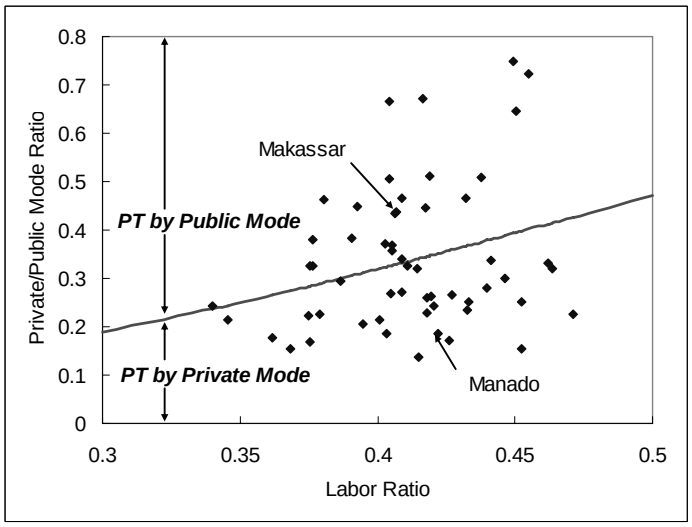
Figure 7.5.2 Interrelation between Labor Ratio and Type of Vehicle used in Person Trips (PT)

3) Public Mode vs. Private Mode

The person trips by passenger vehicles can be divided into private mode and public mode as shown in the Figure 7.5.3.

When household income or per capita GRDP increases, ownerships of motorcycle and car increases generally as well, and mode of person trips shifts from public mode to private mode. According to the survey result, however, this tendency is not so clear. The reason might be that the ratio of public mode is very high in inter zonal trips compared with usual intra zonal trips. People do not select private mode for long distance travel. The ratio of private mode is generally high in the urbanized zones with higher labor ratios.

For the forecast it is assumed that this tendency would continue in the future. In some zones where the usage of private mode the ratio is very high, it was assumed to increase from the present condition.



Source: Traffic Survey by JICA Study Team

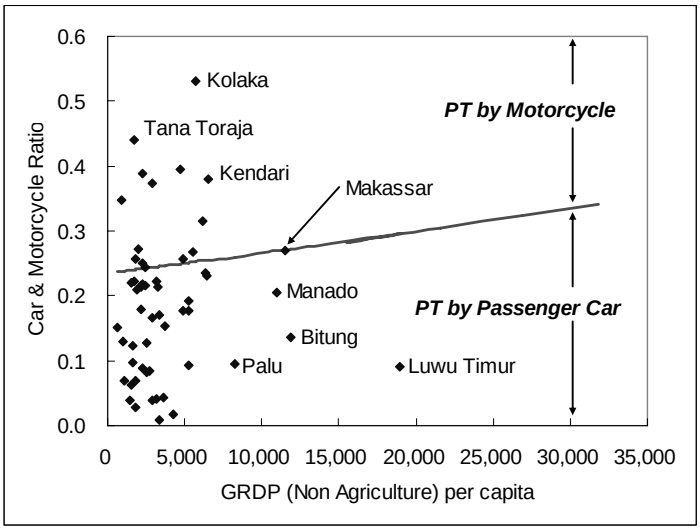
Figure 7.5.3 Labor Ratio vs. Mode of Passenger Transport (Public and Private)

4) Car vs. Motorcycle

The relation between motorcycle and car shows a general pattern seen also in other cities and other countries. As shown in Figure 7.5.4, the increase of per capita GRDP of non-agriculture sector brings about a growth in the share of car.

In Indonesia the number of motorcycle is quickly increasing at present. As mentioned in Maminasata study, use of motorcycle will shift to that of car at high income level. This tendency will be the same in other areas of Sulawesi. In the future the share of car will thus increase by the growth of per capita GRDP.

In the following figure the ratio of car is higher than the tendency line at some geographically isolated zones because motorcycle is not comfortable to travel for long distance. This is natural considering the location of traffic surveys carried out at the borders of zones. Hence the forecast model for estimating the usage ratio of car was constructed based on per capita GRDP of non-agriculture sector.

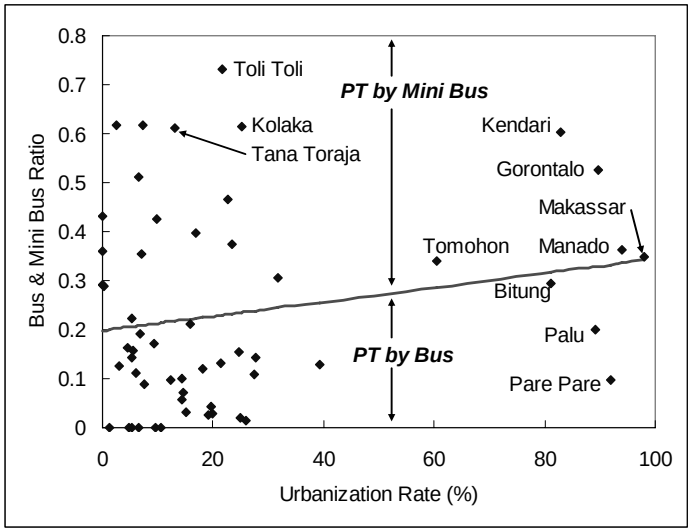


Source: Traffic Survey by JICA Study Team

Figure 7.5.4 Modal Share: Car vs. Motorcycle

5) Ordinary Bus vs. Minibus

Figure 7.5.5 shows the relation between minibus and ordinary bus of the public mode. Terminals of ordinary bus are located usually in urbanized area. The survey result thus shows that the usage ratio of ordinary bus is proportional to urbanization ratio. But even if urbanization ratio is low, there are some different zones like Toli Toli or Tana Toraja. In those zones which are the center of its region, the usage ratio of ordinary bus is high. Therefore the deviation from the result of the model should be maintained in the future. In the future forecast the ratio of ordinary bus use is assumed to be basically the same and to slightly increase if it is extremely low.



Source: Traffic Survey by JICA Study Team

Figure 7.5.5 Modal Share: Ordinary Bus vs. minibus

6) Cargo Vehicles

Although traffic demand of cargo is sometimes estimated by cargo item, it is difficult to grasp the volume of cargo between origin and destination based on roadside interview survey, because shape and quantity of cargo sometimes vary on the way by transshipment. In this study the forecast of future cargo trips was conducted based on present OD tables, which were estimated in terms of cargo vehicles instead of cargo items. Since the increase of total trips was forecasted by GRDP of non-agriculture sector per capita as mentioned earlier, future trips by cargo vehicles grow also by it. In case that new products, which have not been considered in the socio-economic framework, will be developed in the future, the new trips should be added on this forecast.

(2) Trip Generation/Attraction Models

According to the above models, future person trips by zone, by vehicle type, and by year were forecasted based on the socio-economic framework. The deviation by zone and by vehicle type between surveyed result and model output for 2007 was adjusted for the near future, and was assumed to gradually diminish toward the target year 2024. After the conversion from person trips to vehicle trips using the average occupancy surveyed, it was inputted to estimate future OD tables. In addition, the average occupancy by vehicle type was assumed to be the same in the future.

Generated trips at airports and sea ports were estimated considering the growth of the zone and its hinterland.

The model equations used are as follows:

Total Inter Zonal Trips

Y = K/(1+a*exp^-b*X) + E

Y=PT per person, X=non-agriculture GRDP per capita

Urbanized Area a=3.57465, b=0.00017, K=0.22941, R=0.34641

Rural Area a=3.382432, b=0.0000737, K=0.101179, R=0.1296

E=adjustment factor by zone and by year

Passenger Vehicle Ratio

Y = K – a*b^X + E

Y=Ratio, X=Labor force ratio

a=0.26808, b=0.38419, K=1.08193, R=0.1024

E=adjustment factor by zone and year

Private Mode Ratio of Passenger Vehicle

Y = K/(1+a*exp^-bx) + E

Y=Ratio, X=Labor force ratio

a=31.7133, b=7.4864, K=0.82456, R=0.2580

E=adjustment factor by zone and year

Car Ratio in Private Passenger Vehicle

Y = K/(1+a*exp^-bx) + E

Y=Ratio, X=non-agriculture GRDP per capita

a=2.81723, b=0.000025, K=0.58458, R=0.0712

E=adjustment factor by zone and year

Medium and Large Bus Ratio in Public Mode

Y = a*X + b + E

Y=Ratio, X=Urbanization ratio

a=0.00147, b=0.19799, R=0.2001

E=adjustment factor by zone and year

Truck share --- Not modeled (present pattern is assumed)

7.5.2 Forecast of Future OD Tables

Future OD tables were prepared based on vehicle trips. The number of vehicle types is 7, i.e. motorcycle, passenger car, mini bus, bus, pickup, small truck and large truck. The base year is 2007 and the target years for the forecast are year 2014, 2019 and 2024 according to the long term national plan. The total number of trips was estimated by the equations listed above. Some socio-economic indices in intermediate years have been calculated by linear interpolation. Future OD tables were forecasted by the present pattern method (Fratar Method). Since a few vehicle types in a few zones have zero values because the survey could not get any interview samples, gravity model was applied in this case to get the initial values instead of zero before Fratar iterative calculations.

Forecasted vehicle trips by year are shown in Figure 7.5.6. The highest growth ratio is 4.3% per year for passenger car until the year 2024 for 17 years. The growth ratio of motorcycle trips is 3.4% per year. All vehicle trips will be about more than 1.5 times in year 2024 as compared to the present. Note that these are only for inter zonal trips, and usually intra zonal trips increase more quickly. Therefore vehicle trips in and near cities will be growing upto about 2 times in the future.

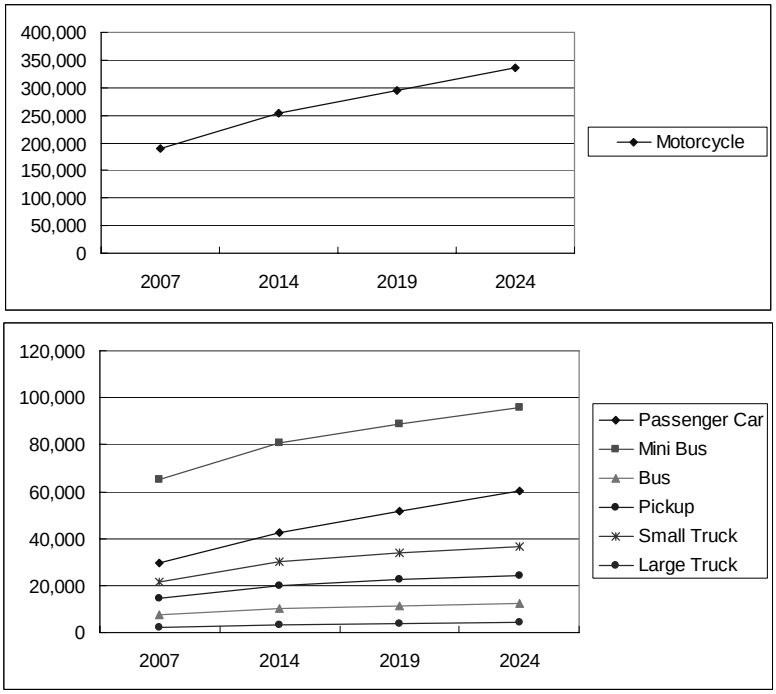


Figure 7.5.6 Forecasted Inter Zonal Trips by Vehicle Type

In Sulawesi Selatan, generated and attracted vehicle trips across zone borders are the largest both at present and in the future. The second is Sulawesi Utara. In Sulawesi Tenggara, the traffic demand will become significant in the future, because a part of present demand is still latent at present due to the lack of road network.

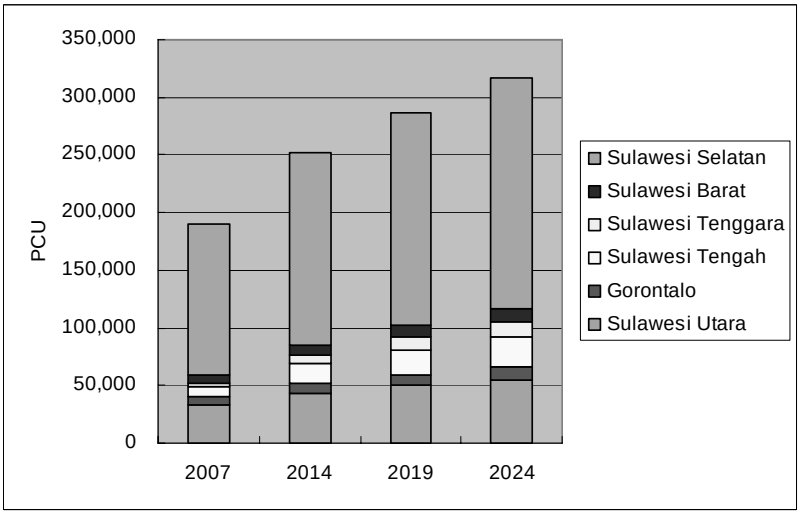


Figure 7.5.7 Forecasted Trips by Province

Forecasted future OD matrices by year are shown below.

Table 7.5.2 Forecasted Future OD Tables (vehicular trips)

**) Symmetric matrix excluding intra zonal trips*

PCU in Year 2014	Sulawesi Utara	Gorontalo	Sulawesi Tengah	Sulawesi Tenggara	Sulawesi Barat	Sulawesi Selatan	Major Airports	Major Ports	Total
Utara	41,244	2,102	183	2	0	201	0	0	43,732
Gorontalo	2,102	5,735	792	3	0	21	0	2	8,655
Tengah	183	792	10,933	178	1,061	1,168	8	2,475	16,797
Tenggara	2	3	178	5,903	0	887	70	312	7,353
Barat	0	0	1,061	0	4,784	3,128	0	92	9,065
Selatan	201	21	1,168	887	3,128	147,873	677	12,184	166,140
Major Airports	0	0	8	70	0	677	0	0	755
Major Ports	0	2	2,475	312	92	12,184	0	0	15,064
Total	43,732	8,655	16,797	7,353	9,065	166,140	755	15,064	267,561

PCU in Year 2019	Sulawesi Utara	Gorontalo	Sulawesi Tengah	Sulawesi Tenggara	Sulawesi Barat	Sulawesi Selatan	Major Airports	Major Ports	Total
Utara	46,729	2,503	241	5	0	279	0	0	49,756
Gorontalo	2,503	6,276	1,036	5	0	26	0	2	9,846
Tengah	241	1,036	13,896	269	1,358	1,498	8	3,349	21,654
Tenggara	5	5	269	8,235	0	1,287	109	502	10,411
Barat	0	0	1,358	0	4,998	3,645	0	103	10,104
Selatan	279	26	1,498	1,287	3,645	163,368	792	13,860	184,755
Major Airports	0	0	8	109	0	792	0	0	909
Major Ports	0	2	3,349	502	103	13,860	0	0	17,816
Total	49,756	9,846	21,654	10,411	10,104	184,755	909	17,816	305,250

PCU in Year 2024	Sulawesi Utara	Gorontalo	Sulawesi Tengah	Sulawesi Tenggara	Sulawesi Barat	Sulawesi Selatan	Major Airports	Major Ports	Total
Utara	51,342	2,890	287	8	0	340	0	0	54,866
Gorontalo	2,890	6,870	1,251	9	0	30	0	2	11,052
Tengah	287	1,251	16,703	302	1,594	1,730	10	4,190	26,066
Tenggara	8	9	302	10,569	0	1,567	148	683	13,285
Barat	0	0	1,594	0	5,292	4,132	0	114	11,132
Selatan	340	30	1,730	1,567	4,132	176,655	890	15,255	200,598
Major Airports	0	0	10	148	0	890	0	0	1,047
Major Ports	0	2	4,190	683	114	15,255	0	0	20,243
Total	54,866	11,052	26,066	13,285	11,132	200,598	1,047	20,243	338,288

Desire lines of the OD tables are shown in Figure 7.5.8. Each line represents vehicle trips of more than 50 (vehicles/day). They are not expressed in PCUs, therefore all vehicles including motorcycle are counted equally.

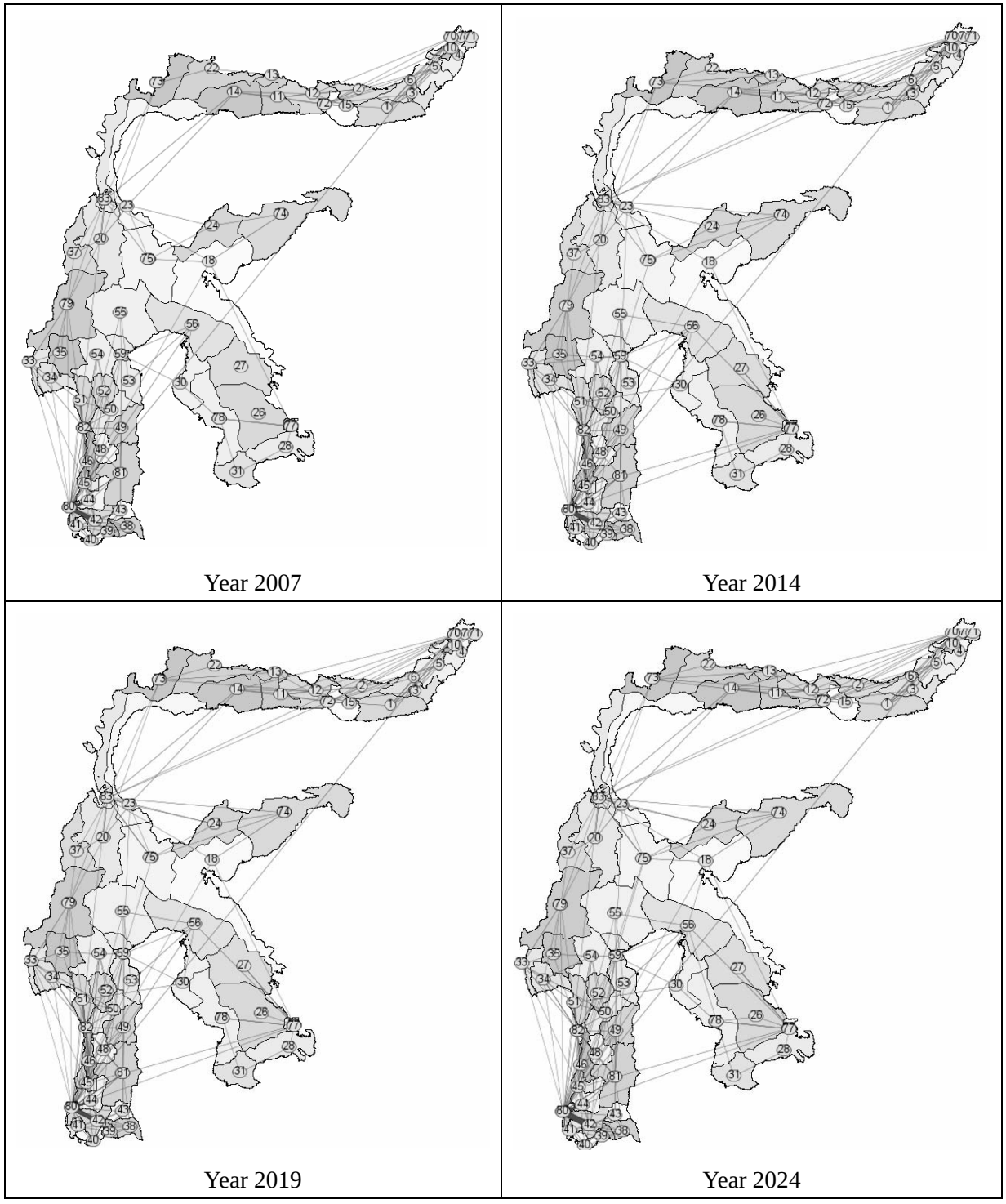


Figure 7.5.8 Desire Lines of Present and Future Vehicle Trips

7.5.3 Traffic Assignment of Future Demand on Existing Network (Do-Nothing Assumption)

Future traffic demand of 7 vehicle types was assigned onto the existing road network. The vehicle types and their PCUs are shown in Table 7.5.3. PCU conversion factor is different between inter and intra urban networks in Indonesian Highway Capacity Manual. The difference makes a conflict on estimated traffic volumes between this Sulawesi Master Plan Study and the Maminasata F/S. Hence, taking into account the fact that trip length of motorcycle and minibus is not so long, the same PCU values as the Maminasata study were used only to avoid the conflict and to adjust the traffic volume across the border of Maminasata.

Table 7.5.3 Different PCU Conversion by Source

PCU	(source) Maminasata F/S Study	(source) Inter-urban (Flat) by IHCM
Motorcycle	0.25	0.5
Car	1.0	1.0
Mini Bus	1.0	1.3
Bus	1.5	1.5
Pickup	1.0	1.0
Small Truck	1.3	1.3
Large Truck	2.0	2.0

The results of traffic assignment are shown in Figure 7.5.9. These are so-called Do-Nothing Case (or Without Case) without any improvement of the road network. This analysis is the basis of road planning because demand/supply relations of road space could be visibly quantified.

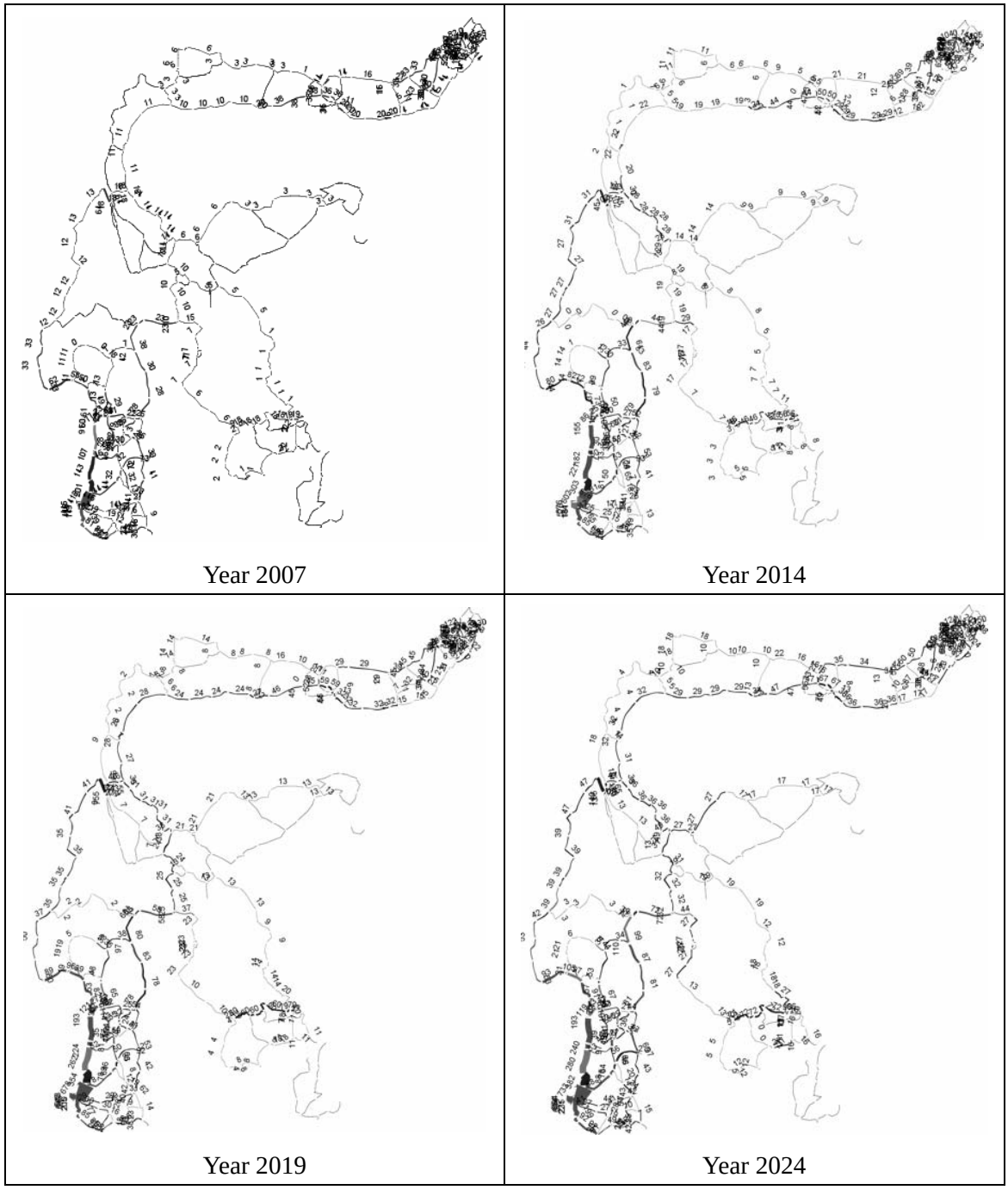


Figure 7.5.9 Traffic Assignment (Do-Nothing Case) by Year

CHAPTER 8 DIRECTIONS IN TRANSPORT NETWORK DEVELOPMENT AND THE ESTABLISHMENT OF THE ROAD MASTER PLAN

8.1 Directions in Transport Network Development

8.1.1 Review of National Transport Development Plans

National transport development plans should be reviewed prior to the formulation of a road development plan for Sulawesi. The basic directions and policies stated in these plans form an integral part of the road network development plan to be proposed in this study.

(1) The National Transport System, SISTRANAS, Departemen Perhubungan 2005

The policies on national transport system were declared in 2005 in the form of government regulation that form as the guideline for transport development in Indonesia. This regulation aims to establish an efficient and effective nationwide transport system mainly from the standpoint of operation. Though conceptual in nature, this guideline stipulates the following principles:

1. Provision of strong transport infrastructure with high competency according to national and international standards.
2. Improvement of competitiveness of national transport industry in the global market to increase value added in national economy.
3. Empowerment of society, business and government an efficient and effective operation of transport system.
4. Enhancement of the transport role to accelerate national development.
5. Strengthening of strategic position and national interest in international relations.

(2) BIMP – EAGA

Brunei Darussalam, the provinces of Indonesia, Malaysia and the Philippines agreed in 1994 to form the BIMP-EAGA an ASEAN sub-regional growth area. Sulawesi is part of this area. In spite of their rich natural resources and with the exclusion of Brunei Darussalam, this sub-region, however, has been underdeveloped when compared with their capital regions. The major goal of the BIMP-EAGA is to increase trade, tourism and investments in the sub-region.

At present, various initiatives led by the ADB and other international organizations are ongoing in BIMP-EAGA. So far, most of these initiatives are capacity development, consensus building, database creation and other technical assistance. In the future, however, major investments will be on infrastructure, industries, tourism and so on, supported by the transport network as conceived in Figure 8.1.1.

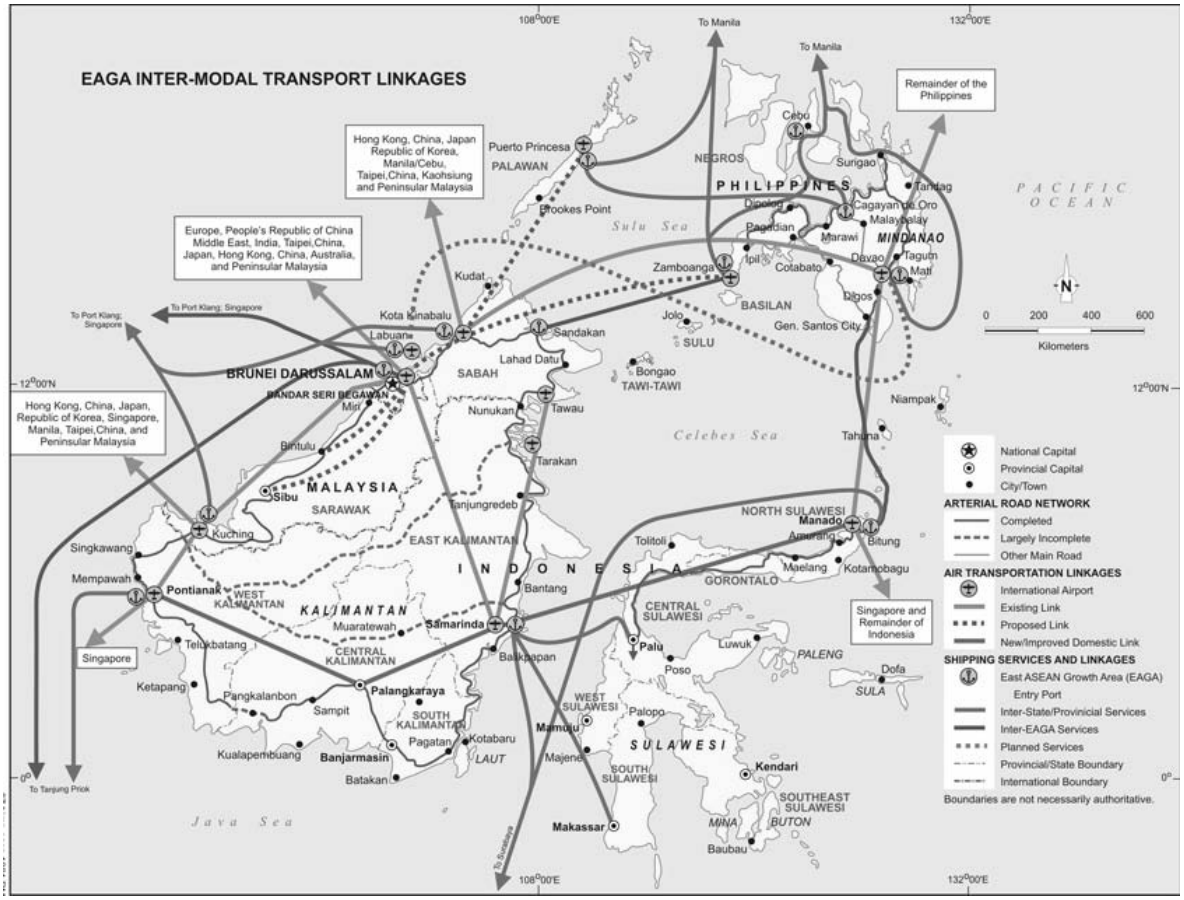


Figure 8.1.1 EAGA Inter-modal Transport Linkages

(3) National Long-Term Development Plan 2005-2025, BAPPENAS 2007

The National Long-Term Development Plan stipulates the basic long-term development policies of Indonesia in the form of an act enacted under the name of the president. Its broad objectives are two-fold: A. To construct a good society in terms of manner, moral, ethics, culture and civilization, and B. To attain a competitive nation. With regard to infrastructure, the role of the private sector is emphasized in the form of public-private partnership due to financial constraints of the government.

For transport, an efficient and effective system similar to SISTRANAS has been advocated. According to this plan, the national transport system should have the following factors:

1. Accessible, environmentally friendly, and sustainable.
2. Integrated between different modes.
3. Consistent with regional development socially, culturally and economically.
4. Supports the unity of the nation.

The issues identified for realizing the goals above include development of organizational capacity, public participation in public transport services, development of financing alternatives, application

of advanced technologies and the protection of natural and living environments.

(4) National Mid-Term Development Plan 2005-2009, BAPPENAS 2004

The National Mid-Term Development Plan determines the basic mid-term development policies of Indonesia through the form of an act. Regarding road infrastructure, it sets three (3) general development targets:

1. Maintenance and improvement of road transport service to support regional economic development.
2. Provision of an improved road transport service in terms of accessibility, speed and comfort in all areas including isolated islands.
3. Realization of good cooperation and coordination between government, state-owned enterprises and the private sector in developing road infrastructure.

Following these general targets, the importance of formulating the road network master plan in Sulawesi is mentioned as one of the directions of road infrastructure development. In the road and bridge development program, and traffic facilities development program, Sulawesi is referred to in the following points:

1. Primary arterial roads should be developed in major economic corridors including Trans-Sulawesi (West, East and Central).
2. Road maintenance should be duly conducted in isolated areas such as Trans-Sulawesi (East).
3. Traffic safety facilities should be improved in South-east Sulawesi, Central Sulawesi and North Sulawesi.

In addition, the possibility of water transport is laid out between Sulawesi and Kalimantan (Balikpapan-Mamuju and Nunukan-Manado) and in some lakes of Sulawesi (Tempe, Towuti, and Matano). Airport development at Makassar is included in the program. Railway development is not mentioned in Sulawesi.

(5) National Spatial Plan

The latest National Spatial Plan (RTRWN), prepared by the National Spatial Planning Coordination Board in October 2007, specifies the principles and strategies of land use. These aspects are described in Chapter 5 of this report.

In relation to transport infrastructure development, the following references are made:

1. Toll road: Manado-Bitung, Manado-Tomohon, Maros-Mandai-Makassar, Makassar-Sungguminasa, Sungguminasa-Takalar, Limboto-gorontalo (intercity), Ujung Pandang I and Makassar IV (urban).

2. Port: Pantoloan, Makassar and Bitung (international), Gorontalo, Donggala, Tolitoli and Parepare (national).

3. Airport: Hasanuddin and Sam Ratulangi (primary), Djalaludin, Mutiara and Wolter Monginsidi (secondary), Tanpa Padang, Melonguane and Bubung (tertiary).

(6) Sulawesi Island Spatial Plan

The latest Sulawesi Island Spatial Plan was prepared in December 2005 by the Regional Development Coordination Board of Sulawesi (BKPRS). This plan aims to promote regional development in Sulawesi in an efficient and balanced manner by establishing the principles and strategies of land use. The details are described in Chapter 5 of this report as well.

With regard to transport infrastructure development, the proposed projects can be summarized as presented in Table 8.1.1.

Table 8.1.1 Transport Infrastructure Developments included in the Sulawesi Island Spatial Plan, 2005

Sub-sector	High Priority	Medium Priority	Low Priority or Not Specified
Road	*Trans Sulawesi East	*Trans Sulawesi West *Trans Sulawesi Central *Feeder and peninsula-crossing roads	*Circular roads for remote islands
Railway	*Urban and suburban lines around Makassar and Manado	*Medium-distance lines near regional centers along Trans Sulawesi	*Medium to long distance lines connecting major cities along Trans Sulawesi
Water (shipping, ferry,etc.)			*Major lakes in Sulawesi *Inter-provincial and inter-island ferries within Sulawesi *Inter-island shipping lines between Sulawesi and external areas
Port	*International ports (4)	* National ports (27) * Local ports (17)	
Air	*Primary airports (2) *Secondary airports (3)	*Tertiary airports (2) *Other airports (15)	

(7) Five-Year Plan (Renstra 2005-2009) of the Ministry of Public Works

The Ministry of Public Works (MPW) established this plan comprising vision, mission and goals under RPJM–I. Public road development policy, strategy and targets for 2005 to 2009 are stipulated in the plan. In relation to road development, the following issues were identified:

- Lack of capacity and fund for road maintenance.
- Regional disparity between areas and poor access from production centers to market areas.
- Road infrastructures damaged by natural disaster, which leads to diversion of budget allocation from road maintenance to restoration from damages.

The vision of MPW in the five year plan is, in one word, to provide infrastructure reliable, beneficial and helpful to realize safe, peace, equal, democratic and more prosperous nation.

Following are the implementation targets for Sulawesi Island stipulated in the five-year plan:

- 50km road construction in disaster-vulnerable and social conflict areas in Central Sulawesi.
- Road treatment in isolated areas including small islands; 100 km in North Sulawesi, 100 km in Gorontalo, 200 km in Central Sulawesi, 200 km in South Sulawesi and 150 km in Southeast Sulawesi.
- Road maintenance; 6,125 km in North Sulawesi, 3,026 km in Gorontalo, 8,507 km in Central Sulawesi, 10,208 km in South Sulawesi and 6,125 km in Southeast Sulawesi.
- Bridge maintenance; 35,141 m in North Sulawesi, 17,570 m in Gorontalo, 48,805 m in Central Sulawesi, 58,567 m in South Sulawesi and 35,141 m in Southeast Sulawesi.
- Enhancement of road capacity; 249 km in North Sulawesi, 124 km in Gorontalo, 345 km in Central Sulawesi, 414 km in South Sulawesi and 249 km in Southeast Sulawesi.
- Bridge replacement and construction; 1,155 m in North Sulawesi, 577 m in Gorontalo, 1,604 m in Central Sulawesi, 1,925 m in South Sulawesi and 1,155 m in Southeast Sulawesi.
- Toll road construction by private companies for Makassar Section IV (11 km).

8.1.2 Development Directions for Integrated Transport Network

Based on the existing transport development plans described above and various analyses conducted earlier, the following directions have been identified in the establishment of an integrated transport network for the entire island of Sulawesi:

(1) Modal Shares by Travel Distance

Although it is difficult to accurately grasp inter-modal relations in Sulawesi, the likely modal shares were roughly determined based on the analysis presented in Section 7.4.1 of this report, as follows:

1) Passenger Transport

* Air travel will be dominant in the future for long-distance travel of more than about 500 km (as the crow flies). Considering the progress of airport development and the emerging LCCs (low-cost carriers), its modal share will reach 50 to 100%. Road transport will share 50 to 0% in this distance range. The role of provincial bus will be limited, with a share of around 30 to 0% of the road transport share.

* For short- to medium-distance travel of up to 500 km, road transport will play a major role with a share of 100 to 50%, although it decreases with distance. The share of public transport (provincial bus and small bus including "petepete") will be around 30% of the of the road transport share.

* The ferry mode will play an additional but important role for some specific OD pairs such as Makassar-Kendari. Although the ferry is regarded as a part of the road share in this study, the share sometimes reaches more than 50% of all person trips for some zone pairs.

2) Cargo Transport

* Air transport is negligible in cargo transport.

* Maritime transport will be dominant in the future for long-distance transport of more than 500 km (as the crow flies). At present, the modal share is more than 60% for major routes. This modal share is considered to decrease slightly in the future due to the expected increase of high-value products. The remaining share of up to 40% will be shouldered by road transport (e.g. trucks).

* For short- to medium-distance transport of up to 500 km, road transport will play a major role in similarity with passenger transport with a share of 100 to 40%, although decreasing with distance.

* The ferry mode is considered part of the road system as mentioned above. Ferries carry trucks loaded with cargoes. However, at present its role in cargo transport is not so significant. In the future, however, its function can be strengthened if the ferry system is upgraded.

(2) Roads

Sulawesi, is a mountainous island surrounded by complex coastlines and a combination of four prominent peninsulas. The road network of Sulawesi has been developed along its coastlines as well as along a small number of rivers with slopes that are not steep. As a result, most available land space is already served by existing roads, which are often in bad conditions.

Therefore, there is little room for a new arterial road in Sulawesi. The master plan for an arterial road network will basically be more of a road improvement plan focusing on widening, realignment, rehabilitation, strengthening, and maintenance, coupled with some new projects of strategic importance. Figure 8.1.2 shows the topography of Sulawesi and its conservation areas which determine the structure of the road network.

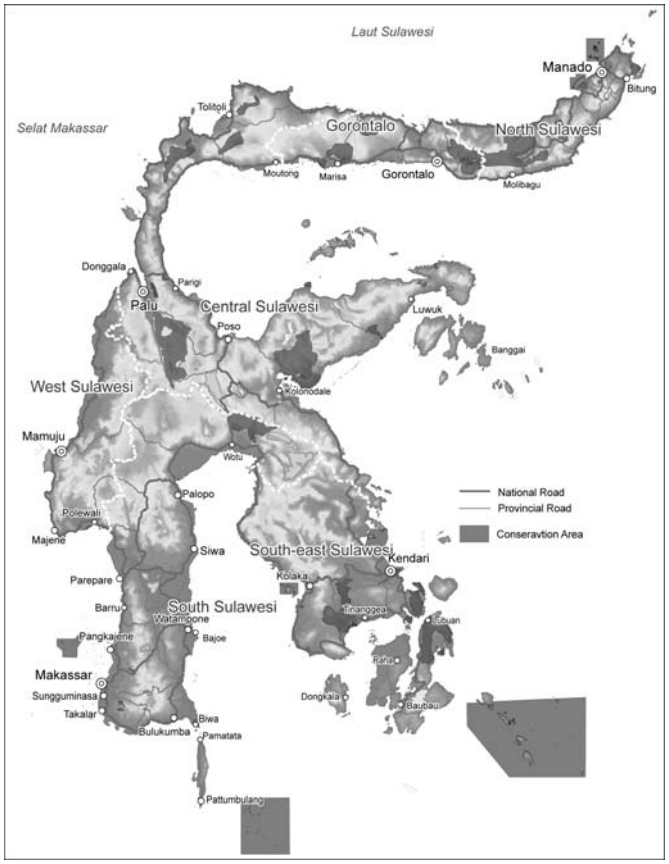


Figure 8.1.2 Topography and Conservation Areas of Sulawesi

In addition, it is also important to consider the nationwide and international linkages. Based on the BIMP-EAGA concept, the arterial road network of Sulawesi should form an integral part of the global transport network.

Based on the existing data/information and a series of analysis carried out by the Study Team, the basic directions in road development can be as follows:

1) The road network of Sulawesi will basically be composed of two-lane roads. This is because the traffic volume of inter-city roads is mostly below 3,000 PCUs at present. Even with a growth rate of 9% per year, these roads will not reach the capacity of 7 m 2-lane road (20,000 PCUs per day) before 2024.

2) The road network mentioned above should be well maintained. All-weather characteristics are needed for the road network in Sulawesi. Recently, huge efforts have been made by several donors to maintain Sulawesi's roads. Ideally, this should be continued in the future with a sustainable responsibility sharing among local governments.

3) In order to realize the regional development plan of this study, strategic feeder roads shall be proposed to link strategic points. Some existing roads may require additional improvements such as widening and pavement strengthening.

4) Towns, villages, and other inhabited areas developed along the main roads of Sulawesi need traffic safety and environmental measures as the local residents are currently threatened by fast through traffic. For larger towns this measure can be a bypass depending on the traffic volume and topography. For smaller villages the provision of wider lateral clearances or separator medians may be a possible solution.

5) The design standard of arterial roads in Sulawesi should be in accordance with the criteria of the ASIAN and ASEAN Highways considering the possible expansion of ASIAN/ASEAN Highways in the future. The strength of the roads in terms of axle load should also be considered based on the recommendation of the HLRIP study.

6) Toll roads are proposed in Sulawesi, and the National Spatial Plan (2007) includs eight (8) priority toll roads, i.e. Manado-Bitung, Manado-Tomohon, Maros-Mandai-Makassar, Makassar-Sungguminasa, Sungguminasa-Takalar, Limboto-Gorontalo, Ujung Pandang I and Makassar IV. This study covers all intercity roads were covered, however, urban roads such as Ujung Pandang I and Makassar IV were not included due to their urban features. For the urban toll roads near Makassar, see the Feasibility Study part of this study for details.

(3) Maritime Transport

Cargo demand at the ports of Makassar, Bitung, Kendari, and Pantloan (Palu) is significantly increasing.

The development needs and potential of ports in Sulawesi are summarized below.

Makassar Port: Cargo volume will reach port capacity by 2015. Medium- and long-term improvement plan of port facilities should be formulated before 2010.

Bitung Port: Bitung – Its container yard will be full after several years considering the increase in container demand. Medium- and long-term improvement plan of port facilities should be formulated. Manado road should be improved immediately due to the congestion caused by container truck traffic.

Kendari Port: Outdated port facilities are damaged due to the congestion caused by high cargo demand. Improvement of port facilities is urgent. Since the port backyard is limited, the expansion and/or relocation to an appropriate site should be studied.

Parepare Port: Port yard and car parking areas are very limited. Container yard development should be accelerated in line with cargo demand increases.

Gorontalo Port: Installation of cargo handling machines, such as mobile harbor cranes,

is recommended.

Anggrek Port: Overall port development was completed as a new deep sea port.

Pantoloan Port: Large vessels call at this port due to its deep, calm water and sheltered location, makes it suitable to be developed into a large-scale port and one of the core ports of Sulawesi.

Berang berang Port: Overall port development is necessary as a new central port for West Sulawesi Province. This port is under construction at present.

The ports mentioned above should be developed together with the improvement of feeder roads.

The demand for ferry and passenger ship services is still large. In 2005 inter-island passengers by air reached approximately 1.3 million, while passenger ships transported 1.9 million, as shown in Table 8.1.2. However, intra-island travel by air transport has increased rapidly after the implementation of the "open-sky" policy, bringing down airfare rates at competitive levels and making them more affordable. Ferry and passenger shipping services are both decreasing in terms of passenger numbers and cargo volumes. Approximately 55% of intra-island passengers now travel by air, while the number of ferry passengers is decreasing.

Table 8.1.2 Number of Passengers by Air, Ferry and Ship, 2005

Inter-island passenger (no.)		Intra-island passenger (no.)	
Ship:	1,900,000	Ferry:	560,000
Air:	1,300,000	Air:	680,000

Second-hand ferry boats operating in Sulawesi are so superannuated that safe and on-time services become difficult. Safe and high-speed services will be necessary for the system to recover and to increase the demand.

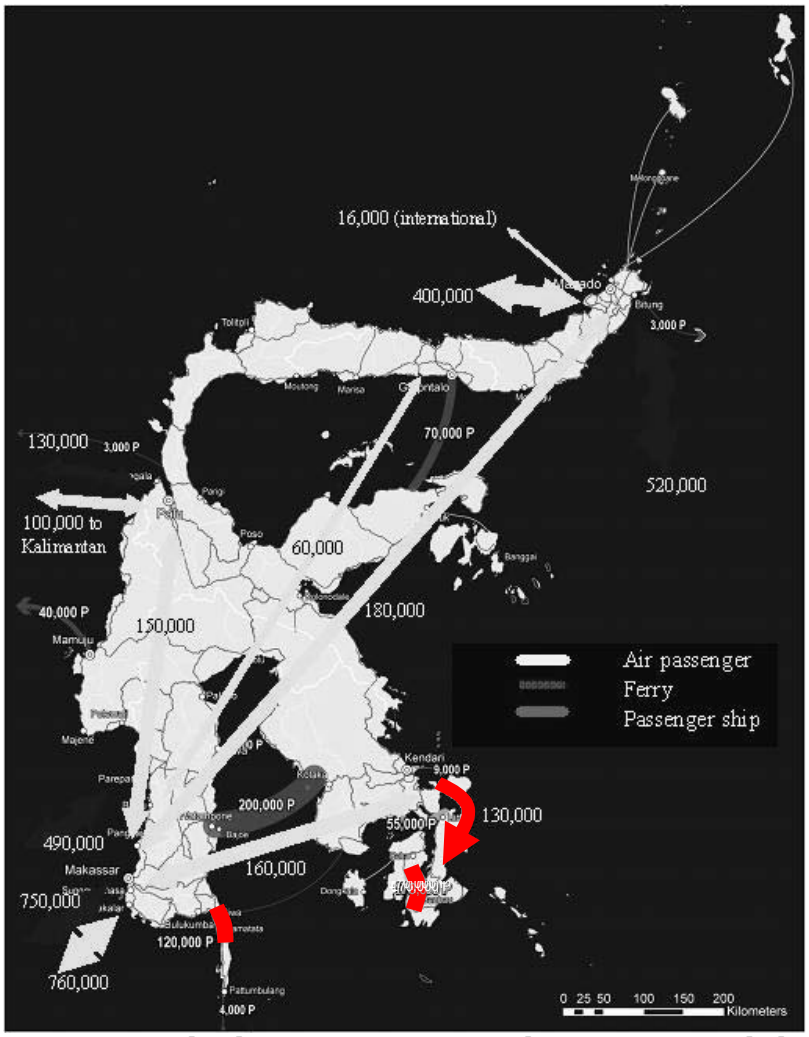


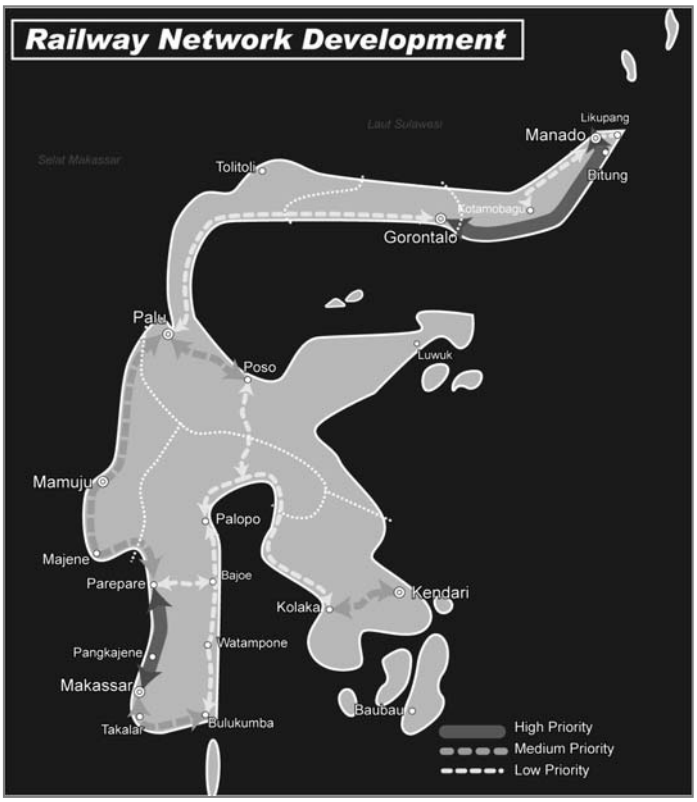
Figure 8.1.3 Inter/Intra-island Passenger Movement by Air, Ferry, and Ship, 2005

Due to the characteristics of peninsular Sulawesi, the use of inter-peninsula ferries is desirable. This is particularly true in the eastern and southeastern peninsulas where road travel is more than twice longer than traveling by ferry. By strengthening ferry services for Bajoe-Kolaka (Siwa-Lasusua), Kendari-Luwuk, and Pagimanan-Gorontalo, a nautical highway system can be effectively established. The introduction of RoRo ships, jetfoils, and other modern modes of sea travel may be needed for this purpose. Maritime transport should be effectively incorporated into the transport network considering the long winding coastlines.

An alternative road route should be developed as well for the nautical highway sections that become nearly un-navigable during the rainy season.

(4) Railway Transport

The railway development plan for Sulawesi is indicated in the Sulawesi Island Spatial Plan. As shown in Figure 8.1.4, the two sections of Makassar - Parepare and Manado - Gorontalo are proposed as high priority projects, while the three sections of Parepare - Palu via Mamuju, Kendari - Kolaka, Palu - Poso are given medium priority. The proposed routes are competing with the road projects that have been proposed already or are proposed in this Study. These railways are planned mainly for freight and not for passengers, according to the past studies.



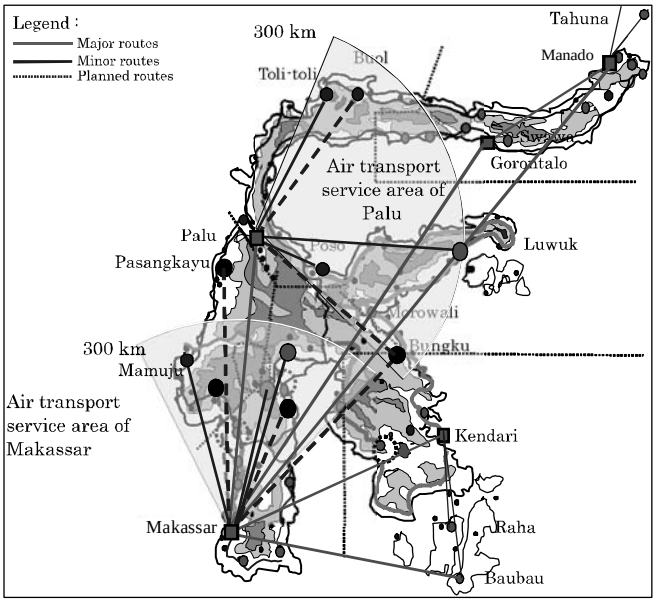
Source: Sulawesi Island Spatial Plan

Figure 8.1.4 Existing Railway Plan

Judging from the estimated volume of traffic demand, there is a concern that these railways would not be feasible financially (financial evaluation is not provided in the past studies) if implemented at present. These projects should thus be studied in detail in the near future when the transportation capacity of existing transport infrastructure has been reached.

(5) Air Transport

With the open-sky policy taking effect, it is expected that air transportation will become the principal mode in long-distance passenger movement in Sulawesi as the economy further develops and income increases. At the same time, however, flight delays and a series of recent air mishaps have exposed the unsafe operations of aircrafts, which could have an adverse impact on the open-sky policy. A safe and punctual operation is essential to increase inter- and intra-island air transport demand.



Source: JICA Study Team

Figure 8.1.5 Feeder Air Routes in Sulawesi

Feeder airports are located within a 300-kilometer radius of the provincial capitals of Makassar and Palu, as shown in Figure 8.1.5. These short-range commuter services are expected to compete with road transport after the improvement of the road network and bus services.

(6) Direction of Transport Network Development (Summary)

The following direction should be pursued in developing an integrated transport network for the entire island of Sulawesi:

* The international linkage proposed in the concept of BIMP-EAGA should be strengthened by improving air and shipping services between northern Sulawesi (Manado and Gorontalo) and Mindanao (Davao and General Santos cities) of the Philippines. This corridor has a tint of Christianity unlike other areas of Sulawesi, and will thus add a variety in tourism development of the region. The islands located in between, such as Sangihe and Talaud, have large potentials for trade, tourism and fishery.

* The road network master plan proposed in this Study will basically be more of a road improvement plan focusing on the widening, realignment, rehabilitation, strengthening and maintenance coupled with some new projects with strategic importance. The road should be all-weather, ensuring accessibility throughout the year even for isolated areas.

* Energy-saving maritime transport should be effectively incorporated in the network considering the long winding coastlines. Since coastal shipping will play a major role in long-distance cargo transport also in the future, port facilities should be improved together with feeder roads to/from the ports. In addition, an inter-peninsula nautical highway using RoRo ships is proposed to link the east coast of Sulawesi; Makassar - Bajoe(Siwa)=Kolaka - Kendari=Luwuk - Pagimana=Gorontalo - Manado. Although the traffic volume on the ferries is not large yet, it will grow if the nautical highway is operated more efficiently using modern ships and upgraded facilities. Alternative land routes should be developed at the same time with the nautical highway that becomes nearly unnavigable during the rainy season.

* Long- and medium-distance passenger travel by air will grow in light of the lowering airfares due to the proliferation of LCCs (low-cost carriers). Airport development should be promoted as proposed.

* There are some railway projects proposed for Sulawesi. However, the estimated traffic demand for these railways is generally small, and their financial viability is quite doubtful even in the absence of financial analyses in past studies. Since inter-city roads have enough capacity at present to absorb increasing traffic demands, the implementation of railway projects should better be studied in the future when road capacity has been reached.

8.2 Establishment of Sulawesi Road Master Plan (SRMP)

8.2.1 Road Development Policy

The objectives of the Road Development Master Plan aims to support the national and regional economic developments in accordance with the strategies aimed at achieving the economic development goals of Sulawesi as established in the study, as well as to build the road network system to realize a sustainable and stable socio-economic development of Sulawesi, especially in rural areas.

As stated in Chapter 5 "Development Strategy and Concept", the Study Team established the following development goals and strategies:

Goal 1: Economic Development in Sulawesi as a Leading of East Indonesia

Strategy 1: Effective Economic Growth of Sulawesi by Strengthening not only Economic Linkages in Sulawesi but also International Economic Linkages.
Strategy 2: Economic Growth through Processing Industrial Development on the basis of the Potential Resources of Sulawesi.

Goal 2: Poverty Alleviation and Development of Environment Friendly Sulawesi

Strategy 3: Social Improvement and Mitigation of Regional Gaps in the Rural Areas through Integrated Services Development.
Strategy 4: Development of Sulawesi with proper consideration of its Environment, Safety and Human Resource.

In line with the above development strategies as well as based on the transport development directions discussed in Clause 8.1.2, the Study Team established the following road development policy taking into consideration existing road conditions and traffic demand forecasts.

Policy 1: Building the transport network backbone of the island to enhance the economic linkages between the six provinces.

Policy 2: Accommodation of increasing large traffic volumes and heavy vehicles.

Policy 3: Improvement of accessibility to potential resource areas.

Policy 4: Strengthening the road network in the rural areas and isolated islands.

Policy 5: Reduction of environmental loads in the transport sector.

Policy 6: Enhancement of traffic safety and capacity of sub-urban arterial roads.

Policy 7: Development of a road network paying due consideration of the environment.

Policy 8: Strengthening the road management including maintenance system.

Table 8.2.1 shows the summary of road development policy showing the correspondence to the regional economic development strategy in Sulawesi.

Table 8.2.1 Road Development Policy to be applied for Road Master Plan

Development Goal	Regional Development Strategy	Road Developemnt Policy
[Goal 1] Development of Sulawesi as the Leading Island in East Indonesia and as the Gateway to other Asian Countires	[Strategy 1] Effective Economic Growth by Strengthening Inter-regional Linkages not only in Sulawesi but also with other Asian Countries	[Policy 1] Building the backbone of transport network of island to enhance the economic linkage between six provinces
		[Policy 2] Accommodation to increasing large sized traffic and heavy vehicle
	[Strategy 2] Economic Growth through Development of Processing Industry on the Basis of Potential Resources of Sulawesi	[Policy 3] Improvement of accessibility to the potential resources areas
[Goal 2] Poverty Alleviation and Development of Sulawesi as an Environmentally Friendly Island	[Strategy 3] Alleviation of Social and Economic Disparities in Rural Area by Strengthening Public Administration Services through Integration of Prioirty Regional Center and Cities	[Policy 4] Strengthening the road network in rural area and isolated island
	[Strategy 4] Development of Sulawesi with due Consideration on Environment, Safety and Human Resources	[Policy 5] Reduction of environmental load in transport sector
		[Policy 6] Enhancement of Traffic Safety and Capacity of Suburban Arterial Roads
		[Policy 7] Development of road network paying due consideration on environment
		[Policy 8] Strengthening the road management including maintenance system

8.2.2 Road Development Plan and Possible Projects

The Study Team exchanged opinions with government officials by way of discussions in seminars and workshops on how to develop the roads in Sulawesi. The Team obtained various comments and information through the discussions regarding the road development which included the issues and problems that each province faces or has faced as well as the proposals to solve these issues which include concrete road development projects.

The Study Team reviewed the comments and proposals. It has set up the road development plan according to the road development policy involving 8 items discussed in Clause 8.1.3 as follows:

Road Development Plan;

i) Strengthening the Trans-Sulawesi Road as a backbone of the transport network in Sulawesi and the peninsula crossing road connecting each Trans-Sulawesi Corridor to complete the missing link.

ii) Reinforcement of access to/from main port/ferry or container routes to accommodate increasingly large-sized containers and over-loaded heavy trucks.

* The Study Team categorizes the above access road as “heavy loaded roads” and proposes the strengthening of these roads through the widening and strengthening of pavement structures.

iii) Strengthening roads into all weather conditions and connecting them with high potential

resource areas to in order to enhance regional development in the rural areas.

iv) Upgrading road functions into higher classification in order create linkages with major cities or new regency capitals along with their improvement in accordance with road classification.

v) Incorporation of energy-saving ferry transport in the road network system as a nautical highway to reduce environmental loads.

vi) Widening of congested suburban roads or construction of bypass/toll roads to cope with with increasing traffic demands and improve the natural/living environments along the congested major roads.

vii) Reinforcement of disasters prevention measures for flood and landslide disasters and the restriction of road development to maintain environmental preservation on natural resources and to protect isolated cultural communities.

viii) Strengthening of the road maintenance system and its management including traffic safety, capacity development, privatization, etc

Taking into consideration existing road conditions as well as future traffic demand forecast the possible projects were examined by the Study Team based on the above road development plan.

Table 8.2.2 shows the summary of the road development plan showing possible projects identified by the Study Team based on the information and data obtained through the discussion in workshops and seminars as well as information obtained at the site visit to each province.

Table 8.2.2 Proposed Road Development Plan

Proposed Road Development Plan		Possible Major Projects identified by the Study team (Excluding on-going projects)	Province
[Policy 1] Inter-regional transport network of six provinces in Sulawesi in Sulawesi	(1-1) Strengthening the Trans Sulawesi Road (West, Central and East Corridors) as a backbone of transport network in Sulawesi	① West Corridor of TS between Mamuju - Palu including proposed re-alignment section of Mamuju - Tappalang	Central & West
		② Central Corridor of TS from Parepare - Palu Section	South & Central
		③ Central Corridor of TS from Gorontalo - Molibagu - Bitung	Gorontalo and North
		④ East Corridor of TS in the Poso - Ampana - Biak - Luwuk - Baturube - Kolonodale - Border of South East Sulawesi - Kendari	Central & Southeast
	(1-2) Strengthening peninsula crossing road connecting each Trans Sulawesi Corridor to complete the road network	① Capacity Expansion of Maros - Watampone (by Tunnel)	South
		② New construction of Mountong - Buol Road	Central
		③ Improvement and Upgrading of Kaluku - Sabbang Road	West
		④ Capacity Expansion of Tawaeli - Toboli Road by Tunnel	Central
		⑤ North Mountain Area Crossing Road	Southeast
[Policy 2] Accommodation to the Heavy Vehicle	(2) Reinforcement of access to/from port facilities to accommodate increasing large-sized container and over-loaded heavy truck.	① Makassar - Maros - Watampone/Bajoe Route and Kolaka - Kendari Route	South & Southeast
		② Mamuju - Parepare - Siwa Route and Palopo - Siwa Route	West, South
		③ Gorontalo - Isimu - Kwandang/Anggrek Port - Manado - Bitung Route	Gorontalo & North
[Policy 3] Improvemen of accessibility to potential resource areas	(3) Strengthening the road to be in all weather conditions which connected with high potential resource areas to enhance regional development in rural area	① Lakahang - Tumongan Road : 85km (requesting upgrade to national road)	West
		② Kaluku - Tabang Road:168km (requesting upgrade to national road)	West
		③ Wonomulyo - Keppe: 95km	West
		④ Beteleme - Border of South Suwawesi - Nuha (requesting upgrade to national road) = Soroako (Lake Matano Crossing Ferry should be provided)	Central
		⑤ New development of north crossing road (Tatewatu - Routa - Porehu: 200km)	Southeast
[Policy 4] Strengthening the road network in rural areas and isolated islands	(4-1) Upgrading the road function to be higher classification which linked with major cities or new regency capitals and improvement of the road in accordance with the road classification	① Upgrading West Corridor of Trans Sulawesi Road from Mamuju to Palu to be arterial national road from collector national road	West & Central
		② Upgrading East Corridor of Trans Sulawesi Road (Poso - Luwuk - Baturube - Kolonodale) to be collector national road from collector provincial road	Central & Southeast
		③ Upgrading East Coast Buton Road (Pasar Wajo - Lasalimu -Bubu - Ronta;174km and Malingano - Ronta - Ereke:73km) and Road in Wakatobi Islands	Southeast
		④ Upgrading Lapoa - Poli pololia - Kolaka (90 km)	Southeast
		⑤ Upgrading ferry routes from Manado - Bitung - Melanguane and Tahuna	North
	(4-2) Improvement of access to the underdeveloped areas to be in trafficable condition by proper maintenance.	① Access roads to underdevelopment areas should be trafficable in all seasons under the road maintenance program	Six Provinces
[Policy 5] Reduction of environment load in tranport sector	(5) Incorporation of energy-saving ferry transport in the road network system as a Nautical Highway to reduce the environmental load	① Watampone/Bajoe = Kolaka route	South & Southeast
		② Siwa = Kolaka route	South& Southeast
		③ Kolonodale = Baturube/Tokala Route across Tomori Bay (Need of New Ferry Service)	Central
		④ Kendari = Luwuk = Gorontalo	Central & Southeast
		⑤ Manado/Bitung = Tahuna = Melanguane = (Davao in Philippine)	North
		⑥ Kendari = Labuan = Baubau	Southeast
		⑦ Sinjai = Kambara - Raha	South & Southeast
[Policy 6] Improvement of traffic safety and and expansion of road capacity	(6) Widening of congested suburban roads or construction of bypass/toll roads to cope up with increasing traffic demand and to improve the natural/living environment along the congested major roads	① Trans Sulawesi Mamminasata Road /Mamminasata Bypass	South
		② Manado Bypass and Manado Ring Road	North
		③ Palu Bypass	Central
		④ Kendari Bay Crossing Bridge	Southeast
		⑤ Gorontalo - Jalaluddin - Anggrek Port Bypass	Gorontalo
[Policy 7] Control of road development with due consideration to environment	(7-1) Reinforcement of disasters prevention measurers for a flood and a landslide disasters	① East corridor of Trans Sulawesi (Luwuk - Toili - Baturube)	Central
		② Crossing roads from Mamuju to Toraja in West Sulawesi	West & South
	(7-2) Restriction of road development to maintain environmental preservation on natural resources and to protect isolated culture community	① Baturube - Kolonodale road should not be developed because of natural preservation of Morowali and appropriate ferry transport be provided instead of new road.	Central
[Policy 8] Road Management and Maintenance	(8) Strengthening road maintenance system and its management including traffic safety, capacity development and privatization, etc	① Improvement of road maintenance system including its organization, administration, capacity, fund, etc	Six Provinces
		② Enhancement of traffic management including traffic safety and control to cope up with increasing motorcycle and large sized vehicles	
		③ Road management (Reinforcement of land acquisitions and land use control, etc)	
		④ Capacity Development of regional government	
		⑤ Shifting to a private sector for implementation of toll road (Manado -Bitung Toll Road, Sutami Toll Road in Makassar)	
		⑥ Asset Management on Road and Bridge Facilities	

Source: JICA Study Team

8.2.3 Proposed Improvement Plan

Following the road development plan, the road improvement plan for the different road categories was developed with proper consideration of the present conditions of existing roads, the required classes and levels of roads as proposed in the master plan.

The Study Team classified the road improvement measures into three categories of programs, as follows:

(1) New road construction (The work includes new road development on new road alignment including right-of-way acquisition)

* **New bypass**: New bypass road construction is required to improve suburban arterial roads and mitigate traffic congestion.
* **New road**: Construction of new roads is required on missing links to complete the road connection.
* **Re-alignment:** Re-alignment of the existing road is required to improve horizontal alignment and road gradients.

(2) Betterment (The work involves reconstruction and widening, and the road alignment basically follows the existing road alignment with minor modification, if necessary)

* **Betterment 1**: The work involves reconstruction of existing pavement without widening.
* **Betterment II**: The work involves widening of existing travel-way 3.5m – 5.4m road to 6.0m to increase exiting road capacities.
* **Betterment III**: The work involves widening of existing travel-way 6.0m road to 7.0m to increase existing road capacities.
* **Betterment IV**: The work involves widening of existing travel-way 6.0m to more than 7.0m or provides for additional traffic lanes to increase their width.

(3) Maintenance

* Periodic maintenance by overlay of existing roads without widening.
* Routine maintenance by patching, cleaning, cutting glasses, etc.

The above improvement measures are applied to all existing road network of arterial and collector roads.

8.2.4 Upgrade of Road Classification

The review of functional and administrative classifications of roads is necessary due to increases in traffic volume as well as changes in the administrative functions of regional capitals from regional centers to national centers or by setting up of new regency. According to the information obtained from the road administrator in charge of each state, the upgrading of road standards is carried out through the following:

Case 1: Upgrade of Functional Classification (change in functional role by increase of traffic) - Collector Road to Arterial Roads

Case 2: Upgrade of Administrative Classification (change in administrative role by setting up of new regencies)
- Provincial Road to National Road, or
- Kabupaten Road to Provincial Road

The following is the road to be upgraded as proposed by each province.

(1) Central Sulawesi Government

1) Upgrade from collector provincial road to collector national road.
   i) Poso – Luwuk – Baturube – Kolonodale

(2) West Sulawesi Government

1) Upgrade from collector national road to arterial national road.
   i) Mamuju - Palu
2) Upgrade from the collector provincial road to collector national road.
   i) Lakahang – Tumongan Road
   ii) Kalukku – Tabang Road

(3) Southeast Sulawesi Government

1) Upgrade from the collector road to collector provincial road.
   i) East Coast Buton Road (Pasar Wajo- Lasalimu – Bubu – Ronta and Malingano – Ronta – Ereke)
   ii) Lapoa – Poli Polopia – Kolaka
   iii) Road in Wakatobi Islands

(4) South Sulawesi Government

1) Upgrade from collector provincial road to collector national road.
   i) Benteng – Barang Barang and Benteng - Patori
   ii) Bulukumba – Bira
   iii) Makale – Se'seng – BTS. Mamasa
   iv) BTS. Mamasa – Sae- Tallang - Sabbang

Figure 8.2.1 shows the proposed upgrade plans of arterial and collector roads in Sulawesi.

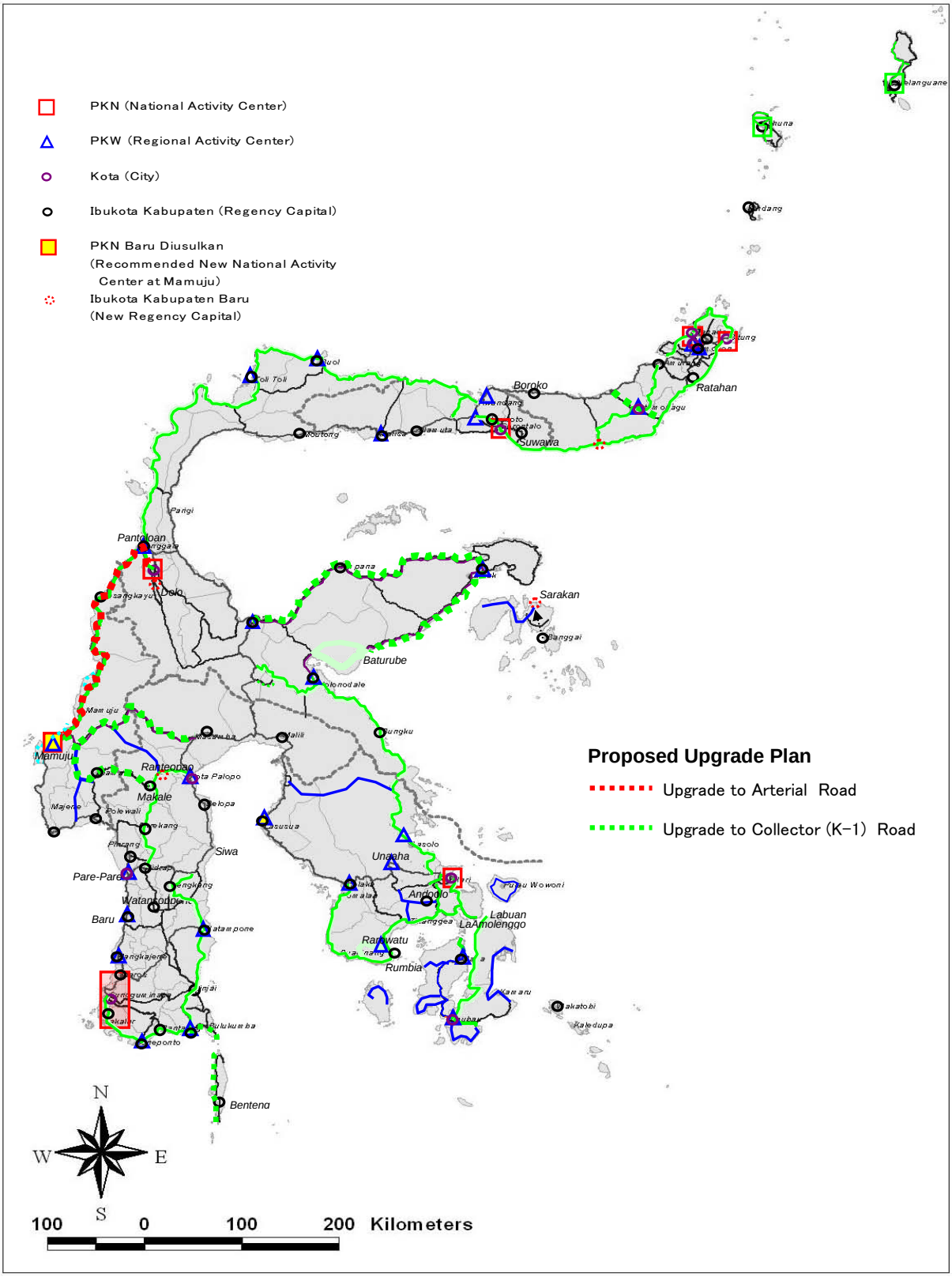


Figure 8.2.1 Proposed Upgrade Plan of Arterial and Collector Roads

8.2.5 Staged Application of New Road Standard Regulations

The government issued the new regulation "Government Road Regulation/Peraturaan Pemerintah Nomor No.34 Tahun 2006 Tentang Jalan (PP No. 34 Year 2006) replacing PP No. 26, 1985. One of the major changes in the new regulation is roadway and travel-way widths. The new regulation specifies a 7 m- travel-way width for the medium roads. The relation of road width with the traffic level has not yet been issued concerning PP No.34 Year 2006.

The road survey reveals the road network length to be relatively sufficient however road design levels and the quality of bridges are in poor condition. Approximately 90% of the national roads and 95% of the provincial roads have less than 7 m travel-way width and approximately 66% of the national roads and 89% of the provincial roads have a travel-way width of 3.0m – 5.4m.

The Study Team judged that it is not technically and economically feasible to promptly apply new road regulations to all road projects taking into consideration the above existing road conditions as well as the existing traffic volumes. It made a per stage study based on present and future traffic demands.

As the result, the Study Team prepared the proposal "Stage-wise Road Development Standards with a 7m Travel-way as specified in the New Road Regulation (PP Mo 34 Year 2006) for Arterial Road and Collector Roads in Sulawesi Island." It submitted the proposal to the Bina Marga as a discussion paper on October 5, 2007. (See Appendix 7) of this study.

Figure 8.2.2 shows the proposed stage-wise application on new road standards by type of existing road widths, road classifications and proposed improvement measures based on present and future traffic demands.

The following is the summary of recommendations:

- Primary arterial roads should be widened to the 7.0m travel-way standard by the target year 2024.
- Primary collector roads should be widened to 7.0m by stages based on present and future traffic demands.
- Periodic and routine maintenance should be given first priority to sustain national and provincial road assets.

The Study Team examined the economic feasibility on the stage-wise application of the new road standard based on the following assumptions and evaluation methods:

(1) Assumption

- Road length assumed : 30km
- Evaluation period : from 2007 to 2030

- Traffic volume : For the case involving 500, 1000, 2000, 3000 and 4000 pcu per day starting from 2007 with a growth rate of 5% annum and afterwards up to 2030.
- Road roughness : IRI = 3 (fixed)
- Q-V Formula : The Q-V Formula (relationship between traffic volume (Q) and travel speed (V) was applied changing both Vmax and Qmax (capacity) depending on the travel speed width (4.5m, 6.0m and 7.0m respectively)

(2) Methodology for Evaluation

From an economic point of view 11 cases were evaluated by type of width, traffic volumes in 2007, applying the Cost Benefit Analysis.

(3) Cost Estimation

The cost estimates were conducted for periodic maintenance, betterment (widening) and routine maintenance. Land acquisition costs were excluded as most of the roads were located in the rural areas making them not too substantial compared with road development and maintenance costs.

(4) Benefit Estimation

Economic benefit estimates in the analysis showed savings in the Vehicle Operating Cost (VOC) due to the widening of travel-way widths and the application of the same unit values of the VOC's and prepared for the IRMS as follows:

- $VOCi = BASEi * NDXi$
- $NDXi = kli + k2i/Vi + k3i*Vi^2 + k4i*IRI + k5i*IRI^2$

Where

VOCi	: Unit VOC for vehicle type (i) in Rp/km
BASEi	: Base VOC for vehicle type (i) in Rp/km under the "good condition" with roughness 3
NDXi	: VOC index for vehicle type (i)
Vi	: Vehicle speed for vehicle type (i) in km/hour
IRI	: Road roughness (m/km)
k1 --- k5	: Coefficients by vehicle type

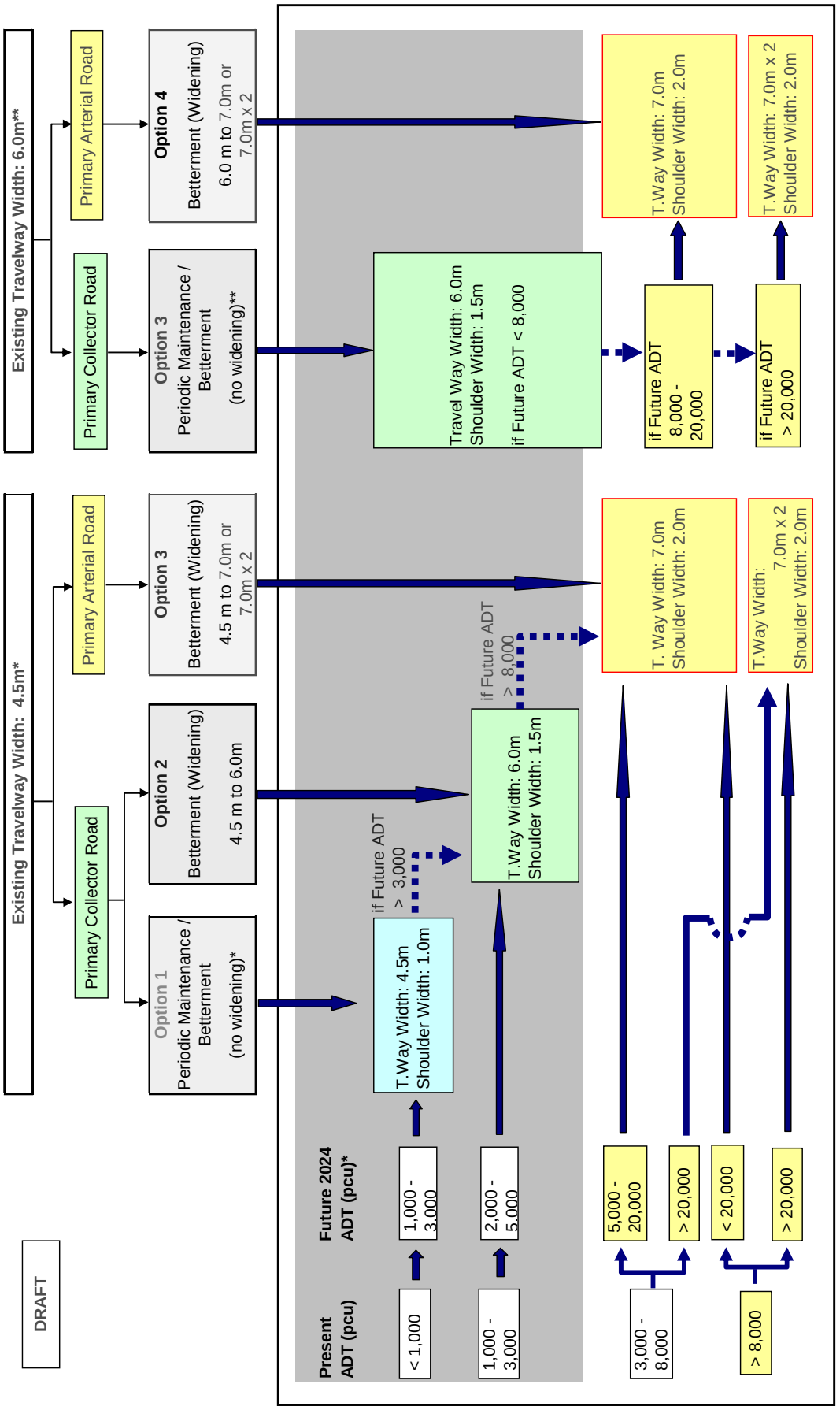
(5) Result of Evaluation

Economic Internal Rate of Return (EIRR) was evaluated for each 11 cases based on the VOC

saving benefits compared with the costs for widening and maintenance. **Figure 8.2.3** shows the result of the Economic Evaluation by Road Development Option. The following are the summary and recommendations:

(6) Conclusion and Recommendations

- If present traffic volume is less than 500 pcu:
  - ✧ Widening of existing road will not be economically feasible in any case, so that these roads should be maintained as they were without widening until 2024.
- If present traffic volume is 1,000 pcu more or less:
  - ✧ Widening (either to 6.0m or 7.0m) is economically feasible for the existing 4.5m road, but it should consider the best timing for opening the FYRR (First Year Rate of Return).
  - ✧ Widening (to 7.0m) is not economically feasible for the existing 6.0m roads. They should be maintained as they were until 2024 without widening..
- If present traffic volume is 2000 pcu more or less:
  - ✧ Widening (either to 6.0m or 7.0m) is economically feasible for the existing 4.5m road, it should be widened as soon as possible.
  - ✧ Widening (to 7.0m) is economically feasible for existing 6.0m roads, but the best timing for opening of the FYRR (First Year Rate of Return) should be considered.
- If present traffic volume exceeds 3000 pcu more or less:
  - ✧ Widening of existing roads is economically feasible in any cases, therefore existing roads should be widened as soon as possible.



Notes: 1. * Exiting Travelway Width 3.0 - 5.4m, ** 5.5 - 6.5m
2. T.Way : Travelway
3. Standard travelway width of medium road is 7.0m for 2-lane/2-way road.

Figure 8.2.2 Proposed Stage-wised Application on New Road Standard

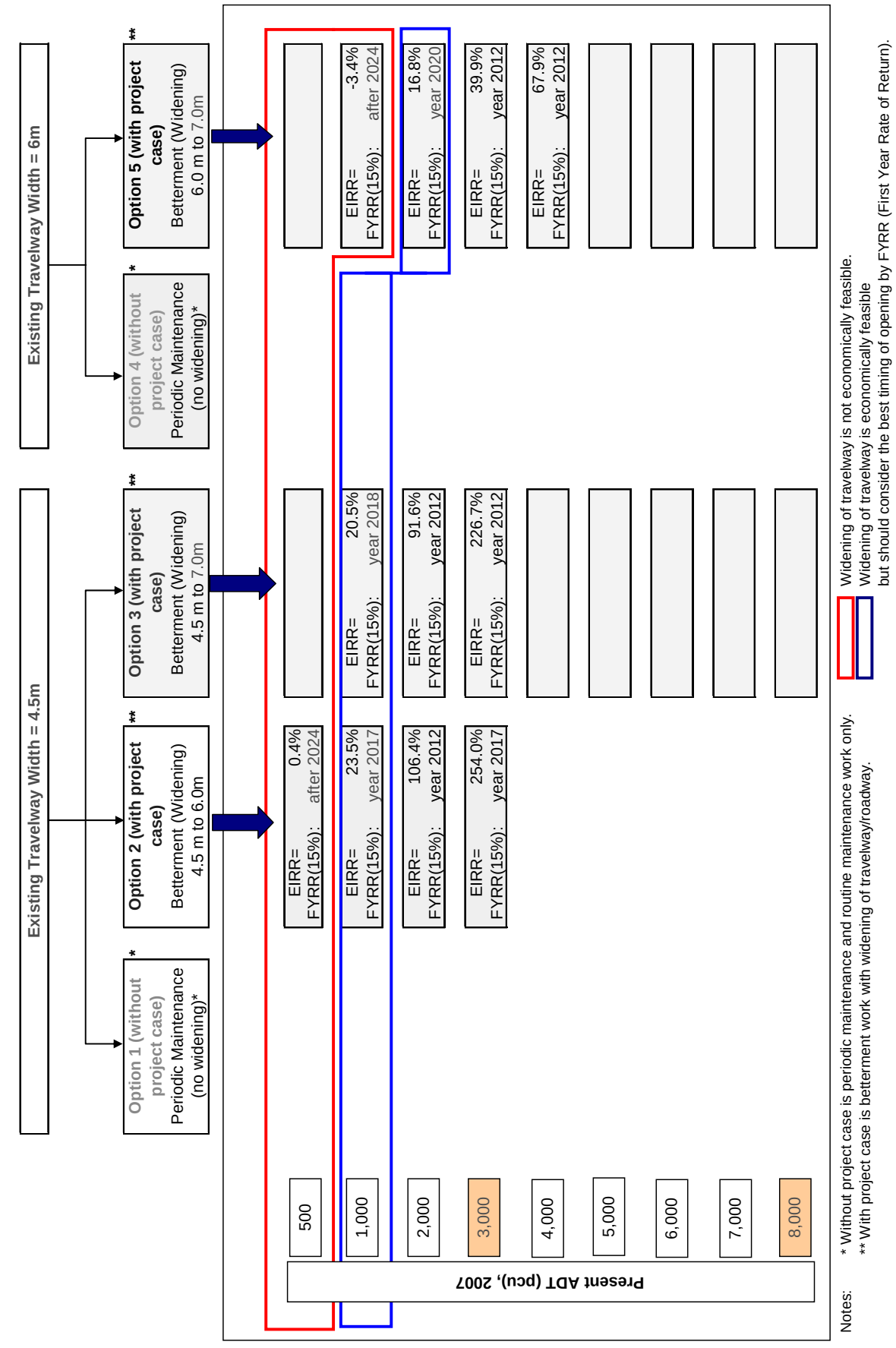


Figure 8.2.3 Economic Analysis by Road Development Option

8.2.6 Needs for Capacity Expansion Plan

In a "without project" case for 2024, the Study Team conducted future traffic assignments on the existing road network to identify the capacity expansion needs of the existing road network in Sulawesi.

The need for capacity expansion can be determined through the application of a stage-wise application method on the new road standard regulations as recommended by the Study Team.

Figure 8.2.4 (1) ~ Figure 8.2.4 (3) show the needs of capacity expansion for existing roads by province based on the category of existing carriageway widths of either 4.5 m or 6.0 m. **Figure 8.2.5** shows the summary of capacity expansions of the road network.

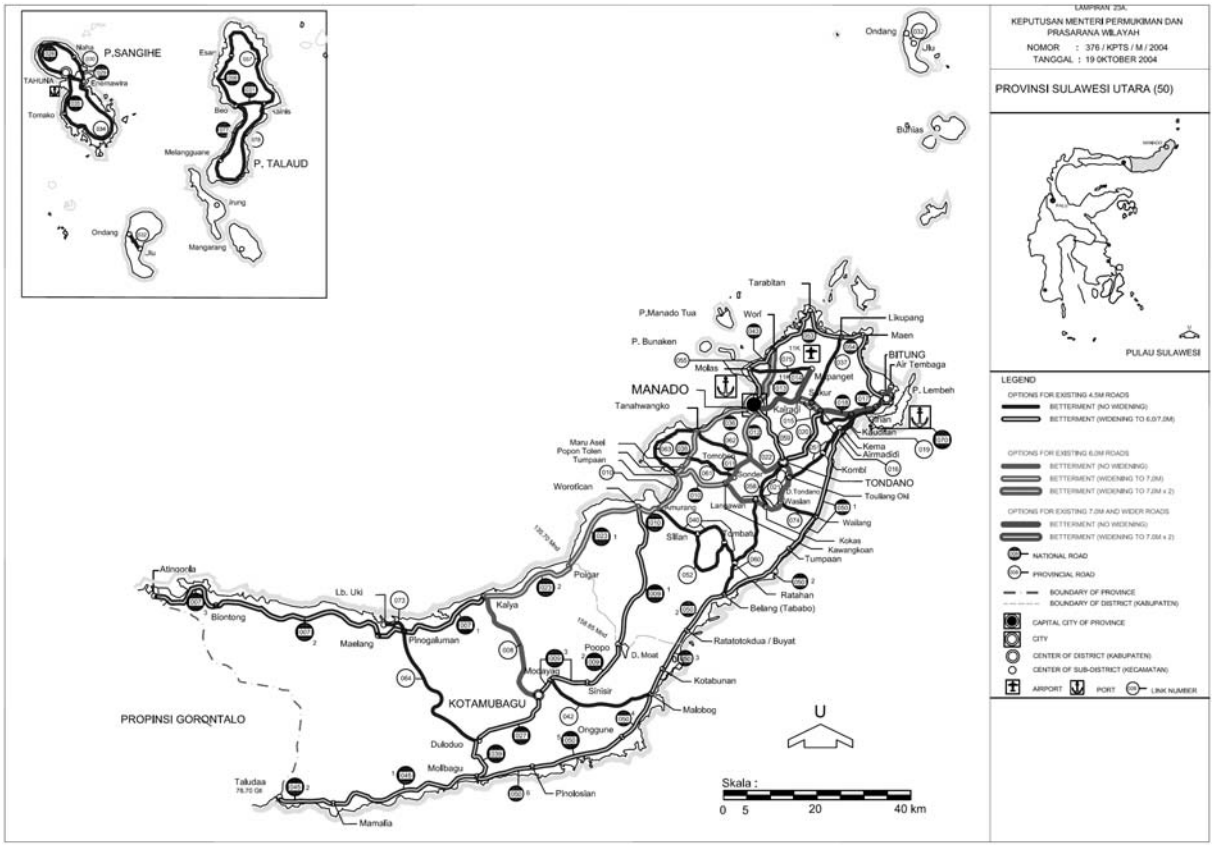
Table 8.2.3 shows the summary of capacity expansions of the existing road network divided into the trunk road network that constitutes the Trans-Sulawesi road network and other road networks consisting of arterial and collector roads excluding the Trans-Sulawesi road.

Table 8.2.3 Needs for Capacity Expansion of Existing Road Network

unit: km

PROVINCE/ROAD CATEGORY	BETTERMENT					NEW ROAD	MTNCE ONLY	TOTAL
	I	II	III	IV	TOTAL			
NORTH SULAWESI PROVINCE								
NATIONAL ROAD	109	638	368	29	1,144	0	188	1,332
ARTERIAL	0	0	315	15	329	0	22	351
COLLECTOR 1	109	638	53	15	814	0	167	981
PROVINCIAL ROAD	276	50	18	0	344	30	516	890
TOTAL	384	688	386	29	1,488	30	704	2,222
GORONTALO PROVINCE								
NATIONAL ROAD	60	73	320	0	453	0	151	604
ARTERIAL	0	0	306	0	306	0	0	306
COLLECTOR 1	60	73	14	0	147	0	151	299
PROVINCIAL ROAD	262	0	0	0	262	0	123	385
TOTAL	322	73	320	0	715	0	274	989
CENTRAL SULAWESI PROVINCE								
NATIONAL ROAD	419	0	724	0	1,142	0	1,179	2,322
ARTERIAL	0	0	724	0	724	0	20	743
COLLECTOR 1	419	0	0	0	419	0	1,160	1,578
PROVINCIAL ROAD	624	0	0	0	624	0	803	1,426
TOTAL	1,043	0	724	0	1,766	0	1,982	3,748
WEST SULAWESI PROVINCE								
NATIONAL ROAD	219	100	512	0	831	0	2	833
ARTERIAL	0	0	512	0	512	0	2	514
COLLECTOR 1	219	100	0	0	319	0	0	319
PROVINCIAL ROAD	143	100	0	0	243	0	45	288
TOTAL	362	200	512	0	1,074	0	47	1,121
SOUTH SULAWESI PROVINCE								
NATIONAL ROAD	110	349	767	162	1,389	16	275	1,679
ARTERIAL	0	0	657	134	791	16	72	879
COLLECTOR 1	110	349	110	27	598	0	203	800
PROVINCIAL ROAD	73	319	43	0	436	70	602	1,108
TOTAL	183	669	811	162	1,824	86	877	2,787
SOUTHEAST SULAWESI PROVINCE								
NATIONAL ROAD	419	0	464	0	882	150	339	1,372
ARTERIAL	0	0	464	0	464	0	0	464
COLLECTOR 1	419	0	0	0	419	150	339	908
PROVINCIAL ROAD	335	0	0	0	335	0	354	689
TOTAL	753	0	464	0	1,217	150	694	2,060
TOTAL	**3,046**	**1,630**	**3,215**	**191**	**8,083**	**266**	**4,577**	**12,926**

Betterment I: Re-construction without widening of road structure that is currently in poor condition
Betterment II: Widening from existing 3.5 – 5.4 m road to 6.0m
Betterment III: Widening from existing 6.0m road to 7.0m
Betterment IV: Widening from existing 6.0/7.0m road to 2 x 7.0m
New Roads include 6.0m roads, 7.0m roads and 2 x 7.0m roads.



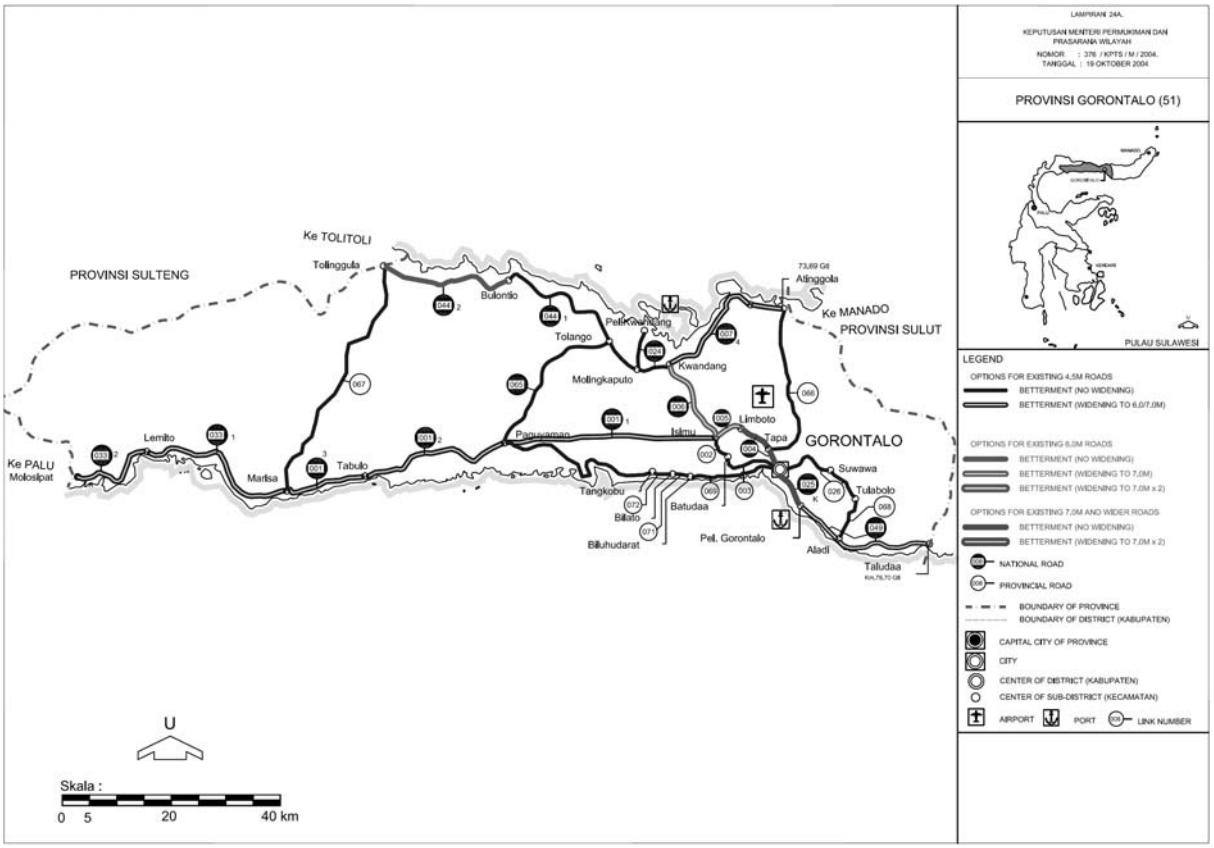


Figure 8.2.4 (1) Needs for Capacity Expansion of Existing Roads (North & Gorontalo)

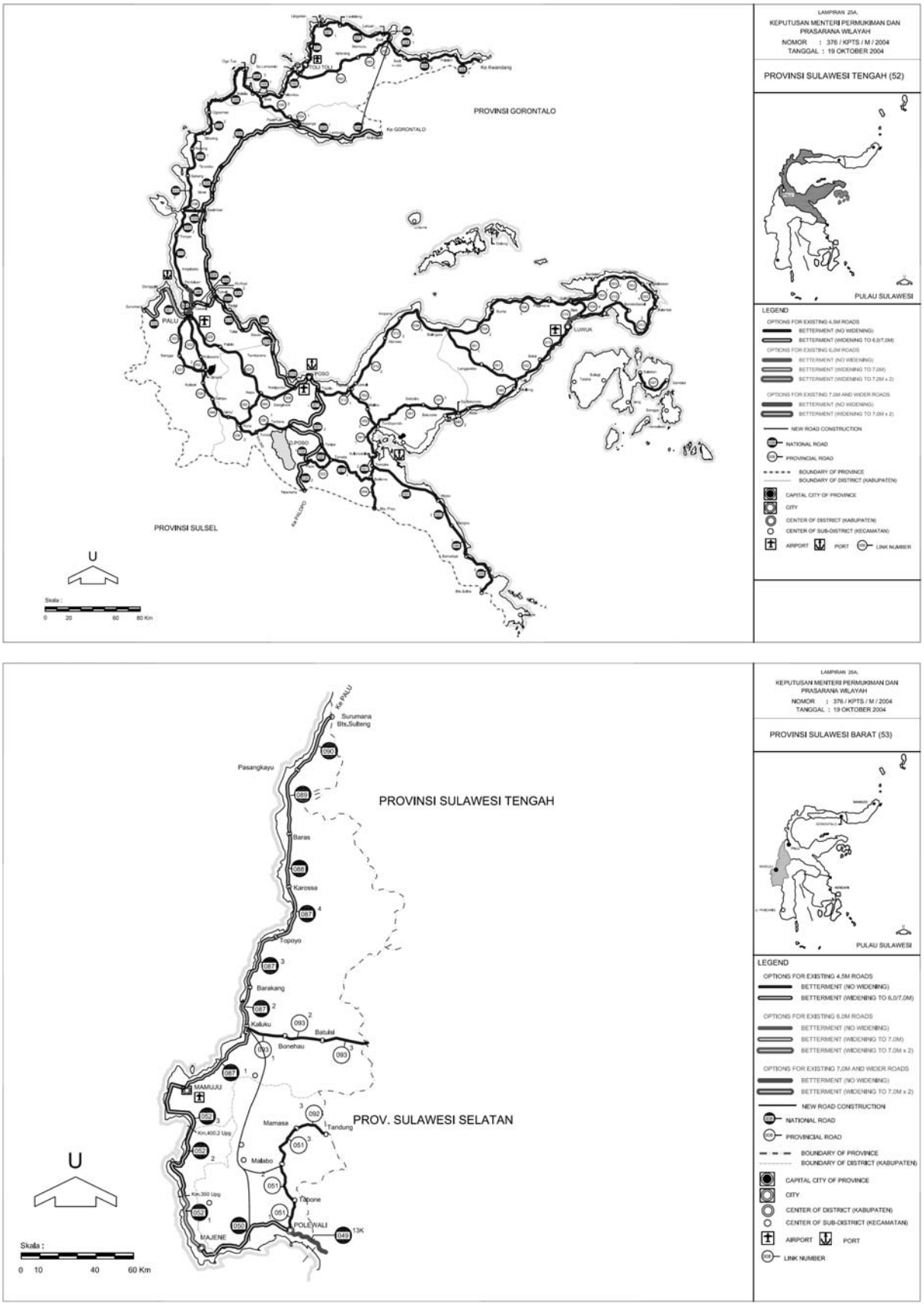


Figure 8.2.4 (2) Needs for Capacity Expansion of Existing Roads (Central & West)

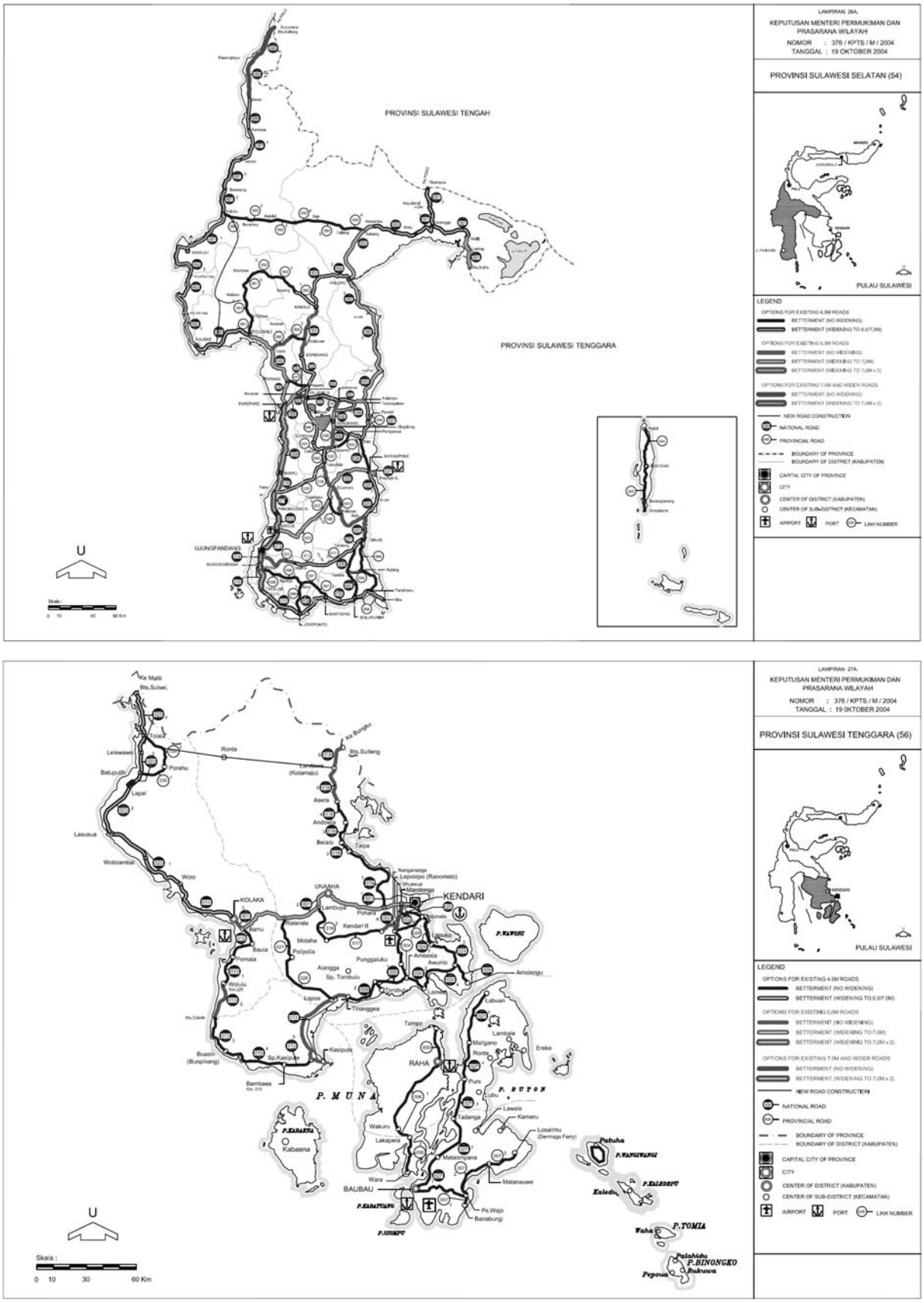


Figure 8.2.4 (3) Needs for Capacity Expansion of Existing Roads (South & Southeast)

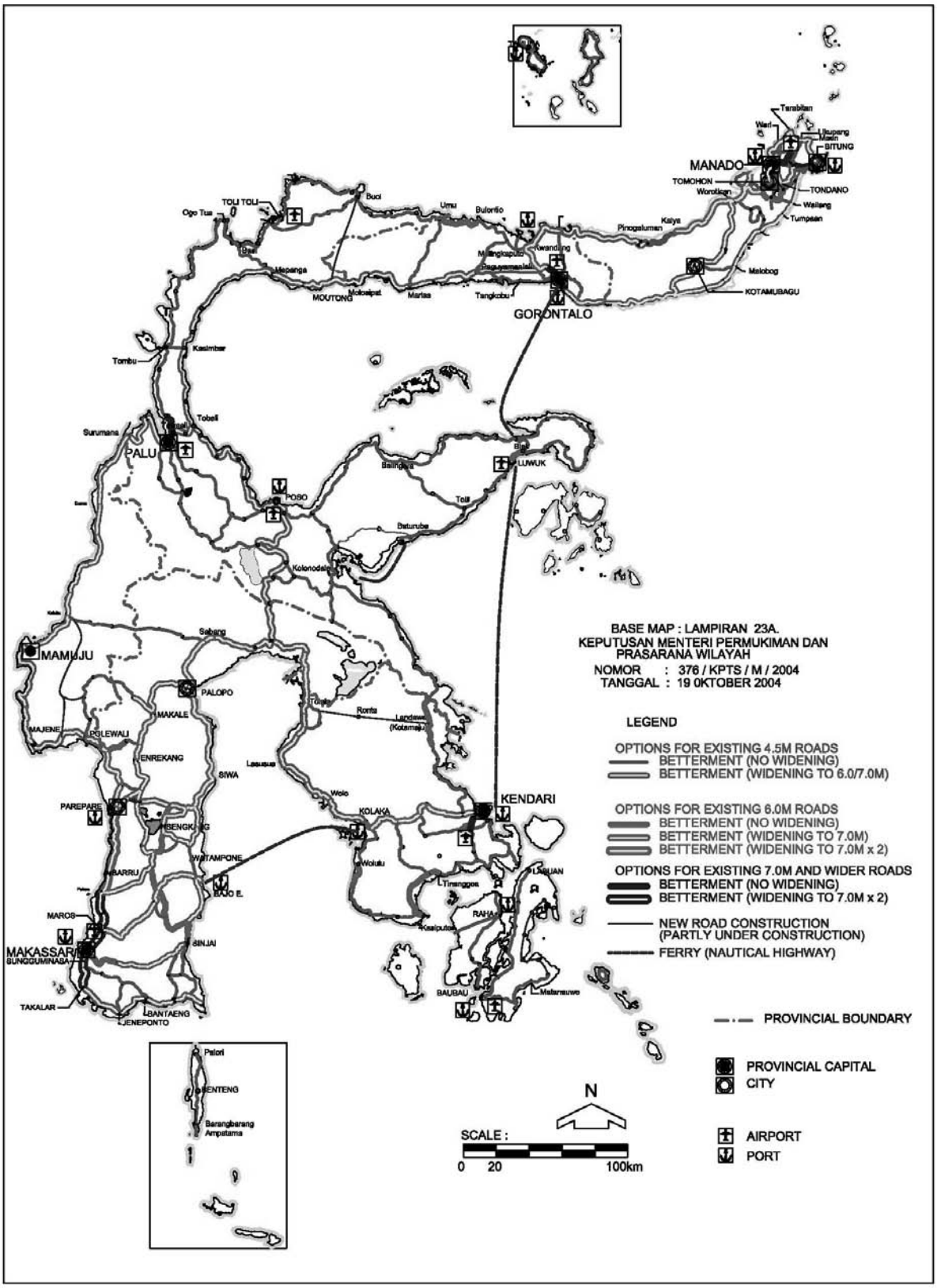


Figure 8.2.5 Summary of Capacity Expansion Plan

8.2.7 Needs for Pavement Improvement Plans

In addition to the study on capacity expansion needs, the Study Team examined the existing road network from the view point of pavement improvement needs based on the inventory of existing road conditions.

Existing road conditions is classified into four degrees depending on pavement conditions as shown below:

Class I: Good, Class II: Fair, Class III: Poor, Class IV: Bad

In principle, the pavement improvement should be conducted taking into account the timing for widening for of the existing roads which can be determined in line with the stage-wise application method of the new road standard regulations. However, the Study Team proposes that the road sections which are in poor and bad conditions and classified as Class III and Class IV should be improved by either overlay or reconstruction, in the short term, taking into consideration traffic safety as well as roadside environmental conditions.

The summary of pavement improvements is shown in **Table 8.2.4**.

Table 8.2.4 Needs for Pavement Improvement of Existing Road Network

Prog. No	Project	Section	Need for Pavement Improvement				
			Class I Good	Class II Fair	Class III Poor	Class IV Bad	Total
TS-1	West Corridor (South section)	Jeneponto – Makassar – Parepare – Mamuju – Palu	276	304	73	193	846
TS-2	West Corridor (North section)	Palu – Kwandang – Manado – Bitung	741	475	61	113	1,390
TS-3	Central Corridor (South section)	Jeneponto – Watampone – Tarregne – Poso – Tobori	507	405	38	1	951
TS-4	Central Corridor (North section)	Tobori – Gorontalo – Bitung	445	319	184	64	1,012
TS-5	East Corridor	Tarrenge – Kolaka – Kendari – Tompira –Luwuk – Poso	378	1113	402	304	2,197
Total (1)			**2,347**	**2,616**	**758**	**675**	**6,396**
PR-1	North Sulawesi Province		492	455	260	152	1,359
PR-2	Gorontalo Province		151	102	219	4	476
PR-3	Central Sulawesi Province		92	633	293	177	1,195
PR-4	West Sulawesi Province		6	45	0	256	307
PR-5	South Sulawesi Province		401	839	241	165	1,646
PR-6	Southeast Sulawesi Province		276	174	20	227	697
Total (2)			**1,418**	**2,248**	**1,033**	**981**	**5,680**
			3,765	**4,864**	**1,791**	**1,656**	**12,076**

Source: JICA Study Team

8.2.8 Bridge Improvement Plan

According to the Integrated Bridge Management System (IBMS), the prevailing conditions of the exiting bridges are classified into five degrees depending on their structural integrity:

Grade 1: Good, Grade 2: Fair, Grade 3: Poor, Grade 4: Bad, Grade 5: Impassable

The Study Team updated the IBMS bridge inventory based on the data and information collected from each province. As a result, it was revealed that there are currently 3,344 bridges on the national roads and 2,523 bridges on the provincial roads..

Of this total, about 10% on the national roads an 16% on the provincial roads are Grade 4 "Bad", Grade 5 "Impassable" and wooden bridges.

The Study Team proposes that all bridges categorized in Grade 4, Grade 5 and wooden should be improved as permanent bridges in the short term to avoid traffic accidents as well as minimize impacts on local socio-economic activities caused by potential bridge collapses.

To achieve the above objective the following bridge improvement projects are recommended:

Program B-1: All temporary bridges, or bridges with low standards, on national roads should be reconstructed into permanent bridges in the medium- and long-term plans by the year 2024.

Program B-2: All bridges under Grade 4 and Grade 5 should be reconstructed into permanent bridges in the short-term plan by 2014.

Table 8.2.5 and **Table 8.2.6** show the summary of bridge improvement plans by an urgent bridge repair program.

Table 8.2.5 Summary of Bridge Conditions on National Road

Province	No Damage /Good (Grade 1)	Fair/Poor (Grade 2 & 3)	Bad/Very Bad (Grade 4 & 5)	Wooden/ Unknown	Total
North Sulawesi	399 (67.5%)	109 (18.4%)	41 (6.9%)	42 (7.1%)	591 (100%)
Gorontalo	271 (95.4%)	10 (3.5%)	3 (1.1%)	0 (0%)	284 (100%)
Central Sulawesi	496 (53.6%)	381 (41.2%)	40 (4.3%)	8 (0.9%)	925 (100%)
West Sulawesi	178 (64.3%)	43 (15.5%)	20 (7.2%)	36 (13.0%)	277 (100%)
South Sulawesi	489 (70.5%)	194 (28.0%)	11 (1.6%)	0 (0%)	694 (100%)
South East Sulawesi	308 (53.8%)	140 (24.4%)	75 (13.1%)	50 (8.7%)	573 (100%)
Total	2,141 (64.0%)	877 (26.2%)	190 (5.7%)	136 (4.1%)	3,344 (100%)
			326 (9.8%), 5,510m		

Source: JICA Study Team based on information form Dinas PU

Table 8.2.6 Summary of Bridge Conditions on Provincial Road

Province	No Damage /Good (Grade 1)	Fair/Poor (Grade 2 & 3)	Bad/Very Bad (Grade 4 & 5)	Wooden/ Unknown	Total
North Sulawesi	272 (71.2%)	51 (13.4%)	1 (0.3%)	58 (15.2%)	382 (100%)
Gorontalo	21 (38.9%)	0 (0%)	33 (61.1%)	0 (0%)	54 (100%)
Central Sulawesi	726 (92.8%)	9 (1.2%)	0 (0%)	47 (6.0%)	782 (100%)
West Sulawesi	63 (71.6%)	22 (25.0%)	2 (2.3%)	1 (1.1%)	88 (100%)
South Sulawesi	476 (69.6%)	127 (18.6%)	56 (8.2%)	25 (3.6%)	684 (100%)
South East Sulawesi	242 (45.4%)	117 (22.0%)	69 (12.9%)	105 (19.7%)	533 (100%)
Total	1,800 (71.3%)	326 (12.9%)	161 (6.4%)	236 (9.4%)	2,523 (100%)
			397 (15.8%), 6,049m		

Source: JICA Study Team based on information form Dinas PU

8.2.9 Sulawesi Road Master Plan in 2024 (SRMP)

Based on the discussion in section 8.3.1 to section 8.3.7, the Study Team lays down the Sulawesi Road Master Plan by 2024 (hereinafter referred to as SRMP) for arterial roads and collector roads with the proposed improvement measures**.**

All roads including arterial and collector roads in Sulawesi will be improved to the road levels with sufficient capacities and standards so as to meet the required traffic demands. Table 8.2.7 shows the summary of the development concepts in the SRMP by 2024:

Table 8.2.7 Development Concepts of the Sulawesi Road Master Plan by 2024

Road Classification			Road Structure		Development Concept of Sulawesi Road Master Plan
			Nos. of Lane	Pavement Width	
I	Nationa Road	Arterial Road	2 lanes	7.0 m	All arterial national road become 7.0m road regardless of traffic volume and will be improved to be all weather condition with sufficient capacity and standard
		Collector Road (K-1)	2 lanes	6.0m - 7.0 m	The road carrying the traffic more than 3,000 p.c.u/day - 8,000 p.c.u/day become 6.0 m road and the road more than 8,000 p.c.u/day become 7.0m road
			1.5 lanes	4.5m (3.5m-5.4m)	The road carrying the traffic less than 3,000 p.c.u/day will be the 1.5 lanes road but improved to be all weather condition road with asphaltic concrete
II	Provincial Road	Collector Road (K-2&3)	2 lanes	6.0m - 7.0 m	Same as Collector K-1 Road
			1.5 lanes	4.5m (3.5m-5.4m)	Same as Collector K-1 Road

Figure 8.2.6 shows the proposed road master plan (SRMP) by 2024 and the proposed road length of the national roads and provincial roads by province by 2024 is presented in Table 8.2.8. The total length of the national roads will increase from 1,050km to 8,141km while the provincial roads will decrease by 191km to 4,786km in 2024.

Table 8.2.8 Summary of the Sulawesi Road Master Plan by 2024

Unit: Km

Province	National Road			Provincal Road	Total
	Arterial Road	Collector K-1	Total	Collector K-2&3	
North Sulawesi Province	351	981	1,332	890	2,222
Gorontalo Province	306	299	604	385	989
Central Sulawesi Province	743	1,578	2,322	1,426	3,748
West Sulawesi Province	514	319	833	288	1,121
South Sulawesi Province	879	800	1,679	1,108	2,787
Souteast Sulawesi Province	464	908	1,371	689	2,060
Total	3,256	4,884	8,141	4,786	12,926

The following benefits are expected upon the completion of the road network system by 2024,;

i) A harmonized economic development in Sulawesi is expected through the strengthening of economic linkage between the six provinces due to the completion of Trans-Sulawesi Road which can now be categorized as a high standard all weather road network.

ii) Improvement of basic human needs as well as poverty alleviation will come about in the rural areas and isolated islands through the strengthening of the road network system by the completion of the missing links in the network.

iii) The development of processing industries that utilizes the potential resources of Sulawesi will grow due to the increase in accessibility to the resource areas.

iv) The natural environment and isolated cultural communities will be properly protected by the road development with proper and diligent consideration of the surrounding environment.

v) Increase of environmental load in Sulawesi will be minimized through the incorporation of energy-saving transport ferries servicing the road network system and strengthening the nautical highway network.

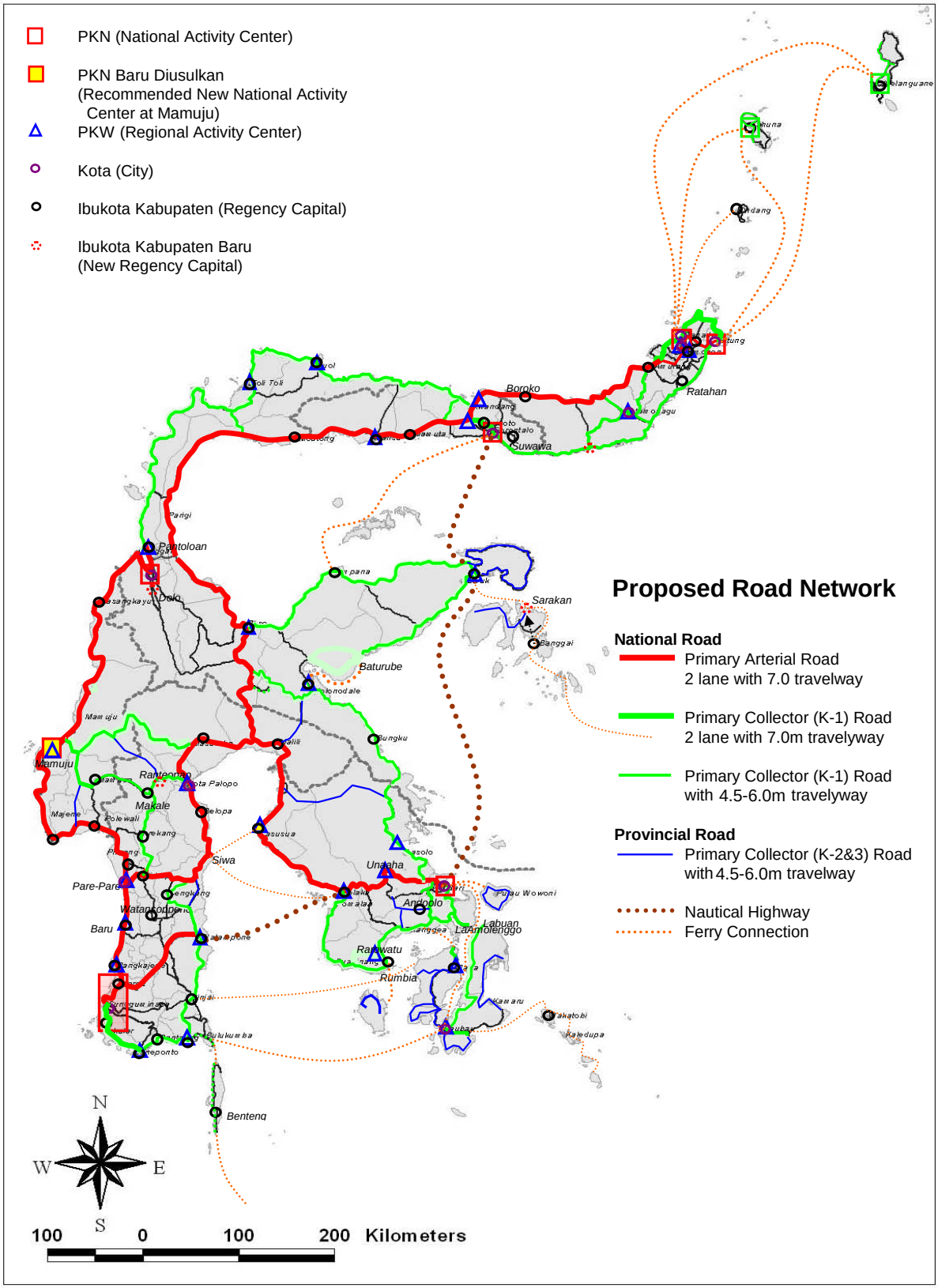


Figure 8.2.6 Sulawesi Road Master Plan in 2024 (SRMP)