4.5 Preliminary Study for a Satellite Town Development along Mamminasa Bypass

4.5.1 Satellite Town Development for Mamminasata Metropolitan Area

(1) Introduction

In the Integrated Spatial Plan for the Mamminasata Metropolitan Area, ("the Mamminasata Study"), new town development outside the boundary of Kota Makassar was proposed with the aims of dispersing population and urban activities to the east of Makassar City so as to alleviate the present and future traffic and population congestions and consequently to increase urban green areas, and of reducing urban sprawls rampant on the outskirts of the city.

However, before finalizing such urban policies, careful re-examination must be conducted. For instance, the following questions should be studied and answered appropriately: "Is or will be soon the Makassar administration area plagued with so high population density that the population and urban activities must be dispersed outside its administrative boundary and towards the neighboring regencies by constructing satellite towns?"; or "Is the Makassar administration area too small to accommodate the present and predicted population size (1.69 million)?"; and "What is the real cause of the current traffic congestion? Is it over-concentration of population in Makassar City or poor road infrastructure and management?". If the latter is the answer, priority for investment should be placed on the road improvement in the urban area, rather than on the development of a satellite town.

A new town development or any urban development schemes should be carefully elaborated in line with the appropriate city planning. Otherwise, it may result in waste of precious land resources and fund and inconvenient urban living environment for the next generation. City planning system is designed to effectively contain urbanization for effective land management and consequently accommodate the most part of urban population within the limited distance from the city center - "General built-up urban area with high efficiency of landuse (reasonably high population density) and effective infrastructure". However, on the other hand, new urban areas with specific purposes like new/satellite towns or industrial towns/estates associated with the general urban areas are planned to be developed outside.

(2) Population Accommodation Capacity of Makassar City

It should be noted that the population density of Makassar City is not higher, but is rather low compared to other major cities in Indonesia as shown in **Table 4.5.1**, even so in the case where such water land areas as river, wetland/fishpond and reservoir are deducted from the administrative area of Makassar City. With a population size of 1.69 million as forecast for 2020, the population density in Makassar will increase to 11,000 people per km^2 which is slightly higher than the present population densities in Surabaya and Medan.

Table 4.5.1 Population Densities in Major Cities in Indonesia

Major Cities	Population	Area (km^2)	Density (pop./km^2)
Bandung	2,510,982	167.67	14,976
Surabaya	2,599,796	274.06	9,486
Medan	2,392,922	265.10	9,026
Yog Jakarta	511,744	32.80	15,602
Makassar	1,100,000	180.54	6,093
Excl. water land	1,100,000	153.64	7,160
2020 estimated	1,690,000	153.64	11,000

Water land (26.9 km^2): River, Wet land/Fishpond, reservoir

In fact, a report on Makassar City Spatial Plan (BAPPEDA, Makassar City) in December 2005 estimated the maximum population capacity of Makassar City at 3.0 million people for the total area of 17,438 ha (residential area: 9,018 ha, population density: 100 to 500 person/ha). This denotes that one half of the total land capacity is enough for accommodating the estimated future population (1.69 million in 2020) of Makassar City, and the other half can be kept for natural preservation or disaster prevention (mainly flood) by prohibiting urban housing and development on it. The above-mentioned Mamminasata Study proposed "Improvement of Landuse" through the construction of three-story multi-family apartment houses (gross 70 persons/ha) instead of the existing one-story independent buildings (gross 90 persons/ha), consequently accommodating 1.6 million people in the territory of Makassar. This contributes to reducing the required housing land for accommodating the estimated population of Makassar City.

(3) Depopulating Inside and Populating Outside

Urbanization or built-up areas has been spreading broadly throughout and beyond the administrative boundary of Makassar City. **Figure 4.5.1** and **Table 4.5.2,** showing the recent change of population distribution by sub-district from the center to suburbs, indicate a prominent trend of "**Depopulating inside and populating outside**". It may be said that the most important task of city planning for Makassar City is to cope with this prominent trend of urbanization, otherwise it would lead to the existence of ineffective and inefficient urban areas in future.

While eight (8) dictrics in the central part of Makassar City have been losing population and those in the fringe areas next to the central district (Tallo, Panakkukang, Rappocini, Tamalate) had a stagnant population growth rate, the districts located in a 5-10 km radius from the city center (Manggala and Tamalanrea) have been experiencing a higher population growth, and Biringkanaya located 10-15 km from the city center recorded the highest increase of 6.04 % per annum. This proves that Makassar City has a definite pattern of suburbanization of population or, in other words, out-spreading settlements or sprawls. In addition, Somba Opu in Gowa Regency located within a 5-10 km range from the Makassar City center, and even such Kecamatans as Mandai (M), Moncongloe (M) and Pattallassang (G), which are all located 15-20 km from the Makassar City center, have shown considerable population increase. This suggests that Makassar's population has been spilling over beyond its administrative boundary.

If the above situation continues, Makassar and the surrounding regencies may be faced with serious a urban problem, that is "Hollowing urban areas with vacant unused land inside, especially Makassar, and sprawled urban areas scattered outside, especially in Maros and Gowa Regencies".

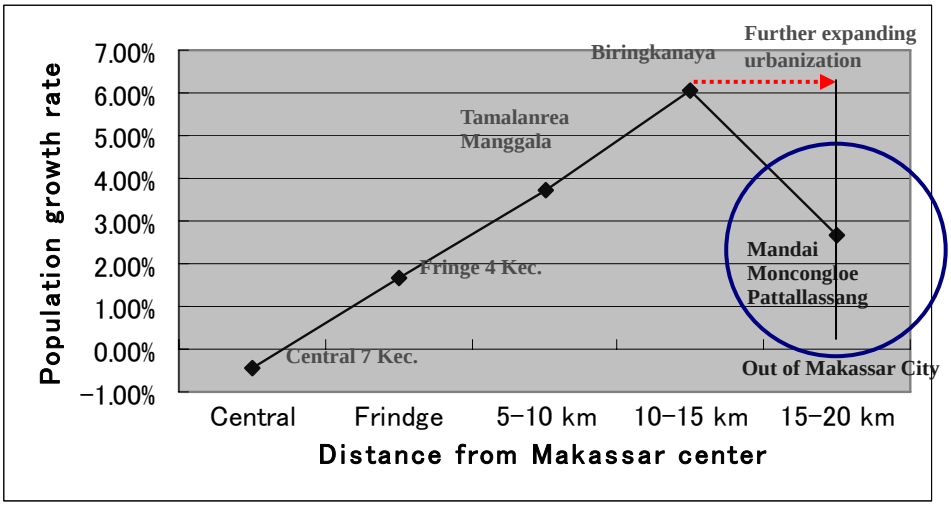


Figure 4.5.1 Depopulating Inside and Populating Outside (2000-2003)

Measures to combat this urban problem in city planning are to absorb the increasing population in the urban area within the limited distance from the Makassar City center, redevelopment of the city center (old towns), and development of new towns for the out-going population at the optimal distance.

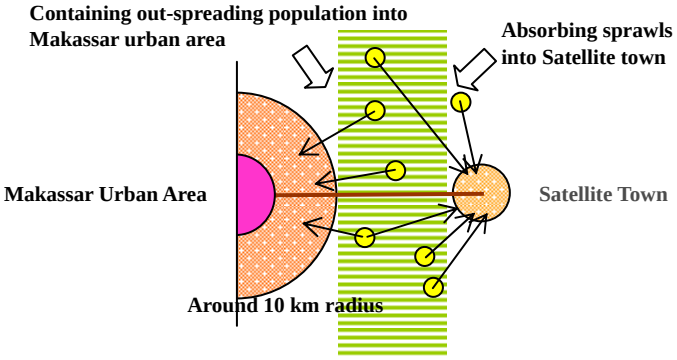


Figure 4.5.2 Makassar City Planning Measures

(4) Makassar Urban Area

There seems to be a variety of factors that reduce the population in areas closer to the center and enhance the out-spreading of population, among which is the "rising land prices" of areas closer to the central districts. Higher land value tends to convert residential land into commercial land in the Makassar urban center according to the economic rules.

However, it must be admitted that there remains a large amount of unused/undeveloped land left in and around the built-up areas and especially sprawl areas with small housing estates and subdivisions in the suburban area. Unused/undeveloped areas or pocket lands are prominent where urban land use (buildings and housings) emerge only along the frontline of the arterial roads, leaving the large tract of land behind inaccessible and undeveloped. This is because of the lack of collector/distributor roads from and to the arterial roads to develop the urban areas in an effective manner.

Table 4.5.2 Changing Population Distribution and Projection

		2000		2003		2000-2003		2020		2003-2020
Kecamatan	**Area (ha)**	**Pop.**	**Den.**	**Pop.**	**Den.**	**Rate**	**Pop.**	**Pop.**	**Den.**	**Pop.**
Makassar	**18,057**	**1,100,019**	**61**	**1,160,011**	**64**	**1.79%**	**59,992**	**1,567,279**	**87**	**407,268**
Central	**1,749**	**352,789**	**202**	**347,955**	**199**	**-0.46%**	**-4,834**	**301,220**	**172**	**-46,735**
Ujung Tanah	268	44,055	164	45,156	168	0.83%	1,101	48,039	179	2,883
Wajo	212	34,114	161	32,519	153	-1.58%	-1,595	22,931	108	-9,588
Bontoala	204	56,875	279	54,671	268	-1.31%	-2,204	40,423	198	-14,248
Ujung Pandang	301	27,765	92	27,279	90	-0.59%	-486	22,830	76	-4,449
Makassar	250	80,127	321	79,362	318	-0.32%	-765	69,525	279	-9,837
Mariso	257	51,003	198	51,980	202	0.63%	977	53,539	208	1,559
Mamajang	257	58,850	229	56,988	222	-1.07%	-1,862	43,933	171	-13,055
Fringe	**8,089**	**446,459**	**55**	**469,012**	**58**	**1.66%**	**22,553**	**579,467**	**72**	**110,455**
Tallo	864	115,527	134	124,755	144	2.59%	9,228	178,367	206	53,612
Panakkukang	1,585	123,820	78	127,632	81	1.02%	3,812	140,190	88	12,558
Rappocini	821	125,498	153	133,660	163	2.12%	8,162	176,686	215	43,026
Tamalate	4,819	81,614	17	82,965	17	0.55%	1,351	84,224	17	1,259
5-10 km	**5,308**	**205,451**	**39**	**229,394**	**43**	**3.74%**	**23,943**	**401,783**	**76**	**172,389**
Tamalanrea	3,175	128,329	40	140,306	44	3.02%	11,977	215,180	68	74,874
Manggala	2,132	77,122	36	89,088	42	4.93%	11,966	186,603	88	97,515
10-15 km	**2,910**	**95,320**	**33**	**113,650**	**39**	**6.04%**	**18,330**	**284,809**	**98**	**171,159**
Biringkanaya	2,910	95,320	33	113,650	39	6.04%	18,330	284,809	98	171,159
Other Kabupaten	228,174	849,134		900,855		1.99%	51,721	1,258,933	6	358,078
5-10 km	2,851	84,566	30	91,069	32	2.50%	6,503	154,140	54	63,071
Somba Opu (G)	2,851	84,566	30	91,069	32	2.50%	6,503	154,140	54	63,071
15-20 km	22,624	75,770	3	82,040	4	2.69%	6,270	146,693	6	64,653
Marusu (M)	4,764	21,050	4	21,597	5	0.86%	547	27,781	6	6,184
Mandai (M)	5,498	25,659	5	28,774	5	3.89%	3,115	61,263	11	32,489
Moncongloe (M)	4,476	9,335	2	10,425	2	3.75%	1,090	21,681	5	11,256
Pattallassang (G)	7,886	19,726	3	21,244	3	2.50%	1,518	35,967	5	14,723
& over	28,328	34,352	1	36,270	1	1.83%	1,918	55,134	2	18,864
Tanralili	6,379	21,419	3	22,343	4	1.42%	924	31,572	5	9,229
Parangloe	21,949	12,933	1	13,927	1	2.50%	994	23,562	1	9,635
Others	174,371	739,011	4	782,545	4	1.93%	43,534	1,057,106	6	274,561
MAMMINASATA	246,230	1,949,153	8	2,060,866	8	1.88%	111,713	2,826,212	11	765,346

Source : JICA Study Team

In this regard, it may be advisable that the urban development policy of Makassar should be geared toward effectively and efficiently accommodating the urban population and activities within the 10 km radius area of Makassar (see **Figure 4.5.2**), especially urban sprawl areas in its east parts like Kecamatans of Panakkukang, Rappocini, Manggala, and Tamalanrea, where the planned urban roads under this feasibility study are due to serve directly or indirectly, with flood protection measures if necessary. This will lead to effective land management through "Compact City Planning" minimizing the administrative and investment costs of Makassar including infrastructure construction and social services, reducing CO^2 emission of motor traffic that results in global warming, and protecting the natural environment in and around the city. The compact city is universally becoming a goal or target of city planning and development policies in many local cities in the world nowadays, taking into serious consideration energy saving, global warming and ecological environment.

As the planned urban roads including the radial roads (Jl. Hertasning and Jl. Abdullah Daeng Sirua) and the Outer Ring are due to pass through and improve the access to the undeveloped land among the urbanizing/sprawling areas, those roads are to enhance the housing development, resulting in the increase of population in the east within the Makassar territory. They are expected to organize the urbanization so as to create urban space to effectively and efficiently accommodate the future population. This would be one of the main purposes of the urban roads constructed in the urban areas. In this regard it is recommendable to execute the urban area development like Land Readjustment as proposed in Section 7.11 along and in conjunction with the planned road construction.

(5) Satellite Town

In the context of population allocation and urban development stated above, the purposes of Satellite town are defined from the needs in such three sectors as 1) City planning, 2) Housing policy, and 3) Regional development of the Mamminasata Metropolitan Area, as follows:

1) City Planning Policy

A. Addressing urban sprawl

In addition to the high efficient land use (utilization of unused land) in the general urbanization area of Makassar City, it may be necessary to accommodate the spilling-over population beyond the boundary of Makassar City into the satellite new town, addressing urban sprawl in Kecamatan Mandai, Moncongloe and Pattallassang in Gowa and Maros Regencies.

B. Stabilization of land price by supplying cheaper land in the real-estate market

The new town schemes also aim at land price stabilization by means of supplying new land in the land market. It is also intended that SMEs of developers and housing companies are invited to take part in the housing development business so as to stop the sprawl-type urbanization in the disastrous areas and promote sound and active real-estate industry.

C. Alleviation of population pressure on the general urban areas of Makassar

It will need longer time to improve/develop living environment including urban infrastructure in the built-up areas responding to rapid urbanization. It is a case for new town development so as to alleviate the population pressure on the built-up areas, because new towns can be developed more quickly and less cost in vacant land areas.

2) Housing Policy

A. Provision of affordable housing

In and around the built-up area of Makassar city, land price has been soaring so high that low and middle income groups are facing difficulties to find their affordable land and houses in Makassar City. It is also becoming hard for the private developers and housing companies, which are mostly

small and medium enterprises (SMEs), to find and consolidate developable land because of the piecemeal land in the sprawl area. In this situation housing projects or subdivision projects are spreading over beyond the boundary of Makassar City in pursuit of cheaper land for development. Addressing to this situation, the government should take concrete measures for providing affordable houses and land for the metropolitan population

B. Developable land in large scale for housing provision

In order to provide affordable houses, large scale housing development based on scale economy for economizing the cost of development must be implemented in the areas where there remains large undeveloped land available with relatively cheaper land prices. It is difficult to find such potential land in Makassar City. In this regard sites, new town development should be pursued outside of the Makassar City boundary to provide houses within reasonable price and environment.

3) Regional Policy

The Mamminasata Study proposed the regional development plan for the Mamminasata Metropolitan Area. It is apparent that the study stressed the de-concentration policy judging from the planned allocation of future population and GRDP. In line with this regional policy, an industrial park (**KIWA)** in Gowa Regency and other developments are planned to be located along the Mamminasa Bypass. The satellite town is designed to accommodate the housing needs for the employees commuting to those work places.

4.5.2 Proposed Location of Satellite City

As shown in **Figure 4.5.1** development potential lands for new towns are identified taking into account the topography (elevation over 10 m sea level), land availability for large scale development, land prices, location/accessibility, existing landuse and others.

1. Land under elevation of 10 m sea level in the Tallo River basin covers mostly wet/flood-prone area and paddy fields, in which urban development without river improvement and flood control measures should be avoided. The private subdivision projects started encroaching on the wet and low land without effective measures for disaster prevention. The planned new town is designed to absorb these unplanned subdivisions.

2. Flat lands in large scale over the elevation of 10 m sea level (free from flood) can be found only in Kecamatan Biringkanaya in Makassar City, Moncongloe in Maros Regency and Pattallassang in Gowa Regency. In Biringkanaya urban and housing developments have been proceeding with land being subdivided and consequently land values have increased considerably. In contrast to Biringkanaya, Moncongloe is vastly undeveloped/less populated and best located at 15-20 km from the Makassar City center to attract/ accommodate spilling-over population/ households.

3. Opening of the radial urban arterial road (Abdullah Daeng Sirua Road) directly connecting Makassar central districts and Moncongloe will accelerate the land development in Moncongloe. In addition the Mamminasa Bypass is due to greatly increase south-north accessibility from both Gowa and Maros Regencies.

4. "Neither too far nor too close to the existing urban center" is a vital criterion for selecting the location of the Satellite city, especially self-contained city. If it is too close, the new town will become a part of the existing urban center, and if it is too far, economic linkage with the existing urban center, which is of significant importance for the new town' viability, will be lost. Moncongloe located at 15-20 km from the center of Makassar meets this golden rule. In addition it is close to the economic hub of Makassar in Tamalanrea and Biringkanaya, and also the Hasanuddin International Airport.

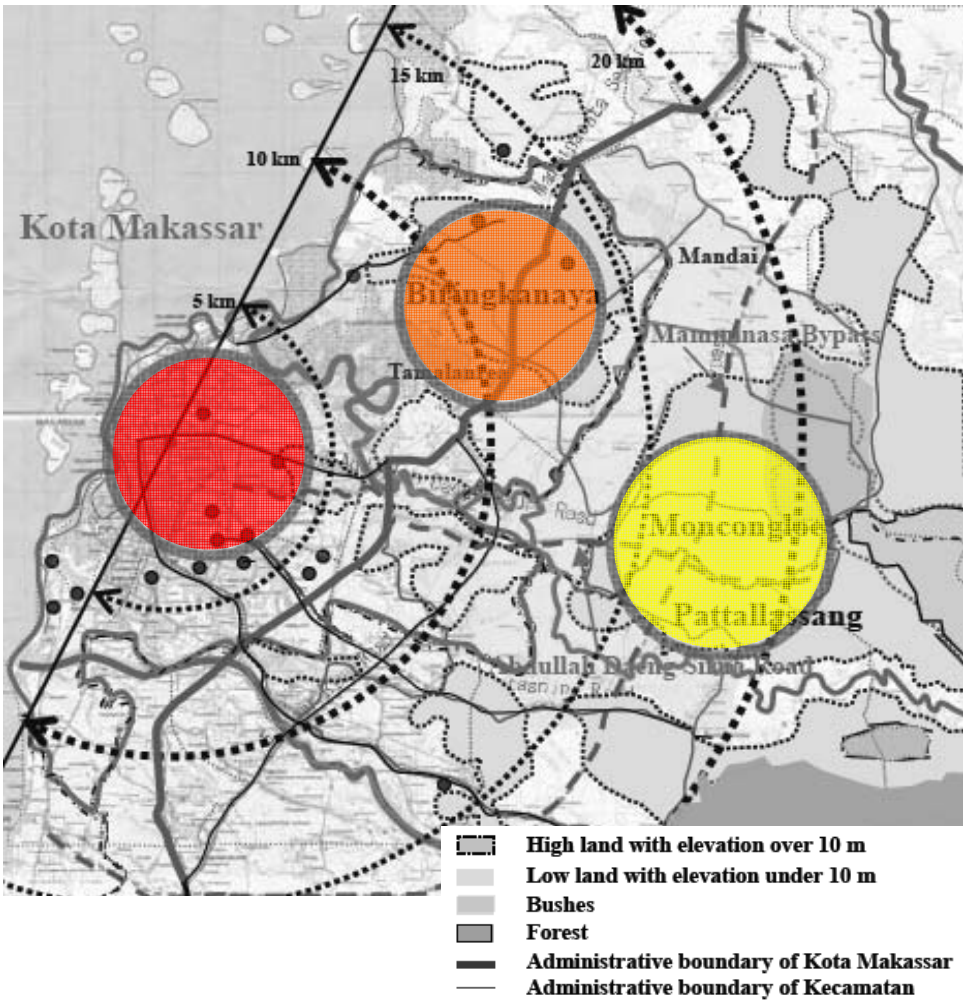


Figure 4.5.3 Development Potential Land at Outside of Makassar City

4.5.3 Potential Population Size of Satellite City

The preceding **Table 4.5.2** includes the size of future population (2020) by Kecamatan, estimated

by extrapolating the past trend (population growth rate 2000-2003) for the purpose of estimating the potential population size of the satellite town. These figures indicate at least the magnitude of urbanization pressure in market economy. Following the market trends, private developers have been spreading housing provision outward. City planning must intervene in this laissez-faire urbanization by means of providing serviced land through urban/housing development projects in the general urbanization areas in Makassar City, and in parallel with it attracting the over-spreading population outside the Makassar city into the satellite new town.

While the population of Makassar City will reach to 1.69 million for which the Makassar urban area has to prepare urban settlement, over-spreading population into the 15-20 km area (Marusu, Mandai, Moncongloe, and Pattallassang) is more or less at the level of 60,000 (2.69% annual growth rate 2000-2003) or 140,000 (6.04% equal to annual growth rate 2000-2003 in Biringkanaya) in the case of accelerated suburbanization in the 15-20 km area. Potential population for the satellite town is set at one third (1/3) of the calculated out-spreading population, or 20,000 - 46,000 at best.

The number of affordable houses in need to be supplied in the satellite town should be precisely estimated based on the housing backlog statistics and housing marketing survey. Without such data and information, it is assumed that it is equivalent to about10 % of the increased population of Makassar city in 2003-2020, or 40,000 (conservative).

The Mamminasata Study proposed to develop a Satellite town in Tanralili with a population of about 100,000 (revised to 60,000 in this FS study), the location of which is transferred to Moncongloe, and the other in Pattallassang with a population of 50,000, totaling 160,000.

The potential population greatly varies from 20,000 to 160,000 according to the development concepts as stated above. For the preliminary study purpose, the population size of 50,000, which is needed for supporting high level urban services, is set up to map out the development concept of the satellite town in Moncongloe and Pattallassang. In this regard the proposed urban structure of the Satellite town should be flexible enough to population change either upward or downward. However it must be stressed that such development sizes as envisioned in the Mamminasata Study are only conceptual or wishful targets, not based on the real feasibility study.

4.5.4 Development Concept of Satellite City

(1) East Makassar Urban Service Center

In addition to and in conjunction with the housing development as defined above, a new urban service center (satellite town) is proposed to be developed at the east of Makassar City in responding to the accelerating eastern urbanization beyond the Makassar City boundary. The new urban service center should be planned to promote and boost the industrial development in the eastern part of the Mamminasata Metropolitan Area as envisioned in the Mamminasata Study. As the territory of Makassar City ends at around 10 km east from its center, adjoining Kecamaten belong to Maros or Gowa Regencies would be appropriate location as indicated in **Figure 4.5.4**.

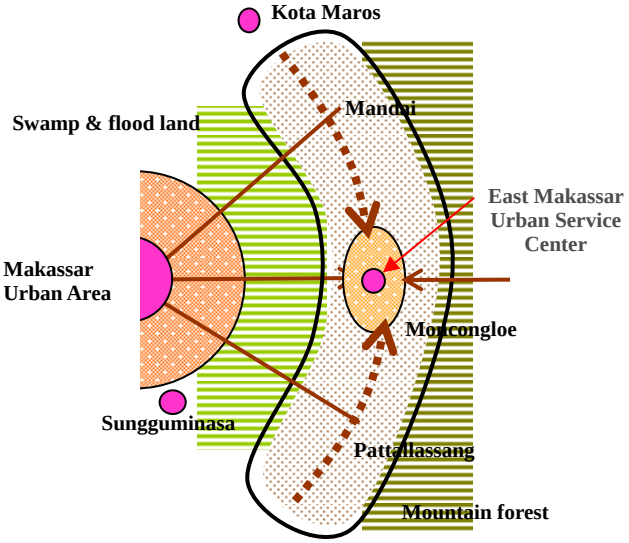
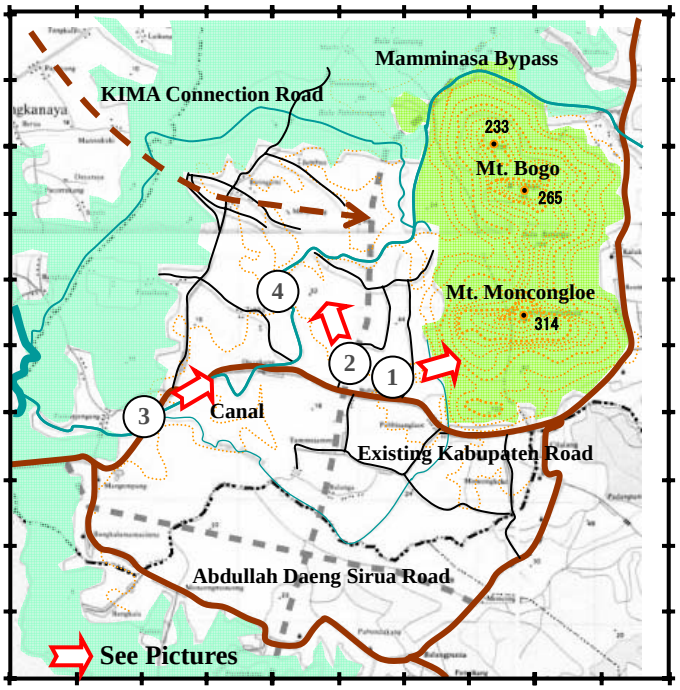


Figure 4.5.4 East Makassar Urban Service Center

(2) Development Concept of Satellite City

1) Existing Condition

The new town study area is enclosed mostly by the paddy fields in the valley (under 10 m sea level) along the Tallo River and its tributary at the west, and the mountains (Mt. Moncongloe 317 m and Mt. Bogo 265 m) at the east.



④ Landuse of Dry Land Farming

③ Canal traversing the study site

② Typical Landscape of study site

① Mt. Moncongloe (317 m)

Figure 4.5.5 Study Area for Satellite Town

The basic feature of landuse is dry farmland (casaba, corn and others) on the gentle slope (elevation 10-40 m), served by the canals with the intake from the Maros River

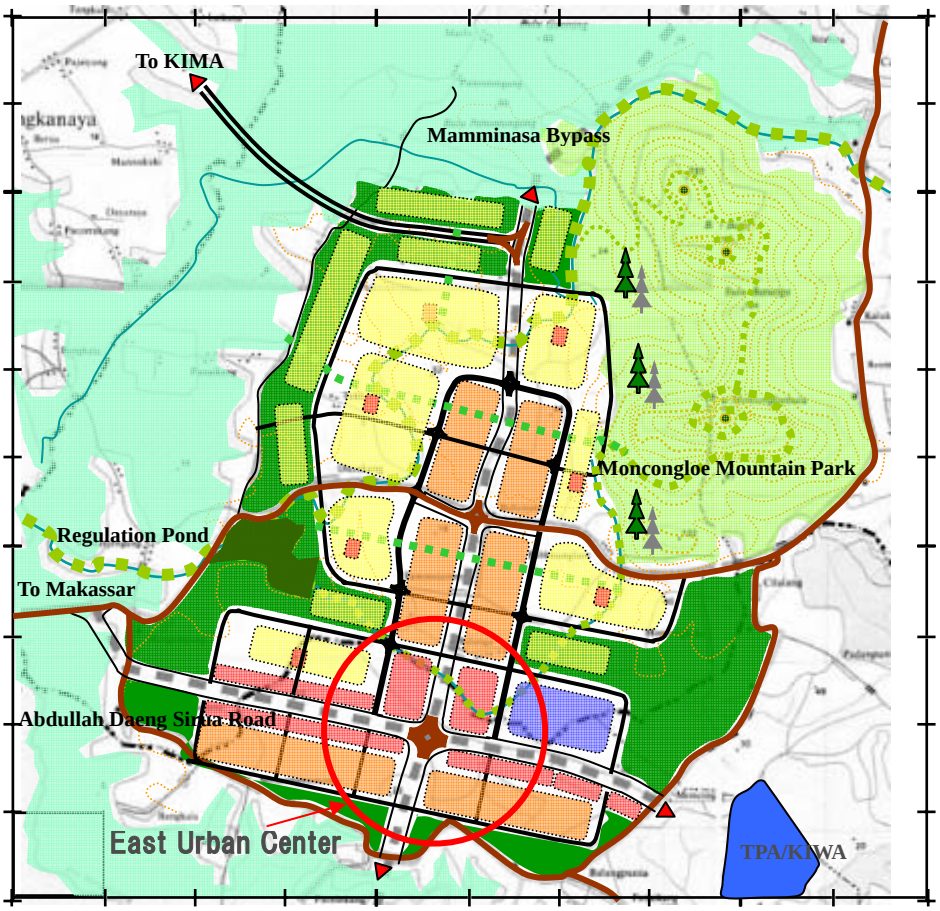
2) Development Concept (Preliminary)

The development concept of the East Makassar Satellite Town (illustrated in **Figure 4.5.6**) is

mapped out based on the following 2 important policies:

1. Ecological town between a mountain (Moncongloe Mountain) and a river (Tallo river)

The planned site is located on the terrace-type terrain between a mountain (Moncongloe Mountain) and a river (Tallo River), being connected with the Tallo River through a water system, and with the Moncongloe Mountain through a land/soil system. Town and land development must be designed to embrace the water and land systems in and around the Moncongloe area.



	Land use	Remarks
	Commercial area	Retail, trade, finance, service, hotel,
	High amenity urban area with multi land uses	Flat houses, Office building, , Culture, Social services, Administration
	Low/medium density housing area	Detached house, Town house
	Urban service industry	
	Reserved and conservation area	Detached houses, parks and greens

Figure 4.5.6 Diagrammatized Development Concept of East Makassar Satellite Town

2. Development potential tapped by the arterial road construction

It is no doubt that the construction of the Abdullah Daeng Sirua road and the Mamminasa Bypass will trigger land development and even land speculation by private sectors and individuals along them, especially Moncongloe at the crossroad on the hill. It is predictable that disorder in land use and abuse of land resources will emerge if no relevant urban control measures are taken.

Consequently efficiency of the road improvement will be lost. The town plan must be designed to effectively regulate and lead the land development facilitated by transportation improvement.

Road side development will proceed along the Abdullah Daeng Sirua Road from Makassar city. Around the node of the crossroad with the bypass road in the south part of the planned site, development potentials are likely highest and extend along the bypass road toward the center of the planned site, where an urban complex belt with high urban amenities should be constructed. Secondly residential areas should be developed around the urban belt. The surrounding areas shall be preserved for natural environment but construction of detached houses in harmony with the preserved nature can be allowed.

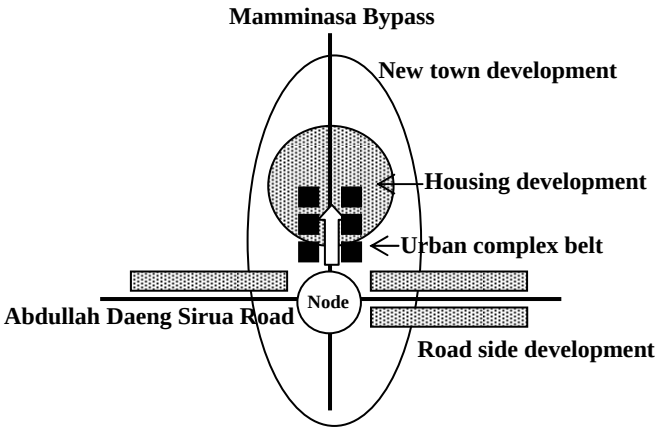


Figure 4.5.7 Spatial Development Structure

The existing canals will be incorporated into the green and pedestrian network structuring the living space and settlement.

4.5.5 Implementation System (Challenge of Local Governments)

(1) Urban Development Implementation System

The purposes of the East Makassar Satellite Town are not merely to promote private land and urban development investment/ business, but also to cater for such public interests as provision of affordable houses, stabilization of land price, prevention of urban sprawl, facilitation of regional development, etc. However, it is certain that the latter cannot be achieved without the former. Accordingly this new town scheme must be implemented by the private sector under the government initiative or guidance.

In Indonesia there are three (3) legal systems for implementing urban development as listed below:

1. Development permit system under spatial plan regulation
2. Land Consolidation (Konsolidasi Tanah)
3. KASIBA (Ready to build: Kawasan Siap Bangun)

Most urban housing development projects (or land subdivision projects), except those of the National Urban Development Corporation (Perum Perumnas), have been implemented by private investors/developers with development/location and planning permits granted by the government. However, the following constraints have been observed:

1. It is more of business concern than of public concern; and

2. There are difficulties in land acquisition (land consolidation)

In the past, large scale housing developments were implemented mainly through utilization of large properties like plantation estates available especially around Jakarta. Location permits, which worked to avoid land speculation and facilitate land acquisition, are no longer applied to authorization for land purchase by the developers like those before "reformasi".

Moreover, special attention must be paid to the large scale of the East Makassar Satellite Town to be developed in an integrated manner, which can be handled only by one or a few larger scale developers with large financial capabilities. It can be said that local developers or housing companies in Makassar belong to small and medium enterprises. If things go under the existing development systems, land speculation or patchwork development by many small local developers will be the result at best. In this situation government's intervention or initiative is necessitated typically in the second and third implementation systems listed above.

(2) Land Consolidation

Land consolidation is interpreted in Section 7.11: Road Development Methods, which are reiterated below.

"Land Readjustment System" or "Land Consolidation System (K/T: Konsolidasi Tanah)" in Indonesia version, have been established and a number of projects have been implemented throughout the country (in more than 25 provinces) under the authority or responsibility of land administration, especially the National Land Agency (BPN). By provision of Article 2, Section 2 of the Indonesian Basic Agrarian Act (No. 5/1960), the implementation of Land Consolidation is put under BPN's jurisdiction. It was upon such legal basis that the first Land Consolidation in Renon, Bali (1982) took place prior to the issuance of a ministerial protocol (1985) and BPN decree (1991) on practicalities and procedures of Land Consolidation. In this context urban land consolidation projects have been implemented in all of the provinces in the Sulawesi Island since 1983.

However attention must be paid to the recommendations in the past, including those of the JICA Study[1], made for improving and strengthening the existing system of land consolidation in Indonesia so as to make the urban development system effective. The important points to be addressed are:

1. The existing K/T has not been equipped with self-financing mechanism for constructing infrastructure especially roads through reserved land for income-generating, leaving the responsibility of infrastructure construction on the local government.

2. The existing K/T has rarely been applied to the urbanizing areas, mostly rural areas,

[1] The Study on Land Provision for Housing and Settlements Development through KASIBA and Land Consolidation in Jakarta Metropolitan Area (2000) *The State Ministry for Agrarian Affairs/National Land Agency (BPN) and The State Ministry of Housing and Human Settlements (MENPERKIM)*

failing to combat most urgent urban sprawl.

It is said that Indonesia may need a specific Act for Land Consolidation to address these barriers so as to generalize the application of L/K over the urban area.

Land readjustment system has been well utilized for developing new towns in Japan (ex. Tokyu Garden City, Kohoku new town). Land Consolidation system may be employed to develop the East Makassar Satellite Town in such a manner as combining land preemption and land readjustment. Raw land may be purchased on the voluntary basis in advance from the landowners who want to sell them in the planned site. Subsequently the purchased lands are consolidated into blocks to develop in line with the new town development plan through Land Readjustment (especially using re-plotting techniques). Furthermore, land holding farmers who want to continue farming are transferred to the farmland area designated in the development plan.

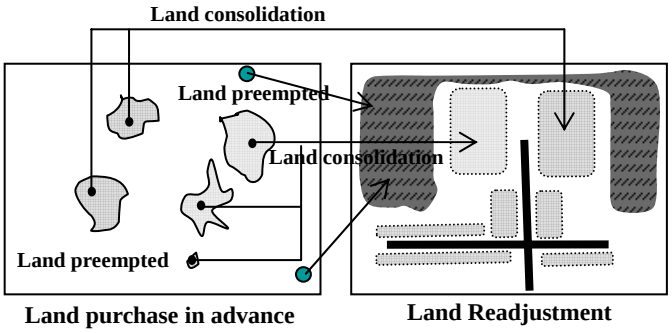


Figure 4.5.8 Land Readjustment for New Town Development

(3) KASIBA

KASIBA, an integrated development system for large-scale areas, is quite innovative and unique (Law No. 4, 1992, Implementation Regulation 2000) but has not been implemented yet in Indonesia. The KASIBA Management Body (KMB) is in charge of acquiring land and constructing major infrastructure (main streets and access roads) so as to create LISIBA (serviced land in block, or ready to build), which are released to private developers or housing companies under concession. The developers are granted permits for developing house estates and commercial buildings for sale or rental. Theoretically KASIBA is equipped with a variety of advantages such as cost recovery for development, cross-subsidy for providing low income group with affordable houses, integration of private urban and housing developments, and others. Although there seem to be many hurdles to overcome for putting KASIBA into practice, it is undoubtedly an effective instrument for realizing city planning in Indonesia. Especially in the local cities like Makassar city

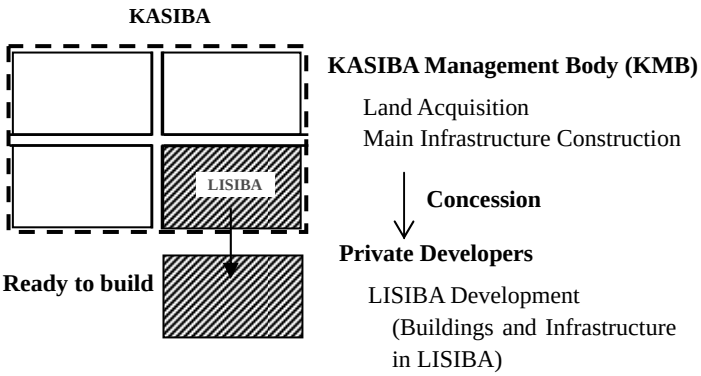


Figure 4.5.9 Basic System of KASIBA

where large scale developers/investors are absent, KASIBA appears appropriate in that it can invite and unify SME developers and housing providers for integrated new town development.

CHAPTER 5 TRAFFIC SURVEY AND TRAFFIC DEMAND FORECAST

5.1 Supplemental Traffic Survey and Review of Mamminasata Traffic Study

5.1.1 Objectives of Supplemental Traffic Survey

A comprehensive traffic survey was conducted in the Study on Integrated Spatial Plan for the Mamminasata Metropolitan Area ("the Mamminasata Study") for the following objectives:

- To obtain latest information/data on transport situation;
- To identify transport characteristics;
- To quantify existing transport movements in Mamminasata Metropolitan Area; and
- To provide baseline data for traffic demand forecast.

The JICA Study Team conducted a supplemental traffic survey at 9 points selected from the 29 Mamminasata traffic study points, to calibrate and review the traffic survey and analysis conducted by the Mamminasata Study as more accuracy is required for the F/S roads. The supplemental survey also covered three additional points.

5.1.2 Outline and Schedule of Traffic Survey

The traffic survey conducted by the Mamminasata Study is as summarized in **Table 5.1.1**.

Table 5.1.1 Outline of Traffic Surveys by Mamminasata Study

Survey	Objectives	Coverage	Method
1. Traffic Count Survey	To grasp traffic volume and vehicle type at major road sections	29 stations	Traffic count (vehicles) 24/16 hours
2. Roadside OD Interview Survey	To capture trip information of vehicles at major road sections	27 stations	Direct interview to drivers at roadsides 16 hours
3. Intersection Traffic Count Survey	To obtain traffic volume at major intersections by turning direction	8 major intersections	Traffic count (vehicles) 2 hours * 2 time periods
4. Travel Speed Survey	To understand travel speed on major routes by section	5 routes	"Floating car" method 9 round trips by route by vehicle type 3 time periods (morning/evening peak and off-peak)
5. Freight Transport Survey	To grasp characteristics of freight vehicle transport	5 stations of port, airport, industrial park and warehouse	Traffic count and OD interview for trucks at gates 24 hours
6. Public Transport Operator Survey	To understand operational condition on current public transport	Major public transport operators	Direct interview to public transport operators
7. Road Inventory Survey	To collect information and data in terms of roads, bridges and intersections	MAMMINASATA Metropolitan area	To collect existing data To collect data through supplemental field survey
8. Public Transport Terminal Inventory Survey	To collect present bus terminal information	All bus terminals in MAMMINASATA Metropolitan area	Facility inventory survey

Source: JICA Mamminasata Study

The items of supplemental survey for the F/S are as follows:

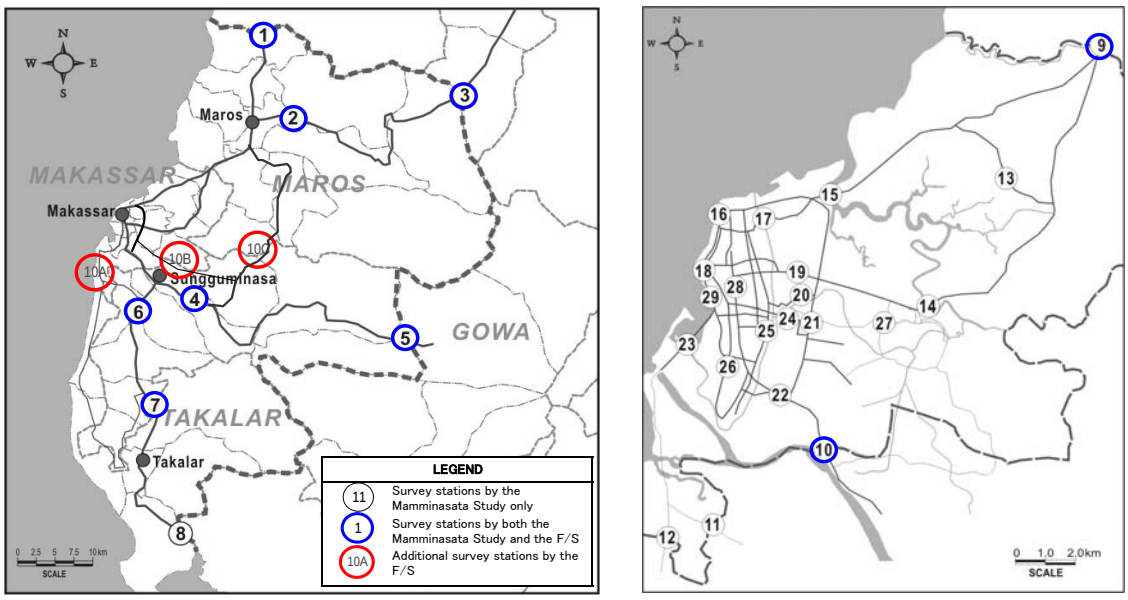
1) Traffic Count Survey
2) Roadside OD Interview Survey
3) Intersection Traffic Count Survey
4) Travel Speed Survey
5) Axle Load Survey
6) Distribution System Survey

The traffic survey in the Mamminasata Study was conducted in May - June 2005 in the dry season. The traffic survey for the F/S was executed in February - March 2007 in the rainy season.

5.1.3 Survey Locations and Zoning

(1) Traffic Count and Origin/Destination (OD) Interview Survey

In the Mamminasata Study traffic surveys were conducted at 29 stations at Kabupaten and/or Kecamatan (district) borders in the Mamminasata Metropolitan Area. In the F/S traffic surveys were conducted at 12 stations (refer to **Figure 5.1.1** and **Table 5.1.2**).



Source: JICA Study Team

Figure 5.1.1 Traffic Survey Stations in Mamminasata Metropolitan Area

Table 5.1.2 List of Traffic Survey Stations in Mamminasata Study and F/S

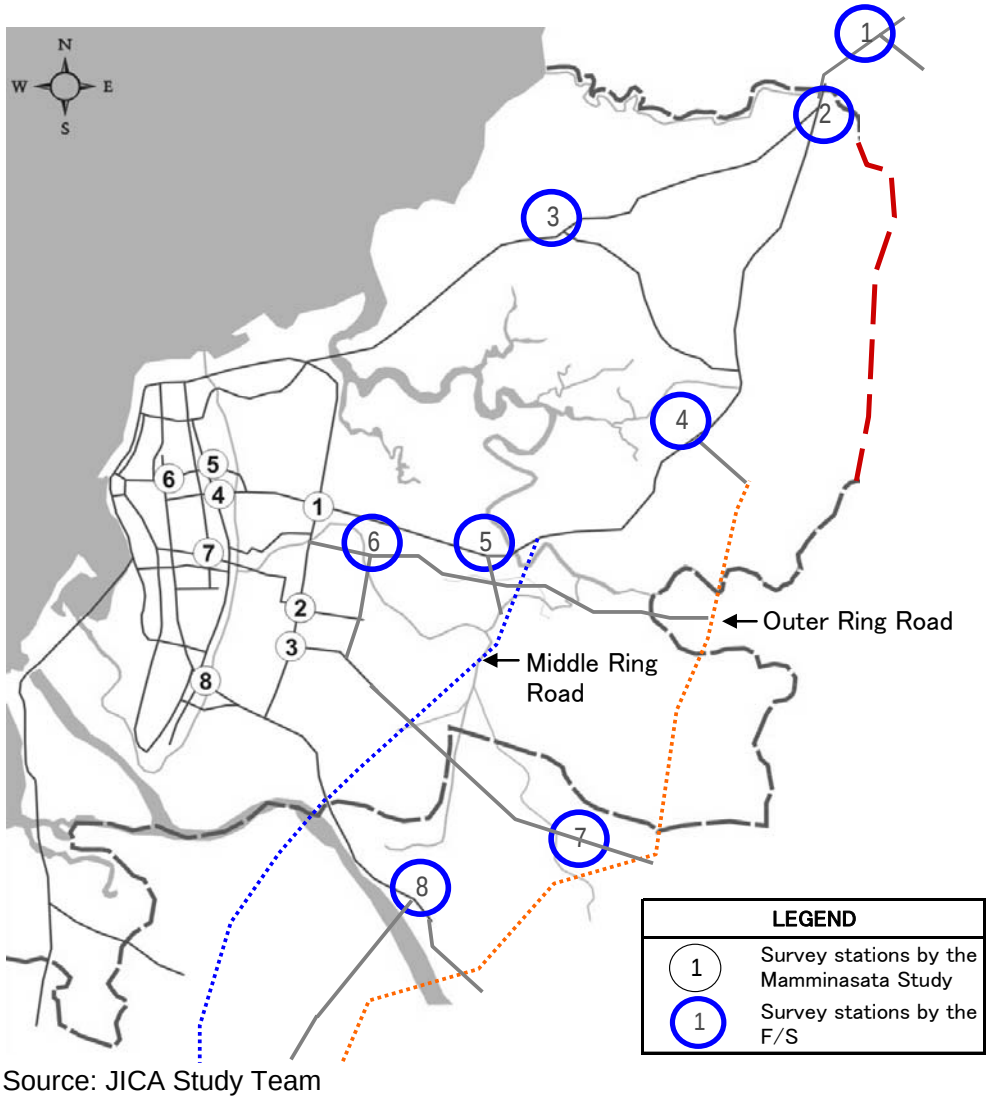
No.	Survey Station	Location	Traffic Count Survey	
			Mamminasta *	FS**
1	Pekkae - Pangkajene Kepulauan (National Road)	Boundary of Kec.Bontoa & Kab.Pangkep	24 hrs	16 hrs
2	Maros - Ujung Lamura (National Road)	Boundary of Kec.Turikale & Kec.Bantimurung	16 hrs	16 hrs
3	Maros - Ujung Lamura (National Road)	Boundary of Kec.Cenrana & Kec.Camba	16 hrs	16 hrs
4	Sungguminasa - Malino (Provincial Road)	Boundary of Kec.Somba Opu & Kec.Pattallassang	16 hrs	16 hrs
5	Sungguminasa - Malino (Provincial Road)	Boundary of Kec.Parangloe & Kec.Tinggimoncong	16 hrs	16 hrs
6	Sungguminasa - Takalar (National Road)	Boundary of Kec.Pallangga & Kec.Bajeng	16 hrs	16 hrs
7	Sungguminasa - Takalar (National Road)	Boundary of Kab.Gowa & Kab.Takalar	16 hrs	16 hrs
8	Takalar - Jenepond (National Road)	Boundary of Kab.Takalar & Kab.Jeneponto	16 hrs	16 hrs
9	Jl.Perintis Kemerdekaan	Boundary of Makassar City & Kab.Maros (Kec.Biringkanaya & Kec.Marusu)	16 hrs	24 hrs
10	Jl.Sultan Alaudin	Boundary of Makassar City & Kab.Gowa (Kec.Tamalate & Kec.Somba Opu)	24 hrs	24 hrs
11	Makassar - Gowa (Other Road)	Boundary of Makassar City & Kab.Gowa (Kec.Tamalate & Kec.Baronmbong)	16 hrs	-
12	Makassar - Takalar (Other Road)	Boundary of Kab.Makassar & Kab.Takalar (Kec.Tamalate & Kec.Gareson U)	16 hrs	-
13	Jl.Kawasan	Boundary of Kec.Tamalanrea & Kec.Biringkanaya	16 hrs	-
14	Jl.Perintis Kemerdekaan	Boundary of Kec.Tamalanrea & Kec.Manggala	16 hrs	-
15	Jl.Ir.Sutami	Boundary of Kec.Tamalanrea & Kec.Tallo	16 hrs	-
16	Tol Reformasi	Boundary of Kec.Ujungtanah & Kec.Wajo (Near Jl.Nusantara)	16 hrs	-
17	Jl.Tanampu	Boundary of Kec.Tallo & Kec.Ujungtanah	16 hrs	-
18	Jl.Ujung Pang Dang	Boundary of Kec.Wajo & Kec.Ujung Pandang	16 hrs	-
19	Jl.Urip Sumoharjo	Boundary of Kec.Panakkukang & Kec.Makassar	16 hrs	-
20	Jl.Abu Bakar Lambodo	Boundary of Kec.Panakkukang & Kec.Makassar	16 hrs	-
21	Jl.Andi Pangerang Pettarani	Boundary of Kec.Panakkukang & Kec.Rappocini	16 hrs	-
22	Jl.Sultan Alaudin	Boundary of Kec.Rappocini & Kec.Tamalate	16 hrs	-
23	Jl.Metro Tanjung Bunga	Boundary of Kec.Ujung Pandang & Kec.Tamalate	16 hrs	-
24	Jl.Sungai Saddamg Baru	Boundary of Kec.Rappocini & Kec.Makassar	16 hrs	-
25	Jl.Veteran Utara	Boundary of Kec.Bontoala & Kec.Makassar	24 hrs	-
26	Jl.Cendrawasih	Boundary of Kec.Mamajang & Kec.Mariso	16 hrs	-
27	Jl.Abdullah Daeng Sirua	Boundary of Kec.Panakkukang and Kec.Manggala	16 hrs	-
28	Jl.Jendral Sudirman	In Kec.Ujung Pandang	24 hrs	-
29	Jl.Penghibur	In Kec.Ujung Pandang	16 hrs	-
10A	Jl.Metro Tanjung Bunga - Takalar	Dg.Toa (New Jeneberang Bridge, South Side)	-	16 hrs
10B	Jl.Kabupaten (Gowa - Maros)	Boundary of Kab.Gowa & Makassar	-	16 hrs
10C	Jl.Hertasning	Patalassang	-	16 hrs

Notes: * Traffic survey by the Mamminasata Study in May - June 2005
** Traffic survey by the F/S in February - March 2006
Source: JICA Study Team

(2) Intersection Traffic Count Survey

The intersection traffic survey in the Mamminasata Study aimed at identifying traffic movements in CBD of Makassar city during peak periods and at assessing operational efficiency of intersections. The intersection traffic count survey was conducted to obtain the hourly traffic volume by vehicle type and direction at eight (8) stations. These can be used as baseline data for planning intersection improvement including construction of flyovers and installation of optimal traffic signal control in the future.

The intersection survey was conducted at 8 stations in the F/S to identify the traffic volume by direction and characteristics for planning appropriate intersections for the F/S roads. **Figure 5.1.2** shows the survey stations in both the Mamminasata Study and the F/S.



Source: JICA Study Team

Figure 5.1.2 Survey Stations for Intersection Traffic Count

Table 5.1.3 gives a list of intersections which are directly related to the F/S roads, and where traffic surveys were conducted in the F/S.

Table 5.1.3 List of Intersection Traffic Count Survey Stations

Survey Point No.	Intersection Name	Type of Intersection
1	National Road / Hasanuddin Airport Port	3 legs
2	Jl.Perintis Kemerdekaan / Jl.Ir.Sutami (Toll) / AURI Area Road	5 legs
3	Jl.Ir.Sutami (Toll) / Jl.KIMA	3 legs
4	Jl.Perintis Kemerdekaan / Jl.BTP	3 legs
5	Jl.Urip Sumoharjo / Jl.Abdullah Daeng Sirua (PLTU)	3 legs
6	Jl.Abdullah Daeng Sirua / Adyakasa	3 legs
7	Jl.Sykh Yusof / Jl.Antang (Samasa)	4 legs
8	Jl.Malino / Jl.Usman Saleng / Jl.HK Wahid Hasyim	4 legs

Sorce: JICA study Team

(3) Traffic Zoning System and Zone Code

The study area was divided into 60 zones: 43 zones in the Mamminasata Metropolitan Area and 17 zones outside of it, based on Kecamatan/Kabupaten administration boundaries of South Sulawesi Province. The names of traffic zones and the zoning map showing the road network are given in **Table 5.1.4** and **Figure 5.1.3**. The survey zone codes used for compiling the OD survey are composed of traffic terminals and administrative boundaries. The OD zoning for the F/S is same as that applied for the Mamminasata Study.

Table 5.1.4 Traffic Zones for OD Survey for the Mamminasata Metropolitan Area

Inside of Mamminasata Metropolitan Area		
Zone No	Kabupaten	Kecamatan
1	Makassar	Mariso
2	Makassar	Mamajang
3	Makassar	Tamalate
4	Makassar	Rappocini
5	Makassar	Makassar
6	Makassar	Ujung Pandang
7	Makassar	Wajo
8	Makassar	Bontoala
9	Makassar	Ujung Tanah
10	Makassar	Tallo
11	Makassar	Panakkukang
12	Makassar	Manggala
13	Makassar	Biringkanaya
14	Makassar	Tamalanrea
15	Maros	Mandai
16	Maros	Moncongloe
17	Maros	Maros Baru
18	Maros	Lau
19	Maros	Turikale
20	Maros	Marusu
21	Maros	Bontoa
22	Maros	Bantimurung

Inside of Mamminasata Metropolitan Area		
Zone No	Kabupaten	Kecamatan
23	Maros	Simbang
24	Maros	Tanralili
25	Maros	Tompobulu
26	Maros	Cenrana
27	Gowa	Bontonompo
28	Gowa	Bajeng
29	Gowa	Pallangga
30	Gowa	Somba Opu
31	Gowa	Bontomarannu
32	Gowa	Parangloe
33	Gowa	Bontonompo Selatan
34	Gowa	Barombong
35	Gowa	Pattallassang
36	Gowa	Manuju
37	Takalar	Mangarabombang
38	Takalar	Mappakasunggu
39	Takalar	Polombangkeng S.
40	Takalar	Polombangkeng U.
41	Takalar	Galesong S.
42	Takalar	Galesong U.
43	Takalar	Pattalassang

Outside of Mamminasata Metropolitan Area		
Zone No	Kabupaten	Kecamatan
44	Maros	Camba
45	Maros	Mallawa
46	Gowa	Tinggimoncong
47	Gowa	Bungaya
48	Gowa	Tompobulu
49	Gowa	Tombolo Pao
50	Gowa	Bontolempangan
51	Gowa	Biringbulu
52	Jeneponto	All Kecamatan
53	Bantaeng	All Kecamatan
54	Bulukumba	All Kecamatan
55	Sinjai	All Kecamatan
56	Bone	All Kecamatan
57	Soppeng	All Kecamatan
58	Barru	All Kecamatan
59	Pangkep	All Kecamatan
60	Other Kabupaten	All Kecamatan

Source: Mamminasata Study

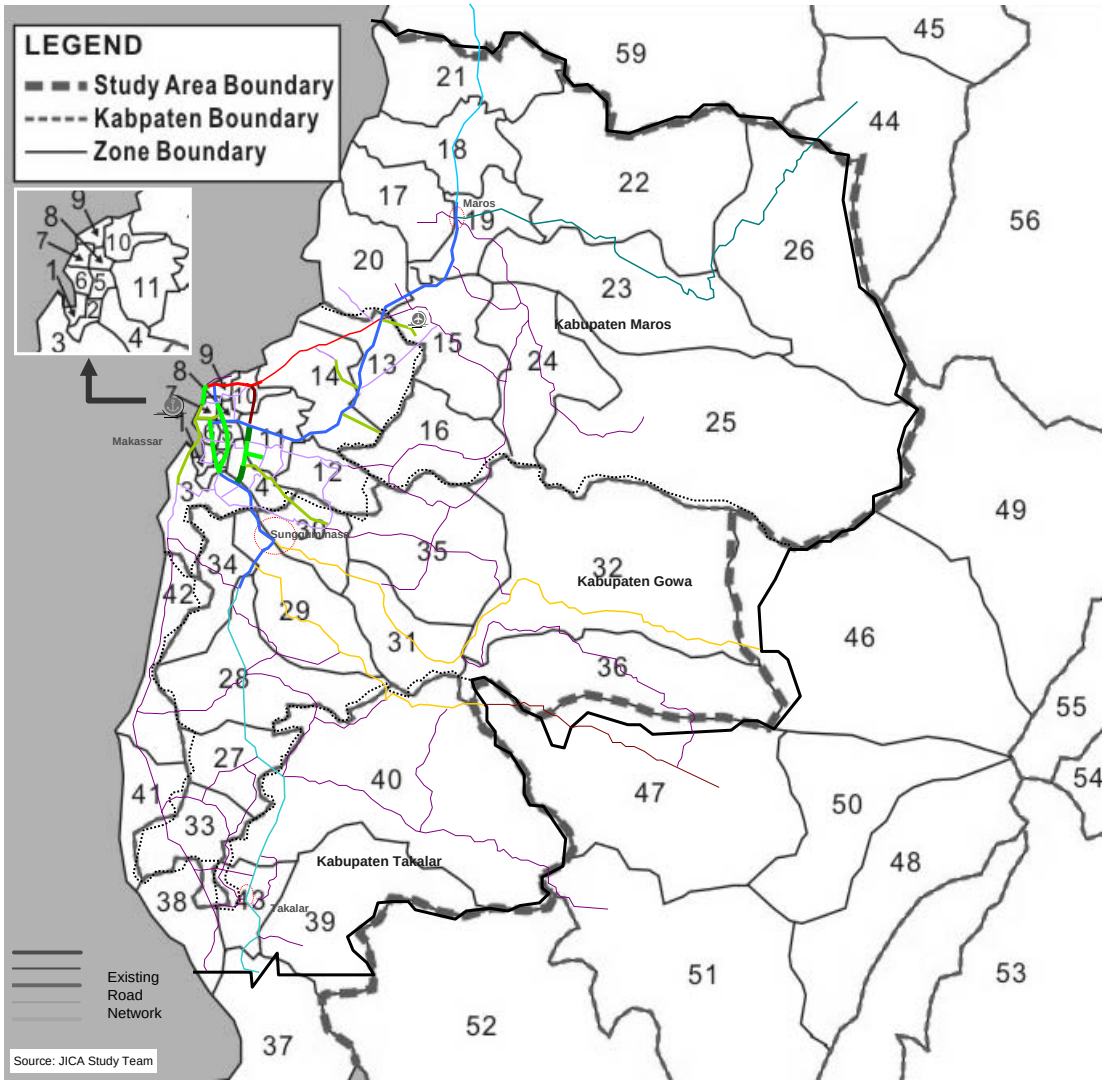


Figure 5.1.3 Zoning Map and Exiting Road Network

5.1.4 Present Traffic Condition

(1) Traffic Volume

The existing traffic volumes are shown in **Table 5.1.5.** Traffic counts were conducted at 29 stations (Stations 1 - 29) in the Mamminasata Study and at three additional stations (Stations 10A, 10B and 10C) in the F/S. The traffic volumes obtained from 16-hour counts were expanded to 24-hour traffic by using the expansion factors obtained from 24-hour count stations.

The heaviest volume was 136,802 vehicles (69,556 pcu) at Jl.Andi Pangerang Pettarani (Station 21), which is a main road of the Makassar City Center running from the north to the south. Jl.Perintis Kemerdekaan (Station 14) and Jl.Urip Sumoharjo (Station 19) have the second heaviest volume of 124,522 - 97,230. Jl.Veteran Utara (Station 25) and Jl.Sultan Alauddin (Station 10) follow with 84,500 and 77,530, respectively.

Table 5.1.5 Current Traffic Volumes in Mamminasata Metropolitan Area

Survey Station	Bicycle	Becak	MC	Car/Taxi /Jeep	Minibus (Inc.Pete Pete)	Large Bus	Pickup	Small Truck (2-Axle)	Large Truck (3-Axle or more)	**Motorized Vehicle Total**	Non-Motorized Vehicle Total	**PCU Total (exclduing Bicycle & Becak)**
Station 1	156	134	3,762	3,832	1,749	450	974	1,767	447	**12,981**	290	**11,362**
Station 2	311	869	5,770	1,476	1,976	59	524	602	28	**10,435**	1,180	**6,346**
Station 3	33	4	1,441	86	1,239	46	229	303	34	**3,378**	37	**2,445**
Station 4	379	18	7,717	1,080	1,767	82	414	1,823	665	**13,548**	397	**9,013**
Station 5	0	0	578	77	339	6	86	146	0	**1,232**	0	**845**
Station 6	3,497	227	20,296	3,524	3,381	87	718	1,996	158	**30,160**	3,724	**15,738**
Station 7	217	91	11,803	1,926	2,480	81	666	1,094	73	**18,123**	308	**9,712**
Station 8	95	39	2,218	304	2,183	108	251	505	46	**5,615**	134	**4,203**
Station 9	165	102	19,274	12,639	6,142	692	1,927	3,532	698	**44,904**	267	**32,552**
Station 10	8,084	475	51,693	11,918	7,232	343	1,495	3,642	1,207	**77,530**	8,559	**41,231**
Station 11	381	20	2,324	195	449	7	85	145	1	**3,206**	401	**1,511**
Station 12	1,042	24	3,833	177	466	8	214	102	3	**4,803**	1,066	**1,966**
Station 13	201	53	18,098	2,991	1,114	580	1,263	1,410	307	**25,763**	254	**13,210**
Station 14	515	193	79,650	20,268	20,272	318	1,785	2,136	93	**124,522**	708	**65,677**
Station 15	578	11	18,332	10,653	3,253	262	2,744	5,032	1,640	**41,916**	589	**31,448**
Station 16	0	0	0	2,560	3,681	76	983	1,538	1,165	**10,003**	0	**11,667**
Station 17	4,487	7,560	16,463	1,622	5,600	117	1,062	1,322	302	**26,488**	12,047	**14,898**
Station 18	1,240	1,966	20,255	11,449	4,072	42	853	713	107	**37,491**	3,206	**22,642**
Station 19	1,331	405	54,741	18,374	21,129	291	1,657	1,028	10	**97,230**	1,736	**56,638**
Station 20	1,221	2,756	16,599	1,097	1,241	39	894	605	15	**20,490**	3,977	**8,257**
Station 21	2,186	1,799	91,750	28,739	8,657	250	3,840	3,035	531	**136,802**	3,985	**69,556**
Station 22	2,912	4,365	43,924	7,297	19,755	150	966	681	14	**72,787**	7,277	**40,137**
Station 23	887	0	14,039	8,084	314	42	646	222	11	**23,358**	887	**12,927**
Station 24	1,358	2,514	34,561	20,554	96	26	1,839	527	47	**57,650**	3,872	**31,947**
Station 25	2,568	4,764	57,609	17,096	6,115	147	2,093	1,303	137	**84,500**	7,332	**41,895**
Station 26	1,118	3,650	25,135	5,597	6,574	22	838	378	67	**38,611**	4,768	**19,951**
Station 27	983	286	22,528	5,582	5,518	97	745	712	28	**35,210**	1,269	**18,604**
Station 28	686	216	28,261	15,847	11,680	82	1,394	140	1	**57,405**	902	**36,293**
Station 29	1,371	2,260	24,559	13,515	2,061	50	1,015	754	87	**42,041**	3,631	**23,960**
Station 10A*			7,959	395	741	0	257	158	2	**9,512**		**3,592**
Station 10B*			2,620	53	109	0	98	107	15	**3,001**		**1,083**
Station 10C*			2,337	15	142	0	62	55	0	**2,611**		**875**

Note: Traffic survey conducted by the F/S.
Source: JICA Study Team

(2) PCU Conversion Factor

The Passenger Car Unit (PCU) conversion factors used in "The Study on Integrated Transportation Master Plan for Jabotabek (SITRAMP)", "Indonesian Highway Capacity Manual (IHCM) 1997", and "Mamminasata Study" and adopted in the F/S are indicated in **Table 5.1.6**.

Table 5.1.6 PCU Conversion Factors

Vehicle Type	SITRAMP*	Mamminasata Study**	IHCM***						Used for the FS**
			Inter-urban Roads (Flat)			Urban Roads			
			2/2 UD W=6-8m	4/2 D	6/2 D	2/2 UD W>6m	4/2 D	6/2 D	2/2 UDD
									4/2 D, 6/2 D
Bicycle	-	0.2	-	-	-	-	-	-	-
Becak	-	0.5	-	-	-	-	-	-	-
Motorcycle	0.33	0.33	0.5	0.5	0.5	0.25	0.25	0.25	0.25
Car/Taxi/Jeep	1	1	1	1	1	1	1	1	1.0
Mini-bus	1.2	1.2	1	1	1	1	1	1	1.0
Medium Bus	1.5	-	1.3	1.3	1.3	1.2	1.2	1.2	-
Large Bus	2	2	1.5	1.5	1.5	1.2	1.2	1.2	1.5
Pickup	1	1	1	1	1	1	1	1	1.0
Small Truck (2-Axle)	1.5	1.5	1.3	1.3	1.3	1.2	1.2	1.2	1.3
Large Truck (3 or more axle)	2	2	2.5	2	2	1.2	1.2	1.2	2.0

Sources: * SITRAMP (Phase 1), 2004
** Mamminasata Spatial Plan Study in 2005-2006
*** Indonesian Highway Capacity Manual, 1997

The F/S roads are located in the Mamminasata Metropolitan Area. As the traffic of motorcycles shares approximately 60% of the total traffic, its PCU conversion factor will significantly influence the road facility planning. There are some differences in the PCU conversion factors between the interurban roads and the urban roads. The JICA Study Team applied the PCU factor of motorcycle (0.25) for the urban roads. As the PCU factors of large bus, small truck and large truck for the urban roads seemed to be too low and many of these traffics go out of the metropolitan area, the interurban PCU conversion factors were applied for the F/S.

(3) Calibration of the Mamminasata Traffic Study

Table 5.1.7 shows a comparison between the traffic counts by the Mamminasata Study and those by the F/S. The average difference between the two studies is 4% and 9% in the number and pcu of traffic, respectively. As there is no substantial difference between the both surveys, the survey results of the former shall be used for the F/S. Some large differences are seen in vehicle composition and these are attributed to the study season and overload control of heavy vehicles by agencies concerned. The traffic survey for the Mamminasata Study was conducted in May - June (dry season) while that for the FS was conducted in February - March (rainy season).

Table 5.1.7 Comparison of Traffic Counts between the Mamminasata Study and the F/S

Survey Station	MC	Car/Taxi /Jeep	Minibus (Inc. PetePete)	Large Bus	Pickup	Small Truck (2-Axle)	Large Truck (3-Axle or more)	Motorized Vehicle Total	PCU Total (exclduing Bicycle & Becak)
Mamminasata Traffic Study									
Station 1	3,762	3,832	1,749	450	974	1,767	447	12,981	11,362
Station 2	5,770	1,476	1,976	59	524	602	28	10,435	6,346
Station 3	1,441	86	1,239	46	229	303	34	3,378	2,445
Station 4	7,717	1,080	1,767	82	414	1,823	665	13,548	9,013
Station 5	578	77	339	6	86	146	1	1,232	845
Station 6	20,296	3,524	3,381	87	718	1,996	158	30,160	15,738
Station 7	11,803	1,926	2,480	81	666	1,094	73	18,123	9,712
Station 8	2,218	304	2,183	108	251	505	46	5,615	4,203
Station 9	19,274	12,639	6,142	692	1,927	3,532	698	44,904	32,552
Station 10	51,693	11,918	7,232	343	1,495	3,642	1,207	77,530	41,231
F/S									
Station 1	5,550	642	4,794	186	819	1,985	144	14,120	13,093
Station 2	6,515	1,378	2,261	56	617	651	6	11,483	7,929
Station 3	1,380	79	977	36	189	237	2	2,900	2,427
Station 4	14,359	1,353	1,687	48	587	2,401	3	20,439	11,236
Station 5	339	1	63	0	38	32	0	473	260
Station 6	19,547	4,320	3,630	115	899	2,295	9	30,815	18,667
Station 7	10,321	1,795	3,284	38	403	868	87	16,796	11,045
Station 8	4,381	704	2,239	14	271	466	3	8,078	6,055
Station 9	30,877	14,233	5,391	457	2,375	4,333	70	57,736	38,644
Station 10	29,958	13,128	8,557	397	1,956	4,733	132	58,861	42,223
Difefrence between the Mamminasata Traffic Study and the F/S									
Station 1	148%	17%	274%	41%	84%	112%	32%	109%	115%
Station 2	113%	93%	114%	94%	118%	108%	21%	110%	125%
Station 3	96%	92%	79%	78%	83%	78%	6%	86%	99%
Station 4	186%	125%	95%	59%	142%	132%	0%	151%	125%
Station 5	59%	1%	19%	0%	44%	22%	0%	38%	31%
Station 6	96%	123%	107%	132%	125%	115%	6%	102%	119%
Station 7	87%	93%	132%	47%	61%	79%	119%	93%	114%
Station 8	198%	232%	103%	13%	108%	92%	7%	144%	144%
Station 9	160%	113%	88%	66%	123%	123%	10%	129%	119%
Station 10	58%	110%	118%	116%	131%	130%	11%	76%	102%
Average:	**120%**	**100%**	**113%**	**65%**	**102%**	**99%**	**21%**	**104%**	**109%**

Source: JICA Study Team

(4) Traffic Characteristics (Vehicle Composition)

Motorcycle has the substantial share of all traffic at 56.6%, followed by car/taxi/jeep at 18.6% and bus (mostly minibus) at 12.6% (see **Table 5.1.8**). Truck and pickup account for only 2.65% and 3.7%, respectively.

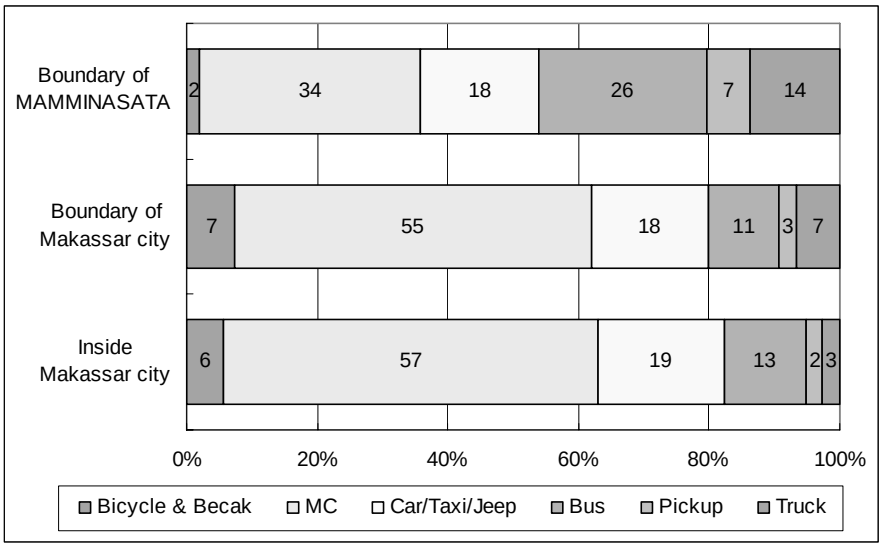
Table 5.1.8 Vehicle Composition

Unit: %

Survey Station	Bicycle & Becak	Motorcycle	Car/Taxi/ Jeep	Bus	Pickup	Truck	Total
Station 1	2.2	28.3	28.9	16.6	7.3	16.7	100
Station 2	10.2	49.7	12.7	17.5	4.5	5.4	100
Station 3	1.1	42.2	2.5	37.6	6.7	9.9	100
Station 4	2.8	55.3	7.7	13.3	3.0	17.8	100
Station 5	0.0	46.9	6.3	28.0	7.0	11.9	100
Station 6	11.0	59.9	10.4	10.2	2.1	6.4	100
Station 7	1.7	64.0	10.4	13.9	3.6	6.3	100
Station 8	2.3	38.6	5.3	39.9	4.4	9.6	100
Station 9	0.6	42.7	28.0	15.1	4.3	9.4	100
Station 10	9.9	60.0	13.8	8.8	1.7	5.6	100
Station 11	11.1	64.4	5.4	12.6	2.4	4.0	100
Station 12	18.2	65.3	3.0	8.1	3.6	1.8	100
Station 13	1.0	69.6	11.5	6.5	4.9	6.6	100
Station 14	0.6	63.6	16.2	16.4	1.4	1.8	100
Station 15	1.4	43.1	25.1	8.3	6.5	15.7	100
Station 16	0.0	0.0	25.6	37.6	9.8	27.0	100
Station 17	31.3	42.7	4.2	14.8	2.8	4.2	100
Station 18	7.9	49.8	28.1	10.1	2.1	2.0	100
Station 19	1.8	55.3	18.6	21.6	1.7	1.0	100
Station 20	16.3	67.8	4.5	5.2	3.7	2.5	100
Station 21	2.8	65.2	20.4	6.3	2.7	2.5	100
Station 22	9.1	54.9	9.1	24.9	1.2	0.9	100
Station 23	3.7	57.9	33.3	1.5	2.7	1.0	100
Station 24	6.3	56.2	33.4	0.2	3.0	0.9	100
Station 25	8.0	62.7	18.6	6.8	2.3	1.6	100
Station 26	11.0	57.9	12.9	15.2	1.9	1.0	100
Station 27	3.5	61.8	15.3	15.4	2.0	2.0	100
Station 28	1.5	48.5	27.2	20.2	2.4	0.2	100
Station 29	8.0	53.8	29.6	4.6	2.2	1.8	100
Total	5.9	56.6	18.6	12.6	2.6	3.7	100

Note: Ratio to the total number of vehicles
Source: Mamminasata Study

Figure 5.1.4 illustrates the vehicle composition by area. Motorcycle has the substantial share of traffic in and around Makassar City, while bus and truck increase their shares on national and provincial roads at the boundaries of the Mamminasata Metropolitan Area. These indicate that private transport means such as motorcycle and passenger car tend to be used in the urban area. On the other hand, public transport and freight transport means are active on intercity roads in suburban areas.

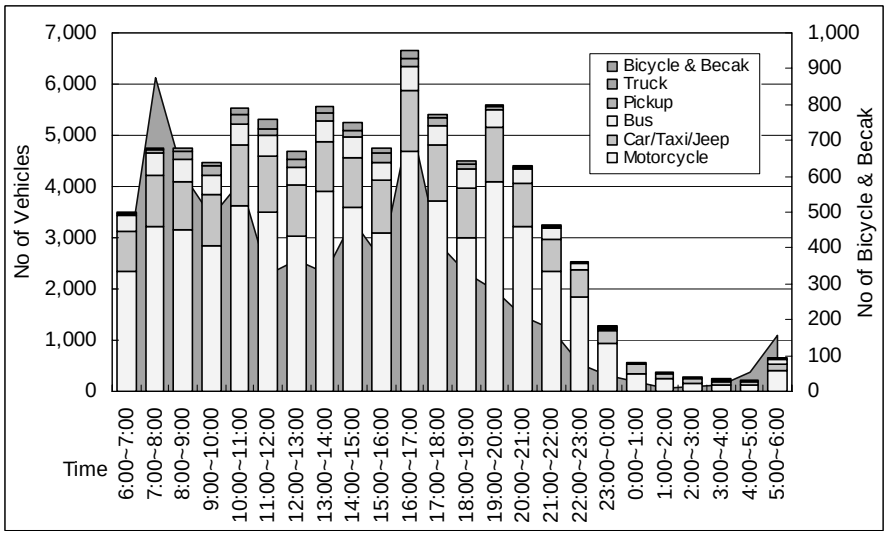


Source: Mamminasata Study

Figure 5.1.4 Vehicle Composition by Area

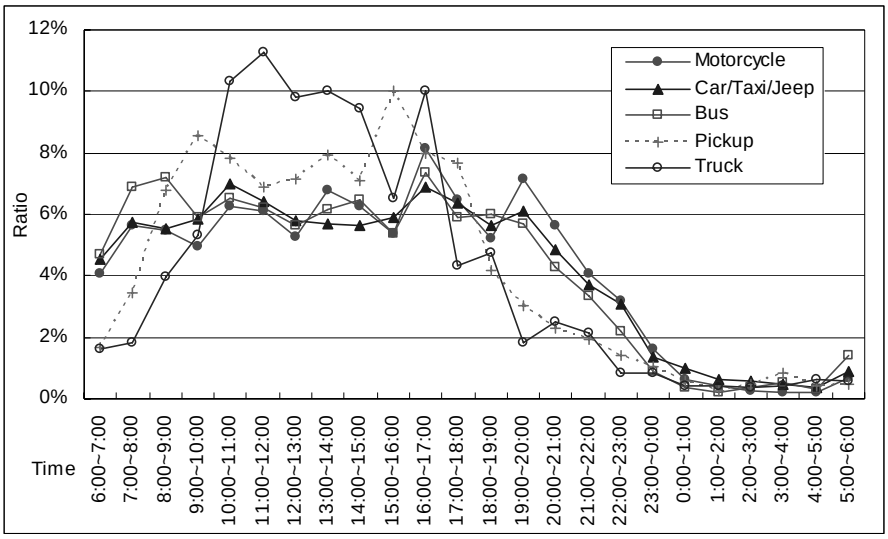
(5) Hourly Variation

Figures 5.1.5 - 5.1.8 show the hourly traffic variation at 24-hour survey stations. At Jl.Veteran Utara (Station 25), which is one of the north-south main roads in the Makassar City center, the highest traffic volume was observed between 16:00 and 17:00 as an evening peak. However, a clear morning peak could not be seen except for bicycle and becak. In contrast to this, constant traffic volumes were recorded from 06:00 to 18:00 at Station 1, the border between Kab. Maros and Kab. Pangkep (Mamminasata border) except at midnight.



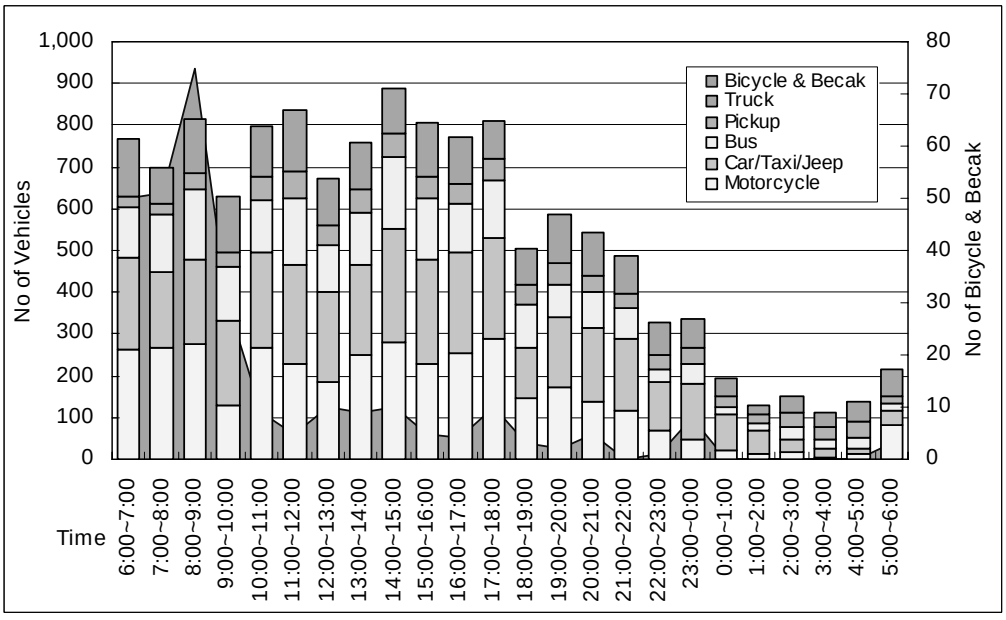
Source: Mamminasata Study

Figure 5.1.5 Hourly Fluctuation of Traffic on Jl.Veteran Utara (Station 25)



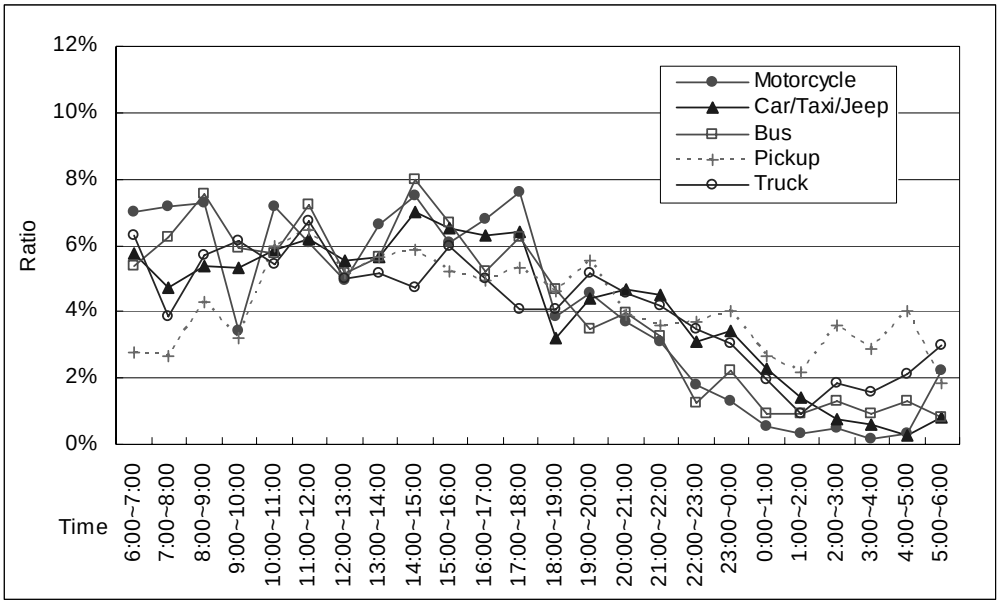
Source: Mamminasata Study

Figure 5.1.6 Hourly Fluctuation by Vehicle Type on Jl.Veteran Utara (Station 25)



Source: JICA Study Team

Figure 5.1.7 Hourly Fluctuation of Traffic on National Road at Kab.Maros/Kab.Pangkep Boarder (Station 1)



Source: JICA Study Team

Figure 5.1.8 Hourly Fluctuation by Vehicle Type on National Road at Kab.Maros/ Kab.Pangkep Boarder (Station 1)

(6) Traffic Volume Change since 1998 JICA Study

The "Ujung Pandang Area Highway Development Study (JICA 1989 Study)" conducted the traffic count survey in 1988. The traffic changes between the JICA Study in 1988 and 2005 on representative roads in Makassar City are shown in Table 5.1.8.

Table 5.1.9 Traffic Growth from 1989 to 2005

Road Name	Traffic Volume (vehicles)		2005/1988	Average Annual Traffic Growth
	1988	2005		
M+B+T (car, bus truck)				
Jl.Urip Sumoharjo	23,700	33,000	139%	2.0%
Jl. A.P. Pettarani	10,200	35,800	351%	7.7%
Jl.Sultan Alauddin	12,700	22,000	173%	3.3%
Jl. Veteran Sultan	13,700	20,200	147%	2.3%
Average			202.7%	3.8%
Motorcycle and becak				
Jl.Urip Sumoharjo	26,900	40,500	151%	2.4%
Jl. A.P. Pettarani	22,100	62,600	283%	6.3%
Jl.Sultan Alauddin	19,400	35,100	181%	3.5%
Jl. Veteran Sultan	20,600	45,100	219%	4.7%
Average			208.4%	4.3%
All Traffic				
Jl.Urip Sumoharjo	50,600	73,500	145%	2.2%
Jl. A.P. Pettarani	32,300	98,400	305%	6.8%
Jl.Sultan Alauddin	32,100	57,100	178%	3.4%
Jl. Veteran Sultan	34,300	65,300	190%	3.9%
Average			204.5%	4.1%

Source: Mamminasata Study and Ujung Pandang Area Highway Development Study

The traffic volume on major roads in Makassar City increased 2.2% - 6.8% annually between 1988 and 2005. The highest increase of 351% was on Jl.Andi Pangerang Pettarani as the capacity of this road was increased by its widening from 2 lanes to 6-8 lanes. The lowest increase of 145% was on Jl. Urip Sumoharjo as its capacity has reached the maximum. The traffic increase on Jl.Veteran Utara and Jl.Sultan Alauddin was 190% and 178% respectively. The traffic increase of motorcycle was higher than car, bus and truck (M+B+T). The traffic on these city trunk roads would not increase in the future except Jl.A.P.Pettarani as their capacity has almost reached the maximum.

(7) Seasonal and Daily Traffic Variation Factors

One-day traffic count was conducted at 16-hour count stations and two-day count at 24-hour count stations. These were required for conversion of the counted traffic to Annual Average Daily Traffic (AADT) by adjusting with seasonal and daily variation factors for the road transport planning. The seasonal factors (Table 5.1.10) to be applied for the Mamminasata traffic analysis were established from the toll traffic on Jl.Ir.Sutami in 2004. The average traffic in the rainy season was less than that in the dry season.

Table 5.1.10 Seasonal Traffic Volume Variation Factors for Mamminasata Area

Month	No. of Days	Monthly Traffic Volume (vehicle)				Daily Traffic Volume (vehicle)					Seasonal Variation Factor
		Car	Pete Pete (Mini-bus)	Truck (2 Axles)	Truck (>3 Axles)	Car	Pete Pete (Mini-bus)	Truck (2	Truck (>3 Axles)	Total	
Jan	31	562,537	100,314	116,008	44,686	18,146	3,236	3,742	1,441	26,566	95.2%
Feb	28	507,918	89,662	100,826	42,125	18,140	3,202	3,601	1,504	26,448	94.8%
Mar	31	566,168	95,717	113,589	49,601	18,263	3,088	3,664	1,600	26,615	95.4%
Apr	30	537,755	92,087	113,290	45,105	17,925	3,070	3,776	1,504	26,275	94.1%
May	31	595,735	98,940	121,099	53,357	19,217	3,192	3,906	1,721	28,036	100.5%
Jun	30	602,206	93,915	126,033	50,123	20,074	3,131	4,201	1,671	29,076	104.2%
Jul	31	623,440	97,345	126,873	52,642	20,111	3,140	4,093	1,698	29,042	104.1%
Aug	31	601,987	96,300	124,794	51,661	19,419	3,106	4,026	1,666	28,217	101.1%
Sep	30	590,923	93,735	122,230	52,320	19,697	3,125	4,074	1,744	28,640	102.6%
Oct	31	601,785	97,371	129,851	54,225	19,412	3,141	4,189	1,749	28,491	102.1%
Nov	30	582,670	100,287	110,995	43,271	19,422	3,343	3,700	1,442	27,907	100.0%
Dec	31	633,537	99,507	128,073	55,973	20,437	3,210	4,131	1,806	29,584	106.0%
									Average:	27,908	100.0%

Note: Toll data at Jl.Ir.Sutami (2004)
Source: JICA Study Team

The daily traffic variation factors (Table 5.1.11) for the Mamminasata Metropolitan Area were established by processing the weekly traffic survey data of the feasibility study for the Jl.Urip Sumoharjo/Jl.A.P.Pettarani Flyover Project. The traffic on Mondays and Tuesdays was higher than other days with 109% and 107%, respectively, while that on Sundays was the lowest at 83%.

Table 5.1.11 Daily Traffic Volume Variation Factors for Mamminasata Area

Period	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Average
Jl.Ulip Sumohardjo								
07.00-08.00	3,033	3,076	3,017	2,976	2,949	2,924	2,352	2,904
08.00-09.00	3,012	2,995	3,165	2,871	3,056	2,933	2,989	3,003
11.00-12.00	2,982	3,012	2,635	2,663	2,674	2,820	2,668	2,779
12.00-13.00	3,064	3,036	1,948	3,204	1,944	2,993	2,605	2,685
16.00-17.00	3,006	3,025	3,175	3,038	3,145	3,034	2,456	2,983
17.00-18.00	3,028	3,130	3,018	3,171	3,167	3,138	2,874	3,075
Average	3,021	3,046	2,826	2,987	2,823	2,974	2,657	2,905
Daily Factor	104%	105%	97%	103%	97%	102%	91%	100.0%
Jl.AP Pettarani								
07.00-08.00	4,017	4,199	3,410	3,114	2,924	2,748	1,664	3,154
08.00-09.00	3,677	3,461	3,258	3,219	3,313	3,043	1,948	3,131
11.00-12.00	3,434	3,159	3,110	2,872	3,240	3,208	2,586	3,087
12.00-13.00	2,809	3,195	3,064	3,202	3,198	3,502	2,684	3,093
16.00-17.00	3,336	3,530	2,897	3,309	3,410	3,502	2,725	3,244
17.00-18.00	5,067	3,496	3,378	3,727	3,857	3,679	2,914	3,731
Average	3,723	3,507	3,186	3,241	3,324	3,280	2,420	3,240
Daily Factor	115%	108%	98%	100%	103%	101%	75%	100%
Average Daily Factor	109%	107%	98%	101%	100%	102%	83%	

Note: Traffic data from Studi Kelayakan Jalan Belakang Kodam, 2004
Source: JICA Study Team

The above seasonal and daily variation factors were combined in Table 5.1.12 and were used for conversion of the traffic count survey data to AADT.

Table 5.1.12 Traffic Volume Variation Factors for the Study

Seasonal Influence (Factor)		**Daily Variation (Factor)**						
Month	Factor	Monday 1.09	Tuesday 1.07	Wednesday 0.98	Thursday 1.01	Friday 1.00	Saturday 1.02	Sunday 0.83
Jan	0.95	1.04	1.01	0.93	0.97	0.95	0.97	0.79
Feb	0.95	1.04	1.01	0.93	0.96	0.95	0.96	0.79
Mar	0.95	1.04	1.02	0.93	0.97	0.95	0.97	0.79
Apr	0.94	1.03	1.00	0.92	0.95	0.94	0.96	0.78
May *	1.00	1.10	1.07	0.98	1.02	1.00	1.02	0.83
Jun*	1.04	1.14	1.11	1.02	1.06	1.04	1.06	0.87
Jul	1.04	1.14	1.11	1.02	1.06	1.04	1.06	0.86
Aug	1.01	1.11	1.08	0.99	1.03	1.01	1.03	0.84
Sep	1.03	1.12	1.09	1.00	1.04	1.02	1.04	0.85
Oct	1.02	1.12	1.09	1.00	1.04	1.02	1.04	0.85
Nov	1.00	1.09	1.07	0.98	1.01	1.00	1.02	0.83
Dec	1.06	1.16	1.13	1.04	1.08	1.06	1.08	0.88

Note: *Survey period by Mamminasata Study (May and June 2005)
Source: JICA Study Team

As the Mamminasata Study did not apply seasonal and daily variation factors, the F/S adjusted it to AADT by applying the above factors as shown in **Table 5.1.13**.

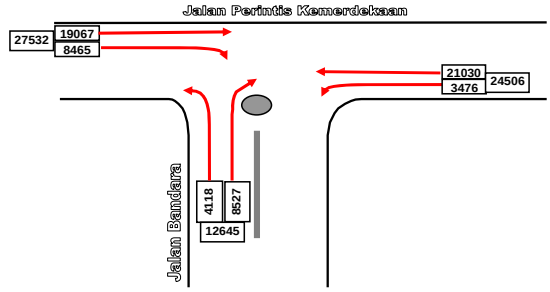
Table 5.1.13 Annual Average Daily Traffic (AADT) for Traffic Survey Stations

Survey Station	Motorized Vehicle Total	PCU Total	Survey Date	Day	AADT Factor	**AADT (vehicle)**	**AADT (pcu)**
Station 1	12,981	11,362	30/05/2005	Monday	1.10	**11,801**	**10,329**
Station 2	10,435	6,346	30/05/2005	Monday	1.10	**9,486**	**5,769**
Station 3	3,378	2,445	19/05/2005	Thursday	1.02	**3,312**	**2,397**
Station 4	13,548	9,013	20/05/2005	Friday	1.00	**13,548**	**9,013**
Station 5	1,232	845	20/05/2005	Friday	1.00	**1,232**	**845**
Station 6	30,160	15,738	20/05/2005	Friday	1.00	**30,160**	**15,738**
Station 7	18,123	9,712	27/05/2005	Friday	1.00	**18,123**	**9,712**
Station 8	5,615	4,203	27/05/2005	Friday	1.00	**5,615**	**4,203**
Station 9	44,904	32,552	19/05/2005	Thursday	1.02	**44,024**	**31,914**
Station 10	77,530	41,231	20/05/2005	Friday	1.00	**77,530**	**41,231**
Station 11	3,206	1,511	27/05/2005	Friday	1.00	**3,206**	**1,511**
Station 12	4,803	1,966	27/05/2005	Friday	1.00	**4,803**	**1,966**
Station 13	25,763	13,210	23/05/2005	Monday	1.10	**23,421**	**12,009**
Station 14	124,522	65,677	23/05/2005	Monday	1.10	**113,202**	**59,707**
Station 15	41,916	31,448	23/05/2005	Monday	1.10	**38,105**	**28,589**
Station 16	10,003	11,667	23/05/2005	Monday	1.10	**9,094**	**10,607**
Station 17	26,488	14,898	25/05/2005	Wednesday	0.98	**27,029**	**15,202**
Station 18	37,491	22,642	25/05/2005	Wednesday	0.98	**38,256**	**23,104**
Station 19	97,230	56,638	25/05/2005	Wednesday	0.98	**99,214**	**57,794**
Station 20	20,490	8,257	25/05/2005	Wednesday	0.98	**20,908**	**8,425**
Station 21	136,802	69,556	26/05/2005	Thursday	1.02	**134,120**	**68,192**
Station 22	72,787	40,137	26/05/2005	Thursday	1.02	**71,360**	**39,350**
Station 23	23,358	12,927	26/05/2005	Thursday	1.02	**22,900**	**12,674**
Station 24	57,650	31,947	26/05/2005	Thursday	1.02	**56,520**	**31,321**
Station 25	84,500	41,895	30/05/2005	Monday	1.10	**76,818**	**38,086**
Station 26	38,611	19,951	30/05/2005	Monday	1.10	**35,101**	**18,137**
Station 27	35,210	18,604	02/06/2005	Thursday	1.06	**33,217**	**17,551**
Station 28	57,405	36,293	02/06/2005	Thursday	1.06	**54,156**	**34,239**
Station 29	42,041	23,960	02/06/2005	Thursday	1.06	**39,661**	**22,604**

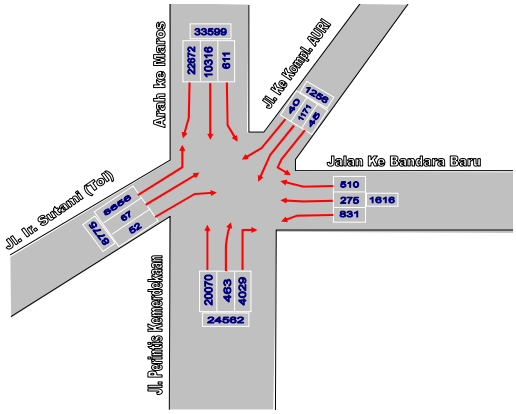
Note: **Average (AADT Factor): 1.04**
Source: JICA Study Team

(8) Major Intersection Traffic

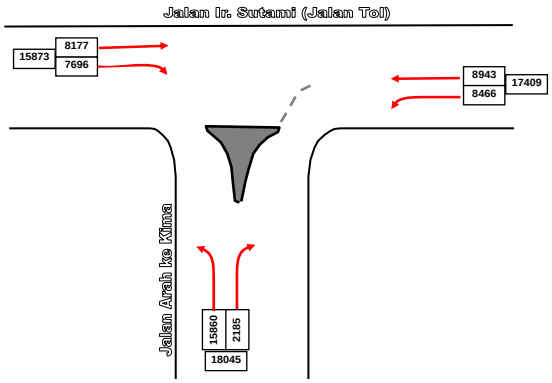
The results of intersection traffic survey conducted at 8 stations in the F/S are summarized in **Figure 5.1.9**. It shows traffic volume by direction and will be used for planning appropriate intersections for the F/S roads.



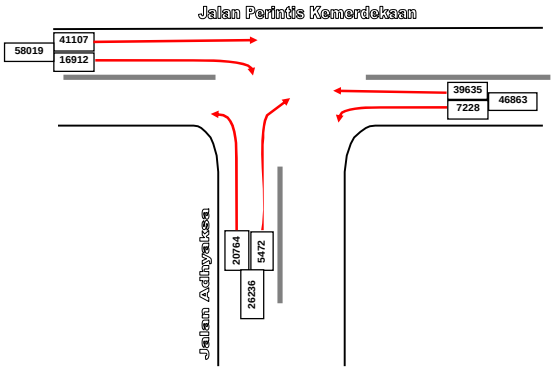
1. National Road / Hasanuddin Airport Port



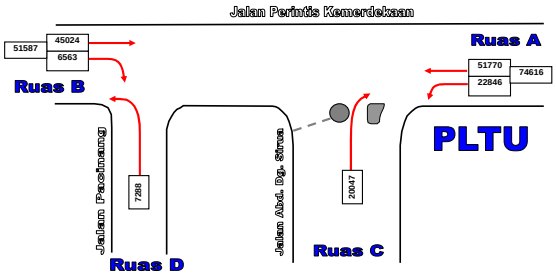
2. Jl.Perintis Kemerdekaan / Jl.Ir.Sutami (Toll) / AURI Area Road



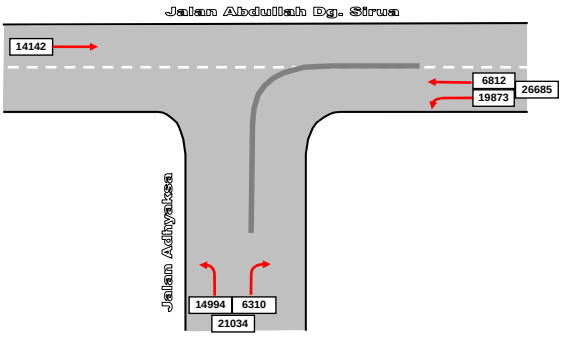
3. Jl.Ir.Sutami (Toll) / Jl.KIMA



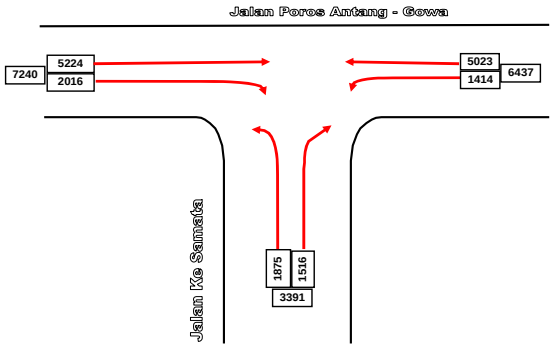
4. Jl.Perintis Kemerdekaan / Jl.BTP



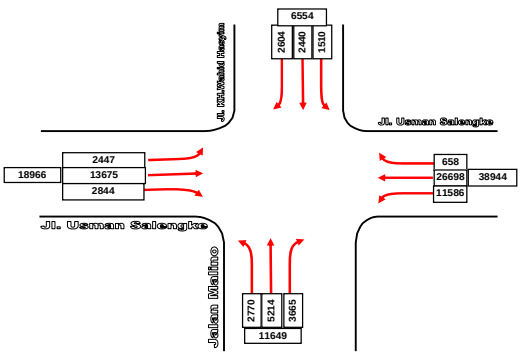
5. Jl.Urip Sumoharjo / Jl.Abdullah Daeng Sirua (PLTU)



6. Jl.Abdullah Daeng Sirua / Adyakasa



7. Jl.Sykh Yusof / Jl.Antang (Samasa)



8. Jl.Malino / Jl.Usman Saleng / Jl.HK Wahid Hasyim

Figure 5.1.9 Major Intersection Traffic

5.1.5 Results of Origin and Destination Survey

(1) Average Passenger Occupancy

The average occupancy by vehicle type obtained from the OD interview survey results is shown in **Table 5.1.14**. The average number of passengers on a motorcycle and a minibus is 1.48 and 5.78 respectively.

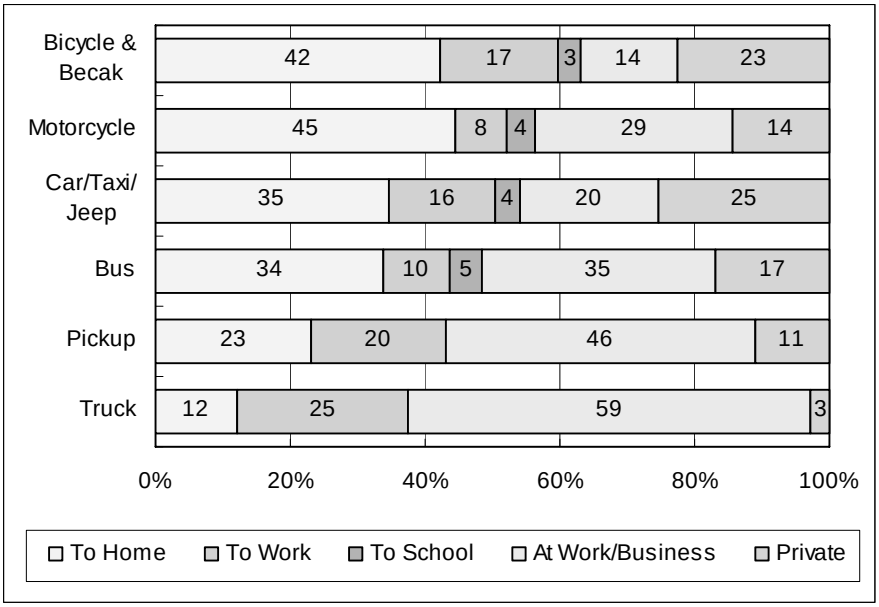
Table 5.1.14 Average Passenger Occupancy

Vehicle Type	Total Passengers	Number of Samples	Average Occupancy (passenger/vehicle)
Bicycle	1,406	1,314	1.07
Becak	2,186	1,156	1.89
Motorcycle	26,307	17,747	1.48
Car/Taxi/Jeep	17,160	6,783	2.53
Minibus	38,919	6,728	5.78
Large Bus	4,818	302	15.95
Pickup	4,354	2,127	2.05
Small Truck (2-Axle)	3,926	1,758	2.23
Large Truck (3 or more axles)	1,658	714	2.32

Note: Above figures include drivers
Source: Mamminasata Study

(2) Trip Purpose

The trip purpose varied by vehicle type as illustrated in Figure 5.1.10. Bicycle/becak, motorcycle and car/taxi/jeep are used for both commuting and business while bus, pickup and truck are used for work and business.

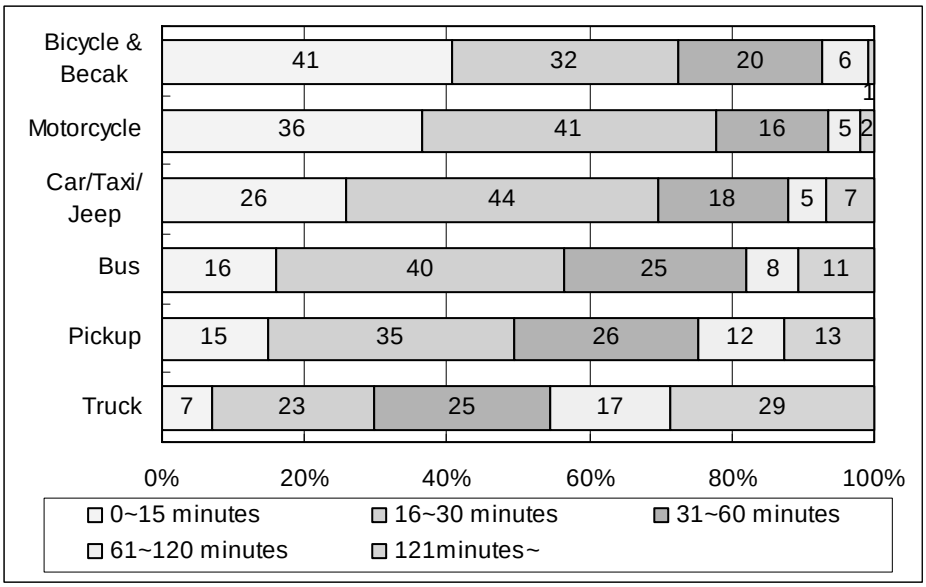


Source: JICA Mamminasata Study

Figure 5.1.10 Trip Purpose by Vehicle Type

(3) Travel Time

Figure 5.1.11 shows the travel time by vehicle type. More than half of respondents except truck users answered that the travel time was within 30 minutes. This means that they live in the area within 30 minutes from/to house, office, etc. The trip length differs by transportation mode in the case of same travel time.



Source: JICA Mamminasata Study

Figure 5.1.11 Travel Time by Vehicle Type

(4) Commodity Type and Loading Condition of Freight Transport

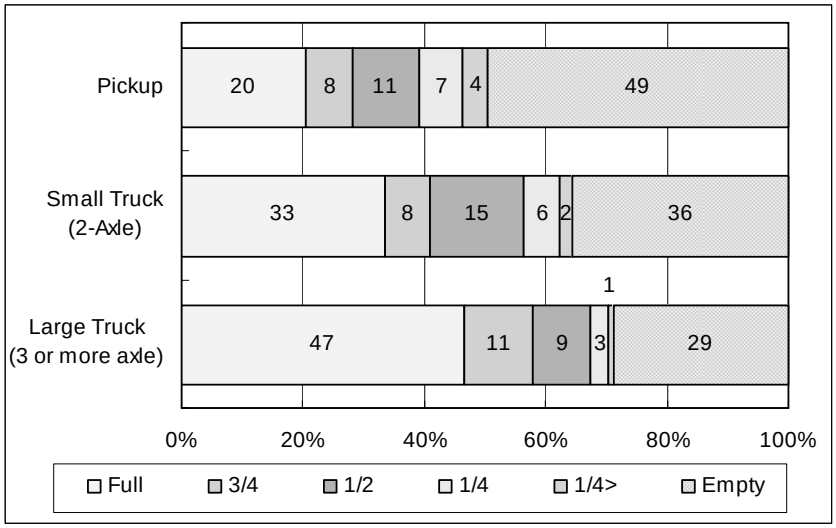
Table 5.1.14 shows the types of commodities carried by pickups and trucks. Construction materials and agricultural products have high shares accounting for 21.0% and 20.8%, respectively. Trucks carrying construction materials were dominant on the Malino road (Station 4) while those carrying agricultural products were many on national roads between Pekkae and Pangkajene Kepulauan and between Maros and Ujung Lamura (Stations 2 & 3).

Table 5.1.15 Commodity Types Transported by Trucks and Pickups

Type of Commodity	%
Construction (Sand, Gravel, Asphalt, Concrete, Re-Bar, Beam, etc.)	21.0
Agriculture (Rice, Corn, Vegetables, Fruit, etc.)	20.8
Miscellaneous Industry (Garment, Shoes, etc.)	9.5
Light Industry / Electronics (Machine Parts, IC, Electronic Appliances, etc.)	7.4
Forest (Log, Timber, Plywood, etc.)	6.2
Fishery (Fish, Shell, Seaweed, etc.)	6.0
Chemical (Petroleum, Alcohol, Acid, etc.)	5.1
Mineral (Coal, Copper, Iron, Salt, etc.)	4.0
Metal & Machine (Steel, Generator, Car & Bike, etc.)	2.5
Others	17.4
Total	100.0

Source: Mamminasata Study

Figure 5.1.12 shows the loading condition by vehicle type. As the vehicle size becomes larger, the loading occupancy tends to be higher. Since some pickups are used for passenger transport, their empty ratio is high (49%).



Source: Mamminasata Study

Figure 5.1.12 Loading Condition by Vehicle Type

(5) Freight Transport

The results of truck traffic count survey and truck OD interview survey at the exit gates of port, airport, industrial park and warehouse are summarized in **Tables 5.1.16** and **5.1.17**.

Table 5.1.16 Freight Transport Survey Stations

Station	Survey Station	Location	Survey Period	Survey Date
1	Soekarno Hatta seaport	Gate	24hrs	03/06/2005
2	Warehouse in Parangloe Indah	Gate	24hrs	03/06/2005
3	Kawasan Industri Makassar	Gate near Jl.Perintis Kemerdekaan	12hrs	03/06/2005
4	Kawasan Industri Makassar	Gate near Terminal Bis Daya	24hrs	03/06/2005
5	Hasanuddin Airport	Gate	24hrs	03/06/2005

Source: Mamminasata Study

The major features of the commodity types are as follows:

- The major commodity is agricultural products at the Soekarno Hatta seaport;
- The commodity type varies between agricultural products, construction materials, fishery commodities and miscellaneous industrial goods at Kawasan Industri Makkasar (KIMA);
- Chemical products are treated at warehouses in Parangloe Indah; and
- Hasanuddin Airport handles fishery as major commodity. Others (64%) include foods for catering for air service and airmail.

Table 5.1.17 Commodity Types by Location

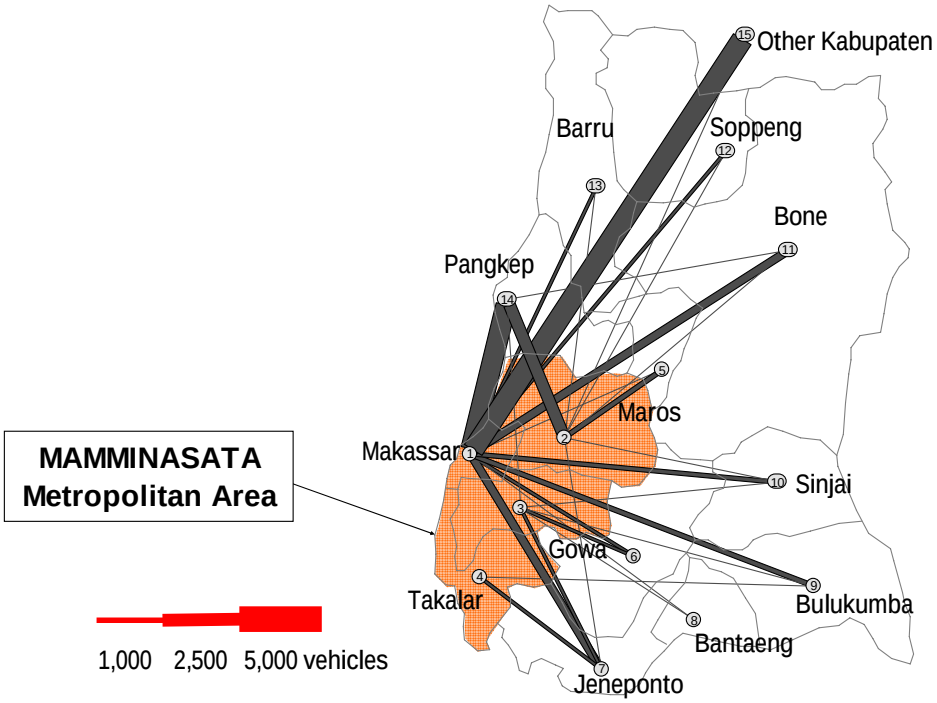
Unit: %

Major Commodity	Soekarno Hatta Seaport	Warehouse in Parangloe Indah	Kawasan Industri Makassar	Hasanuddin Airport	Total
Agriculture	37.3	15.7	19.9	1.7	21.5
Construction	14.3	16.4	19.5	0.0	16.0
Miscellaneous Industry	11.5	9.4	10.6	1.7	10.6
Chemical	10.2	45.3	6.9	0.8	13.2
Mineral	7.5	0.0	6.7	0.0	4.9
Light Industry / Electronics	6.2	4.4	6.3	9.2	6.7
Forest	5.3	0.6	4.2	0.0	3.9
Fishery	3.1	0.0	14.8	22.7	9.3
Metal & Machine	3.1	6.3	4.0	0.0	3.8
Others	1.6	1.9	7.0	63.9	10.1
Total	100.0	100.0	100.0	100.0	100.0

Source: Mamminasata Study

(6) Transport Demand Characteristics Across Mamminasata Metropolitan Area

A desired line was drawn based on the OD matrices to represent the transport demand characteristics (**Figure 5.1.13**). The desired line indicated that most of the traffic from/to outside of the Mamminasata Metropolitan Area has origin or destination in the Makassar City, while there is little traffic from the north to the south passing through this city.



Note: Excluding Bicycle and Becak.
Source: Mamminasata Study / JICA Study Team

Figure 5.1.13 Desired Line Across Mamminasata (2005)

The Makassar City has the most attractive and generative place for both passenger and freight transport. It is connected not only to surrounding Kabupaten but also to other Kabupaten and provinces in the Sulawesi Island. This implies that the Makassar City is playing a leading role in the Sulawesi Island in terms of economy and logistics. On the other hand, Maros, Gowa and Takalar have stronger relationships with adjacent Kabupaten. Motorcycle traffic between Takalar and the Makassar City is substantial while those of car, bus and truck are low.

It is noteworthy that motorcycles and bicycles are very active in the traffic between Gowa and Kecamatan Tamalate in the Makassar City (**Figure 5.1.14**). This traffic goes to two major markets in Kecamatan Tamalate for supply of vegetables and fruit from Kabpaten Gowa. GMTDC also attracts the traffic from Gowa (Sungguminasa).

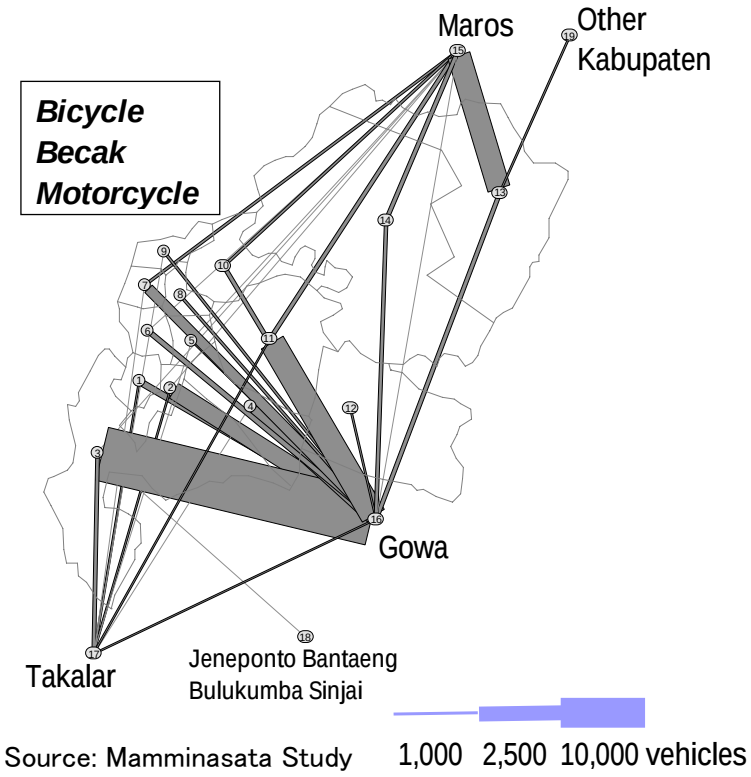


Figure 5.1.14 Bicycle and Motorcycle Movement in Mamminasata Metropolitan Area

5.1.6 Travel Speed Survey

The travel speed survey aimed at measuring the average travel speed and evaluating transport efficiency on the selected routes in the study area. The results of the survey were essential for identifying the congested road sections in the study area as well as for the setting of Q/V formulae of network links for traffic assignment in the traffic demand forecast.

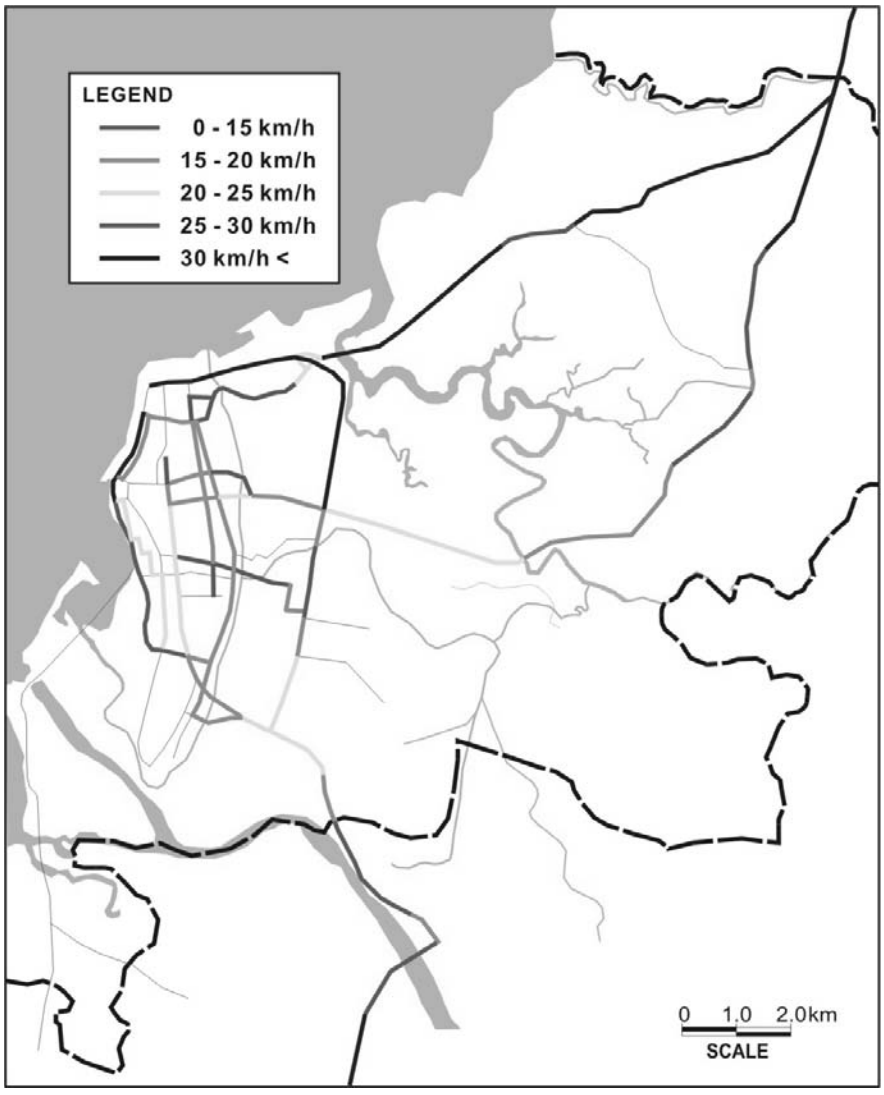
The measured average travel speeds are summarized in **Table 5.1.18**. The lowest travel speed was seen during the evening peak hours (**Figure 5.1.15**). The lowest average travel speed was observed on Jl.Tanampu and Jl.Sungai Saddang (2-lane roads) running in the east and west direction. The average travel speed was relatively low on most of the roads around Jl.Tol Reformasi and Jl.Pettarani. On the other hand, the average travel speed outside the Makassar City was relatively higher except that around Sungguminasa.

The results of the travel speed survey conducted for the Trans-Sulawesi Mamminasata Section by the F/S are as shown in **Figure 5.1.16**. The average travel speed from Makassar to Maros through Jl.Perintis Kemerdekaan was 40 km/hour and that from Maros to Makassar was 32 km/hour. The average travel speed from Makassar to Takalar through national road was 40 km/hour and the opposite direction was 41 km/hour.

Table 5.1.18 Summary of Travel Speed by Route

Route Name	Direction		Distance (Km)	Average Travel Speed (km/h)			
	From	To		AM	Off	PM	All day
A	Makassar Border	Jl.Ahmad Yani	19.5	26.1	29.3	26.5	27.2
	Jl.Ahmad Yani	Makassar Border	18.8	28.1	29.2	24.4	27.0
B	Maros City Border	Jl.Sunu	17.6	35.0	33.6	32.8	33.8
	Jl.Sunu	Maros City Border	18.5	33.0	40.5	36.1	36.3
C	Jl.Cokroaminoto	Jl.Tol Reformasi	16.4	31.1	30.0	27.6	29.5
	Jl.Tol Reformasi	Jl.Cokroaminoto	17.0	30.6	31.0	27.6	29.7
D	Jl.Sunu	Jl. Pasewang	17.2	20.0	20.9	19.6	20.2
	Jl. Pasewang	Jl.Sunu	17.9	22.3	19.8	19.2	20.3
E	End of Kec.Bontanompo	Jl. Jendral Sudirman	25.4	30.1	28.6	28.8	29.2
	Jl. Jendral Sudirman	End of Kec.Bontanompo	25.4	30.7	29.8	24.5	28.1
Total			-	28.1	28.3	25.9	27.4

Source: JICA Mamminasata Study



Source: JICA Mamminasata Study

Figure 5.1.15 Travel Speed Profile (PM Peak) in Makassar City

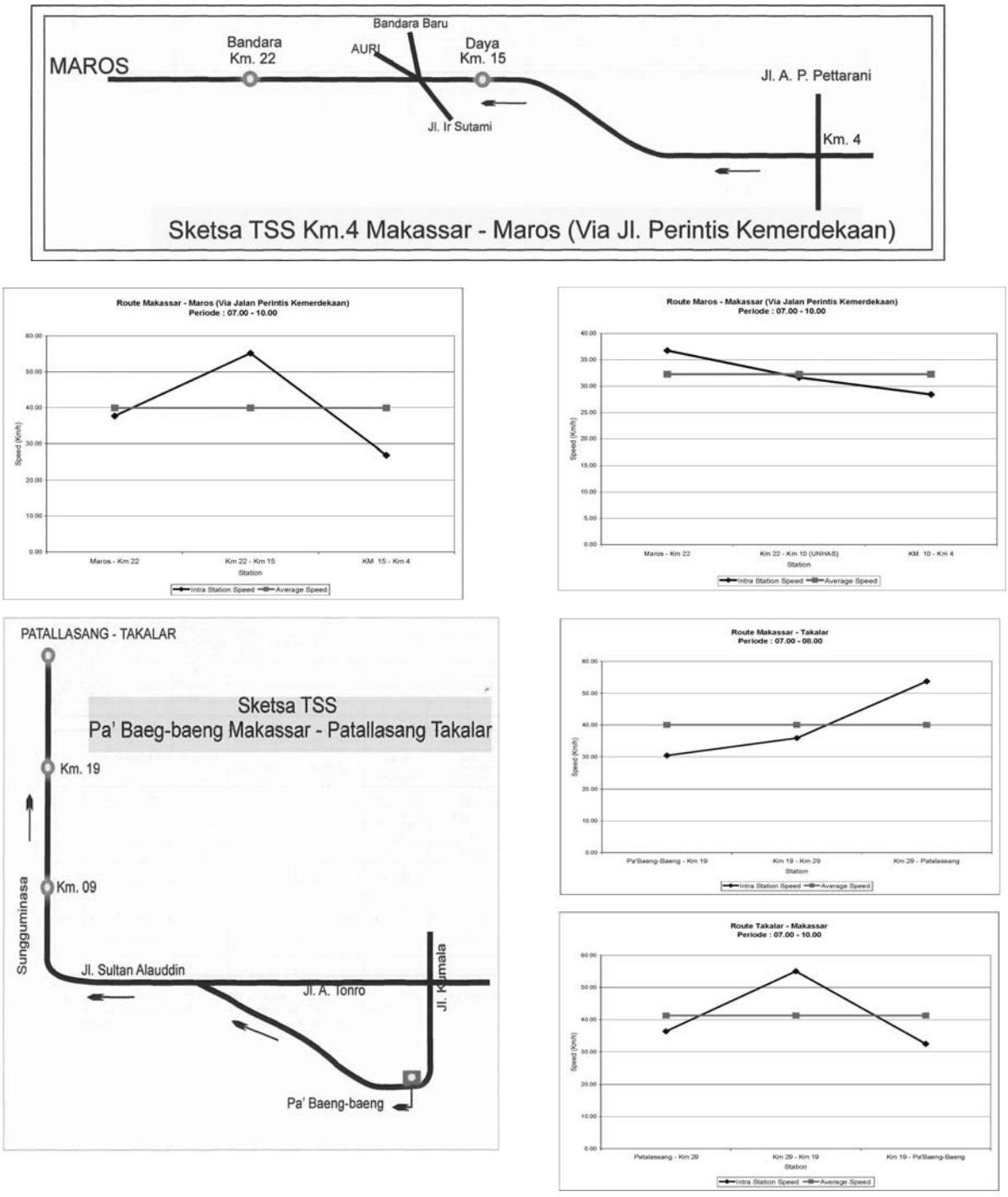


Figure 5.1.16 Travel Speed for Trans-Sulawesi Mamminasata Road (AM)

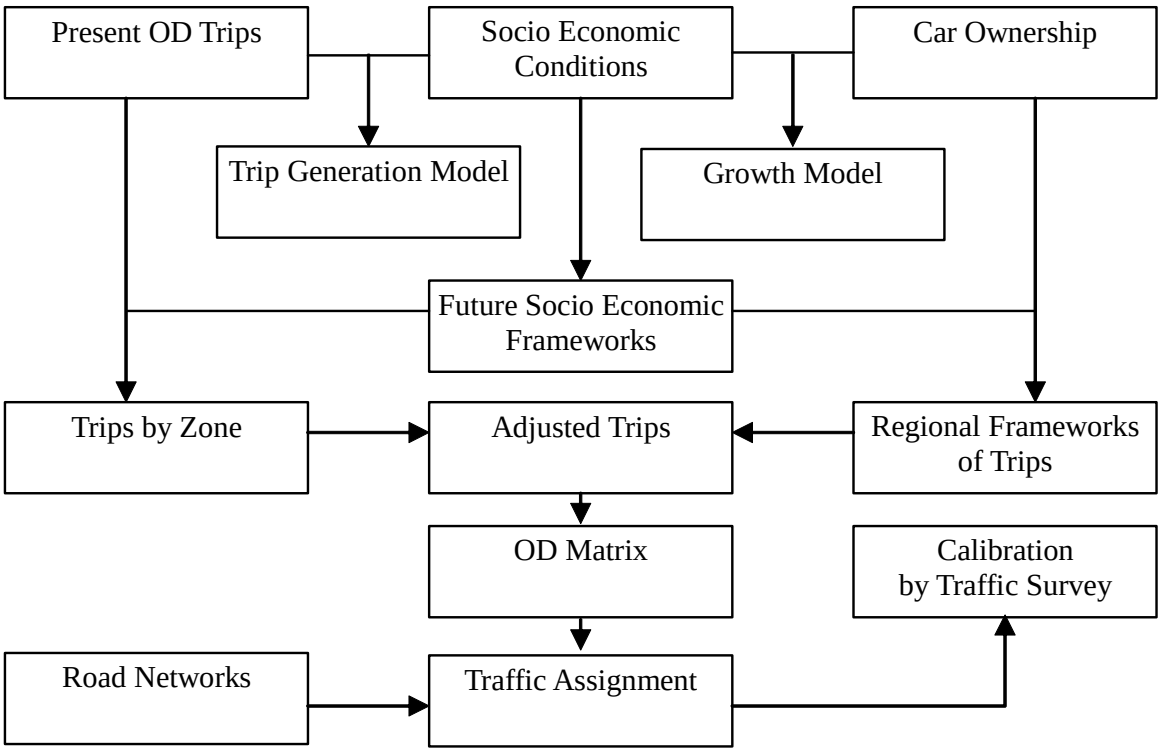
5.2 Method of Traffic Demand Forecast

(1) Forecast Flow

Traffic demand depends on socio economic conditions. Therefore the method of traffic demand forecast should be constructed by the analysis of the relation between traffic demand and socio economic conditions.

The object of demand forecast in this study is mainly the revision of the master plan, therefore the methodology is also based on the former study. The forecast flow consists of two estimation processes: One is the modeling of present trips by zone and the estimation of the future demand by the model and the other is the modeling of total frameworks in South Sulawesi and the forecast of the growth. They should be revised and calibrated by traffic survey and moreover it will be necessary to confirm the result by a comparison with other indices.

As shown in **Figure 5.2.1** the main forecast process takes into consideration stepwise the present socio economic indices, future socio economic plan, traffic assignment by OD tables, and traffic network.



Source: JICA Study Team

Figure 5.2.1 Traffic Demand Forecast Flow

(2) Framework of Traffic Demand

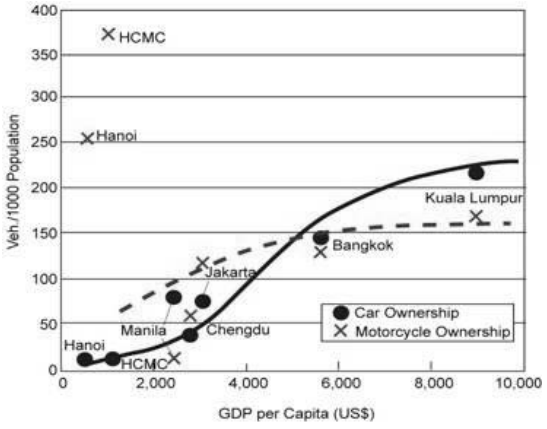
In South Sulawesi car ownership is increasing gradually year by year. The framework of traffic demand is forecast by the growth of car ownership. Even though the growth rate of traffic volume might be higher than that of car ownership because trips per person per day increase in line with economic activities, the data on car ownership is the most reliable one to explain the growth of trips.

Based on the result of modeling of car ownership by vehicle type, the following coefficients were estimated. The result shows that each correlation with forecast is high enough.

Table 5.2.1 Estimation Model of Frameworks Y=a*ln(GDP per capita)+b

	Motorcycle	Car	Mini Bus	Large Bus	Pickup	Small Truck	Large Truck
Coefficient	808100.5	120100	46859.62	3976.67	18283.18	11237.7	2695.195
Constant	-11557.9	-8241.67	3750.68	340.07	16291.31	3342.9	-169.788
Correlation	0.9013	0.9535	0.9471	0.7881	0.7702	0.8279	0.8871

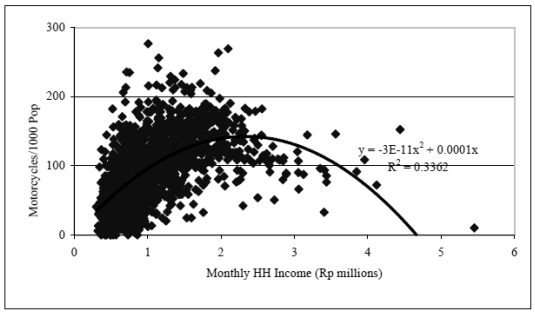
According to the above coefficients, the growth of motorcycle ownership looks like very fast because it is becoming easy to get motorcycles by the new credit system. The ratio of ownership was estimated by socio-economic model to be about 0.2 motorcycles per person in year 2023. That means about one motorcycle per family. However in most Asian cities the ratio tends to reach a saturation point at 0.15 per person (Figure 5.2.2) except Viet Nam.



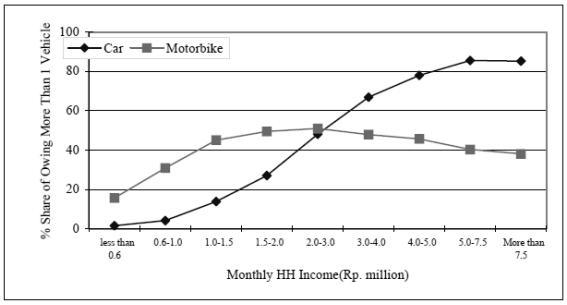
Source: JICA Ho Chi Minh Urban Transport Master Plan in 2004

Figure 5.2.2 Comparison of Car Ownership in Asian Cities

By increasing household income in which GDP per capita is reflected, the share of motorcycle ownership trends lower and car ownership becomes higher. In Indonesia this trend was surveyed in Jakarta by JICA SITRAMP 2004 (refer to Figure 5.2.3). Therefore in this region also the increasing demands for passenger cars due to future affluent society will suppress the growth of motorcycles.



Relationship of
Motorcycle Ownership and Household Income Level



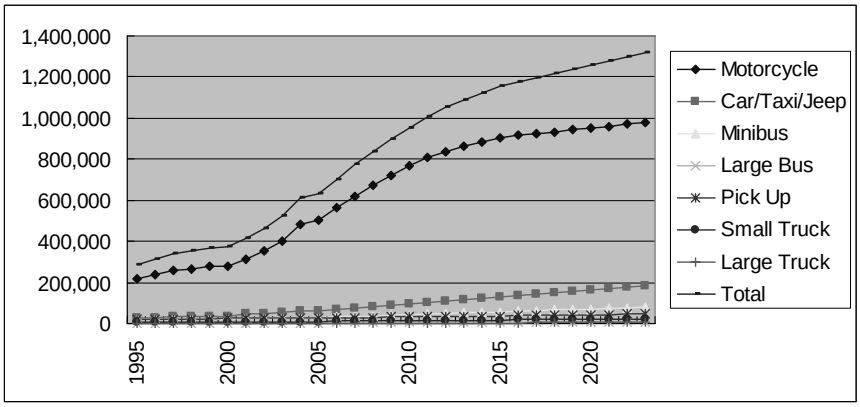
Car/Motorcycle Owning Share
by Household Income Level

Source JICA SITRAMP in 2004

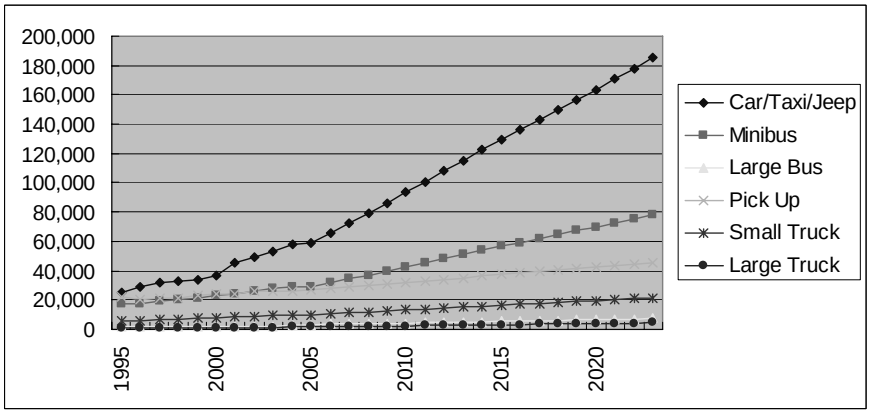
Figure 5.2.3 Motorcycle and Car Ownership by Income Level

From this viewpoint most of vehicles were forecast by trend model as mentioned above, and only motorcycle was forecast by saturated type model.

As GRDP per capita grows higher, car ownership increases. The results of forecast of car ownership by the above model are shown in **Figure 5.2.4** for all kinds of vehicles except motorcycles. The growth of total trips by vehicle in the demand forecast was applied in estimating car ownership.



Note: All types of vehicles



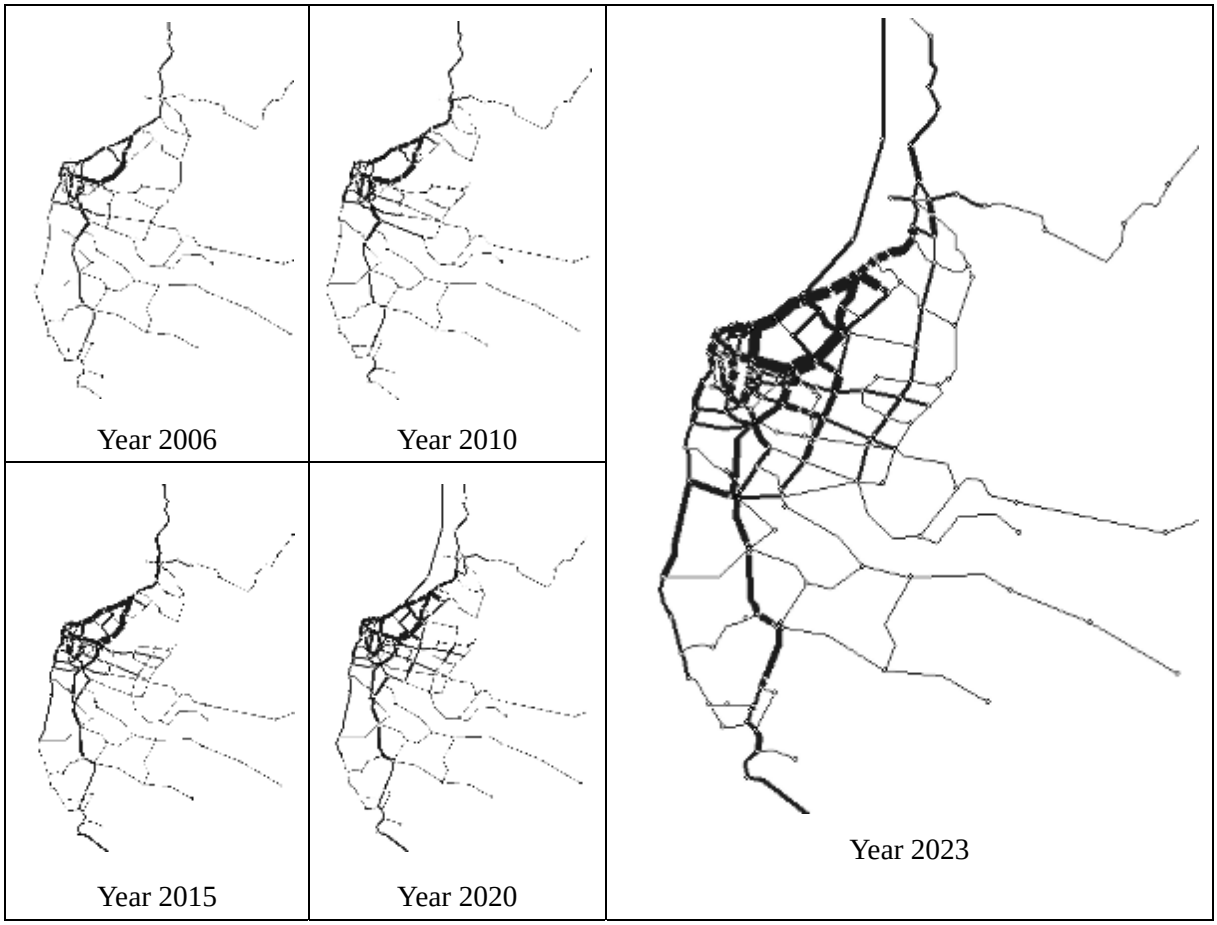
Note: Excluding motorcycles
Source: Statistics of South Sulawesi and JICA Study Team

Figure 5.2.4 Growth of Car Ownership

(3) Zone and Networks

The zoning system is based on Kabupaten and Kecamatan. The zone of Mamminasata which consists of Makassar, Takalar, and a part of Maros and Gowa corresponds with Kecamatan. The zones bordering Mamminasata are combinations of Kecamatan. The zones from 1 to 43 represent Mamminasata. There are 60 zones in total (refer to **Figure 5.1.3**).

Basic network data was prepared in JICA STRADA format which had been used originally in the JICA Mamminasata Study in 2006. It was revised based on the new road plans worked out in this F/S. For traffic analysis, several network maps were prepared and the following **Figure 5.2.3** is sample network maps by year.



Source JICA Study Team

Figure 5.2.5 Network Maps used for Traffic Demand Forecast

(4) Present Trips

The present OD table by vehicle was estimated in the JICA master plan in 2006. The following table is the sum up of PCU of all vehicles. Intra-zone trips were excluded from OD matrices.

Intra-Mamminasata trips and trips between Mamminasata and surrounding areas were adjusted by AADT ratio which was assumed to be 1.04 from traffic survey results. Trips between surrounding areas do not represent total generated trips in zones because only through traffics can be surveyed in Mamminasata. Therefore the shade part of the following table is not completed. PCU coefficients are defined in the former section.

Table 5.2.2 Present AADT OD Table

Year 2006 UNIT : PCU			Mamminasata				Surrounding areas				Total
			Zone 01-14	Zone 15-26	Zone 27-36	Zone 37-43	Zone 44-45	Zone 46-51	Zone 52-55	Zone 56-60	
In	Zone 01-14	Makassar	184,007	10,856	20,346	4,427	131	613	779	2,291	223,449
	Zone 15-26	Maros	16,675	7,335	2,317	908	120	210	234	1,348	29,147
	Zone 27-36	Gowa	20,564	1,978	9,315	3,022	27	309	759	442	36,416
	Zone 37-43	Takalar	2,130	212	1,262	205	0	21	318	27	4,174
Out	Zone 44-45	Maros	341	417	129	81	13	8	6	40	1,036
	Zone 46-51	Gowa	1,682	866	1,043	739	0	0	0	0	4,330
	Zone 52-55	East and South	1,707	658	964	667	0	0	0	0	3,996
	Zone 56-60	North	4,300	2,528	1,314	754	0	0	9	19	8,924
Total			231,406	24,849	36,689	10,804	291	1,161	2,105	4,167	311,472

Source: Revised OD based on JICA Integrated Spatial Plan for Mamminasata Metropolitan Area, July 2006

(5) Growth of Trips

The number of trips from/to each zone was estimated by regression model. The model was constructed by GRDP and population related to present trips in Makassar, Maros, Gowa and Takalar. As shown in the following table, variables were selected by higher correlation from multi regression models. Deviation of each zone from the model was assumed to be the same as present. So the following model formula was applied:

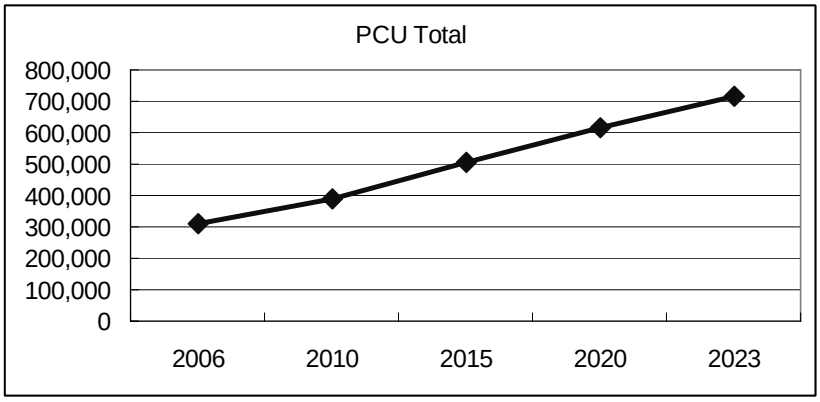
Trips by zone = Sigma (Coefficients x Variables) + Deviation by zone

Table 5.2.3 Multi Regression Model for Zone by High correlation of Selected Variables

		Car	Mini Bus	Large Bus	Pickup	Truck	Motorcycle
Variables	GRDP	0.01042			0.0017		0.04094
	log(GRDP)		1474.405			144.4036	
	Population						0.12460
	GDP per capita	800.669		29.29423			
	Constant	-397.205	-14878.9	-9.860	54.084	-1222.80	-3571.889
Multi Correlation		0.825	0.665	0.698	0.843	0.641	0.820

Source JICA Study Team

After the future trips by zone were estimated by the model, the total trips were adjusted by the growth model of car ownership. Trips in surrounding areas were estimated by the growth ratio of Mamminasata because they have trip ends in Mamminasata. For each vehicle type, the present pattern method was applied to the base OD matrices according to the future generated and attracted trips adjusted by the growth model. OD matrices were forecast for the years 2010, 2015, 2020 and 2023 by socio-economic frameworks.



Source JICA Study Team

Figure 5.2.6 Growth of PCU in Forecast OD Tables

The following tables show the total PCU of 6 types of vehicles in the years 2015 and 2023. The total number of trips in 2015 will be 1.6 times of the 2006 figure and it will be 2.3 times in 2023.

Table 5.2.4 Forecast Future AADT OD Table in Year 2015

Year 2015 UNIT : PCU			Mamminasata				Surrounding areas				Total
			Zone 01-14	Zone 15-26	Zone 27-36	Zone 37-43	Zone 44-45	Zone 46-51	Zone 52-55	Zone 56-60	
In	Zone 01-14	Makassar	269,962	29,234	34,593	6,709	354	1,824	1,811	4,895	349,381
	Zone 15-26	Maros	29,234	14,989	3,672	1,077	403	874	975	3,241	54,463
	Zone 27-36	Gowa	34,593	3,672	18,081	4,385	115	1,078	1,157	1,273	64,355
	Zone 37-43	Takalar	6,709	1,077	4,385	408	62	679	831	596	14,747
Out	Zone 44-45	Maros	354	403	115	62	19	8	4	25	990
	Zone 46-51	Gowa	1,824	874	1,078	679	8	0	0	0	4,462
	Zone 52-55	East and South	1,811	975	1,157	831	4	0	0	5	4,784
	Zone 56-60	North	4,895	3,241	1,273	596	25	0	5	25	10,059
Total			349,381	54,463	64,355	14,747	990	4,462	4,784	10,059	503,240

Source JICA Study Team

Table 5.2.5 Forecasted Future AADT OD Table in Year 2023

Year 2023 UNIT : PCU			Mamminasata				Surrounding areas				Total
			Zone 01-14	Zone 15-26	Zone 27-36	Zone 37-43	Zone 44-45	Zone 46-51	Zone 52-55	Zone 56-60	
In	Zone 01-14	Makassar	325,133	57,455	49,492	11,899	483	2,438	2,237	6,332	455,467
	Zone 15-26	Maros	57,455	32,700	6,487	2,280	521	1,278	1,842	4,952	107,513
	Zone 27-36	Gowa	49,492	6,487	29,463	8,659	123	1,690	1,435	1,747	99,096
	Zone 37-43	Takalar	11,899	2,280	8,659	894	68	1,136	1,357	848	27,141
Out	Zone 44-45	Maros	483	521	123	68	21	8	4	26	1,253
	Zone 46-51	Gowa	2,438	1,278	1,690	1,136	8	0	0	0	6,550
	Zone 52-55	East and South	2,237	1,842	1,435	1,357	4	0	0	5	6,880
	Zone 56-60	North	6,332	4,952	1,747	848	26	0	5	31	13,940
Total			455,467	107,513	99,096	27,141	1,253	6,550	6,880	13,940	717,839

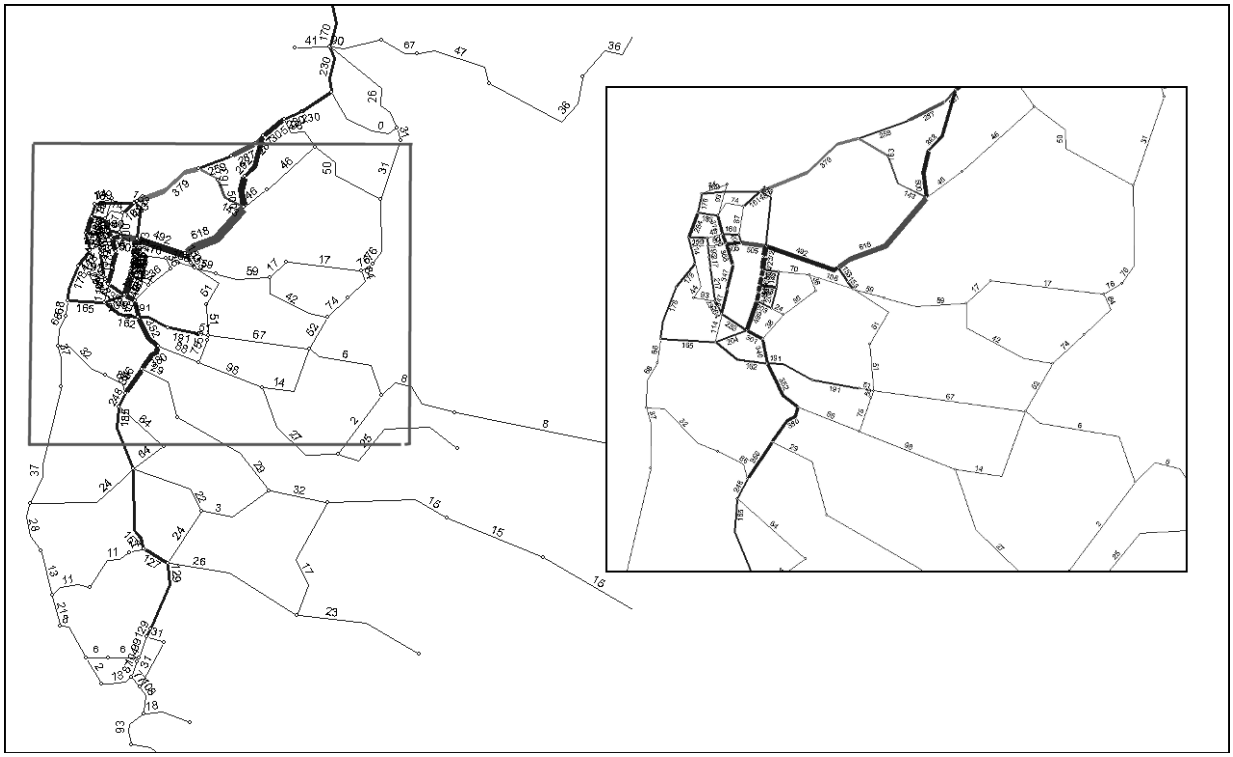
Source JICA Study Team

5.3 Examination of Future Traffic Demand

5.3.1 Calibration of Forecast

Traffic demand should be calibrated by a comparison between the traffic count survey result and the traffic assignment simulation at present.

The present pattern by traffic assignment determined through some revisions of network conditions and OD matrices is shown in **Figure 5.3.1**. The revisions included QV conditions according to the Indonesian standards and AADT conversion. For traffic assignment, the multi-stage assignment method was used because this method is more useful than the equilibrium method to analyze cross section traffics. Although the zone size defined in the JICA Integrated Spatial Plan, July 2006 is not small enough to analyze short trips in the center of Makassar, most traffic volumes recorded on the network reflect real traffics since the traffic surveys in this study were carried out in the dry season. Therefore this network and OD matrices in year 2006 were referred to as basic conditions to forecast future traffics.



Source: JICA Study Team

Figure 5.3.1 Present Traffic Assignment (unit:100 pcu)

5.3.2 Future Traffic Flow

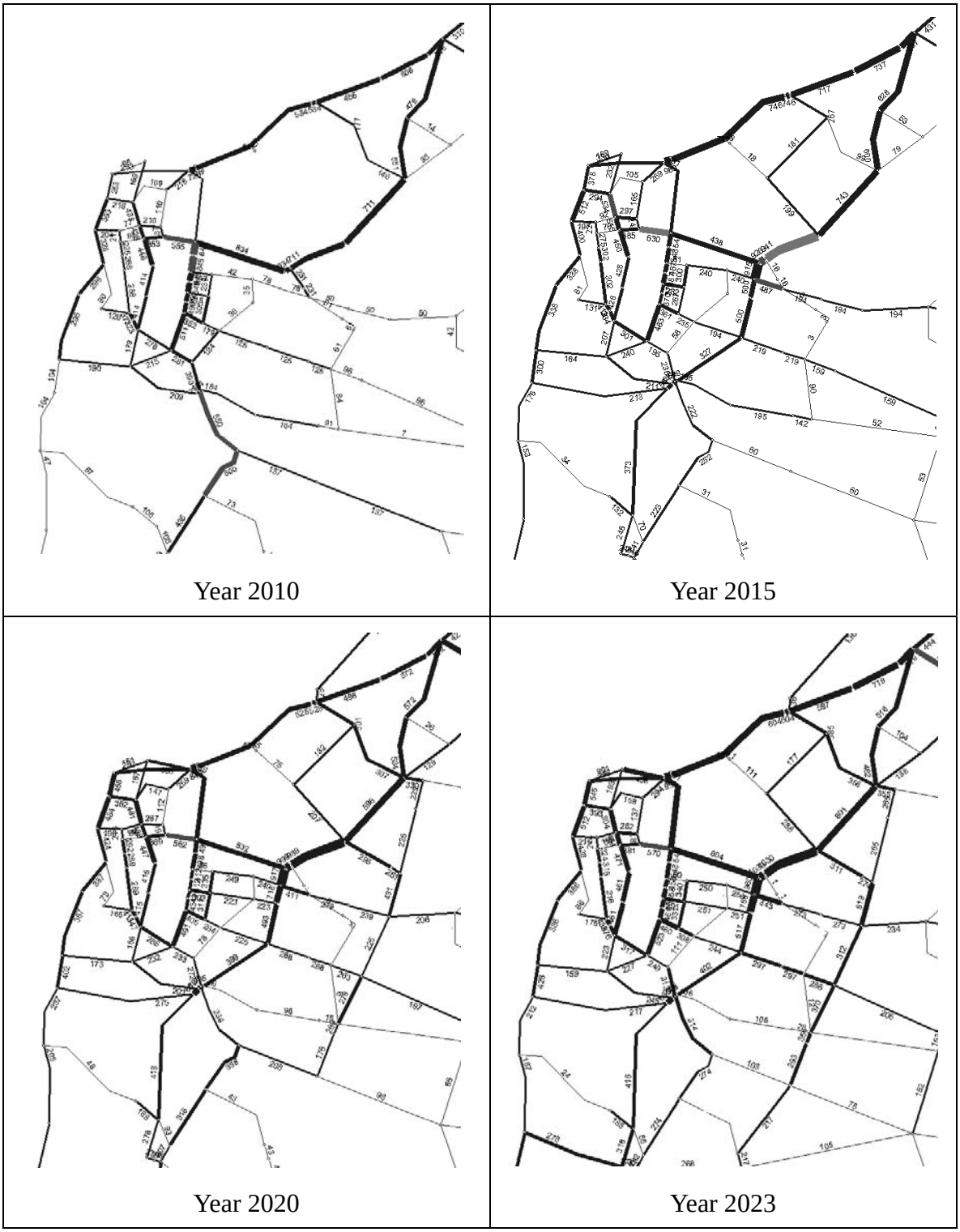
Future traffics on the road network were simulated by multi-stage traffic assignment. The result obtained for the completed network is shown in **Figure 5.3.2**. This is an "all-with" case in year 2023. Although there are no congested links owing to the completion of future networks, traffic volumes larger than capacities are seen on roads in the intermediate years.

The maximum traffic volume on the Trans Sulawesi will be 103,000 PCU on Jl.Perintis Kemerdekaan at the north of the center of Makassar in year 2023. The traffic volume on the outer ring road will be about 30,000 or 50,000 PCU. The outer ring road can effectively distribute traffics from the Trans Sulawesi. On the Mamminasata Bypass which will be connected with the future new suburban town development area, the traffic volume will be about 20,000 or 30,000 PCU. This road will constitute a new connection among the suburban areas. The Abdullah Daeng Sirua, Hertasning and Malino roads connecting the eastern and western regions will carry about 30,000 PCU each. The West Coast road will carry 10,000 or 30,000 PCU and will become an important connection to south after its widening from 4.5 m to 6.0 m.

Source: JICA Study Team

Figure 5.3.2 Future Traffic Forecast in Year 2023 (unit:100 pcu)

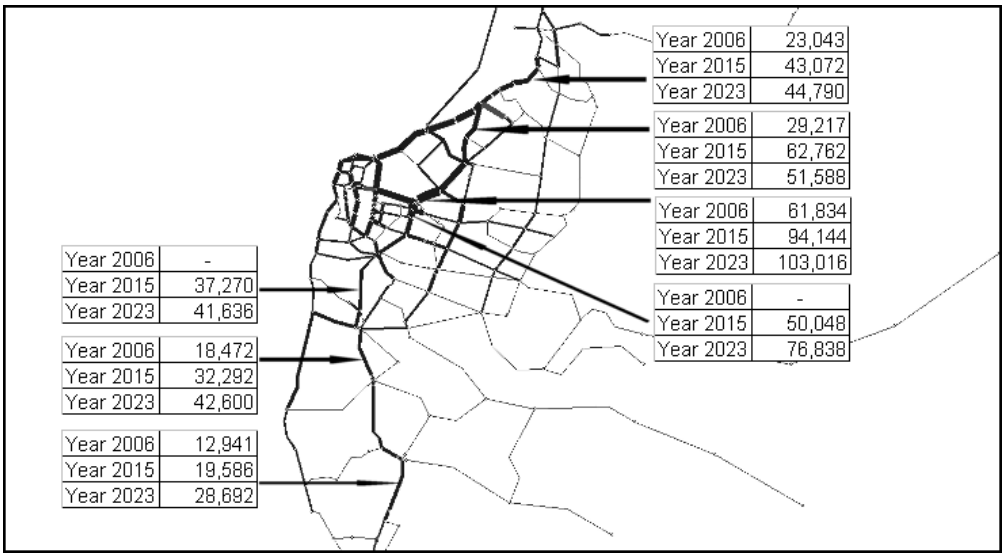
The forecast traffic volumes in areas surrounding the center of Makassar in the intermediate years are shown in **Figure 5.3.3**. New roads and widened roads will play an important role as a result of the increase of traffic demands in the future.



Source: JICA Study Team

Figure 5.3.3 Forecast of Traffic in Makassar (unit:100 pcu)

The traffic volume on most sections of the Trans Sulawesi will increase about 2 times in year 2023 from the present. On the section near Maros, it will reach 45,000 PCU, therefore the Maros bypass section and the New Port-Jl.Ir.Sutami-Tambua road will also become important roads. The traffic volume between the junction of Jl.Ir.Sutami and Jl.Daya IC will likely decrease from 2015 to 2023 because the road network will not be completed by the year 2015. The bridge across the Tallo River will play a key role of carrying the maximum traffic volume of 103,000 PCU on the Jl.Perintis Kemerdekaan. The traffic volume in the center of Makassar will be 77,000 PCU and it will decrease to about 50,000 PCU along the road to the south. The widened West Coast road (Jl.Tj.Metoro Bunga – Takalar) will also contribute to decreasing the traffic volume on the south section from Sungguminasa to Takalar.

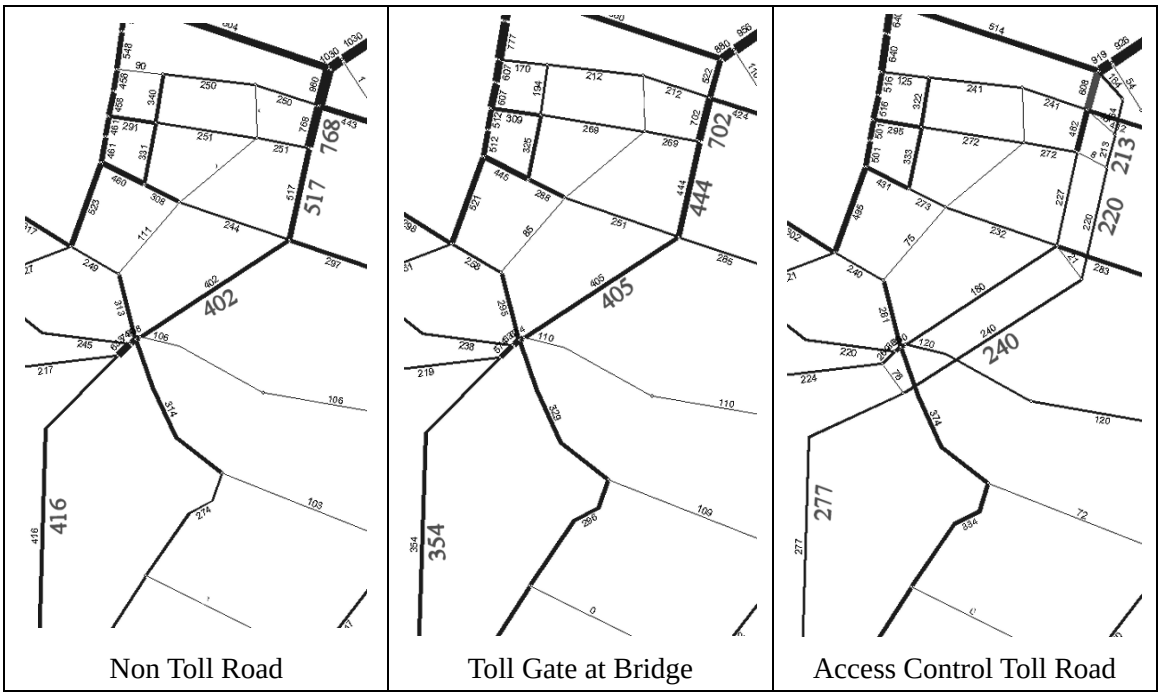


Source: JICA Study Team

Figure 5.3.4 Growth of Traffic Volume on Trans Sulawesi Road (unit:pcu)

In the traffic forecast for an alternative road development plan, two types of toll road systems were simulated for the Trans Sulawesi road. One is the toll gate system installed at the two bridges across the Tallo River and the Jeneberang River. User charges will be collected at each gate for the road maintenance fund at an assumed rate equivalent to a third of the present tariff on JJl.Tol.Ir.Sutami. The other is a full access-controlled toll road system. The section between the Tallo River and the Jeneberang River will be a 2-lane x 2-way toll road at the center and a 2-lane frontage road at the both sides. The south section from the Jeneberang River will be a 2-lane x 2 way access-controlled toll road. The toll rate was assumed to be the same as present rate on Jl.Tol.Ir.Sutami.

The traffic volume will not decrease so much under the bridge toll gate system. However, about a half of the traffic will use non-toll roads (frontage roads) at the middle ring road section in the case of the full access-controlled toll road system. The traffic volume in PCU calculated by forecast simulation for the cases of non-toll road, bridge toll gate and toll road is 52,000, 44,000 and 22,000 respectively. In bridge toll gate and toll road cases, the traffic which avoids paying toll charge will most likely move to the present Jl.Perintis and in the non-toll road case, the frontage roads and the east-west roads crossing them might be congested.

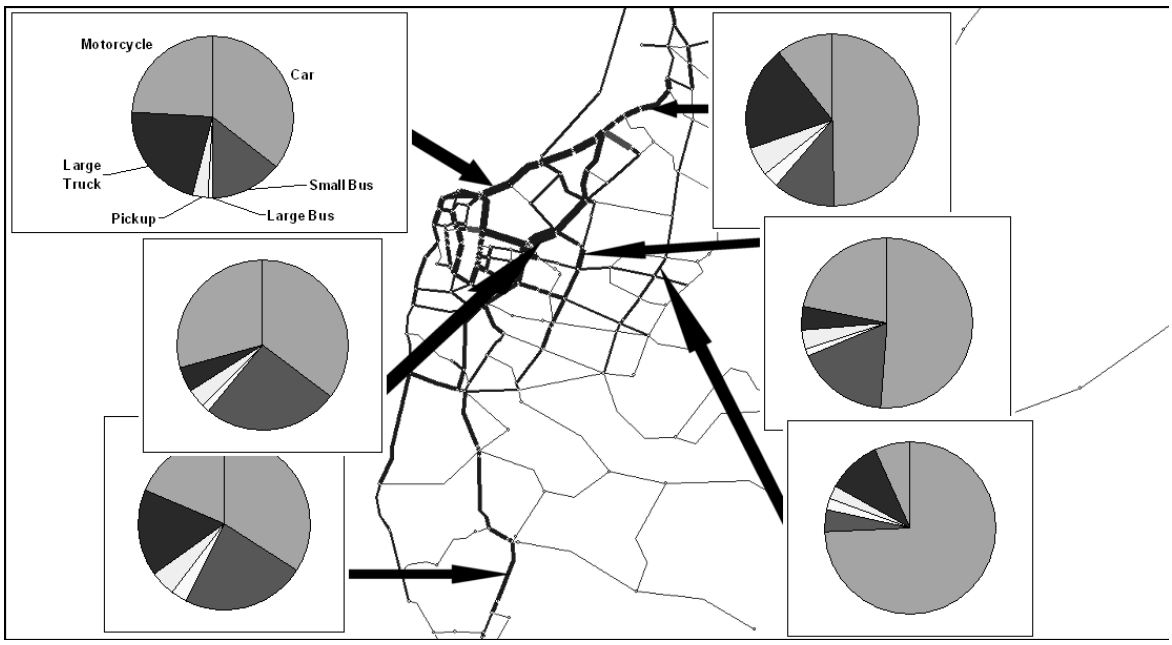


Source: JICA Study Team

Figure 5.3.5 Case Study by Toll Road in Year 2023 (unit: 100 pcu)

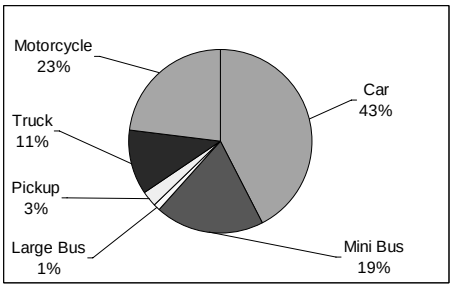
5.3.3 Characteristics of Traffic Flow

The traffic share of motorcycle is highest all over Mamminasata, especially in the urbanized area. The second important traffic share is that of passenger car and mini bus (refer to **Figure 5.3.6**). In the future the road network might face problems produced by the increase of motorcycle trips. In order to avoid traffic congestion by motorcycle and mini-bus, a bus way system might be one of the solutions in the future.



Source: JICA Study Team

Figure 5.3.6 Share of Vehicle Type by PCU in Year 2023

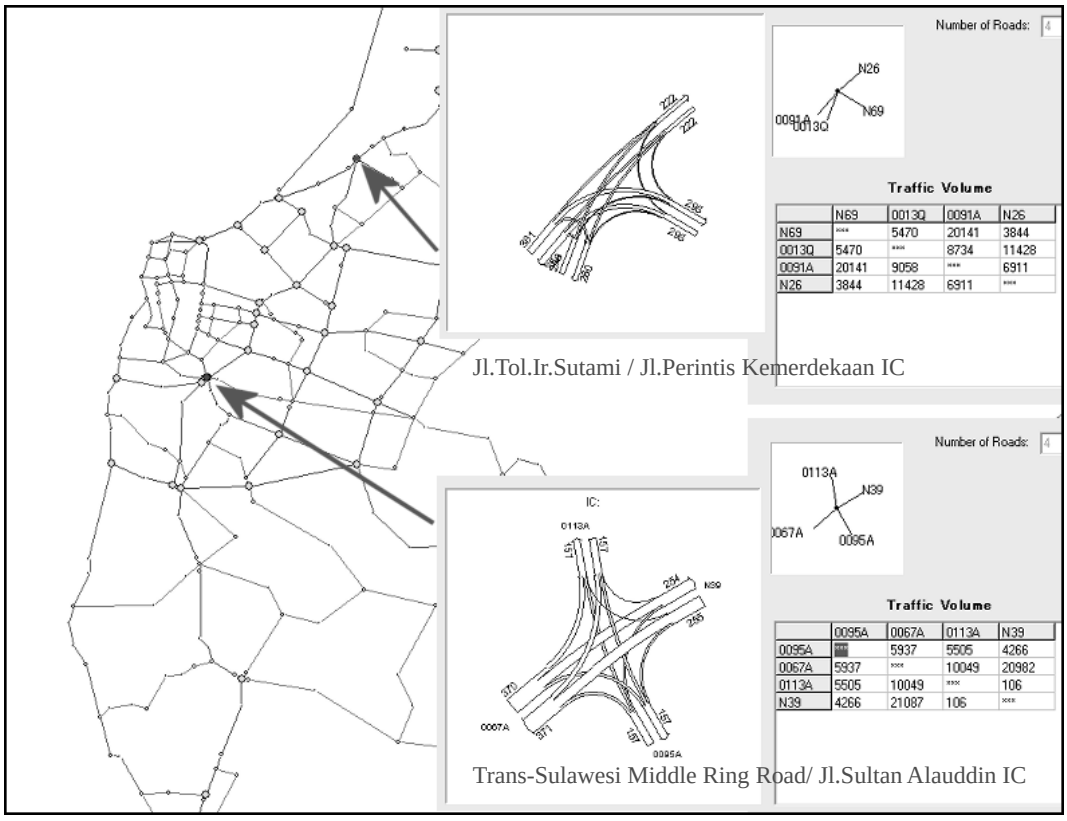


Source: JICA Study Team

Figure 5.3.7 Share of PCU in Year 2023

The total PCU share of OD matrices in year 2023 is shown in the left hand figure. In the future, motorcycle's share is the second largest and minibus's share is the third largest as similar as the present observations.

At major crossings on the planned new roads, provision of right turn lanes will be required. If the Trans Sulawesi will be constructed with a toll road system, frontage roads for non-toll traffics should be constructed in parallel. **Figure 5.3.8** shows the traffic volumes by direction at the Jl.Tol.Ir.Sutami / Jl.Perintis Kemerdekaan IC and the Trans-Sulawesi Middle Ring Road/Jl.Sultan Alauddin IC.

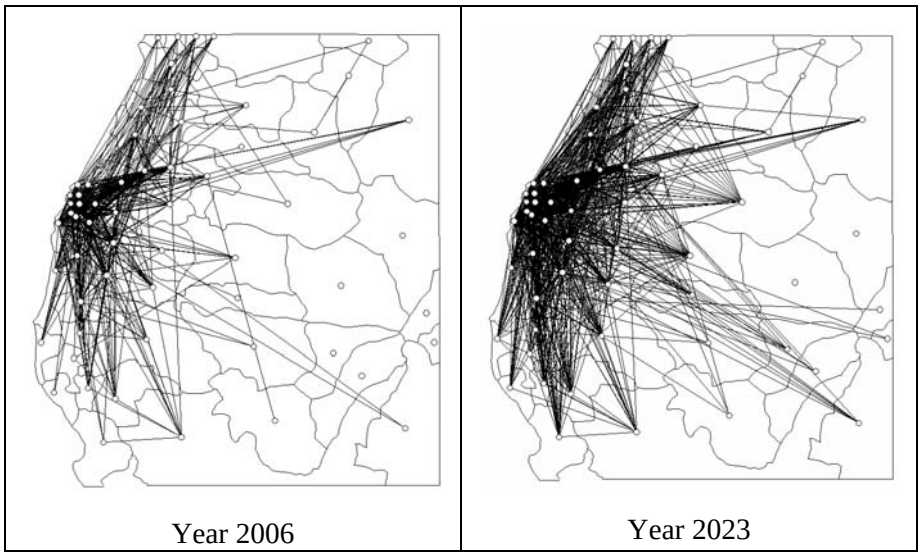


Source: JICA Study Team

Figure 5.3.8 Intersection Traffic Analysis at Flyover Crossings in Year 2023

Most traffic flow consists of intra-Mamminasata trips. Through traffics are small. Although the ratio of through traffics might increase in the future, for example in the case where new industries generate new traffic flows between the north and the south, the characteristics of

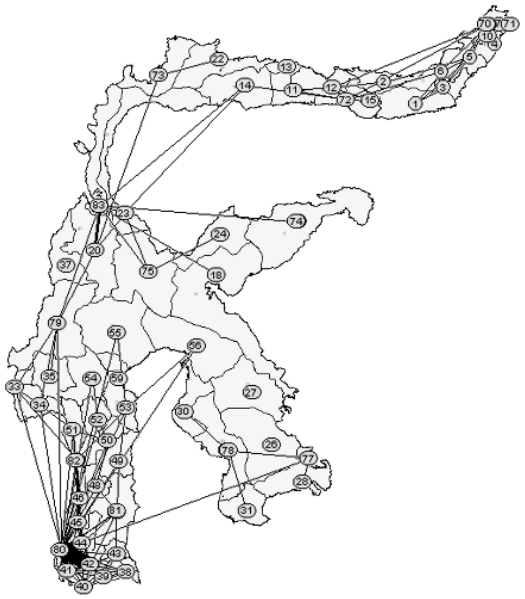
high share of intra-traffics will still remain. Under the similar traffic characteristics, the density of traffics increases and the sphere of traffic flows extends as in the following desire lines among new town and new industrial areas.



Source: JICA Study Team

Figure 5.3.9 Desire Line in the Future

The trip length is not so long in all over Sulawesi Island according to the traffic OD survey in Year 2007 by the JICA Study Team. Most of the traffic flows connect among the socio-economic center of major cities within province. The traffic connections among or between long distance towns are very small. Therefore, it can be said that the characteristics of Mamminasata traffic are similar to other regions in Sulawesi.



Source: JICA Study Team (more than 150 vehicles)

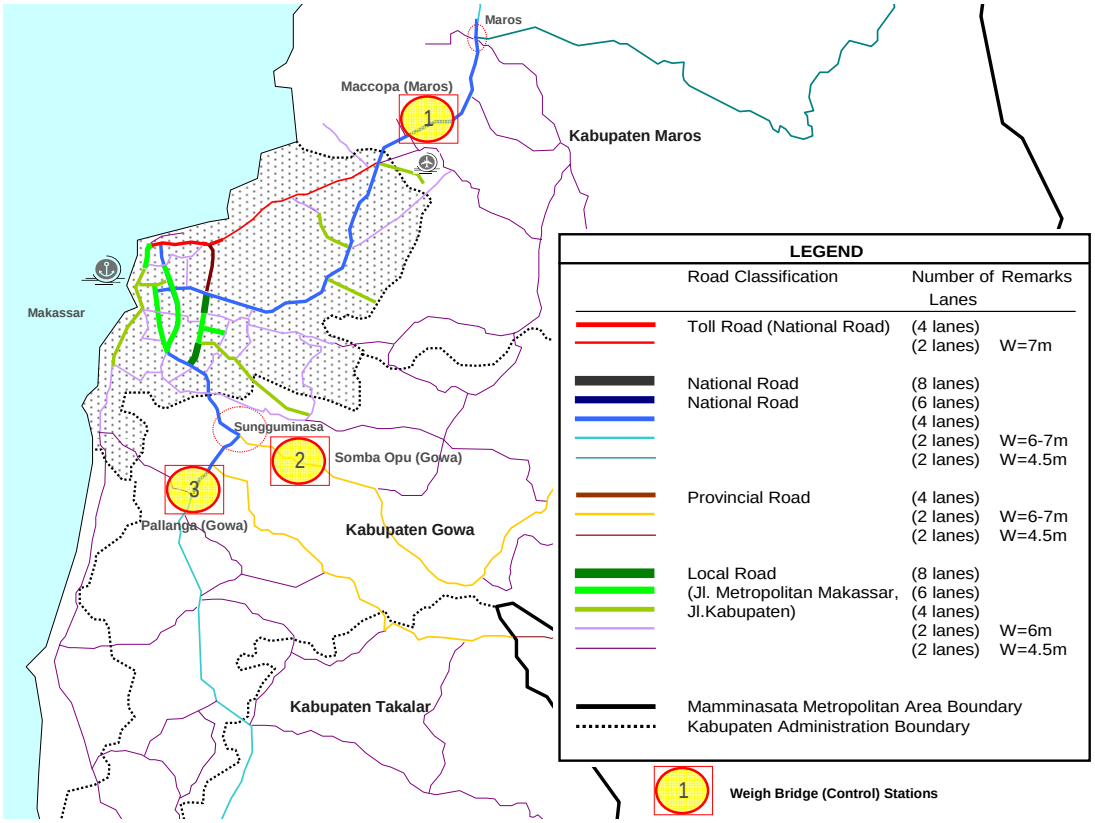
Figure 5.3.10 Desire Line in Sulawesi in Year 2007

5.4 Axle Load Survey and Analysis

5.4.1 Axle Load Survey

The weigh bridges of the transport department of South Sulawesi Province are located at three major inlets /outlets of the traffic from/to Makassar City (**Figure 5.4.1**), as follows:

- Maccopa / Mandai (Kab.Maros) on the national road for the north traffic
- Somba Opu (Kab.Gowa) on the provincial road for the east traffic
- Pallanga (Kab.Gowa) on the national road for the south traffic



Source: JICA Study Team

Figure 5.4.1 Axle Load Survey Stations in Mamminasata Metropolitan Area

The axle load survey was conducted at the above three locations in March 2007. However, as reliable data were not obtained by the first survey, a resurvey was conducted at Maccopa and Somba Opu stations where many overloaded vehicles were observed.

The capacity of the weigh bridge at Maccopa station is 70 tons and that at Somba Opu station is only 30 tons. The former can weigh a vehicle in one time, but the latter weigh front axle and rear axle separately and combines the both for gross weight measurement. Fifty (50) and thirty (30) samples were obtained at Maccopa and Somba Opu station respectively and their results are shown in **Tables 5.4.1** and **5.4.2**.

Table 5.4.1 Weigh Bridge Sampling Data at Maccopa Station in Maros

LOCATION : BRIDGE CONTROLLER : 1. MACCOPA – MAROS ☑ 6 TRUCK 2 AXLES
2. SOMBA OPU – GOWA ☐
3. PALLANGGA – GOWA ☐ 7 BIG TRUCK (MORE 3 AXLES

2-Axle Trucks

Sample No.	TYPE OF LOADING	ORIGIN	DESTINATION	WEIGHT EMPTY (Kg)	GROSS WEIGHT (Kg)	LOAD WEIGHT (Kg)	CAPACITY OF LOADING (Kg)	WEIGHT OF FRONT AXLE (Kg)	WEIGHT OF REAR AXLE (Kg)
1	LNG	Makassar	Kab. Barru	6,160	8,690	2,530	5,110	3,673	6,632
2	Material of Building	Makassar	Kab. Pinrang	6,160	13,456	7,296	5,110	3,675	9,328
3	Box	Makassar	Kab. Pangkep	6,160	7,160	1,000	5,110	3,412	5,460
5	Profil Iron	Makassar	Kab. Pinrang	6,160	9,560	3,400	5,110	3,640	7,038
6	LNG	Makassar	Kab. Wajo	6,160	8,630	2,470	5,110	3,650	6,382
7	Corn	Kab. Wajo	Kab. Gowa	6,160	22,070	15,910	5,110	4,616	17,520
8	Hulled Rice	Kab. Pinrang	Makassar	6,160	11,850	5,690	5,110	3,786	9,932
11	Hulled Rice	Kab. Pinrang	Makassar	6,160	23,340	17,180	5,110	3,685	14,326
12	Hulled Rice	Kab. Sidrap	Makassar	6,160	11,050	4,890	5,110	3,328	7,632
13	LNG	Makassar	Kab. Bone	6,160	9,810	3,650	5,110	3,890	7,362
14	Stone	Kab. Pangkep	Makassar	6,160	8,630	2,470	5,110	3,685	6,823
15	Box	Makassar	Kab. Enrekang	6,160	16,318	10,158	5,110	3,628	9,321
19	Mix Goods	Makassar	Kota Parepare	6,160	10,200	4,040	5,110	3,278	9,700
20	Stone	Kab. Maros	Makassar	6,160	11,140	4,980	5,110	3,889	9,780
21	Stone	Kab. Pangkep	Kab. Maros	6,160	9,800	3,640	5,110	3,565	8,231
22	Hulled Rice	Kab. Sidrap	Makassar	6,160	12,800	6,640	5,110	3,618	10,360
23	Box	Makassar	Kota Parepare	3,590	5,470	1,880	4,980	3,890	3,770
24	Box	Makassar	Kota Parepare	3,590	5,590	2,000	4,980	3,696	3,962
25	Box	Makassar	Kab. Pinrang	3,590	4,780	1,190	4,980	3,024	4,251
26	Sand	Kab. Maros	Makassar	6,160	9,350	3,190	5,110	3,728	6,920
27	Sand	Kab. Maros	Makassar	6,160	10,450	4,290	5,110	4,260	16,120
29	Corn	Kab. Barru	Makassar	6,160	22,070	15,910	5,110	4,480	18,142
30	Box	Makassar	Kab. Pinrang	6,160	10,450	4,290	5,110	3,688	8,326
34	Box	Makassar	Kab. Polman	3,590	9,970	6,380	4,980	3,926	6,680
35	Box	Makassar	Kab. Bone	3,590	10,370	6,780	4,980	3,640	7,590
36	Hulled Rice	Kab. Sidrap	Makassar	6,160	23,210	17,050	5,110	4,826	6,758
37	Sugar	Kab. Bone	Makassar	6,160	28,102	21,942	5,110	4,568	7,286
38	Cocoa	Kota Palopo	Makassar	6,160	18,990	12,830	5,110	4,620	14,230
39	Sand	Kab. Maros	Makassar	6,160	9,780	3,620	5,110	4,525	6,580
40	Sand	Kab. Maros	Makassar	6,160	9,820	3,660	5,110	4,560	6,626
41	Cocoa	Kab. Pinrang	Makassar	6,160	24,542	18,382	5,110	3,768	17,124
43	Stone	Kab. Pangkep	Makassar	6,160	8,760	2,600	5,110	3,694	6,885
45	Sand	Kab. Maros	Makassar	6,160	9,120	2,960	5,110	3,704	6,908
47	Stone	Kab. Pangkep	Makassar	6,160	8,856	2,696	5,110	3,723	6,379
48	Fruit	Kab. Polman	Makassar	6,160	12,256	6,096	5,110	4,362	13,268
				Average :	**12,470**			**3,877**	**8,961**

3-Axle Trucks

Sample No.	TYPE OF LOADING	ORIGIN	DESTINATION	WEIGHT EMPTY (Kg)	GROSS WEIGHT (Kg)	LOAD WEIGHT (Kg)	CAPACITY OF LOADING (Kg)	WEIGHT OF FRONT AXLE (Kg)	WEIGHT OF REAR AXLE (Kg)
4	Hulled Rice	Kab. Sidrap	Makassar	8,350	44,836	36,486	10,890	6,890	32,050
16	Hulled Rice	Kab. Sidrap	Makassar	8,350	27,870	19,520	10,890	6,890	22,812
17	Corn	Kab. Polman	Makassar	8,350	28,300	19,950	10,890	4,286	15,421
18	Cashew Fruit	Kab. Luwu	Makassar	8,350	28,030	19,680	10,890	5,854	18,232
28	LNG	Kab. Majene	Makassar	8,350	8,970	620	10,890	3,028	16,120
31	Cocoa	Kab. Polman	Makassar	8,350	31,840	23,490	10,890	7,128	24,120
32	Cocoa	Kab. Wajo	Makassar	8,350	33,260	24,910	10,890	6,970	21,145
33	Wheat	Makassar	Kota Parepare	8,350	34,160	25,810	10,890	7,060	23,861
42	Cocoa	Kota Palopo	Makassar	8,350	33,845	25,495	10,890	7,375	21,255
44	Hulled Rice	Kab. Bone	Makassar	8,350	45,128	36,778	10,890	6,794	32,282
46	Hulled Rice	Kab. Soppeng	Makassar	8,350	26,380	18,030	10,890	6,460	22,332
49	Cement	Kab. Pangkep	Makassar	8,350	39,606	31,256	10,890	6,721	38,695
50	Cement	Kab. Pangkep	Makassar	8,350	39,628	31,278	10,890	6,742	38,722
				Average :	**32,450**			**6,323**	**25,157**

Source: JICA Study Team

Table 5.4.2 Weigh Bridge Sampling Data at Somba Opu Station in Gowa

LOCATION : BRIDGE CONTROLLER : 1. MACCOPA – MAROS ☐ | 2. SOMBA OPU – GOWA ☑ | 3. PALLANGGA – GOWA ☐

6 TRUCK 2 AXLES

7 BIG TRUCK (MORE 3 AXLES

2-Axle Trucks

Sample No.	TYPE OF LOADING	ORIGIN	DESTINATION	WEIGHT EMPTY (Kg)	GROSS WEIGHT (Kg)	LOAD WEIGHT (Kg)	CAPACITY OF LOADING (Kg)	WEIGHT OF FRONT AXLE (Kg)	WEIGHT OF REAR AXLE (Kg)
1	Sand	Bili-Bili	S.Minasa	6,160	7,480	1,320	5,110	3,286	5,810
2	Gravel	Bili-Bili	Makassar	6,160	9,685	3,525	5,110	4,538	6,456
3	Stone	Bili-Bili	Makassar	6,160	8,680	2,520	5,110	4,614	6,532
5	Sand	Bili-Bili	Makassar	6,160	10,300	4,140	5,110	4,688	7,510
6	Gravel	Bili-Bili	Makassar	6,160	9,856	3,696	5,110	4,562	6,832
10	Sand	Bili-Bili	Makassar	3,590	6,790	3,200	4,980	3,778	4,830
11	Water of Mineral	Makassar	Malino	6,160	12,320	6,160	5,110	4,868	9,210
12	Sand	Bili-Bili	Makassar	3,590	7,600	4,010	5,110	3,876	5,280
13	Gravel	Bili-Bili	Makassar	3,590	8,154	4,564	5,110	4,021	5,218
14	Stone	Bili-Bili	Makassar	3,590	8,532	4,942	5,110	4,255	5,786
15	Sand	Bili-Bili	Kab. Gowa	6,160	9,728	3,568	5,110	4,568	6,846
17	Stone	Bili-Bili	Makassar	6,160	9,440	3,280	5,110	4,586	6,786
19	Gravel	Bili-Bili	Makassar	6,160	18,980	12,820	5,110	4,770	14,180
22	Sand	Bili-Bili	Makassar	6,160	9,620	3,460	5,110	4,582	6,917
24	Sand	Bili-Bili	S.Minasa	6,160	9,700	3,540	5,110	4,579	6,832
26	Sand	Bili-Bili	Makassar	6,160	9,766	3,606	5,110	4,544	6,894
27	Sand	Bili-Bili	Makassar	6,160	10,634	4,474	5,110	4,683	7,180
28	Sand	Bili-Bili	Makassar	3,590	9,216	5,626	5,110	4,285	6,984
29	Sand	Bili-Bili	Makassar	6,160	11,257	5,097	5,110	4,632	6,744
30	Stone	Bili-Bili	Makassar	6,160	12,433	6,273	5,110	4,842	9,675
				Average:	**10,009**			**4,428**	**7,125**

3-Axle Trucks

Sample No.	TYPE OF LOADING	ORIGIN	DESTINATION	WEIGHT EMPTY (Kg)	GROSS WEIGHT (Kg)	LOAD WEIGHT (Kg)	CAPACITY OF LOADING (Kg)	WEIGHT OF FRONT AXLE (Kg)	WEIGHT OF REAR AXLE (Kg)
4	Gravel	Bili-Bili	Makassar	8,350	44,540	36,190	10,890	6,890	37,650
7	Gravel	Bili-Bili	Makassar	8,350	34,980	26,630	10,890	6,570	28,410
8	Gravel	Bili-Bili	Makassar	8,350	35,392	27,042	10,890	6,656	28,736
9	Gravel	Bili-Bili	Makassar	8,350	33,245	24,895	10,890	6,278	26,967
16	Gravel	Bili-Bili	Makassar	8,350	34,018	25,668	10,890	6,345	27,673
18	Gravel	Bili-Bili	Makassar	8,350	33,280	24,930	10,890	6,297	26,983
20	Gravel	Bili-Bili	Makassar	8,350	33,652	25,302	10,890	6,623	27,029
21	Gravel	Bili-Bili	Makassar	8,350	34,351	26,001	10,890	6,476	27,875
23	Gravel	Bili-Bili	Makassar	8,350	35,249	26,899	10,890	6,682	28,567
25	Gravel	Bili-Bili	Makassar	8,350	33,991	25,641	10,890	6,437	27,554
Source: JICA Study Team				**Average:**	**35,270**			**6,525**	**28,744**

The average axle load for the front and rear axles of 2-axle trucks at Maccopa Station is 3.9 tons and 9.0 tons, respectively. Those for 3-axle trucks are 6.3 tons and 25.2 tons. The average axle load for the front and rear axles of 2-alxe trucks at Somba Opu Station is 4.4 tons and 7.1 tons, respectively. Those for 3-axle trucks are 6.5 tons and 28.7 tons.

The JICA Study Team conducted a supplemental traffic survey at 9 points, which were selected from the 29 Mamminasata traffic survey points, to calibrate and review the traffic survey results, and to critically evaluate the results of analyses conducted by the Mamminasata Study as more accuracy is required for the F/S. The supplemental survey also covered three additional points.

5.4.2 Axle Load Analysis

Many trucks sampled for weighing were overloaded. Especially, overloading of 3-axle trucks carrying construction materials (sand, gravel and soil), agricultural products and cement was significant as shown in **Table 5.4.3**. The trucks carrying gravel and sand passing Somba Opu station come from Bili-Bili, which is major construction material supply source, and this is the

major cause of pavement damages.

Table 5.4.3 Sampling Results of Overloading of Trucks

2-Axle Trucks at Maccopa Staion

Sample No.	TYPE OF LOADING	WEIGHT EMPTY (Kg)	GROSS WEIGHT (Kg)	LOAD WEIGHT (Kg)	CAPACITY OF LOADING (Kg)	WEIGHT OF FRONT AXLE (Kg)	WEIGHT OF REAR AXLE (Kg)
7	Corn	6,160	22,070	15,910	5,110	4,616	17,520
8	Hulled Rice	6,160	11,850	5,690	5,110	3,786	9,932
11	Hulled Rice	6,160	23,340	17,180	5,110	3,685	14,326
12	Hulled Rice	6,160	11,050	4,890	5,110	3,328	7,632
22	Hulled Rice	6,160	12,800	6,640	5,110	3,618	10,360
29	Corn	6,160	22,070	15,910	5,110	4,480	18,142
36	Hulled Rice	6,160	23,210	17,050	5,110	4,826	6,758
38	Cocoa	6,160	18,990	12,830	5,110	4,620	14,230
41	Cocoa	6,160	24,542	18,382	5,110	3,768	17,124
48	Fruit	6,160	12,256	6,096	5,110	4,362	13,268
					Average :	**4,109**	**12,929**
							162%

3-Axle Trucks at Maccopa Station

Sample No.	TYPE OF LOADING	WEIGHT EMPTY (Kg)	GROSS WEIGHT (Kg)	LOAD WEIGHT (Kg)	CAPACITY OF LOADING (Kg)	WEIGHT OF FRONT AXLE (Kg)	WEIGHT OF REAR AXLE (Kg)
Agricultural Products							
4	Hulled Rice	8,350	44,836	36,486	10,890	6,890	32,050
16	Hulled Rice	8,350	27,870	19,520	10,890	6,890	22,812
17	Corn	8,350	28,300	19,950	10,890	4,286	15,421
18	Cashew Fruit	8,350	28,030	19,680	10,890	5,854	18,232
31	Cocoa	8,350	31,840	23,490	10,890	7,128	24,120
32	Cocoa	8,350	33,260	24,910	10,890	6,970	21,145
33	Wheat	8,350	34,160	25,810	10,890	7,060	23,861
42	Cocoa	8,350	33,845	25,495	10,890	7,375	21,255
44	Hulled Rice	8,350	45,128	36,778	10,890	6,794	32,282
46	Hulled Rice	8,350	26,380	18,030	10,890	6,460	22,332
					Average :	**6,571**	**23,351**
							146%
Cement							
49	Cement	8,350	39,606	31,256	10,890	6,721	38,695
50	Cement	8,350	39,628	31,278	10,890	6,742	38,722
					Average :	**6,732**	**38,709**
							242%

3-Axle Trucks at Somba Opu Station

Sample No.	TYPE OF LOADING	WEIGHT EMPTY (Kg)	GROSS WEIGHT (Kg)	LOAD WEIGHT (Kg)	CAPACITY OF LOADING (Kg)	WEIGHT OF FRONT AXLE (Kg)	WEIGHT OF REAR AXLE (Kg)
4	Gravel	8,350	44,540	36,190	10,890	6,890	37,650
7	Gravel	8,350	34,980	26,630	10,890	6,570	28,410
8	Gravel	8,350	35,392	27,042	10,890	6,656	28,736
9	Gravel	8,350	33,245	24,895	10,890	6,278	26,967
16	Gravel	8,350	34,018	25,668	10,890	6,345	27,673
18	Gravel	8,350	33,280	24,930	10,890	6,297	26,983
20	Gravel	8,350	33,652	25,302	10,890	6,623	27,029
21	Gravel	8,350	34,351	26,001	10,890	6,476	27,875
23	Gravel	8,350	35,249	26,899	10,890	6,682	28,567
25	Gravel	8,350	33,991	25,641	10,890	6,437	27,554
Source: JICA Study Team					**Average:**	**6,525**	**28,744**
							180%

Overloading causes negative effects on pavement, road safety and traffic capacity. Of these, the effect on pavement is measured by vehicle damage factor (VD) / Equivalent Standard Axle. Table 5.4.4 shows Vehicles Damage Factors for 2-axle and 3-axle trucks estimated based on the data obtained from Maccopa and Somba Opu Stations. The average VDF is 3.0 for 2-axle trucks which should be less than 1.0 on the MST (Axle Load) 8.0-ton roads. The average VDF is 12.0 for 3-axle trucks which should be less than 2.0.

Table 5.4.4 Vehicle Damage Factors (VDF) of Trucks for Pavement

VDF (ESA) of 2-Axle Trucks

Weigh Bridge Station	Front Axle	Rear Axle	Total
Maccopa (Maros)	0.04	4.7	4.7
Somba Opu (Gowa)	0.07	1.1	1.2
Average VDF	0.05	2.9	3.0

VDF (ESA) of 3-Axle Trucks

Weigh Bridge Station	AASHTO Pavement Design Guide 1993					Road Note 31 (UK)			
	Front Axle	Rear Axles		Total		Front Axle	Rear 1	Rear 2	Total
		PCCP	ACP	PCCP	ACP				
Maccopa (Maros)	0.39	23.5	10.6	23.9	11.0	0.4	13.1	13.1	26.5
Somba Opu (Gowa)	0.37	28.3	12.6	28.7	12.9	0.4	14.2	14.2	28.7
Average VDF	0.38	25.92	11.59	26.29	11.97	0.38	13.61	13.61	27.59

Souce: JICA Study Team

5.4.3 Axle Load Regulation and Overloading Control

In accordance with the Government's Regulation No.43, Year 1993, the maximum axle load in Indonesia is as follows:

* Class I: MST >= 10 tons
* Class II: MST = 10 tons
* Classes IIIA, IIIB, IIIC: MST 8 tons.

All roads in Sulawesi were categorized into Class IIIA, IIIB and IIIC by the Degree of MOC KM No.13 Year 2001 and, therefore, 8 tons are axle load limit. The vehicle damage factors increase in 4^{th}-5^{th} power to the axle load as illustrated in **Figure 5.4.2**. Therefore, overloading control is extremely critical to keep the pavement life.

There are some other points to be considered, including:

* Improve transparency in MST control method at weighing stations, introducing computer systems
* Increase the number of weighing stations to prevent overloaded trucks escaping to alternative routes that are out of control
* Establish weigh bridge stations on routes of construction material transportation
* Strengthen education for vehicle owners and drivers
* Exercise 24-hour operations of weigh bridge stations.

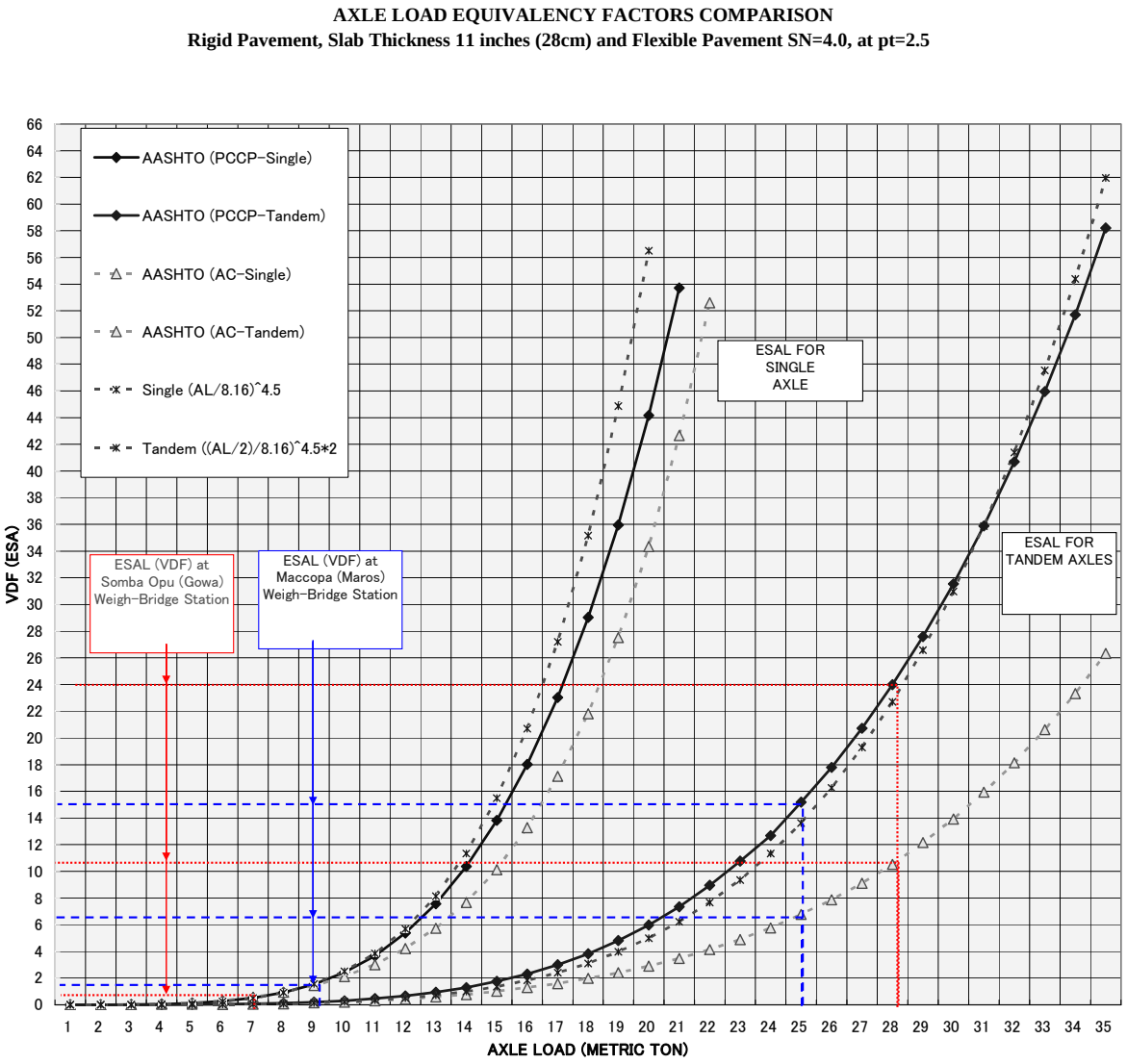


Figure 5.4.2 Effect of Overloading on Truck Vehicle Damage Factors

In addition to the above measures, a policy review will be required for some routes where MST 10 tons should be applied. It will upgrade the design allowance for pavement damage.

Besides application of the MST 10 ton on strategic routes, more strict regulation enforcement should be imposed against overloading to curtail investments on road facilities. Participation of private sector in the weigh bridge operation would be one of the measures increasing efficiency and effectiveness.