

(4) Improvement of Traffic Conditions

In the proposed railway and trunk bus system, since the trunk bus runs on the median of the roadway and only the conventional bus runs on the traffic lanes with mixed traffic, the conventional bus is influenced by traffic congestion on the roads. In 2025, the total number of operated conventional buses decreases 0.6 times of the present. This serves to alleviate traffic and transport congestion in the future. However, traffic congestion will be severe in 2025. This is because traffic congestion is mainly caused by private vehicles, which increase 1.9 times of the present.

The travel speed decreases to 12km/h in 2025, in contrast to 17km/h at the present, which is equivalent to 0.7 of the present. At the same time, the road length with a volume-capacity ratio of over 1.0 increases from 8.0 % at the present to 15% in 2025, which is equivalent to 2.2 times of the present.

In comparison to the “without project” case in 2025, the travel speed is improved from 7.5km/h in the “without project” case to 12km/h in the “with project” case. As for the traffic congestion, the congestion length with a volume-capacity ratio of over 1.5 will decrease at 2.4% in the “with project” case, in contrast to 11.8% in the “without project” case.

21.3. INFLUENCE OF FARE RATE

When the fare rate of the mass transit system composed of trunk bus and railway systems increases, the conventional bus passengers will increase if the conventional bus fare rate is constant. The number of passengers, which divert from the mass transit to the conventional bus, depends on the fare rate. In order to analyze those relationships, the study developed a procedure to forecast a modal share using a Logit model in the disaggregated model and a transit assignment model.

In the sensitivity analysis on the fare rate system, shown in Figure 21.3-1, the public transport passenger volumes on each mode are forecasted on the assumption that the fare rate of the mass transit system increases on the constant fare rate of the conventional bus. The sensitivity of users for flexibility of the fare rate is disclosed in the Master Plan.

The analysis was also made in order to identify the fare rate sensitivity of Estrato E. From the analysis, the sensitivity of Estrato E users towards the flexibility of the fare is disclosed. This is a good guide for the policy of the fare system for Estrato E.

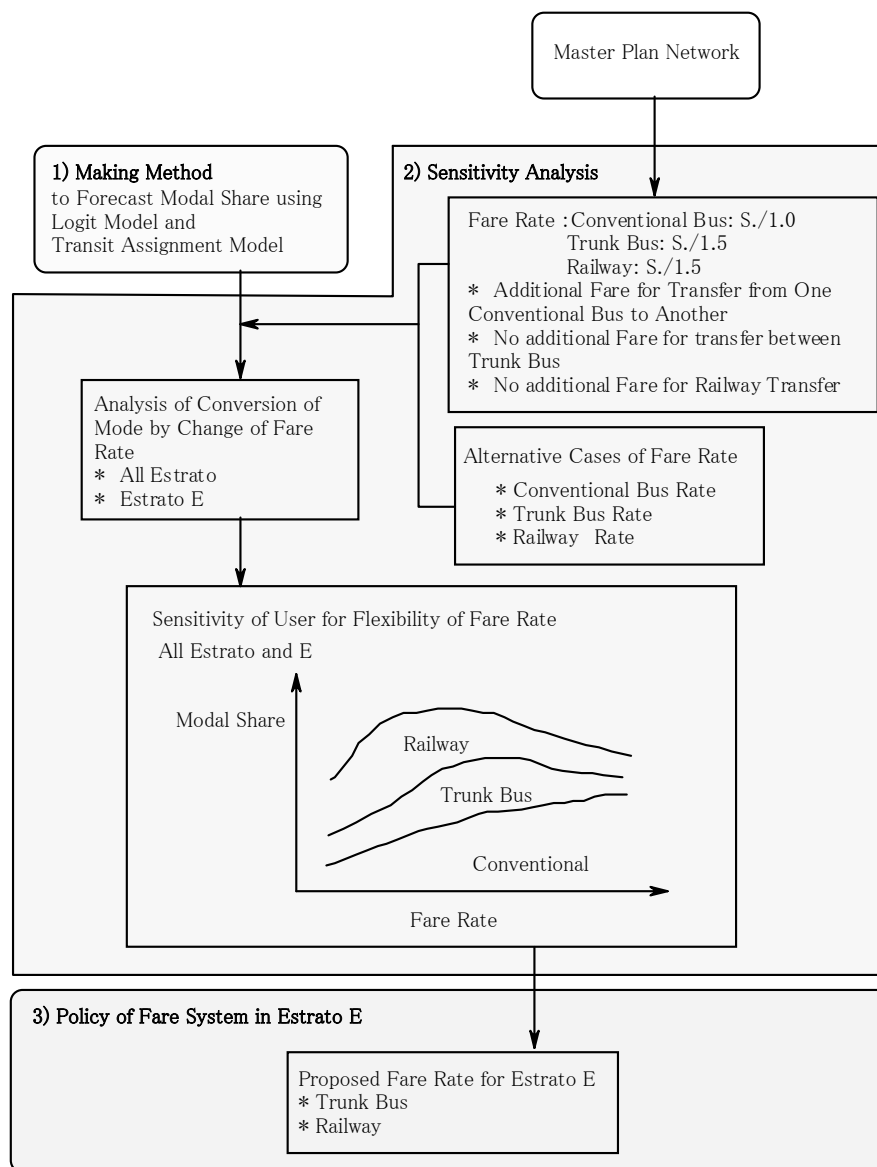


Figure 21.3-1 Evaluation Procedure of Fare Rate

21.3.1. PROCEDURE TO FORECAST A MODAL SHARE

Figure 21.3-2 shows the procedure to forecast a modal share of public transport using the Logit model and transit assignment model in order to disclose the sensitivity of fare rates. There are two models that forecast the modal share under an applied fare rate, one is the transit assignment model and the other is the Logit model. In the transit assignment model, the modal share of public transport, which is composed of the conventional bus, trunk bus and railway, is forecasted under network conditions such as travel time, cost, and transfer times. Those network conditions are converted to a time value from each network index. The modal share depends on the time value. However, it is difficult to decide the time value reflected on the actual user conditions of modal choice.

On the other hand, the modal share in the Logit model depends on the network conditions. The result of the share reflects an opinion of passengers. This is because the Logit model was developed based on the data of the stated preference (SP) survey.

Therefore, the modal share is forecasted using both models. At first, the modal shares of the conventional, trunk bus and railway are forecasted by the transit assignment model on the application of the fare rate of each mode and unit time value. Inputting the route information of the assignment model to the Logit model, the modal share is also forecasted. This step is iterated until both of the shares are close. Finally, the ratio of modal share from the final step is employed.

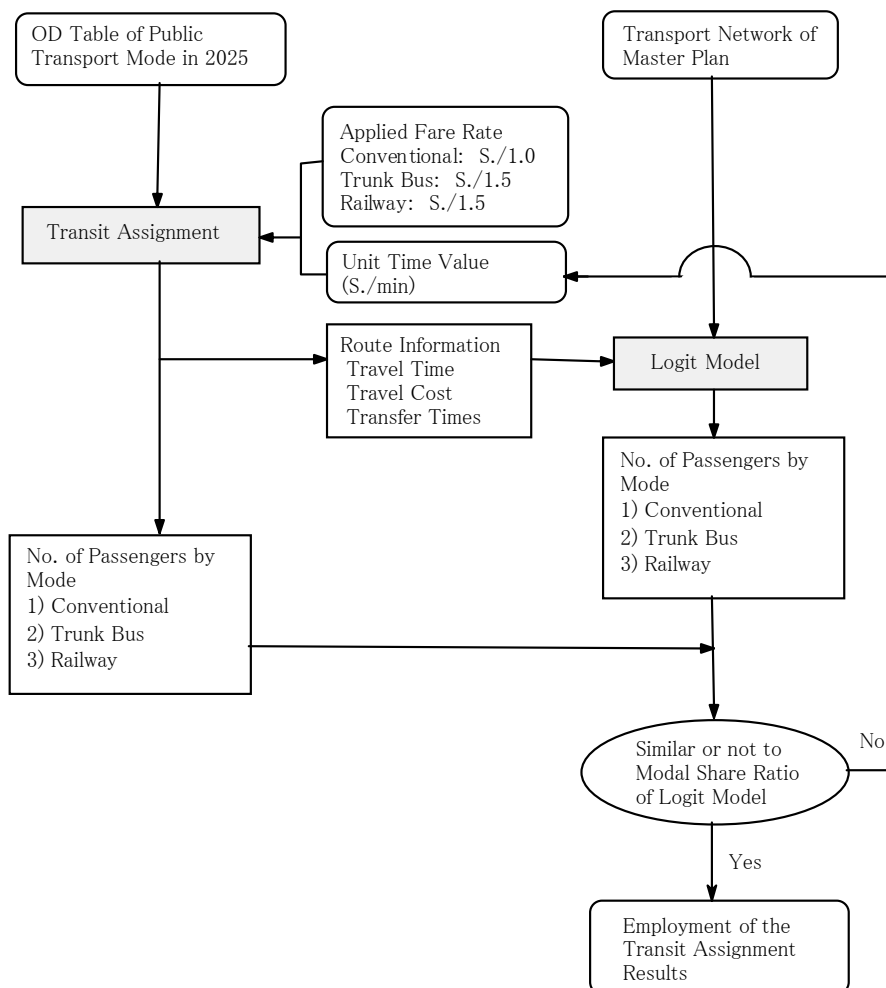


Figure 21.3-2 Procedure to Forecast a Modal Share of Public Transport

21.3.2. SENSITIVITY ANALYSIS FOR PUBLIC TRANSPORT FARE RATE

Figure 21.3-3 and Table 21.3-1 show the distribution of hourly public transport passenger volumes by public mode against fare rate, in which the fare rate of the mass transit system increases in range from S./1.0 to S./2.5 on a constant fare rate of S./1.0 for the conventional bus.

As can be seen, in the case of the same fare rate for all public transport, conventional bus, trunk bus and railway modes, the shares of those modes are 25%, 40% and 35% of the total, respectively. The difference of shares between trunk bus and railway are related to the project length.

When the rate of the mass transit rises, the composition ratio of its mode decreases. In the case in which a mass transit fare rate is S./1.5 against S./1.0 for conventional buses, the share of mass transit decreases and the share of the conventional bus increases. Those

shares are 31% of the total for conventional bus, 37% for trunk bus and 32% for railway. The conventional bus trips increase 1.22 times, and the mass transit decreases 0.93 times.

When the fare rate of the mass transit is higher, those shares are considerably lower. The trips of the mass transit decrease 0.72 times for trunk bus and 0.77 times for railway on a rate of S./2.5 against S./1.0 for conventional bus.

Table 21.3-1 Hourly Public Transport Passengers and Ratio by Mode against Fare Rate

Items	Mode	Case-1	Case-2	Case-3	Case-4			
Fare (Soles)	Conventional Bus	1.0	1.0	1.0	1.0	Case-2 /Case-1	Case-3 /Case-1	Case-4 /Case-1
	Trunk Bus	1.0	1.5	2.0	2.5			
	Train	1.0	1.5	2.0	2.5			
Trips (Passenger/day)	Conventional Bus	255,745	311,932	380,670	453,869	1.22	1.49	1.77
	Trunk Bus	411,862	383,364	341,264	297,422	0.93	0.83	0.72
	Train	356,074	328,469	302,041	272,799	0.92	0.85	0.77
	Total	1,023,681	1,023,764	1,023,975	1,024,090	1.00	1.00	1.00
Ratio	Conventional Bus	25.0%	30.5%	37.2%	44.3%			
	Trunk Bus	40.2%	37.4%	33.3%	29.0%			
	Train	34.8%	32.1%	29.5%	26.6%			
	Total	100.0%	100.0%	100.0%	100.0%			

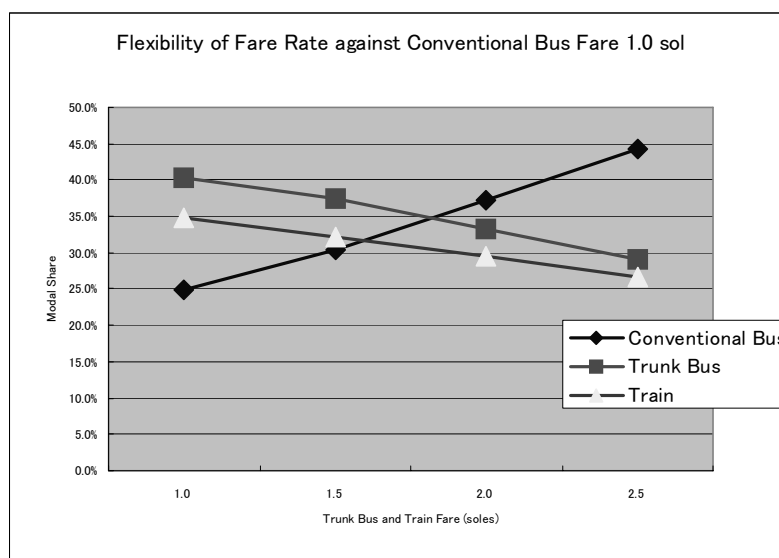


Figure 21.3-3 Distribution of Composition Ratio of Hourly Public Transport Passengers by Mode against Fare Rate

21.4. INFLUENCE OF MASS TRANSIT ON LOWER INCOME POPULATION

In the Master Plan study, the construction of a mass transit system, which is easily used by the lower income population, is one of the study purposes. Particularly, the feeder bus network and fare rate system are important issues according to the results of the lower income population survey carried out in the study.

In this section, the issues of public transport and the lower income population are disclosed based on the lower income population survey results. The fare system and feeder network are recommended. Figure 21.4-1 shows the analytical procedure of influence of the mass transit on the lower income population.

Influence of Mass Transit to Poor People

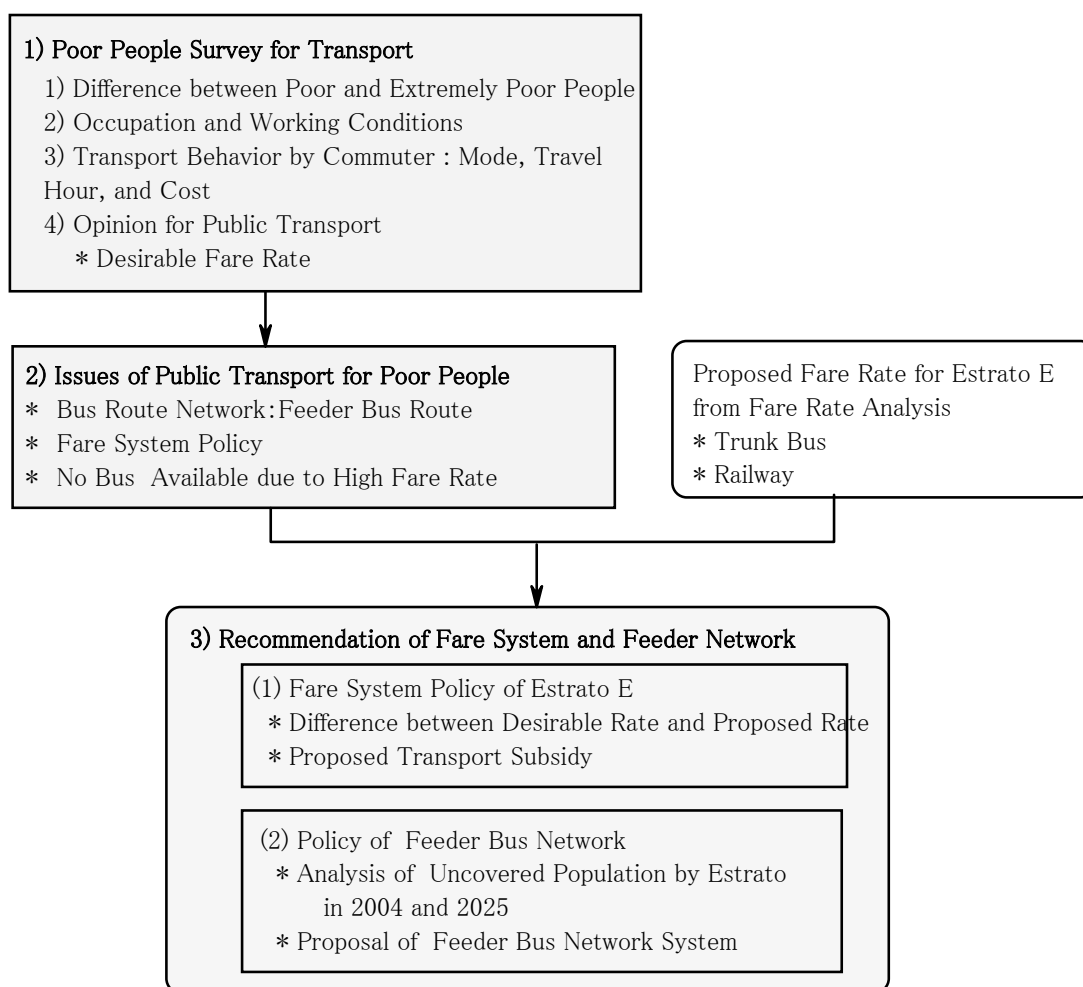


Figure 21.4-1 Analytical Procedure of Influence of Mass Transit on the Lower Income Population

21.4.1. LOWER INCOME POPULATION SURVEY FOR TRANSPORT

(1) Extremely Poor and Poor Conditions

The lower income population survey regarding travel and working conditions was carried out in October 2004, in which 1085 samples were collected from 15 locations of lower income population. 494 samples are for males and 566 are for females.

Since it is difficult to define the lower income population, Estrato E or less than E ranks are targeted in this survey. In the field survey, it is difficult to find out who belongs to Estrato E and less E. Therefore, the survey investigated lifeline conditions such as electric power, water supply and invasion upon public land. Based on the survey data of the lifeline conditions, the interviewees are classified into 2 groups: poor and extremely poor people.

- 1) Extremely poor conditions are defined as shown below.
 - a) Living in public land without permission (invasion).
 - b) Without electric power facilities.
 - c) Without regular water facilities. Supplied by water cistern trucks or others.
 - d) Without electric appliances except radio and TV in a minimum percentage. (It

is possible that they obtain electricity from neighbors or others).

- e) In this case, there are two levels of employment: permanent (salesperson, including street vendors), temporary (usually, unskilled workers, domestic service workers) and unemployed persons.

2) Poor conditions are defined as shown below.

- a) It excludes the extremely poor conditions.

All of the interview data is classified into two groups according to the above definition: extremely poor and poor population. 117 samples are defined as extremely poor, equivalent to 10% of the total, and 968 samples are defined as poor people.

Figure 21.4-2 shows the procedure of data analysis for the poor people survey. At first, the classification of poor people is done based on the above definition. Then there is an analysis of daily working conditions such as occupation and working place. Thirdly, there is an analysis of daily travel condition in the commuter hour such as travel mode, travel time and fare rate. At last, in order to reflect the public transport policy, related to a feeder route network and fare rate, on the poor people, the main reasons for which the interviewee does not use a bus are analyzed from the lower income opinion data.

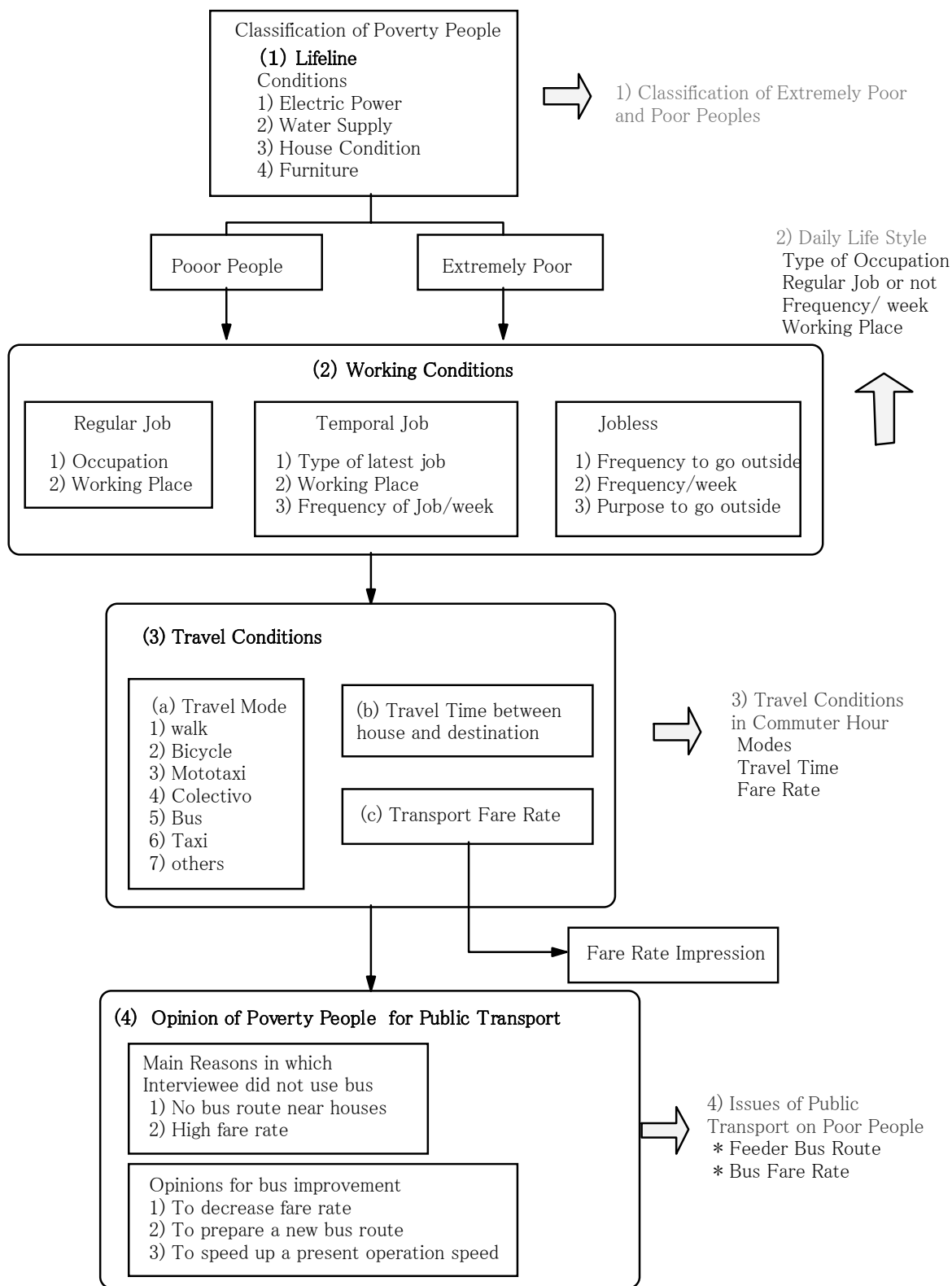


Figure 21.4-2 Procedure of Data Analysis for Lower Income Survey

(2) Lifeline Conditions

In the lower income population survey, electric power, water supply and housing conditions were surveyed. The lifeline conditions are quite different between the extremely poor and poor people. Figure 21.4-3 shows conditions of electric power in both categories. Unsupplied electric power accounts for 94% of the total of the extremely poor people, in contrast to 9% of the poor people. Figure 21.4-4 shows conditions of water supply. The use of water tanks accounts for 64% of the population in extreme poverty. Amongst poor people, the service of water supply accounts for 45%.

Figure 21.4-5 shows housing conditions, whether they live in public land without permission (invasion) or not. 65% of the poor people live in owned and rented land. On the other hand, according to the definition, 100% of the extremely poor people are invaders. Almost all of the extremely poor people live in other land without electric and water supplies.

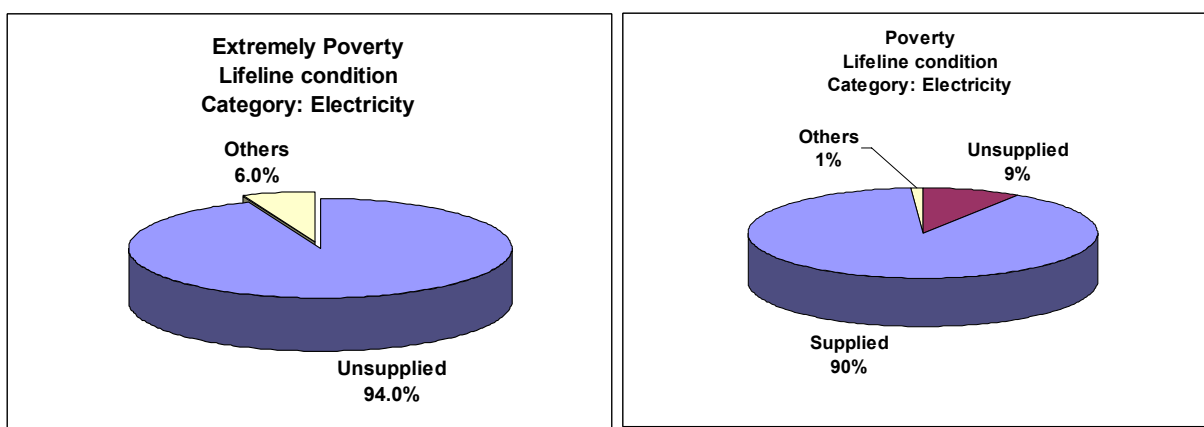


Figure 21.4-3 Conditions of Electric Power

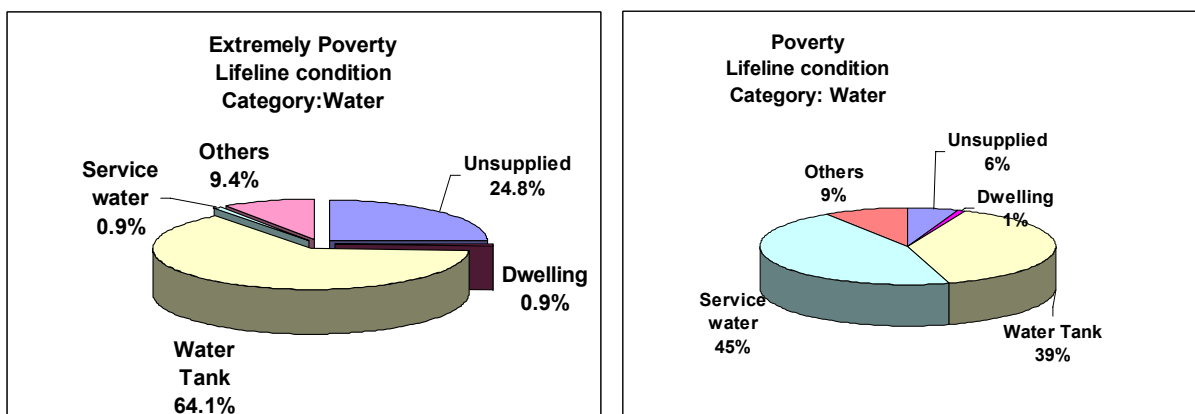


Figure 21.4-4 Conditions of Water Supply

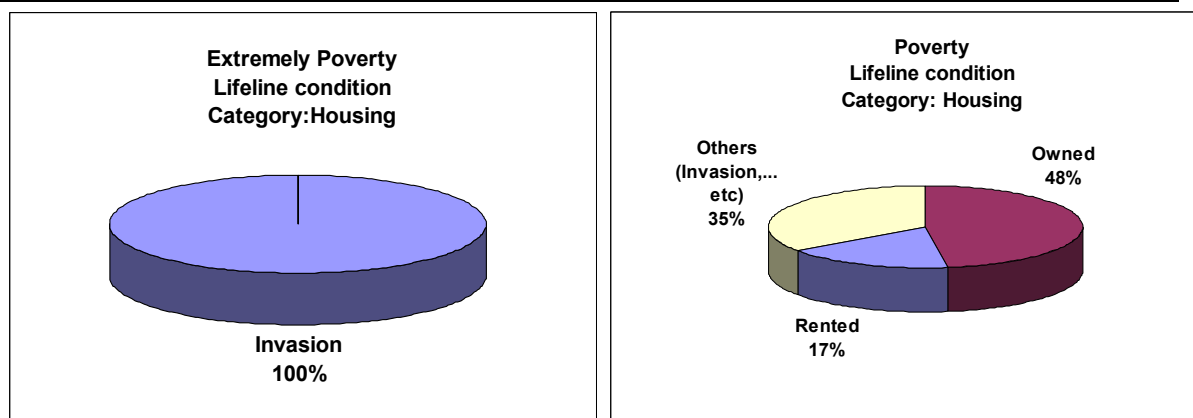


Figure 21.4-5 Housing Conditions

(3) Working Conditions

Figure 21.4-6 shows the employment conditions of poor people. 36% of the extremely poor people are employed in regular jobs and others are in temporary jobs and unemployed. As for the poor people, 56% are in regular jobs. The difference between poor and extremely poor people is for the unemployed. The unemployment ratio of the extremely poor people is higher than that of the poor people.

Figure 21.4-7 shows the type of occupation for temporary jobs for the extremely poor and poor people. Their occupation is mainly street vendor. The ratios of extremely poor and poor people are 50% and 42%, respectively.

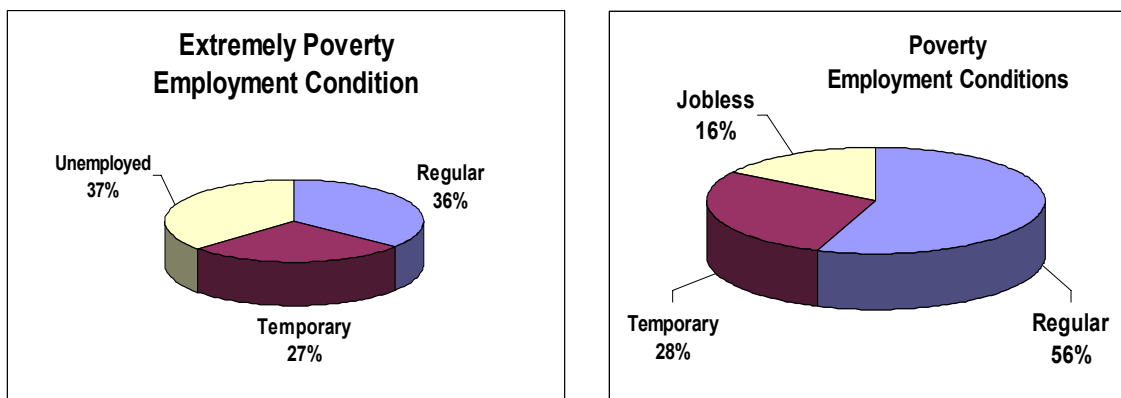


Figure 21.4-6 Employment Conditions

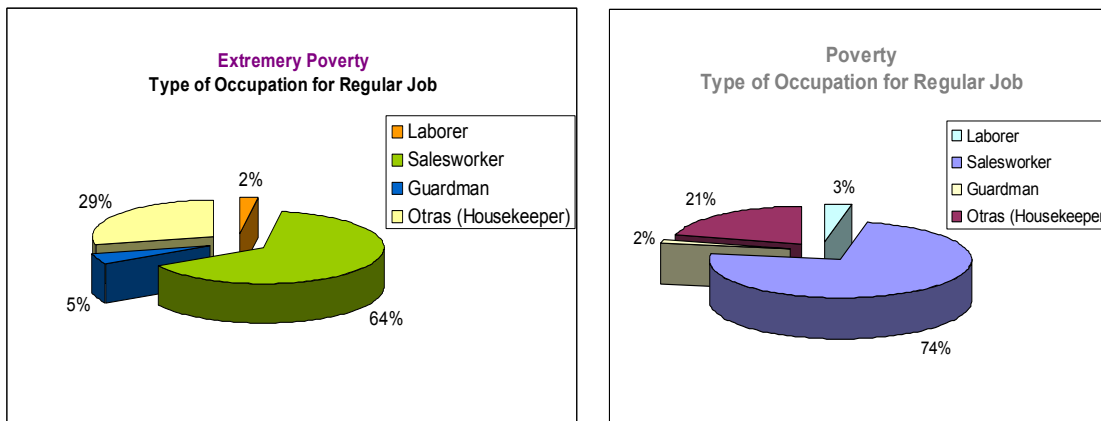


Figure 21.4-7 Type of Occupation for Regular Job

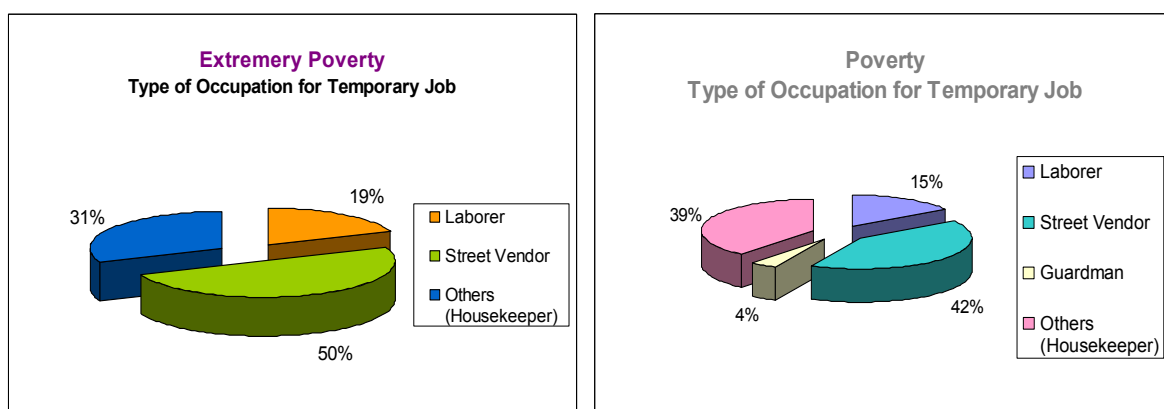


Figure 21.4-8 Type of Occupation for Temporary Job

(4) Travel Conditions

1) Travel Mode

Figure 21.4-9 shows transport modes to working place in commuter mode. The ratios of walking and public transport uses are higher at 40% and 35% in the extremely poor people, respectively. The main modes of poor people are the same as that of the extremely poor.

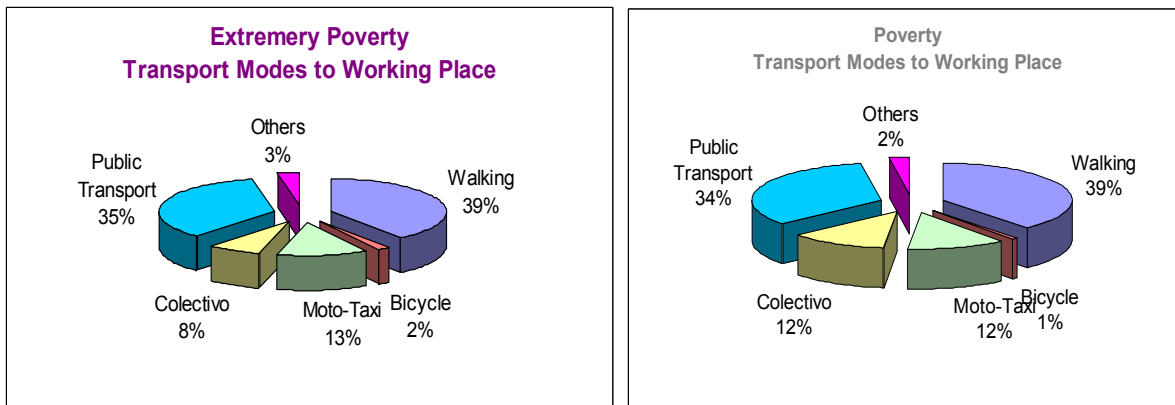


Figure 21.4-9 Transport Modes to Working Place

2) Travel Time by Mode

Figure 21.4-10 shows travel time by mode to working place. The average travel time by the major modes according to the extremely poor and poor people is 16-24 minutes for walking and 38-44 minutes for public transport. As can be seen, their travel conditions in commuting hour are classified into two: one is by walking to working place and another is by public transport. The extremely poor people walk to their working place taking a long time.

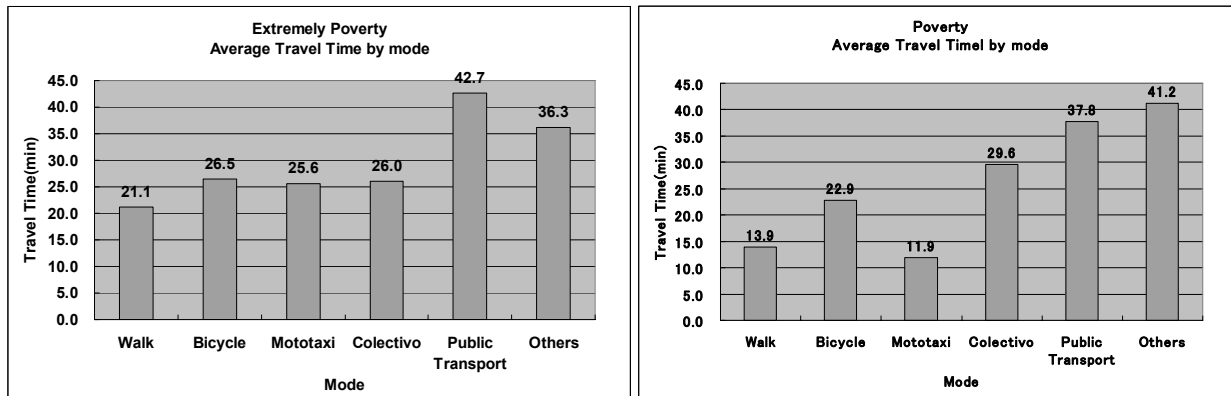


Figure 21.4-10 Travel Time by Mode to Working Place

3) Fare Rate

Figure 21.4-11 shows the paid fare rate of public transport in the poor category. The paid fare rates of the extremely poor and poor are different. A rate of less S./1.0 is 61% of the total for the extremely poor, in contrast to 33% for the poor. The poor people mainly pay a range of S./1 to S./2.

In the interview, their impression of fare rate was collected. 52% of the extremely poor answered that the rate is expensive at less than S./1.0, while 19% of the poor answered that it is expensive. However, in the case of over S./1.0, both poor categories are similar.

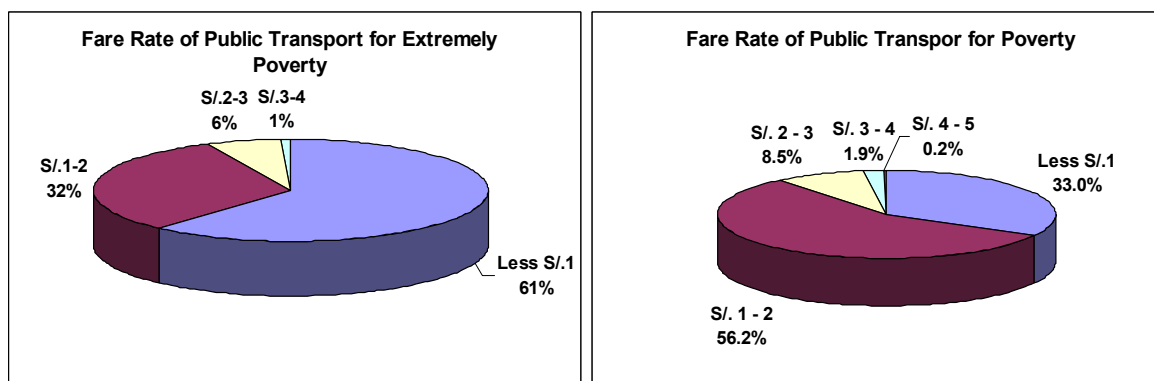


Figure 21.4-11 Paid Fare Rate of Public Transport

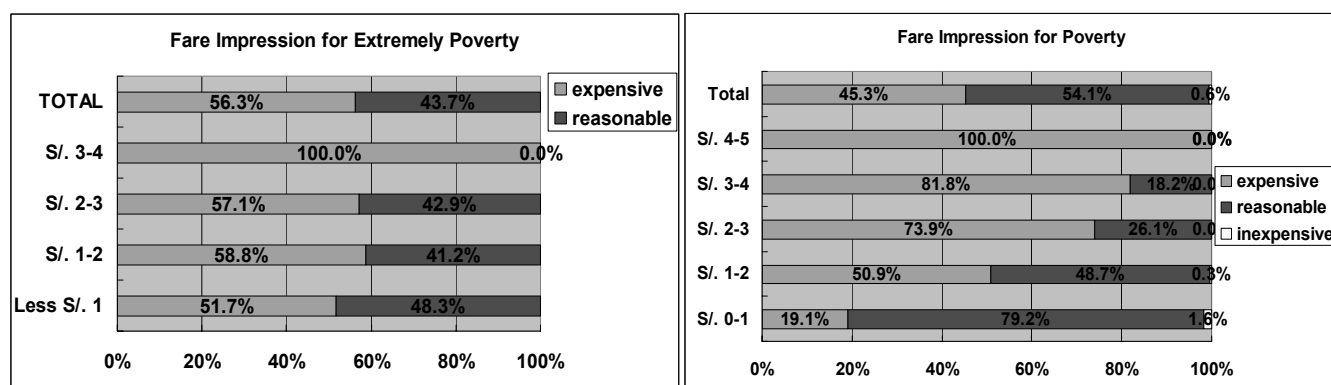


Figure 21.4-12 Fare Impression

4) Travel Conditions by Area

Table 21.4-1 and Figure 21.4-13 show travel conditions by areas in terms of walking time and travel time of bus transport according to the extremely poor and poor people. The Center area is the longest in walking time of the extremely poor (33.3 minutes), followed by the South (23.3 minutes), East (16.5 minutes) and North (14.5 minutes). The poor people of the South have the longest walking time. The walking time varies by area. The travel time and fare rate of bus transport slightly vary by area in exclusive of the South area, in comparison to the walking time.

The extremely poor people in the Central and South areas commute to their working place with long walking times.

Table 21.4-1 Walking Time and Travel Time of Bus Transport

Mode	Area	Unit	Extremely Poor	Poor	Extremely Poor /Poor
Walking	Center	min.	33.3	13.4	2.48
	East		16.5	11.7	1.41
	North		14.5	14.4	1.01
	South		23.3	15.6	1.50
	Average		21.1	13.9	1.52
Bus Transport	Center	min,	46.0	36.9	1.25
	East		42.9	40.1	1.07
	North		45.0	40.3	1.12
	South		35.0	32.4	1.08
	Average		42.7	37.8	1.13
Fare	Center	S./	1.3	1.0	1.32
	East		1.1	0.9	1.21
	North		1.2	1.1	1.07
	South		0.8	1.2	0.72
	Average		1.1	1.1	1.06

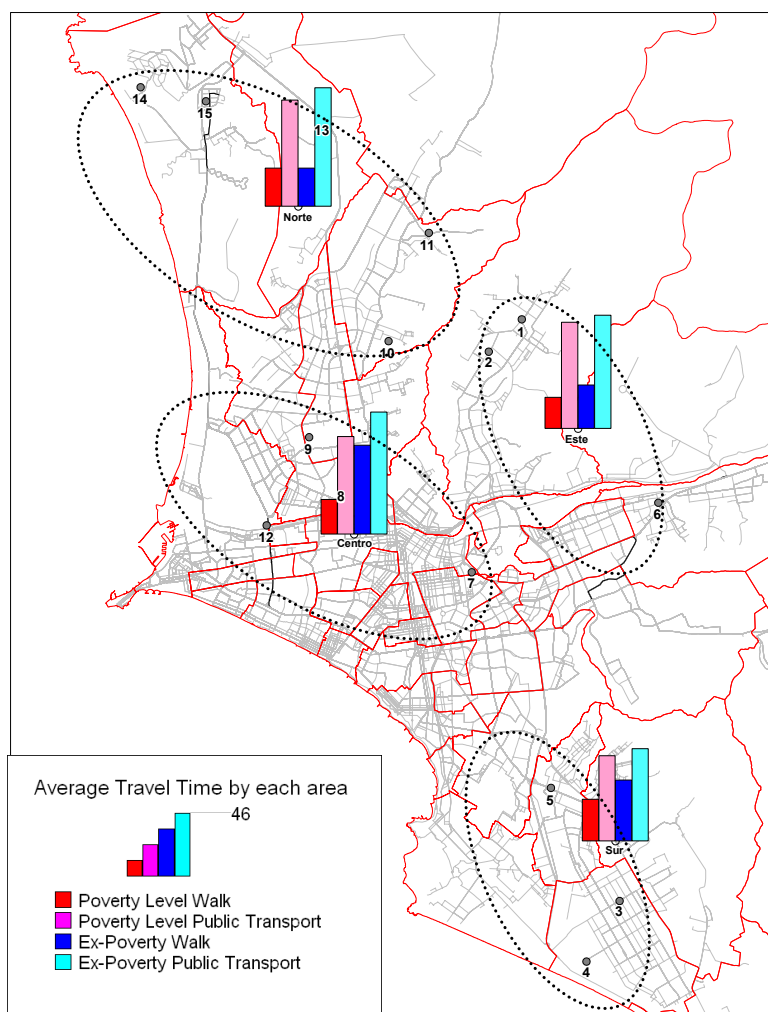


Figure 21.4-13 Average Walking Time by 4 Integrated Zones

(5) Opinions of Extremely Poor and Poor People

1) Problems of Public Transport

In order to reflect the public transport policy, related to a feeder route network and a fare rate, on the poor people, the main reasons for which interviewees did not use a bus are analyzed from the poor people opinion data. Figure 21.4-14 shows the reasons not to use a bus. As can be seen, the highest reason of the extremely poor is “no bus routes near home” (19%), followed by “expensive” (15%), “no bus routes near destination” (11%), and “low speed” (10%), in exclusive of “distance is sufficient to walk” (31%). As for the poor people, “no bus routes near home” is the highest reason (23%). The second is “no bus route near destination” (14%) and “expensive” (14%). Another main reason is “low speed” (8%).

As for the extremely poor and poor people,, no bus routes and fare rate are two major problems.

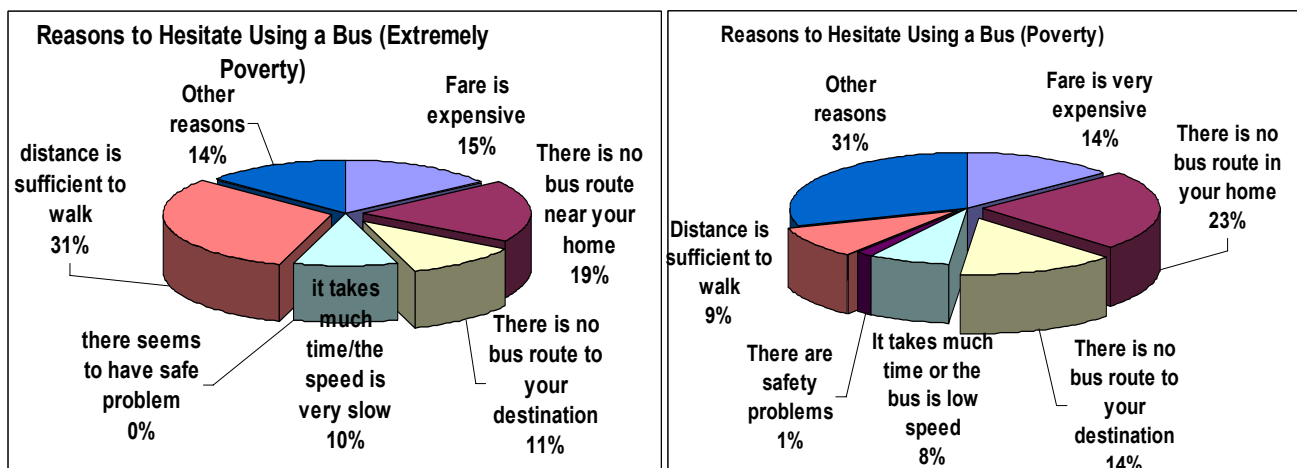


Figure 21.4-14 Reasons to Hesitate Using a Bus

2) User Opinion for Public Transport Improvement

The bus route and fare rate are two major problems according to the user opinions for public transport improvements shown in Figure 21.4-15. This also finds out the public transport problems.

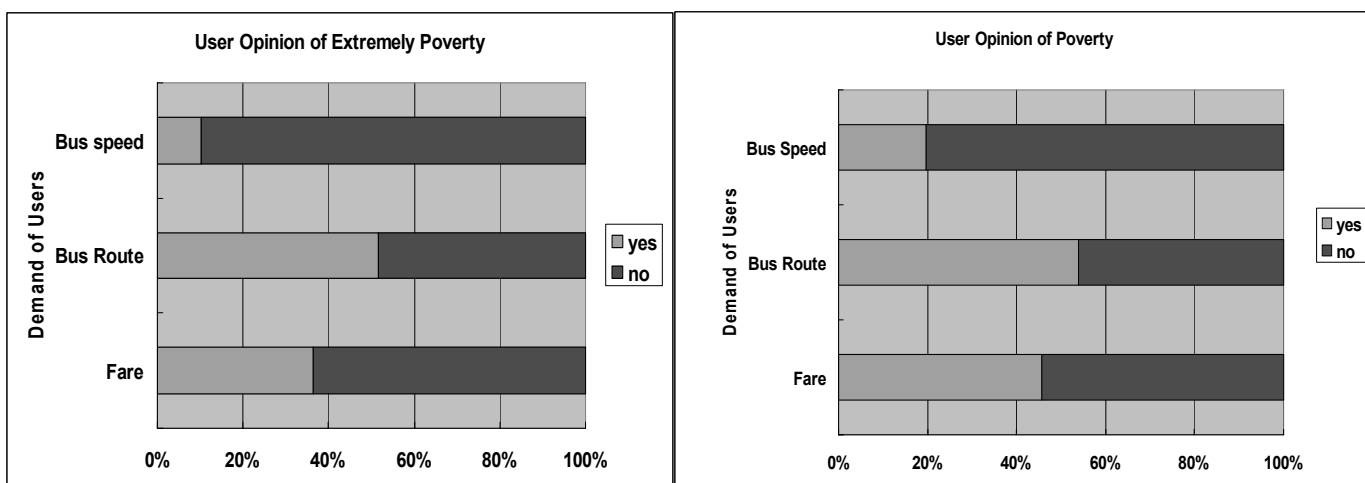


Figure 21.4-15 User Opinion for Public Transport Improvement

3) Demand for Bus Transport

Figure 21.4-16 and Figure 21.4-17 show the demand for bus transport according to the extremely poor and poor people. Both poor people demand the improvement of the bus routes. Approximately 60% of the extremely poor and 35% of the poor have the opinion that the “bus route is very poor”.

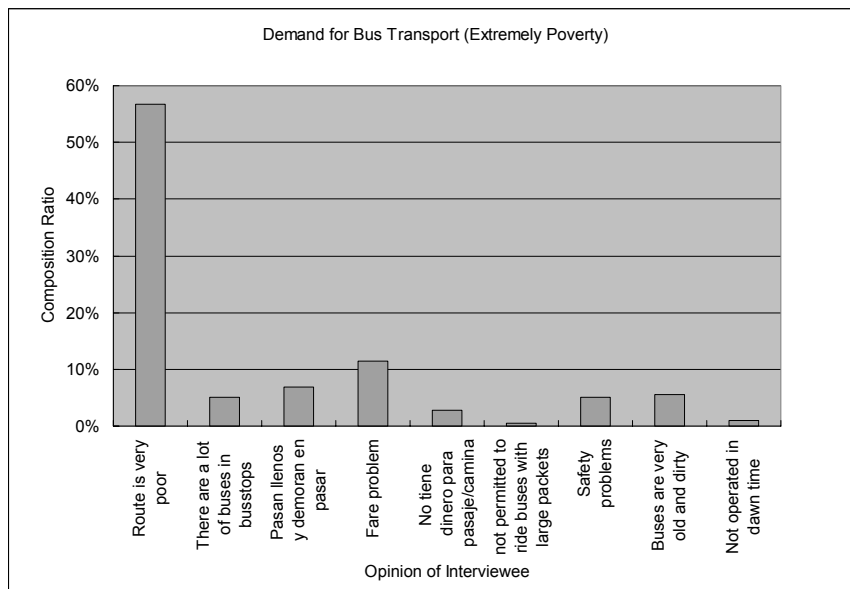


Figure 21.4-16 Demand for Bus Transport (Extreme Poverty)

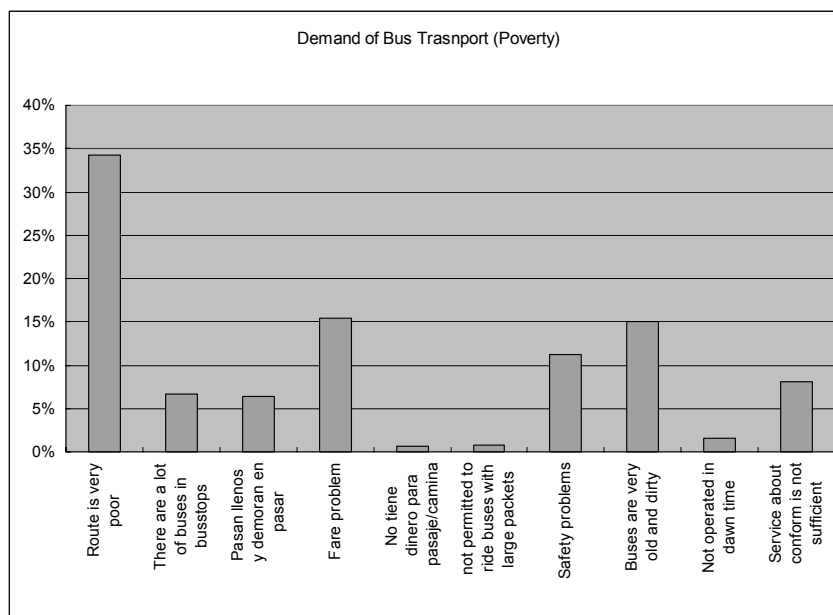


Figure 21.4-17 Demand for Bus Transport (Poverty)

21.4.2. ISSUES OF PUBLIC TRANSPORT ON POOR PEOPLE

According to the poor people survey, the bus route network and the fare rate level are important issues. The fare rate is a very sensitive issue for the extremely poor people. They feel that a rate of less than S./1.0 is expensive, in contrast to S./1.0-2.0 for the poor people. Therefore, it will be necessary to subsidize the extremely poor people to ease the use of public transport.

Table 21.4-2 shows user opinions requesting a lower fare rate on behalf of the extremely poor and poor people in the interview survey. Approximately 20% of the extremely poor and poor people request lower fare rates, particularly, the extremely poor in the east area are higher (35%) in ratio. They currently pay S./1.2. When the rate is lower than that at the

present, all of the extremely poor people who requested lower rates can take a bus, in contrast to 70% of the poor people.

Table 21.4-2 User Opinions Regarding Request of Lower Fare Rates

Items		Extremely Poverty	Poverty
Request of Lower Fare Rate (%)			
	Centro	20.0%	15.3%
	East	35.3%	19.3%
	North	21.9%	21.2%
	South	15.8%	22.3%
	Average	21.4%	19.8%
Paid Rate of Requested People (S./)			
	Centro	1.1	1.05
	East	1.2	0.96
	North	1.6	1.05
	South	0.6	1.33
	Average	1.1	1.11
They take a Bus, if discount			
	Centro		57.1%
	East	100.0%	85.7%
	North	100.0%	64.9%
	South	100.0%	88.9%
	Average	100.0%	68.7%

As for the preparation request of the bus route in Table 21.4-3, approximately 30% of the extremely poor and 35% of the poor people request the bus routes, respectively. Particularly, the extremely poor and poor in the north area are higher (50%) in ratio. They take a bus for approximately 50 minutes in the extremely poor case and for 40 minutes in the poor case, respectively. When a bus route is prepared, approximately 80% of the extremely poor and poor people, who requested the new bus route, answer to take a bus.

In summary, 20% of the extremely poor people take a bus when the rate is discounted. On the other hand, 30-35% of the extremely poor and poor people feel they have a poor bus route, this is particularly felt by the extremely poor and poor people in the north area.

The present bus route network in their residential area has several problems. The extremely poor people live on the slopes of hilly terrains and mountains far away from a major road. Since the bus is not directly operated into this low-income area, the residents in the area must use a moto-taxi to arrive home after alighting a bus.

Though the residents request the extension of a new bus route into the area, the bus companies do not welcome this idea due to a low passenger demand and a worse access road. At the same time, the company is negative from the perspective of the financial balance due to the competition with moto-taxis with low fare rates. At the present, the residents pay the bus fare. Moreover, the moto-taxi or Colectivo fare must be paid. In some cases, the residents must travel on foot to a road with a bus route.

Table 21.4-3 User Opinion Regarding Request of Preparation of Bus Route

Items		Extremely Poverty	Poverty
Request of Bus Route (%)			
	Centro	30.0%	23.8%
	East	11.8%	20.5%
	North	50.0%	49.3%
	South	21.6%	26.6%
	Average	30.2%	34.9%
Average Travel time of Requested People (min)			
	Centro	50.0	38.75
	East	60.0	34.05
	North	52.2	40.66
	South	33.8	32.73
	Average	49.0	37.99
They take a Bus, if prepared (%)			
	Centro		56.3%
	East		90.0%
	North	100.0%	77.5%
	South	50.0%	92.3%
	Average	80.0%	77.3%

21.4.3. RECOMMENDATION OF FARE SYSTEM AND FEEDER BUS NETWORK

In the proposed trunk and feeder bus system, the feeder bus service in those areas is indispensable. Moreover, it will be necessary to introduce a subsidiary fare system for public transport. Figure 21.4-18 shows the summary of recommendations for the extremely poor people. According to the survey, the travel within walking distance is done by walking because of the fare rate and poor bus route. The walking distance is longer than average. There are mainly two bus transport demands: one is to improve the bus routes and the other is related to the fare problem.

Therefore, the recommendation of the fare system and feeder bus network for the extremely poor people is shown below.

- 1) To prepare the feeder bus route network to answer their demand
- 2) To propose a lower fare rate of the feeder bus.

As for the fare rate of the feeder bus, the following can be an idea of how to subsidize the proceeds from the trunk bus and railway.

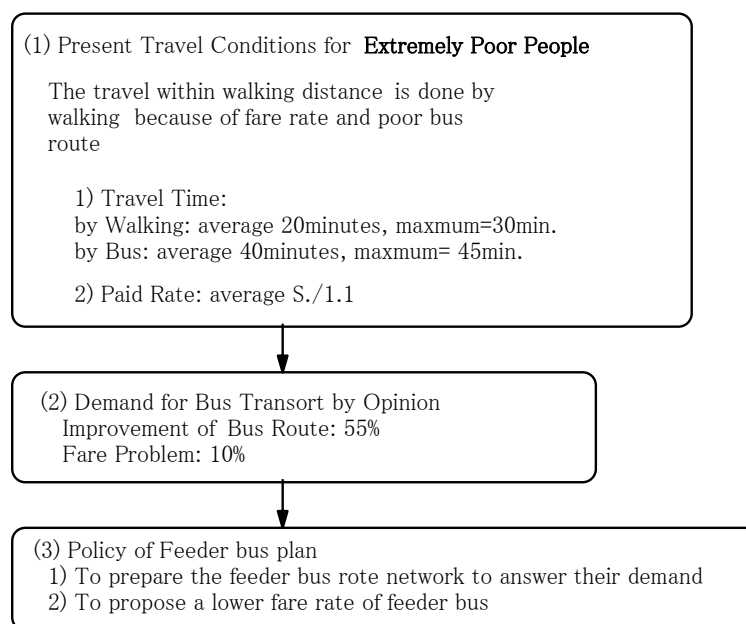


Figure 21.4-18 Summary of Recommendation

21.5. ECONOMIC SENSITIVITY ANALYSIS

In the section, influence on travel demand according to change of economic growth rate is analyzed as an economic sensitivity analysis. The travel demand has close relation to Estrato ranks. The Estrato is closely related to household income levels. A household with a higher rank of Estrato takes a high income and high car ownership ratio. The number of daily trips for the high Estrato household members is higher than for the low Estrato, which means non-motorized, and the ratio of passenger car trips to all motorized trips by the high Estrato is considerably higher than the low Estrato.

In the future, the composition ratio of Estrato rank depends on the economic growth ratio. In this Master Plan study, an economic growth rate for a period of 21 years from 2004 to 2025 in terms of GRDP/capita is a ratio of 1.78 times, equivalent to a growth ratio of 2.8%/annum. Future travel demand is projected based on this growth ratio of GRDP/capita. When the economic growth changes, the future travel demand is influenced on the total number of trips and modal share of private and public modes.

In this section, the travel demand is forecasted based on an alternative economic growth on the assumption that a growth ratio of GRDP/capita from 2004 to 2025 is 1.558 times (a growth ratio of 2.1%/annum), which is estimated by the INEI as a moderate growth rate. Therefore, under a lower economic growth than that in the Master Plan, the impact of the Master Plan projects is evaluated.

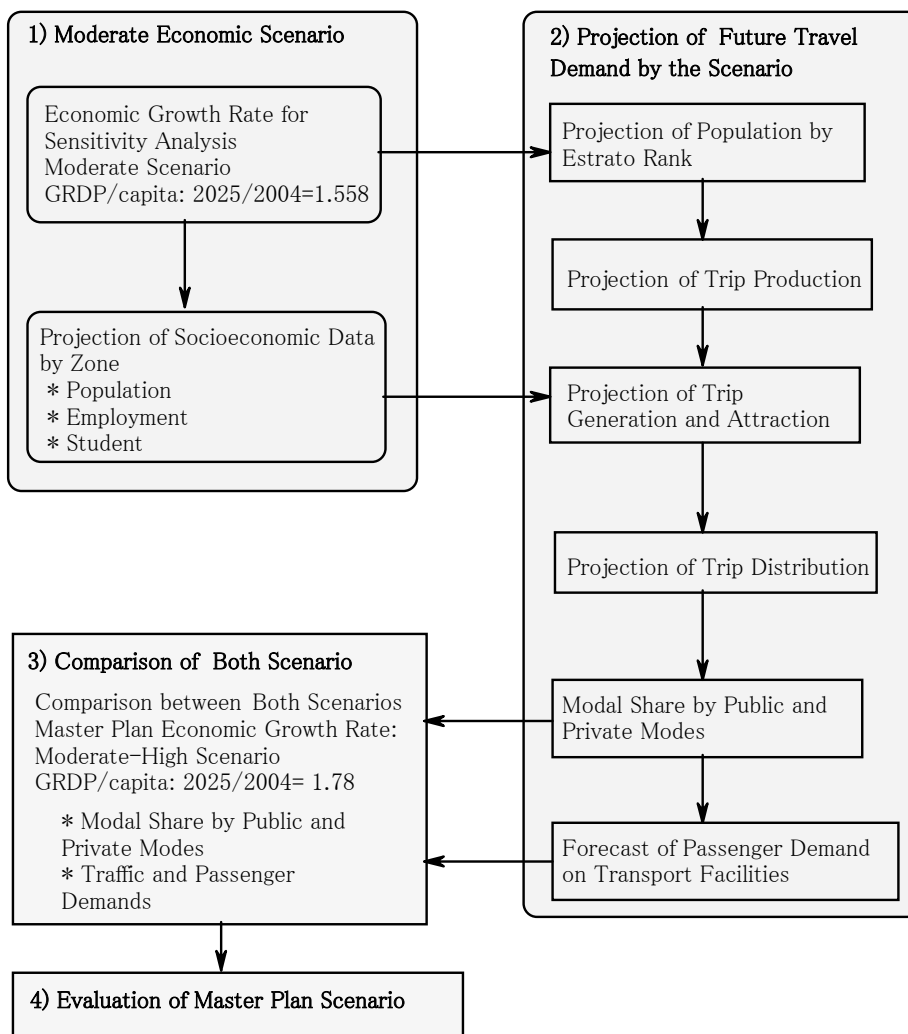


Figure 21.5-1 Influence on Travel Demand According to a Change of Economic Growth Rate

21.5.1. MODERATE ECONOMIC SCENARIO

The composition ratio of Estrato rank depends on an economic growth ratio. Figure 21.5-2 shows the composition ratio of the population by Estrato rank according to an economic growth ratio of GRDP/capita per annum in a range between 0.0% and 6.8% per annum. GRDP/capita of 2.1% (1.558 times the present value) and 2.8% (1.78 times) per annum are equivalent to the moderate scenario and moderate high scenario (the Master Plan scenario), respectively. The composition ratio of the population in Estrato AB to the total increases against the growth of GRDP/capita, while the ratio of Estrato E decreases.

Figure 21.5-3 shows the comparison between the alternative cases, the moderate economic scenario and the moderate high scenario. The population composition ratio of Estrato AB in the moderate scenario slightly decreases in comparison with that in the moderate high Scenario. Estrato C is slightly increasing in the ratio. Since the difference of economic growth between both scenarios is relatively small, the population composition is similar in both scenarios.

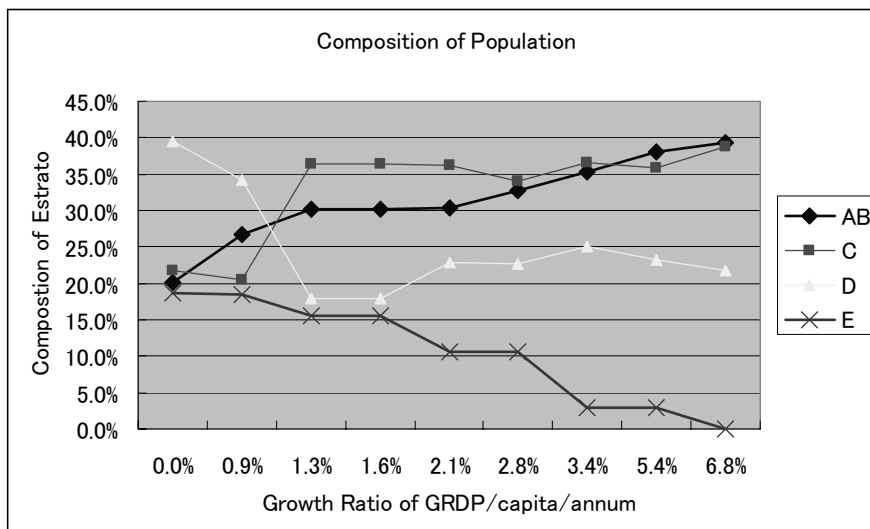


Figure 21.5-2 Composition Ratio of Population by Estrato Rank According to Economic Growth Ratio

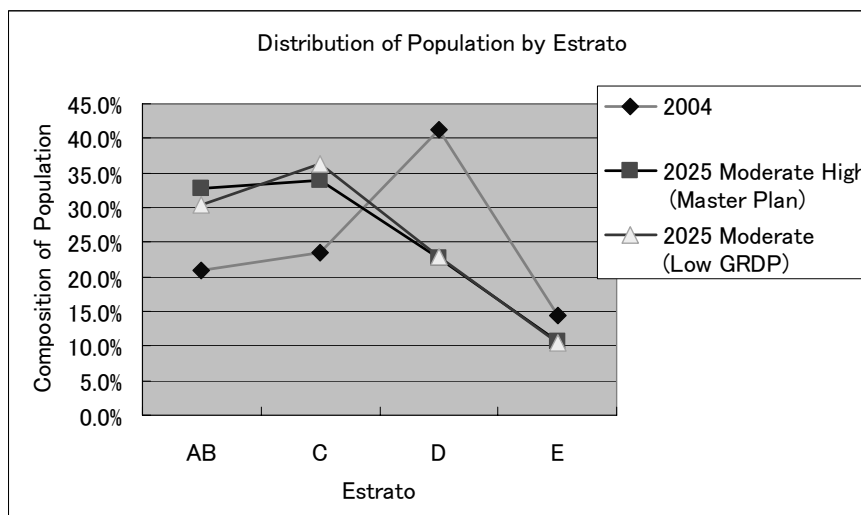


Figure 21.5-3 Composition Ratio of Population by Estrato Rank According to Both Economic Scenarios

21.5.2. PROJECTION OF FUTURE TRAVEL DEMAND BY SCENARIO

Figure 21.5-4 shows increased trips, which are different between the trips in some economic growth ratio per annum and that in 0% /annum, and the increased ratio of trips in some growth ratio to that in 0%/annum according to the economic growth ratio of GRDP/capita per annum in a range between 0.0% and 6.8% per annum. In comparison to a growth ratio of 0%/annum, the difference of trips in 6.8%/annum (4.0 times of the present) is approximately 2.27 million trips and in 0.9%/annum (1.2 times) it is 0.43 million trips.

The increase ratio of trips in 6.8% to that in 0%/annum is approximately 1.14 times. The influence of economic growth in a range of 6.8% (4.0 times) is relatively small.

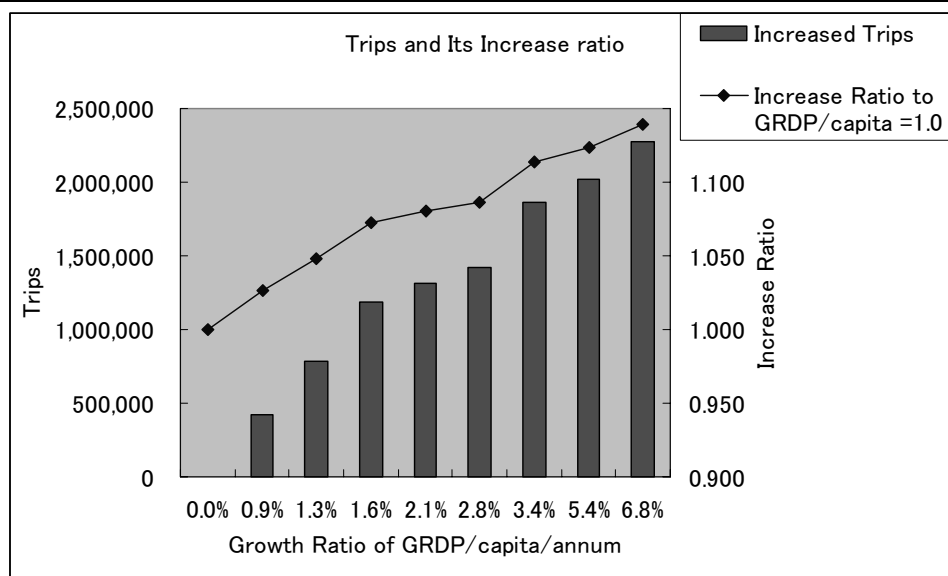


Figure 21.5-4 Distribution of Trips by Economic Growth Ratio of GRDP/capita/annum

21.5.3. COMPARISON OF BOTH SCENARIOS

In the section, the comparison of travel demand in both scenarios is carried out as shown in Table 21.5-1. The difference of travel demand between the moderate and moderate high scenarios is small. The travel demand in the moderate scenario decreases. Its figure is approximately 102 thousand trips. As for the type of vehicle, the demand of public mode increases, while the private mode decreases in demand (see Figure 21.5-5). This is because a decrease of economic growth causes the decrease of the population composition ratio of high-income groups (Strata AB and C) and car trips by those groups decrease. The car trips decrease at 93 thousand trips.

Table 21.5-1 Comparison of Travel Demand by Scenario

Items	Trips				Ratio			
	Car	Taxi	Public	Total	Car	Taxi	Public	Total
2004	1,853,295	900,138	9,365,138	12,118,571	15.3%	7.4%	77.3%	100.0%
2025M (2.1% /annum)	3,941,595	1,232,085	12,502,913	17,676,593	22.3%	7.0%	70.7%	100.0%
2025H (2.8% /annum)	4,034,574	1,245,702	12,498,347	17,778,623	22.7%	7.0%	70.3%	100.0%
Ratio								
2025M/2004	2.13	1.37	1.34	1.46				
2025H/2004	2.18	1.38	1.33	1.47				
Difference								
2025M-2004	2,088,300	331,947	3,137,775	5,558,022				
2025H-2004	2,181,279	345,564	3,133,209	5,660,052				
2025M-2025H	-92,979	-13,617	4,566	-102,030				
(2025M-2025H) /2025H	-2.3%	-1.1%	0.0%	-0.6%				

H: Moderate High Scenario

M: Moderate Scenario

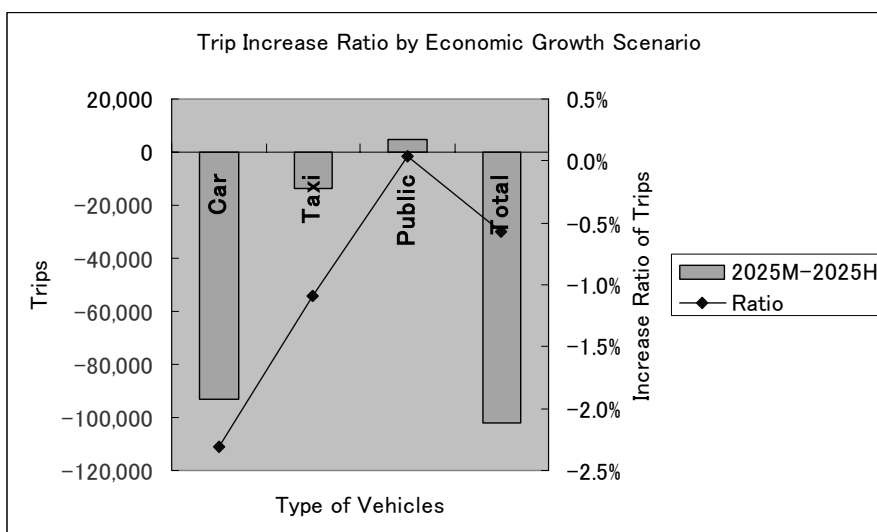


Figure 21.5-5 Difference of Trips by Economic Growth Scenario

21.5.4. EVALUATION OF MASTER PLAN SCENARIO

As can be seen in Figure 21.5-5, the total travel demand decreases in the moderate economic scenario, in comparison to the moderate high scenario, in spite of the increase of travel demand in the public mode. However, its volume is low.

Therefore, the influence of traffic volume on transport facilities such as road, trunk busway and railway is a little. The Master Plan projects are not affected in the implementation program.