(2) Travel Time in the Peak Hour

Table 21.2-2 shows the total and average travel times of the public transport passengers in the peak hour. When comparing the total travel time in the "without project" cases in 2025, the travel time in the "with project" case decreases 0.73 times. The total travel time in 2025 rises 1.50 times in the "with project" case. In the "without project" case, the travel time rises at double figures.

The average travel time in 2025 in terms of total travel time per trip slightly increases. The average travel time in the "with project" case is 48 minutes, in contrast to 45 minutes at the present. In the "without project" cases, the average travel time is approximately 65 minutes. Its figure is 1.44 times of the present. The average travel time in the "with project" case maintains the present level. On the other hand, the average travel distance increases in the future as a result of the growing number of residents living in the suburbs. Moreover, future traffic and transport volumes increase 1.5 times of the present volumes.

Taking into account those conditions, the introduction of the mass transit system serves to improve the travel time of the public transport passenger. The mass transit system is expected to have a reduction of the average travel time in comparison to that in the "without project" case.

Table 21.2-2 Total Travel Time and Average Travel Time in the Peak Hour

(Unit: hour)

Mode	2004	2025			2025/2004	
		With Project	Without Project	With Project/Without Project	With Project	Without Project
Conventional Bus	553,635	334,123	1,144,421	0.29	-	-
Trunk Bus	-	290,087	-	-	-	-
Train	-	209,008	-	-	-	-
Total	555,639	833,218	1,144,421	0.73	1.50	2.06
Average Travel Time (min)	44.9	47.6	64.8	0.74	1.06	1.44

(3) Enlargement of Area Covered in the Same Travel Hour

The average travel time in the whole study area in 2025 slightly increases as mentioned above. The travel time by area is different in direction, regardless if the mass transit system is constructed or not. Figure 21.2-10 and Figure 21.2-11 show the covered area of travel time by public transport and private mode every 15 minutes. As can be seen, in public transport, it is obvious that the covered area of the same travel time in 2025 enlarges in direction of the suburban area, where the mass transit system is constructed. In the "without project" case, the covered area decreases in comparison with that in 2004, though the average travel time in 2025 slightly increases. This is because the population in the suburban area grows in the future.

Figure 21.2-7 shows the covered population ratio by public transport according to 2004, and "with project" and "without project" cases in 2025. In the "with project" case in 2025, the composition ratio is similar to that in 2004 by the influence of mass transit. The covered population in a travel time range of 60 minutes or over in the "without project" case becomes considerably higher. Especially, the population of Estrato E is higher (see Figure 21.2-9).

On the other hand, the area covered by the private mode in the future decreases. The average travel speeds in 2025 in both the "with project" and "without project" cases are 12 and 8km/h, respectively, in contrast to 17km/h in 2004. The influence of decrease of travel

time is shown in the suburban area. The composition ratio of the population covered by the private mode is considerably higher with a travel time of 60 minutes or over in the "without project" case (see Figure 21.2-8).
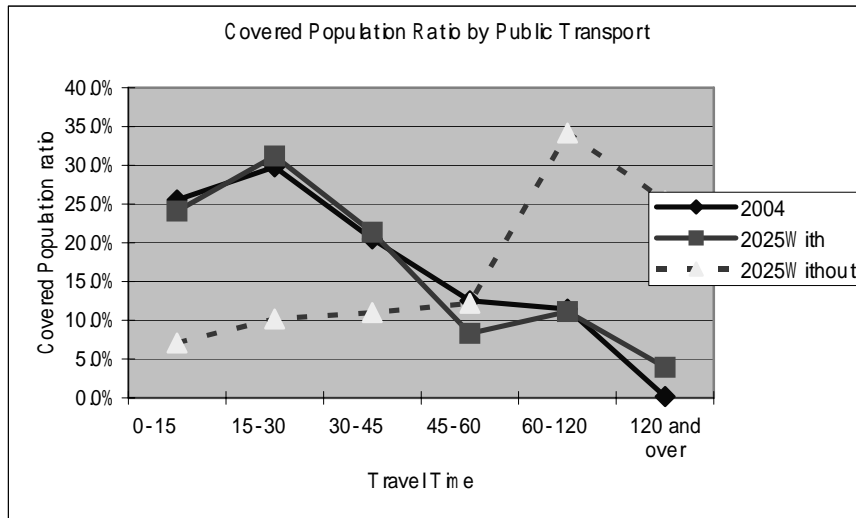

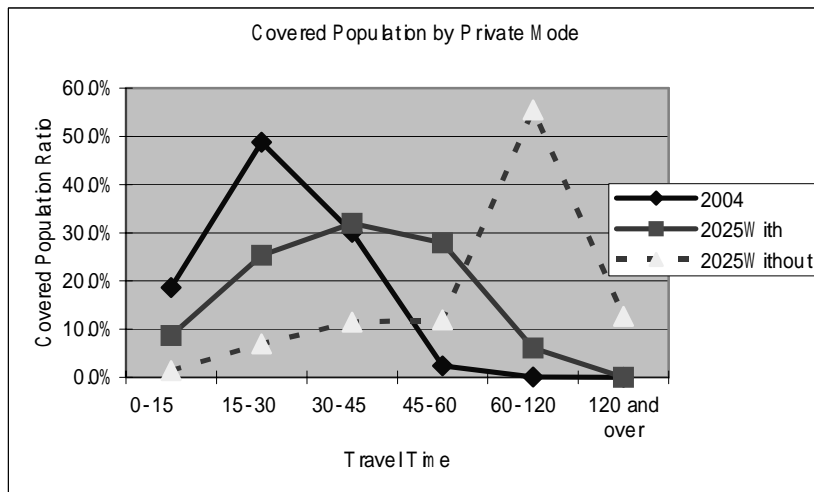Figure 21.2-7 Population Ratio Covered by Public Transport

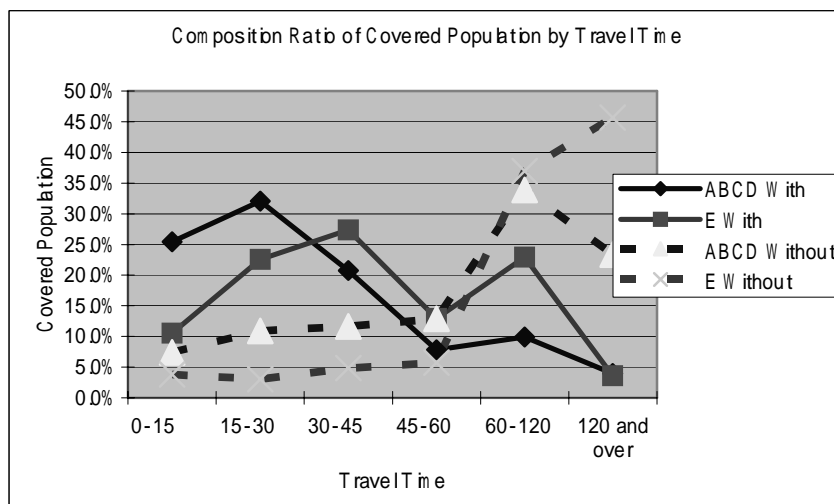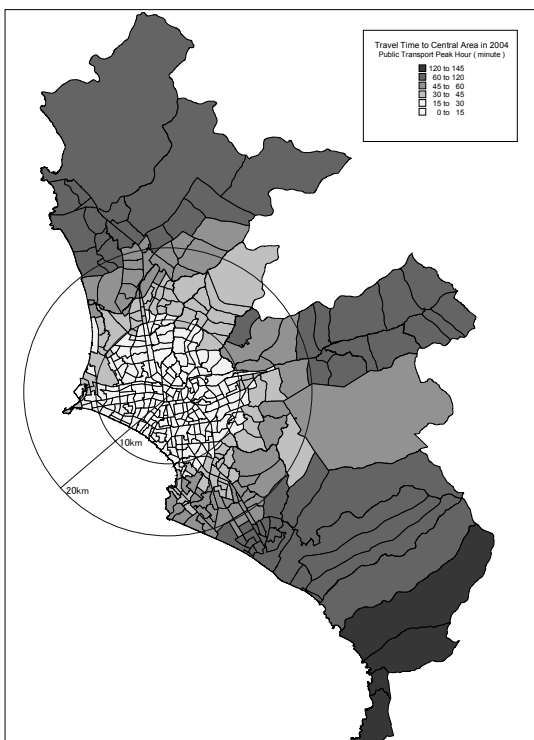Figure 21.2-8 Population Ratio Covered by Private Mode
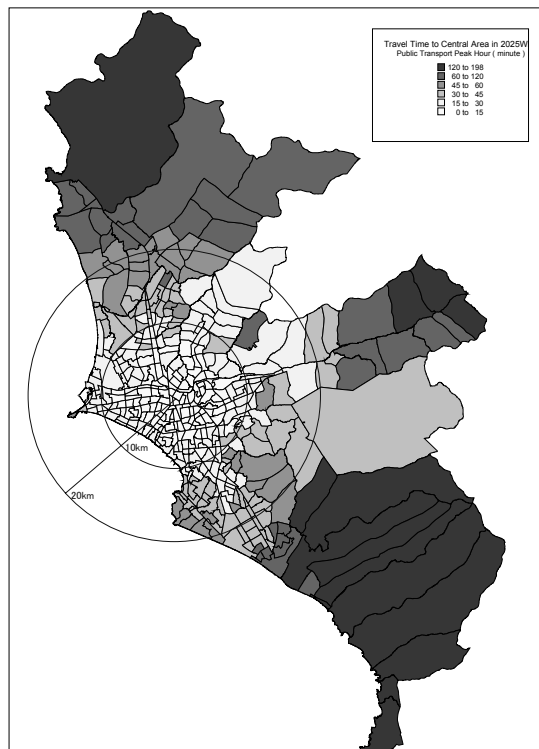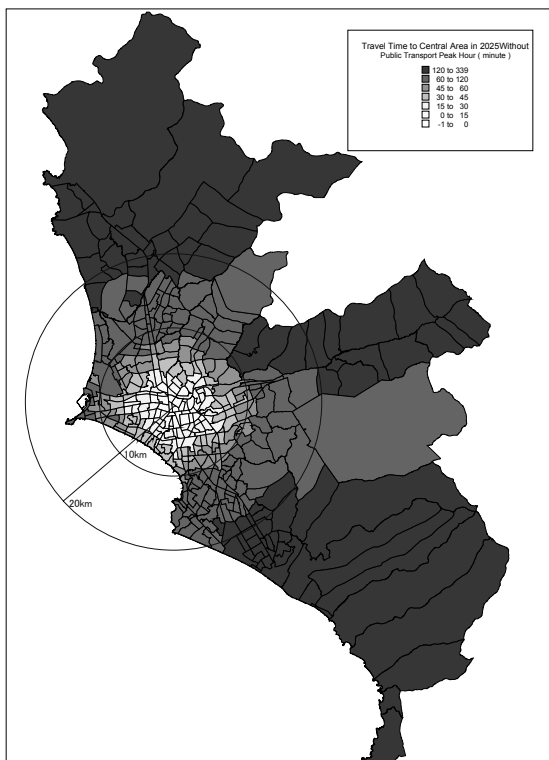

Figure 21.2-9 Population Ratio by Estrato Covered by Public Transport

2004 Present Case

2025 With Project Case

2025 Without Project Case

Travel Time to Central Area
Private mode Peak Hour (minute)

- 120 and over
- 60 to 120
- 45 to 60
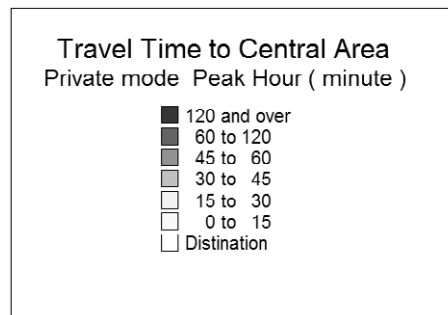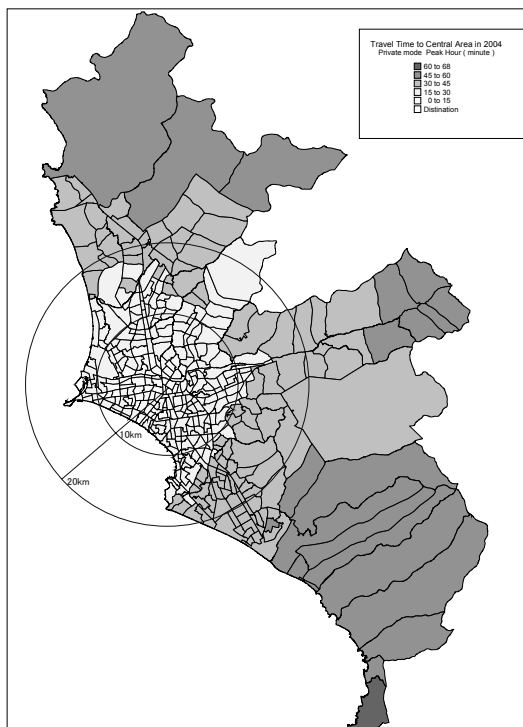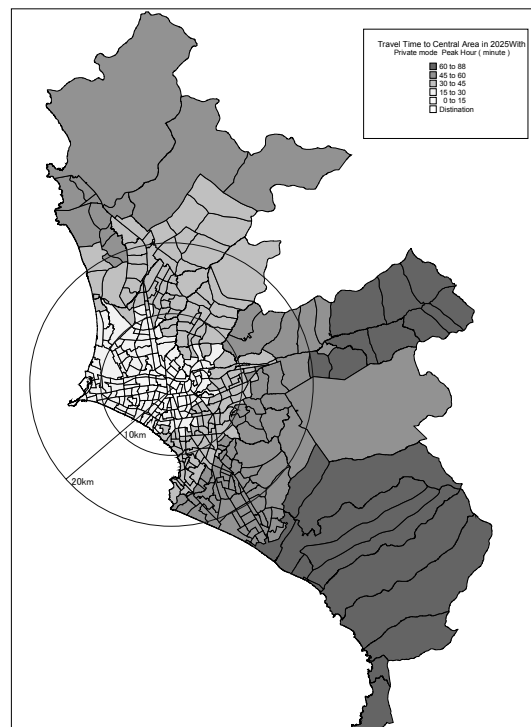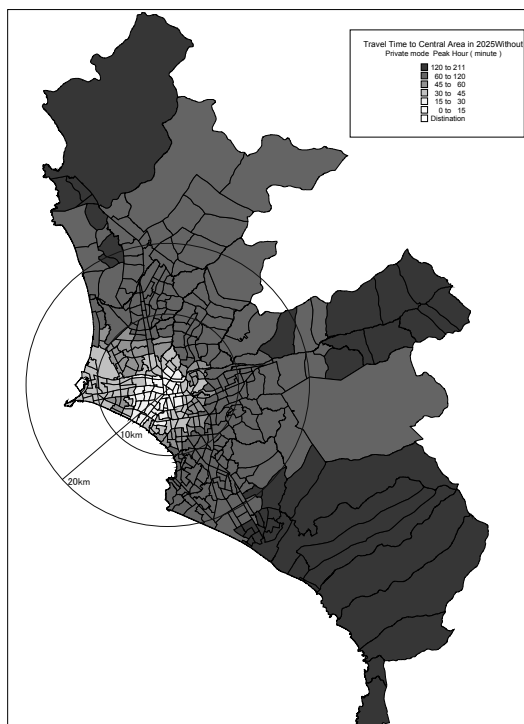- 30 to 45
- 15 to 30
- 0 to 15
- Distination

Figure 21.2-10 Area of Travel Time Covered by Public Transport Every 15 Minutes

2004 Present Case
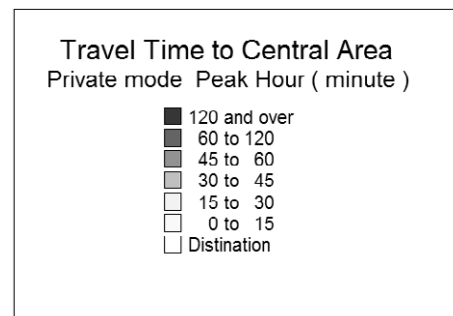

2025 With Project Case

2025 Without Project Case

Figure 21.2-11 Area of Travel Time Covered by Private Mode Every 15 Minutes

(4) Total Number of Operated Bus Fleets and Railway Coaches in the Peak Hour

Table 21.2-3 shows the total number of operated bus fleets and railway coaches in the peak hour. In 2025, the total operated fleets in the "with project" case are approximately 7,100 fleets/hour, of which 4,400 fleets are conventional buses, 2,600 are trunk buses and 150 are railway coaches. In the railway system, a train of 9 coaches is operated in the transit assignment. Those fleets decrease 0.94 times of the present. When comparing the fleet in the "without project" cases in 2025, the conventional bus fleets in the "with project" case decrease 0.50 times. This serves to alleviate traffic and transport congestion in the future.

At the present, it is generally said that the demand and supply of operated bus fleet are unbalance in the study area and that the supply side is over the demand. The estimated total number of conventional bus fleets under the present system in 2004 is approximately 7,600 fleets/hour. However, this figure means that the fleets balanced with passenger demand. This does not mean an actual number of fleets operated on lines. If the actual operated fleets are counted in the field, the different volumes between the actual and assigned figures show the unbalance. Since in the study, the actual counted fleets in 2004 in the whole study area cannot be obtained, the balance is not estimated.

Table 21.2-3 Total Number of Operated Fleets and Coaches in the Peak Hour

(Unit: Number of Fleets/hour)

Mode	2004	2025			2025/2004	
		With	Without	With/Without	with	without
Conventional Bus	7,567	4,427	14,673	0.30	0.59	3.31
Trunk Bus	-	2,572	-	-	-	-
Train	-	146	-	-	-	-
Total	7,567	7,145	14,673	0.49	0.94	3.31

(5) Total Fare Proceeds in the Peak Hour

Table 21.2-4 shows the total fare proceeds from the public transport system in the peak hour under the integrated fare system mentioned above. The total proceeds in 2025 in the "with project" case are approximately S./2.2 million/hour. These proceeds are the same as those in the "without project" case. When comparing the total proceeds in 2004, they increase 1.48 times in 2025.

The fare rate per passenger in the "with project" case increase to S./2.1 in 2025, equivalent to 1.05 times. This is because the transfer times increase in 2025 under the mass transit system.

Table 21.2-4 Total Fare Proceeds in the Peak Hour

Items	2004	2025			2025/2004	
		With Project	Without Project	With Project/Without Project	With Project	Without Project
Total Trips / Hour	741,814	1,049,207	1,059,917	0.99	1.41	1.43
Unlinked Trips /Hour	1,512,716	2,500,495	2,212,095	1.13	1.65	1.46
Total Proceeds (Soles/Hour)						
Conventional Bus	1,512,716	702,464	2,212,095	0.32		
Trunk Bus	0	868,232	0	-	-	-
Train	0	672,449	0	-	-	-
Total	1,512,716	2,243,144	2,212,095	1.01	1.48	1.46
Fare / Trip (Soles)	1.0	0.9	1.0	0.90	0.90	1.00
Fare / Passenger (Soles)	2.0	2.1	2.1	1.02	1.05	1.02

(6) Number of Service Frequencies in the Peak Hour

Table 21.2-5 shows the number of service frequencies and passengers by transport line in the peak hour. The frequencies and passengers by line are a breakdown figure of the total number of passengers in Table 21.2-1 and of operated bus fleets and railway coaches in Table 21.2-3. The configuration of each line is a tentative plan as shown in Figure 21.2-12 and Figure 21.2-13. The detailed line configuration plan must carry out further feasibility or detailed studies.

As can be seen, the total passengers in the railway line No. BT7011 and BT7012 (inbound and outbound directions in the Line No.1) are approximately 120,000 and 145,000 passengers/hour, respectively. The frequencies are 25 and 26 times/hour, which is equivalent to a minimum headway of 2.3 minutes in each direction.

As for the trunk bus lines, the total passengers in the trunk bus line No. BC2021 and BC2022 (COSAC-1) are approximately 114,000 and 133,000 passengers/hour, respectively. The frequencies are 167 and 220 times/hour, which is equivalent to a minimum headway of 18 seconds in each direction.

Other lines are also heavy in passengers and frequency in the peak hour. In 2025, some trunk bus lines will be close to busway line capacity in the peak hour.

Table 21.2-5 Number of Service Frequencies and Passengers by Line in the Peak Hour in 2025

Project		Line No.	Project Size	Frequency	Headway	Total Passengers	Project Type
No.	Name		(km)	(Times/hour)	(min)	/hour	
TP-02	Line-1 (2)	BT7011	38.0	25	2.4	119,667	Railway
TP-03	Line -1 (3)	BT7012	37.9	26	2.3	145,349	
TP-04	Line -2	BT7021	37.8	26	2.3	112,535	
		BT7022	37.6	29	2.1	109,507	
TP-05	Line-3 (1)	BT7031	17.0	1	60.0	420	
		BT7032	17.0	1	60.0	333	
		BT7033	19.0	1	60.0	926	
		BT7034	19.0	1	60.0	1,044	
TP-05, 06	Line-3 (1)	BT7041	34.5	4	15.0	15,934	
	Line-3 (2)	BT7042	34.4	4	15.0	17,557	
		BT7051	45.5	18	3.3	94,404	
		BT7052	45.5	10	6.0	61,225	
BP-01, 03	Av. Grau	BC2011	14.3	170	0.4	55,354	Trunk Bus
	Carretera Central	BC2012	14.3	145	0.4	45,207	
BP-02	COSAC Project	BC2021	45.6	167	0.4	114,389	
		BC2022	45.7	222	0.3	132,766	
BP-04	Av. Venezuela	BC2031	15.3	33	1.8	13,127	
		BC2032	15.3	43	1.4	14,387	
BP-05	Av. Brasil	BC2041	8.5	76	0.8	35,297	
		BC2042	8.5	92	0.7	28,000	
BP-13	Av. Panamericana Sur	BC2051	44.5	92	0.7	61,207	
		BC2052	44.4	93	0.6	67,643	
BP-12	Av. Panamericana Norte	BC2061	45.1	153	0.4	68,574	
		BC2062	44.9	96	0.6	54,588	
BP-09	Av. Callao-Canta	BC2071	15.6	57	1.1	18,920	
		BC2072	15.6	31	1.9	11,740	
BP-08,15	Universitaria Sur	BC2101	21.3	92	0.7	35,500	
	Av. Tomas Valle	BC2102	21.2	85	0.7	26,071	
BP-12, 14	Av. Panamericana Norte	BC2121	34.4	114	0.5	45,946	
	Av. Universitaria Norte	BC2122	34.3	89	0.7	31,814	
BP-06	Av. Angamos	BC2131	26.3	112	0.5	49,306	
		BC2132	26.0	140	0.4	56,712	
BP-10	Av. Néstor Gambetta	BC2141	32.5	36	1.7	14,868	
		BC2142	32.2	55	1.1	19,228	
		BC2151	26.9	131	0.5	37,628	
		BC2152	26.9	70	0.9	22,629	
BP-08,15	Universitaria Sur	BC2161	16.2	15	4.0	5,899	
	Av. Tomas Valle	BC2162	16.2	10	6.0	2,753	
BP-07	Av. Molina	BC2181	16.1	73	0.8	24,216	
		BC2182	16.1	56	1.1	25,361	

Figure 21.2-12 Line Configurations of BT7011 and 7012 in Railway (TP-02 and 03)

Figure 21.2-13 Line Configurations of BC2021 and 2022 in Trunk Bus (BP-02)

(7) Traffic Conditions on Roads in the Peak Hour

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 roads. In 2025, the total number of operated conventional buses in the "with project" case decreases 0.60 times of the "without project" case. This serves to alleviate traffic and transport congestion in the future. Therefore, travel speed and congestion on roads are improved in the peak hour, in comparison to that in the "without project" case. In the section, the conditions of travel speed and congestion are analyzed.

1) Average Travel Speed on Roads

The average travel speeds served on roads in the peak hour are shown in Table 21.2-6. The average travel speeds are a typical index to show service levels. The figures in the "with project" case decrease from 17 km/h at the present to 12 km/h in 2025, which is equivalent to 0.7 of the present.

In comparison to the "without project" case, the travel speed in 2025 is considerably different in increase ratio to the present figure between the Master Plan (with project) and "without project" cases. The "without project" case stands at 0.5 times of the present while the Master Plan case stands at 0.7 times.

It is clear that the service level presented in Master Plan does not reach the present level.

2) Volume-Capacity Ratio on Roads

Table 21.2-6 shows the traffic congestion in terms of congestion length ratio to the total length, which is served at a volume-capacity ratio of more than 1.0. From 2004 until 2025, the road length with a volume-capacity ratio of over 1.0 in the "with project" case increases from 8.0 % at the present to 15% in 2025, which is equivalent to 2.2 times of the present. It is clear that the service level presented in the Master Plan does not reach the present level.

In comparison to the "without project" case, both cases, "without project" and "with project", are considerably different in congestion length. Especially, the congestion length with a volume-capacity ratio of over 1.5 will increase 11.8% in the "without project" case, in contrast to 2.4% in the "with project" case.

This indicates that the congestion level in 2025 is improved, in comparison to the figure in the "without project" case, in which the transport congestion is considerably heavier in the peak hour, if do nothing is selected.

Table 21.2-6 Average Travel Speed and Volume-Capacity on Roads

Items	2004	2025			2025/2004	
		With Project	Without Project	With Project/Without Project	With Project	Without Project
Average Travel Speed (km/h)	16.8	11.7	7.5	1.56	0.70	0.45
Volume-Capacity Ratio						
V/C < 1.0	92.1%	85.1%	67.9%	1.43	1.06	0.74
1.0 =< V/C < 1.5	7.4%	12.4%	20.3%	0.70	1.93	2.76
V/C > 1.5	0.5%	2.4%	11.8%	0.24	5.44	23.10

3) Traffic Impact on Major Roads Parallel to the Mass Transit Lines

With the construction of the mass transit system, the operated number of conventional buses decreases in the whole study area. Particularly, the conventional buses on roads parallel to the mass transit lines considerably decrease in number due to the diversion to the mass transit system. However, in order to increase the number of future private vehicles, the total traffic volume on the roads will increase.

Figure 21.2-14 to Figure 21.2-18 show traffic volumes on major roads parallel to the mass transit lines in which the total traffic volume, the conventional bus volume and total passengers of public transport are shown by 2004 and 2025. Figure 21.2-19 shows the location of those roads. Av. Tupac Amaru, Av. Universitaria and Av. Los Próceres de La Independencia have the mass transit plan on the median, while Av. Arequipa and Av. Oscar R. Benavides have no mass transit plans on those roads. When comparing the indices between 2004 and the "with project" case in 2025, the passengers on the roads with the mass transit increase in 2025, while the roads without plans have fewer passengers. The traffic volumes on those roads in 2025 slightly increase. The conventional bus volumes in 2025 decrease, especially on Av. Los Próceres de La Independencia.
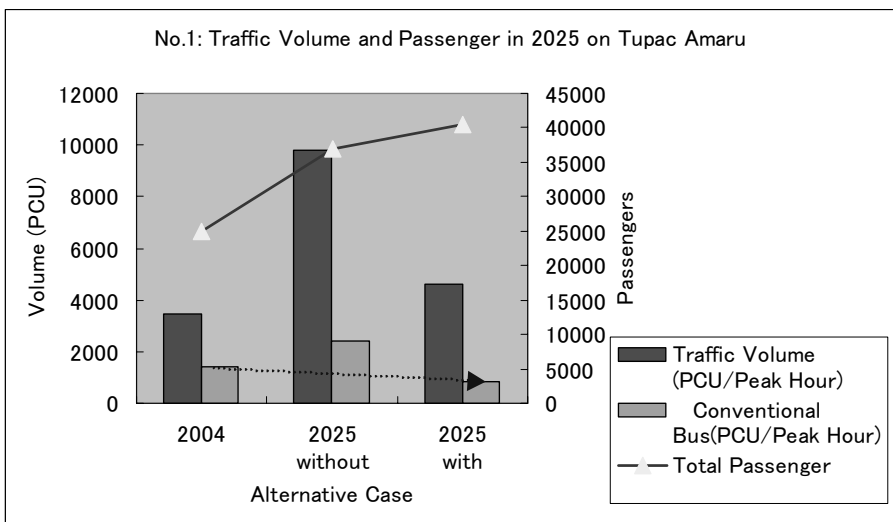

Figure 21.2-14 Traffic Volumes on Av. Tupac Amaru Parallel to the Mass Transit Lines
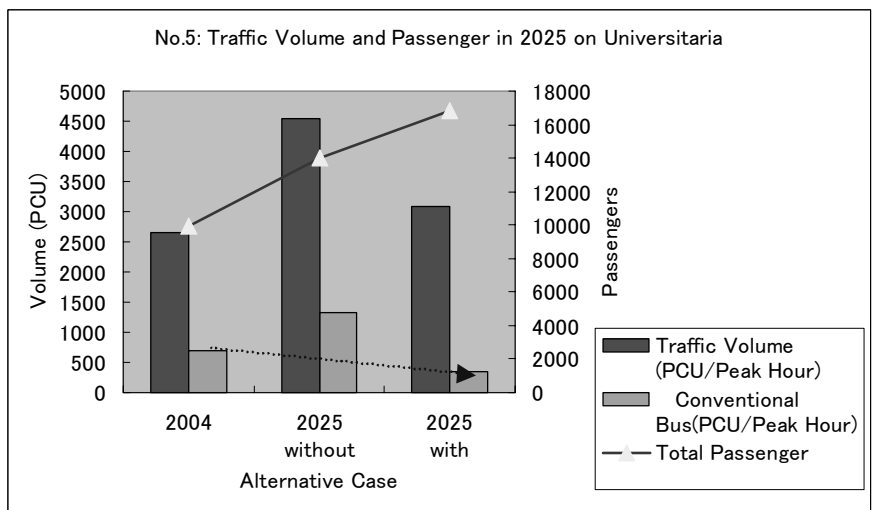

Figure 21.2-15 Traffic Volumes on Av. Universitaria Parallel to the Mass Transit Lines
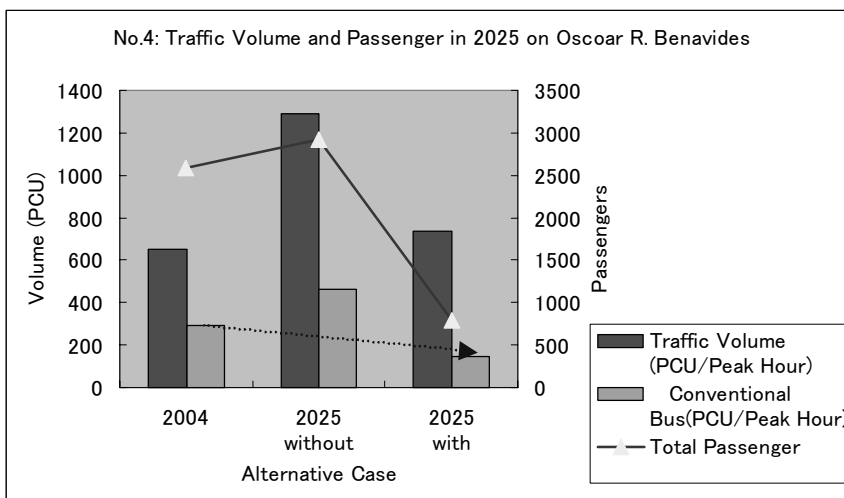
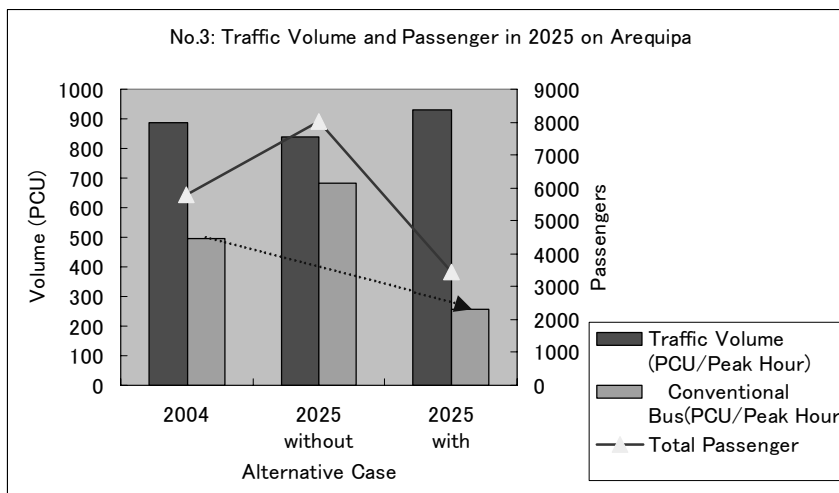Figure 21.2-16 Traffic Volumes on Av. Oscar R. Benavides

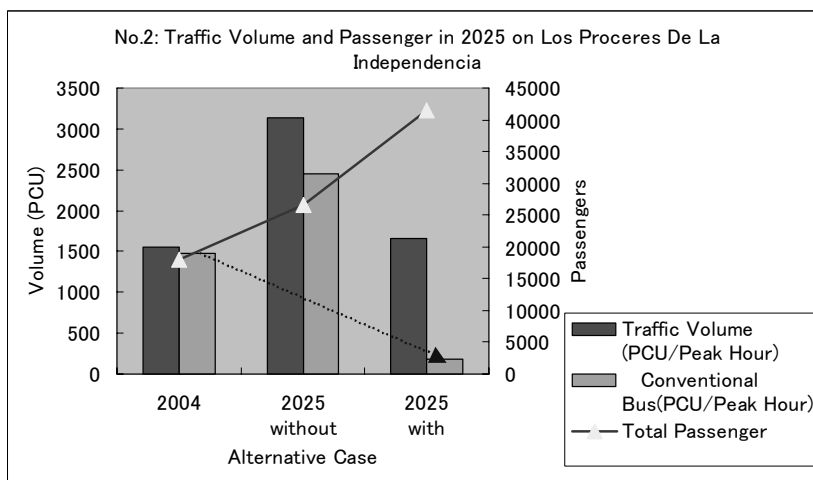Figure 21.2-17 Traffic Volumes on Av. Arequipa

Figure 21.2-18 Traffic Volumes on Av. Los Próceres de La Independencia Parallel to the Mass Transit Lines
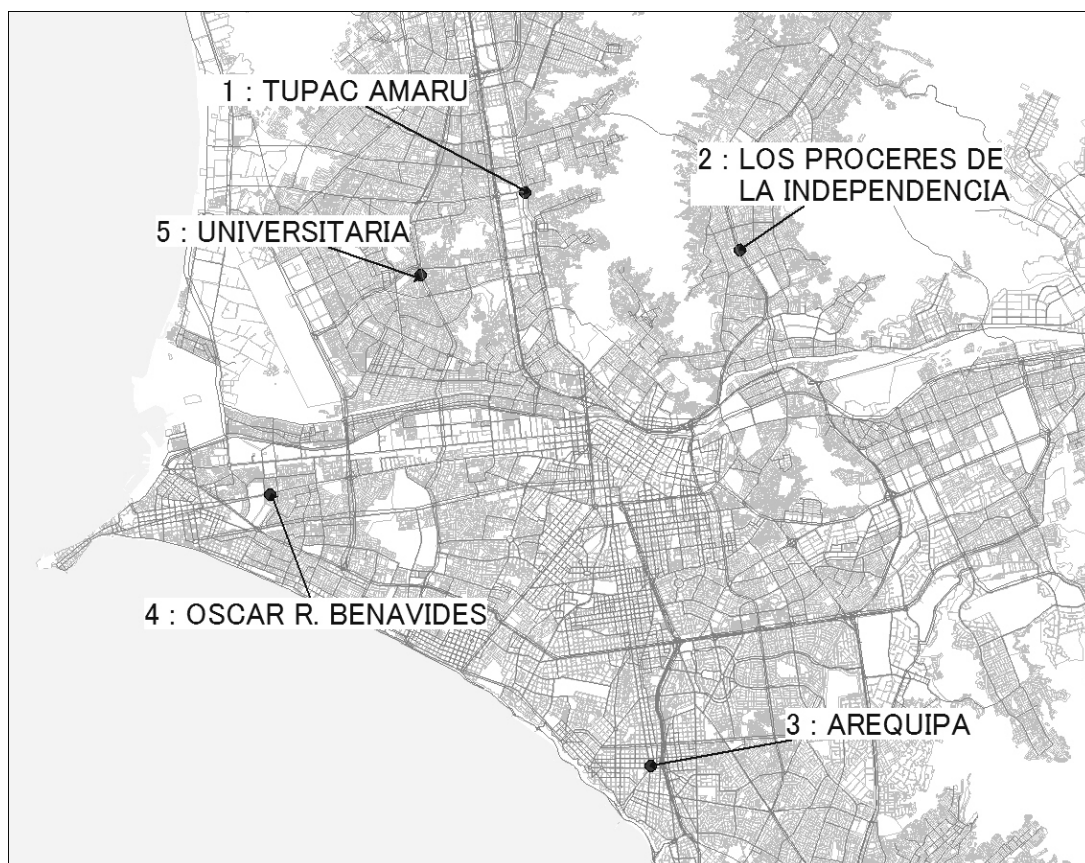
Figure 21.2-19 Location of the Roads

21.2.2. SUMMARY OF TRAFFIC AND TRANSPORT EFFECTIVENESS

As mentioned above, there are several effective measures as a result of the development of the rapid mass transit on the traffic and transport conditions. The effectiveness is summarized again below.

(1) Shortening of Commuter Times in the Peak Hour

In 2004, the average commuter time by public transport is approximately 45 minutes in the peak hour. With the introduction of the rapid mass transit, it takes 48 minutes, in which those commuter hours are the total hours between from house to working place and sum up travel hour of several modes when a passenger transfers from one mode to another in exclusive of waiting time. The commuter time will slightly increase by 6% of the present.

(2) Decrease of Number of Operated Fleets

In the rapid mass transit system, the large articulated bus fleets and railway coaches are introduced. The total operated fleets in 2025 are approximately 7,100 fleets/hour, equivalent to 0.94 times of the present.

(3) Change of Total Proceeds per Trip

Total proceeds in the whole study area will increase at 1.5 times of the present under the integrated fare system. The fare rate per passenger increases to S./2.1 in 2025, equivalent to 1.05 times of the present. This is because the transfer times increase in 2025 under the mass transit system.