Data Collection Study on Transportation Infrastructure Development in Ulaanbaatar, Mongolia

Final Report

March 2022

Japan International Cooperation Agency (JICA)

Almec Corporation
CTI Engineering International Co., Ltd.

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Abbreviation

Abbreviation	Not Abbreviation
AAGR	Average Annual Growth Rate
ADB	Asian Development Bank
AFC	Automatuc Fare Collection System
AI	Artificial intelligence
BRT	Bus Rapid Transit
BYD	BYD (Build Your Dreams) Co.
CCTV	Closed Circuit Television
CVM	Contingent Valuation Method
CVM	*Contingent Valuation Method*
DBM	Development Bank of Mongolia
DEIA	Detailed Environmental Impact Assessment
DIIP	Development Initiative-Infrastructure project
DX	Digital Transformation
E/N	Exchange of Notes
EIA	Environmental Impact Assessment
EIRR	Equity Internal Rate of Return
eVTOL	electric Vertical Take-Off and Landing
F/S	Feasibility Study
GPS	Global Positioning System
HCM	Highway Capacity Manual
HD	High Definition
HH	Household
HIS	Home Interview Survey
HSES	Household Socio-Economic Survey
IC	Integrated Circuit
ICT	Information and Communication Technology
IEE	Initial Environmental Examination
JICA	Japan International Cooperation Agency
L/A	Loan Agreement
LCC	Life Cycle Cost
LDF	Local Development Fund
LED	Light Emitting Diode
LOS	Level of Service (traffic service level)
LPR	License Plate Recognition
LRT	Light Rail Transit System
LTE-U	Long Term Evolution-Unlicensed (3G communication standard)
M/P	Master plan
MaaS	Mobility as a Service
MCUD	Ministry of Construction and Urban Development
MET	Ministry of Environment and Toursim

Abbreviation	Not Abbreviation
MNT	Mongol Tugurug
MOC	Ministry of Culture
MOF	Ministry of Finance
MOH	Ministry of Health
MRTD	Ministry of Road and Transport Development
MSK	Medvedev-Sponheuer-Karnik scale
MTFF	Medium Term Financial Framework
NDA	National Development Authority
NGOs	Non Government Organization
NSO	National Statistics Office
OCC	Operation Control Center
OD	Origin-Destination
ODA	Official Development Assistance
PA	Public Anouncement
PC	Precast Concrete
PCU	Passenger Car Unit (Passenger Car Conversion Factor)
PIP	Public Investment Program
PIS	Public Imformatin System
PIU	Project Implementation Unit
PM	Particulate Matter
PPP	Public Private Pertnership
PQ	Procurement Qualify
PTPS	Public Transport Priority System
QR	Quick Response
RC	Reinforced-Concrete
RFID	Radio Frequency Identifier
RFP	Request For Proposal
ROW	Right of Way
SCF	Standard Conversion Factor
SDR	Social Decreasing Rate
SEA	Strategic Environment Assessment
TCC	Traffic Control Center (UB City Road Control Center)
TDM	Traffic Demand Management
TOD	Transit Oriented Development
TTC	Total Travel Time
UB	Ulaanbaatar
UBCG	Ulaanbaatar City Government
UBMP2020	Ulaanbartar masterplan 2020 and development trend 2030 (Ulaanbaatar urban planning masterplan2020 and development trend2030 2030)
UBMP2040	Ulaanbaatar Urban Transport Planning Master Plan
UBRD	Medium- and long-term master plan for road network development in UB City

Abbreviation	Not Abbreviation
UPRI	Urban Planning and Development Institute
UPS	Uninterruptible Power Systems
VAT	Value Added Tax
VCR	Volume Capacity Ratio (congestion)
VOC	Vehicle Operating Cost
WB	World bank
WTP	Willingness to Pay

Summary of the Study

1 Outline of the Study

1.1 Background of the Study

In Ulaanbaatar City (hereinafter “UB City”), the capital of Mongolia with a population of 1,597,290 in 2020, its rapid population growth in recent years has led to serious urban problems, such as traffic congestion and air pollution, which have had a significant impact on the lives of the residents. The number of cars in Mongolia has consistently been on an upward trend, growing at an average of 5% per year since 2015, and traffic congestion has constantly been occurring, especially at various intersections in UB City. The reasons for this traffic congestion are inadequate traffic infrastructures, such as roads and parking lots, insufficient adherence to traffic rules by road users, and insufficient management of traffic operations. Thus, operational improvement is also one of the issues to be addressed.

The Japan International Cooperation Agency (JICA) conducted the “Study on City Master Plan and Urban Development Program of Ulaanbaatar City” from 2007 to 2010. UB City used the results of the study to prepare the “Ulaanbaatar City Master Plan 2020 and Development Trends 2030” (MP2020), which was approved by the Parliament in February 2013. According to the MP2020, UB City, which is experiencing a high concentration of population and increasing number of registered vehicles, has issues, particularly on inadequate transportation infrastructure. In addition, bus is the only public transportation for commuters and students, and the supply does not even meet the demand. Thus, MP2020 pointed out that these urgent issues needed to be addressed and that development of public transport networks as well as road networks and parking lots and improvement of quality and operations of existing transport infrastructure are necessary. After approval of the MP2020, measures have been taken to improve the road network and convenience of bus services but have not yet reduced traffic congestion. Furthermore, a review survey conducted by UB City in 2017–2018 showed that the progress of the MP2020 implementation was only at 29.6%.

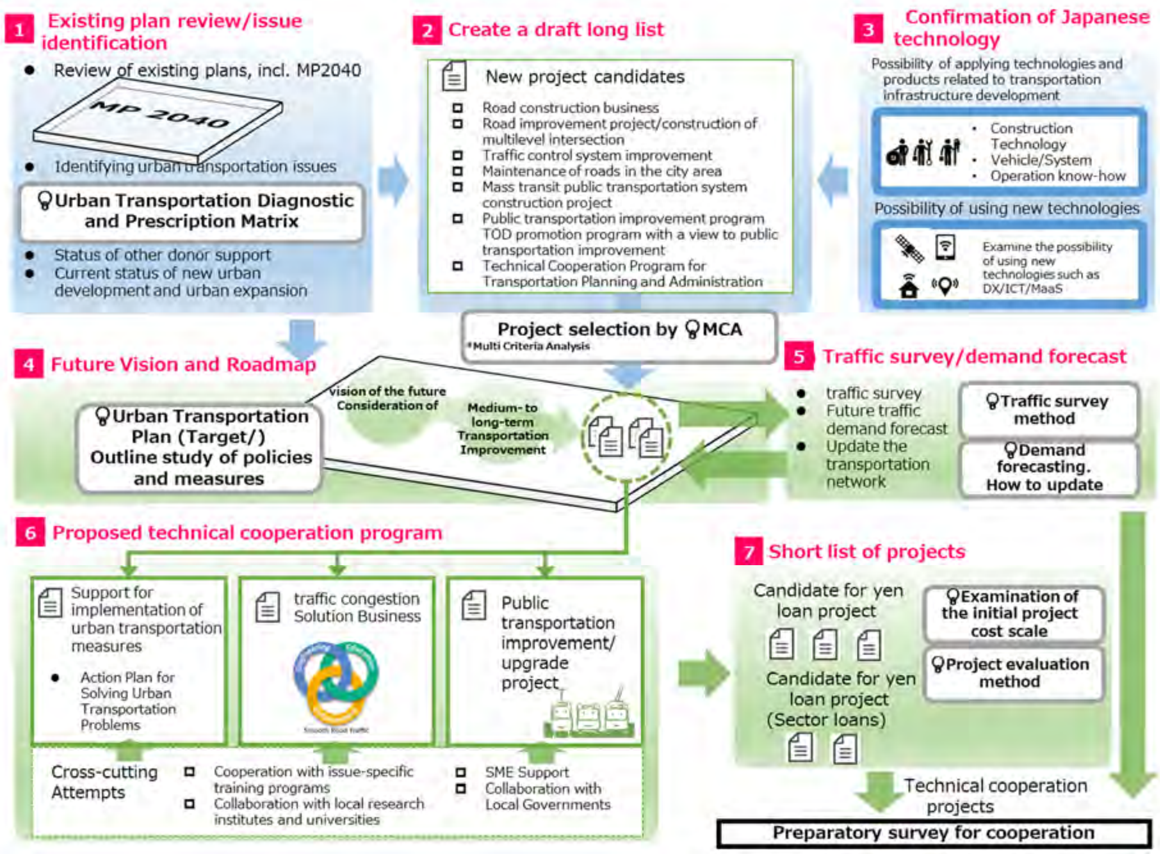
On the other hand, the influx of population from the countryside to UB City has ceased, and urban issues, such as traffic congestion, are becoming severe, causing an increase in economic loss. Since about half of the Mongolian population lives in UB City, there is a great need to strengthen the urban functions of the city for the development of the entire country.

1.2 Purpose of the Study

The purpose of this study is to examine the future vision of UB City by analyzing the current status and issues in urban transportation based on the existing urban planning and urban transport policy, such as MP2020, the General Development Plan of Ulaanbaatar City (hereinafter “UBMP2040”) that is currently under review by the UB City Government (UBCG), and the Countermeasure Plan by the Traffic Congestion Reduction Committee after review of existing projects, and understanding the current traffic situation and future demand forecast. It also aims to present the future cooperation policy for the urban transportation infrastructure development of UB City by organizing the solutions for the current issues.

1.3 Workflow

The workflow of this study is shown in Figure 1.1. Items [1] to [3] were conducted as soon as the study started. The long list of project candidates was made, and the future vision and roadmap for urban transportation in UB City in item [4] were presented to the local government for consensus. Subsequently, the technical cooperation program proposal in item [6] was prepared in parallel with the traffic survey and demand forecast in [5], and necessary data was compiled for the evaluation of the shortlisted projects and implementation of a preparatory study after the study.



Source: JICA Study Team

Figure 1.1 Overview of the Study

2 Fundamental infomation related to Urban Development and Transportation in Ulaanbaatar City

This chapter shows the Mongolian law for transport policy and legislation and the coverage of targets, transport/urban plans, and issues. The current formation of the organization for transport planning is being reviewed in response to various requests from the local government, and the Ministry of Economic Development was established on 1 January 2022.

On the other hand, UB City has formulated various master plans in the field of urban development and transportation planning, including “UB City Urban Planning Master Plan 2020 and Development Trend 2030 (MP2020)” and “UB City Urban Planning Master Plan 2040 (MP2040)” as urban development master plans, “UB City Road Network Development Medium-and Long-Term Master Plan (UBRD2030)” as urban transportation plans, “UB City Traffic Congestion Mitigation Measures,” and master plans by other donors. Chapter 2 presents an overview of these plans besides the higher government policies and shows their relevance to this study.[1]

At present, many suggested urban transportation plans were comprehensive, focusing on individual infrastructure or master plans and small/large-scale projects. However, Mongolia needs approval from MOF and Parliament for the discussion of project contents to start an ODA project. In many instances, a project cannot secure a budget because of the lack of discussions and no

[1] In Mongolia, the implementation of national and municipal policies and plans often does not proceed as planned due to the lack of budgetary considerations in the plans and the lack of a mechanism to ensure the funds of approved plans.

mechanism to acquire a budget; therefore, such projects have to be stopped or discontinued. As a result, the project implementation ratio is quite low, especially the essential and large projects. Although international donors have actively suggested to Mongolia, it is not always easy to secure financial resources for ODA projects because the ratio of external government debt is close to the sealing limit of the Fiscal Stabilization Law. It is necessary to increase the possibility of securing further financial resources.

3 Ulaanbaatar City Urban Transport Condition

In this chapter, transport conditions and issues are described through the aspects of (i) road transport, (ii) public transportation, (iii) traffic survey, (iv) social environment, and (v) natural conditions.

3.1 Road Transport Condition and Issues

Road transport conditions and issues are shown in Table 3.1. All the issues found should be resolved or improved.

Table 3.1 Road Transport issues

Road transport issue	Description
(i) Lack of road network	UB City has a road density of less than half in Japan in spite of having a similar level of vehicle registration. The number of vehicle registrations has increased at an annual rate of 9.5% since 2010. However, the average annual growth rate of the road network is only about 1.5%.
(ii) Lack of Railway Crossing Road	The traffic volume is concentrated at the four existing railway overpasses and two flat crossing intersections. These are overcapacity.
(iii) Existence of a missing link	Main road in the east–west direction has missing links.
(iv) Lack of network Connectivity	There are many U-turns at intersections, causing traffic congestion.
(v) Traffic Management Issues	There are currently 408 intersections in the city, 154 intersections of which (38%) are not signalized because of budget shortage. There are traffic violators, non-payment of fines, and lack of policing.
(vi) Congestion in the district area	Road congestion occurs in the district because of not enough space on living roads.
(vii) Parking problem	There is no parking plan in the district, and vehicles park on the roadside due to insufficient parking space.
(viii) Lack of connectivity with the main road.	Apartments are built without consideration for access traffic from/to main roads. As the result, It generates much detour traffic.
(ix) Main road congestion in the new development area	Lack of coordination between urban development and transportation planning in the new development area. Resulting in the arterial road to have not enough capacity
(x) Congestion of public facilities	School pick-up and drop-off traffic increase the volume and generate congestion.
(xi) Road congestion near the large shopping mall	Waiting vehicle to enter and exit facilities vehicle is suffering the other traffic at the entrance of large facilities.

Source: JICA Study Team

3.2 Status and Issues of Public Transport

Public transport issues are shown below, categorized into operation and planning issues. Some points can be easily improved. Also, an urban railway can contribute to modal shift, but the railway plan is delayed. Bus service would be important as the access mode for the railway after railway construction.

Table 3.2 Public Transportation Issues

Category	Issue	Description
Operation	Bus Convenience	The service frequency is not enough that passengers can be left behind. Necessary for a transfer facility.
	Bus lane	Bus priority lane doesn't work because of private use on the lane. Bus from bus priority lane is suffering from vehicle queue for entering to a shopping mall.
	Bus stop	Illegal parking for boarding and alighting. Bus stop is not divided into each destination. It is not easy to confirm the destination of the bus.
	Bus operation	Bus obstructs the passage of other vehicles by turning on the road Bus drivers do not follow rules, such as smoking, unsafe lane switching, and departing when the door is still open. Not punctual operations.
Planning	Express and on-time delivery	With unreliable timetables at bus stops and the convenience is low, it will lead to the conversion from public transportation to private vehicles.
	Bus route is too long distance	Bus route goes from the suburban area to the city center and back to the suburban area. The congestion in the city center delays the bus route; therefore, operation frequency is quite low, and stable service cannot be provided.
	Improvement of bus network	Information on GPS, IC card, and camera are not used for bus planning. There is no bus route in the ger area. Bus routes on Peace Avenue have high ridership, but have very high frequency and too many duplicate sections.
	Railway System	There is no railway system. There are many railway plans, but none are implemented.

Source: JICA Study Team

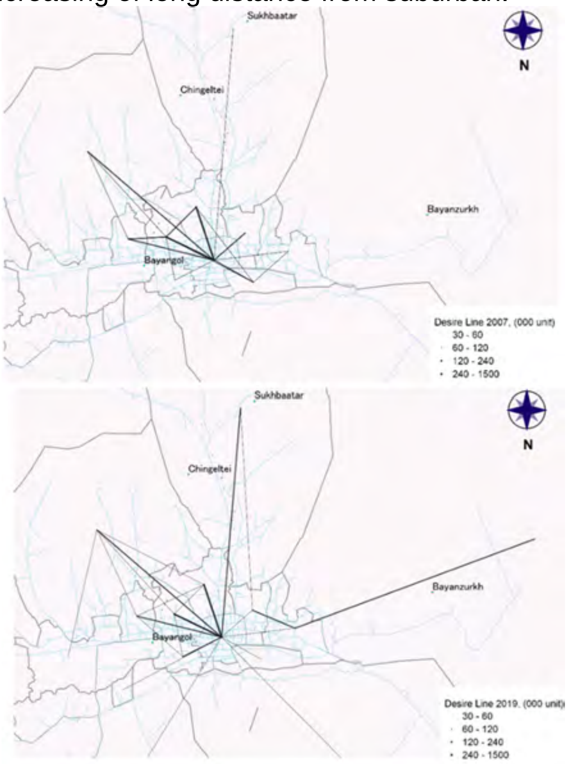
3.3 Traffic Survey and Bottleneck Analysis

In this section, the Home Interview Survey (HIS) and bottleneck analysis were determined using the existing traffic volume counting survey and travel time survey to check the traffic situation in UB City. The results of HIS show that (i) car ownership increased from 2007 to 2019 due to increasing income, (ii) private traffic volume is increasing because the long distance trip from the suburban area is increasing and not public transport availability, (iii) public transportation importance has become to higher to resolve transport issues because the service level is low, and (iv) citizens are willing to construct railway like large scale development.

Bottleneck analysis survey is based on the existing traffic count survey data, site work, and travel time survey, and results show (i) there are many bottleneck points on Peace Ave., a primary arterial road that serves the east–west corridor, that impairs its function as an arterial road, 2) shopping malls are along the roadside to the south of the East Side Intersection, and bottlenecks caused by road users occur due to many pedestrians crossing to shopping malls and waiting access for to the parking areas, and; 3) traffic congestion occurs at signalized and non-signalized intersections due to the concentration of traffic in the city center. In addition, crossing occurs in the intersections, and the police unavoidably control the traffic signals manually.

In order to alleviate traffic congestion, it is important to eliminate bottlenecks and start priority projects with existing soft measures or inexpensive construction, such as lane operations, review of intersection processing, on-street parking measures, and review of intersection signal processing. Based on the results, the infrastructure development like grade separation is important at the intersection which the many vehicles are passing at the intersection and the volume is approaching to the intersection capacity.

HIS Survey:
Increasing of long distance from suburban.

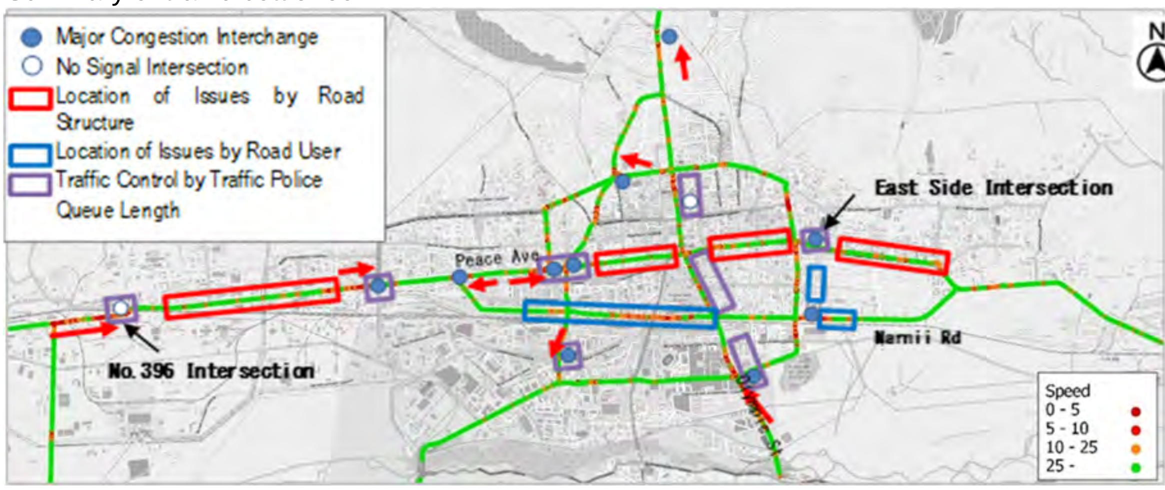


Current traffic survey result:
Check the congestion cause

Bottleneck analysis:
Delay time is worst level

No.	Intersection	Delay Time(sec)
1	East Intersection	192.4
2	Sapporo Intersection	160.9
3	No. 17 Intersection	183.4
4	West Intersection	149.0
5	Bayanburd Intersection	185.3

Summary of traffic bottleneck:



Source: JICA Study Team

Figure3.1 Traffic Survey Result

3.4 Environmental and Social Issues

Discussions and submission of resolutions are primarily conducted in city councils, and explanations and information disclosure to the general public and affected residents have not been implemented. Only the information on the project title, location, and implementation period will be disclosed, not the impact on citizens' lives and the risk assessment.

3.5 Natural Condition

Considering the natural environmental conditions surrounding UB City, it is necessary to create a plan that considers the following points regarding infrastructure development in UB City.

(i) Since civil engineering work (outdoor work) is difficult in the midwinter, it is necessary to make a plan that can shorten the outdoor work as much as possible.

(ii) To consider the track system that can run stably in extremely cold regions, it is necessary to devise ways to comfortably operate public transportation, including buses, in cold environments.

(iii) When planning bridge structures, etc., it is necessary to introduce the latest seismic intensity knowledge and design with sufficient seismic capacity.

(iv) When constructing roads, bridges, etc., at the water source along the Tuul River, it is necessary to adopt a construction method that minimizes groundwater pollution. Especially when constructing bridge foundations, it is necessary to select a construction method that does not allow harmful substances to penetrate groundwater.

(v) When planning a transportation infrastructure in the floodplain of the Tuul River, it is important to make a flood forecast by referring to past flood damage, etc., and to secure a sufficient water flow section.

UB City has a particularly high risk of flooding. The following photos show flooding that occure in June 2021.

Source: JICA Study Team

Near the Peace Bridge

Source: https://gogo.mn/r/v5l0l

Bayanmongol underpass

Figure3.2 Flooding Occured in June 2021

4 Future Transport and Demand Forecast in UB City

In this chapter, the social economic trend, demand forecast methodology, and future transport overcomes and orientation are described.

4.1 Social Economic Indicators

4.1.1 GDP Trend

The GDP per capita of UB City has increased by 1844% in the last 20 years, from 884,900MNT in 2000 to 16,314,100MNT in 2020. The GDP per capita of UB City in 2020 was 1.4 times more than that of the entire country of Mongolia (11,612,900 MNT), but the ratio has shrunk since 2000. The following table summarizes the trend of GDP per capita of UB City and the country of Mongolia from 2000.

Table 4.1 Trends in GDP per Capita

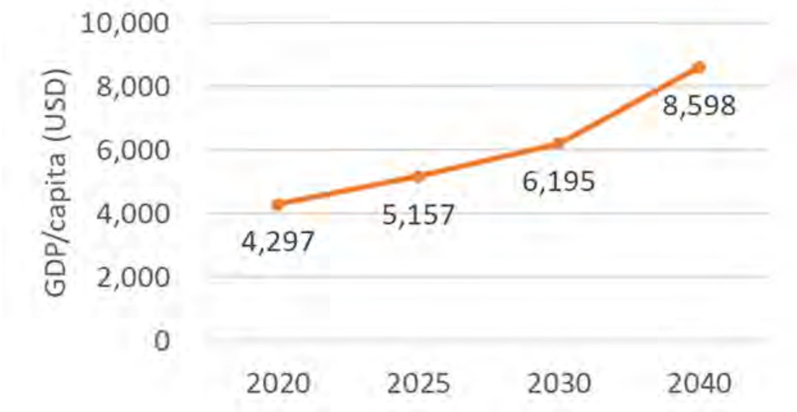
(Unit: 1,000 MNT)

Aimag	2000	2005	2010	2015	2020
Total	522.2	1,223.0	3,697.6	7,724.1	11,612.9
UB City	884.9	1,852.4	5,398.5	11,055.8	16,314.1

Source: 1212.mn

On the other hand, Mongolia's GDP per capita is expected to double to 8,598USD in 2040 from 4,297USD in 2000.

	2020	2025	2030	2040
GDP/capita (USD)	4,297	5,157	6,195	8,598
Percent	100%.	120%.	144%.	200%.



Source: USDA, Economic Research Service U.S. Department of Agriculture.

Figure 4.1 Forecast of GDP per Capita

4.1.2 Population Estimates Used in This Study

In order to estimate the population for transportation demand estimation based on the policies and the trends of urban development indicated in the previous sections, the following three development scenarios by 2040 are proposed: (1) Do Nothing case, (2) Sub-center development case, and (3) Satellite city development case. The results of the population estimates are shown in Table 4.2.

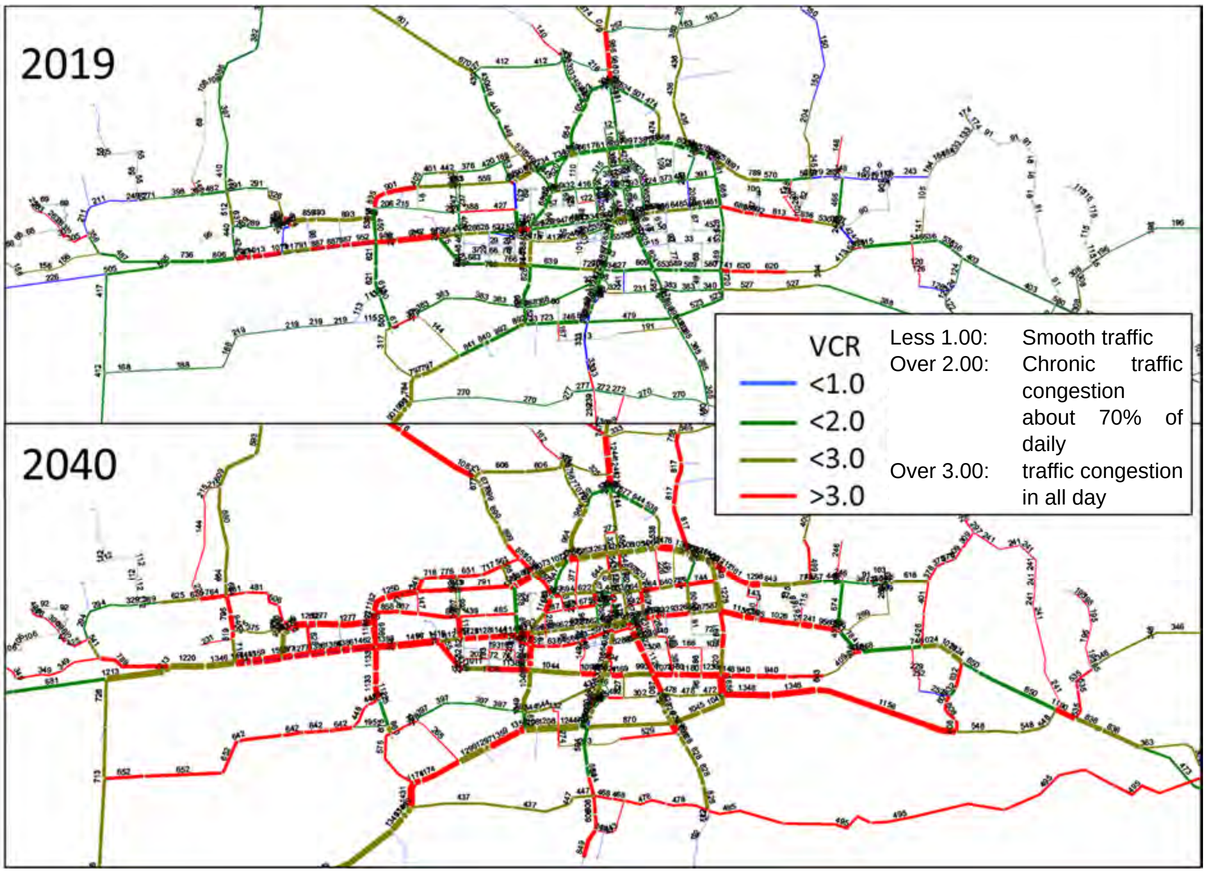
Table 4.2 Night-Time Population in Each Case

(000)	Past Trends		Do Nothing Case			Sub-center Concentration Case				Satellite City Development Case			
	2010	2020	2025	2030	2040	2025	2030	2035	2040	2025	2030	2035	2040
Khan Uul	112	196	252	309	358	251	306	337	351	256	293	300	312
Baganuur	27	29	30	30	31	30	30	31	31	33	36	69	85
Bayanzurkh	266	368	419	470	541	419	471	504	537	414	467	482	491
Nalaikh	31	39	42	45	48	41	43	45	46	44	49	64	80
Sukhbaatar	137	145	159	173	193	158	171	179	188	167	182	193	204
Bayangol	185	232	240	249	257	240	248	252	255	251	269	269	267
Bagakhangai	4	4	5	5	5	5	5	5	5	5	6	11	16
Chingeltei	147	151	159	166	173	160	169	177	185	152	153	150	146
Songinokhairkhan	252	336	378	420	484	380	424	457	490	357	388	402	414
UB City	1,162	1,499	1,683	1,867	2,090	1,683	1,867	1,987	2,090	1,683	1,867	1,987	2,090
Satellite cities (Tuv)	-	-	-	-	-	-	-	-	-	4	24	47	75
Khan Uul (%)	9.6	13.1	15.0	16.5	17.1	14.9	16.4	17.0	16.8	15.2	15.7	15.1	14.9
Baganuur (%)	2.3	2.0	1.8	1.6	1.5	1.8	1.6	1.5	1.5	2.0	2.0	3.5	4.1
Bayanzurkh (%)	22.9	24.5	24.9	25.2	25.9	24.9	25.2	25.4	25.7	24.6	25.0	24.2	23.5
Nalaikh (%)	2.7	2.6	2.5%	2.4	2.3	2.4	2.3	2.3	2.2	2.6	2.6	3.2	3.8
Sukhbaatar (%)	11.8	9.6	9.4	9.3	9.2	9.4	9.1	9.0	9.0	9.9	9.8	9.7	9.8
Bayangol (%)	15.9	15.4	14.3	13.3	12.3	14.2	13.3	12.7	12.2	14.9	14.4	13.5	12.8
Bagakhangai (%)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.6	0.8
Chingeltei (%)	12.7	10.1.	9.4	8.9	8.3	9.5	9.0	8.9	8.9	9.0	8.2	7.5	7.0
Songinokhairkhan (%)	21.7	22.4	22.4	22.5	23.1	22.6	22.7	23.0	23.5	21.2	20.8	20.3	19.8
UB City (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.8	98.7	97.6	96.4
Satellite cities (Tuv) (%)	-	-	-	-	-	-	-	-	-	0.2	1.3	2.4	3.6

Source: JICA Study Team

4.1 Traffic Demand Forecast

In this study, the general demand forecast methodology “four-step model” is applied, comprising of (i) traffic generation/attraction, (ii) traffic distribution, (iii) modal shift, and (iv) traffic assignment. In 2040, traffic congestion will to the point of it will be all day.



Source: JICA Study Team

Figure 4.2 Demand Forecast Results in 2019 and 2040

4.2 Future Urban Transportation Development in UB City

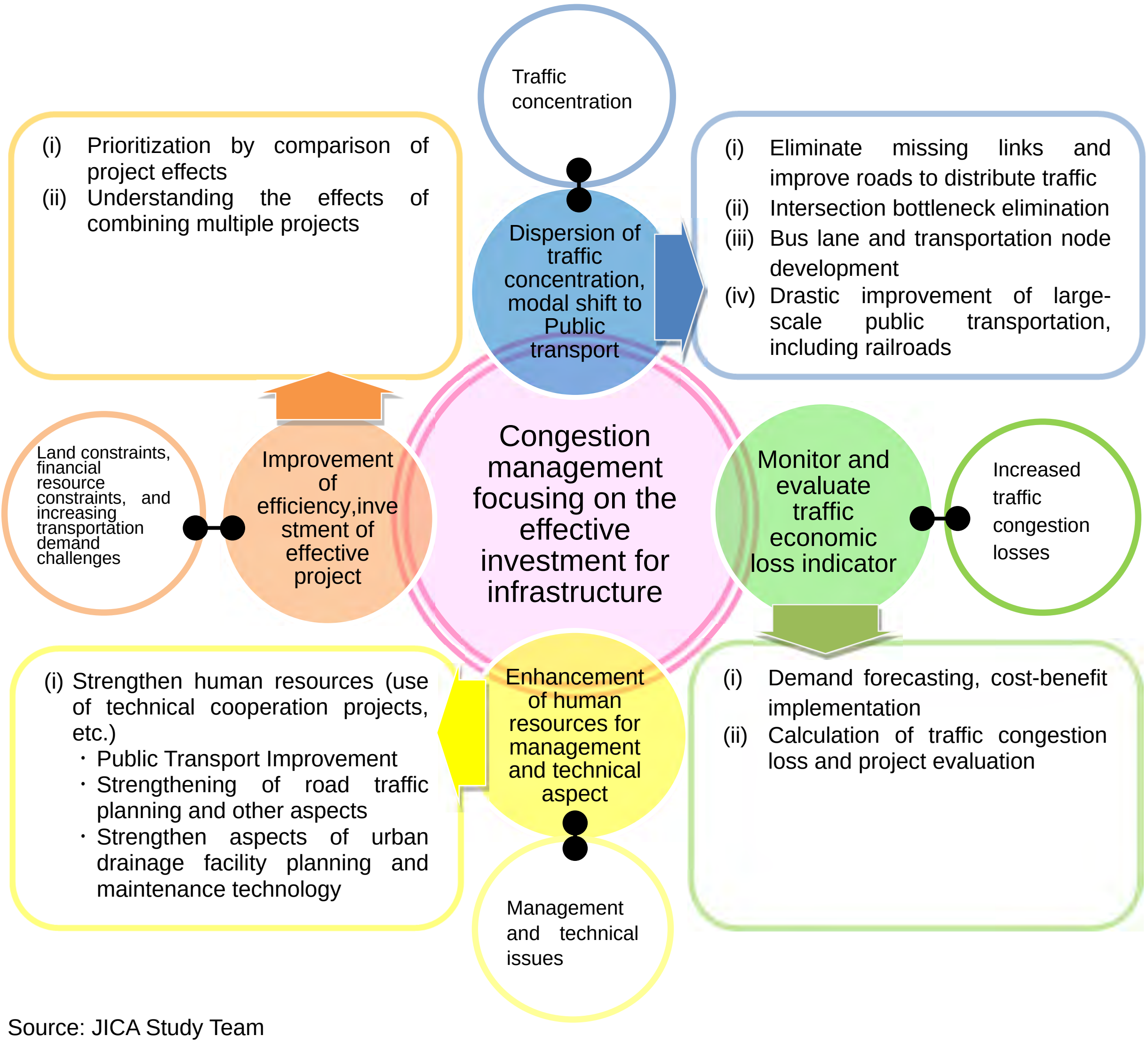
Following Table 4.3, the traffic issues, increasing losses due to traffic congestion, management and technical issues and land constraints, financial resource constraints, and increasing transportation demand are shown with solutions for traffic congestion management focusing on the effective investment for infrastructure.

Table 4.3 Orientation for future from issues

Issues	Orientation
Traffic Concentration ・ Traffic congestion is serious in UB City. Peace Avenue and Chinggis avenue are very congested. ・ Bus is the only public transport, and it has many issues and poor services from planning and operation aspects. Essential mass transit projects are not progressing because of financing and stakeholder coordination issues. ・ In the future, the service level of roads and public transport (bus, rail) is necessary.	**Dispersion traffic, Modal shift to PT** ・ It is necessary and important for the traffic dispersion and modal shift by public transport to be solved, missing link cut down, traffic bottleneck reduced, road network and bus services strengthened, and railway and traffic management developed.
Increased Traffic Congestion Losses ・ Traffic congestion losses reach 2700 mil. Tg/day in 2019 and will reach 7500 mil. Tg/day by 2025 in UB City, 2.7 times more from 2019. ・ Policy outcome such as the use of traffic congestion losses has the merit to clarify and communize the issues the government and citizens should lead to a desirable future, and the discussion level can be raised.	**Monitor and evaluate traffic economic loss indicator** ・ Evaluation of using time cost, vehicle operating cost, and environmental cost like UB City estimated can help understand how the effect is averagely generated from a number objective and not “discussion” subjective. The tools of demand forecast and cost-benefit analysis can prioritize projects using social environmental and implementation capacity on the Mongolia side.
Management and technical issues ・ Adequacy in parking lot operations, public transportation planning and management, traffic policing, intersection geometry design, maintenance, and traffic operations are not enough. ・ For UB City to truly grow, it is extremely important for it to have the ability to clarify issues in terms of management and technology from an outside perspective through experts and solve these issues autonomously by strengthening its capacity.	**Strengthen Human Resource Capacity in terms of Management and Technology** ・ On the aspects of human resource management and technical issues, capacity building for both can be done simultaneously to help increase the traffic capacity of intersections and existing roads and deter private vehicle traffic growth by improving bus services. This could be done by utilizing JICA's technical cooperation project.
Land Constraints, Financial Resource Constraints, and Increasing Transportation Demand ・ In city center, there is a case when the public sector sold public land to a private company even if the land can be utilized for public transport facilities in the future. In order to secure land for public transport facilities or similar, the readjustment of university and college in the urban city to the suburban area is suggested, but that has not progressed. ・ Various transport planning is suggested with a secured budget, but many have not been implemented. ・ New towns in the suburban area, like some arterial roads in the Yarmag area, have already been congested. There is a concern that the area is not enough to include developing a public transport system.	**Improvement of efficiency, investment on effective projects** ・ In order to deal with financial resources constraints, land constraints, and the increasing transportation demand, it is necessary to improve the efficiency of projects and concentrate investment in highly effective projects. ・ In order to invest in an effective project, prioritize projects and compare effectiveness, as well as consider the substantial effects when combining multiple projects.

- **Future Orientation: Congestion management focusing on the effective investment for infrastructure**

Source: JICA Study Team



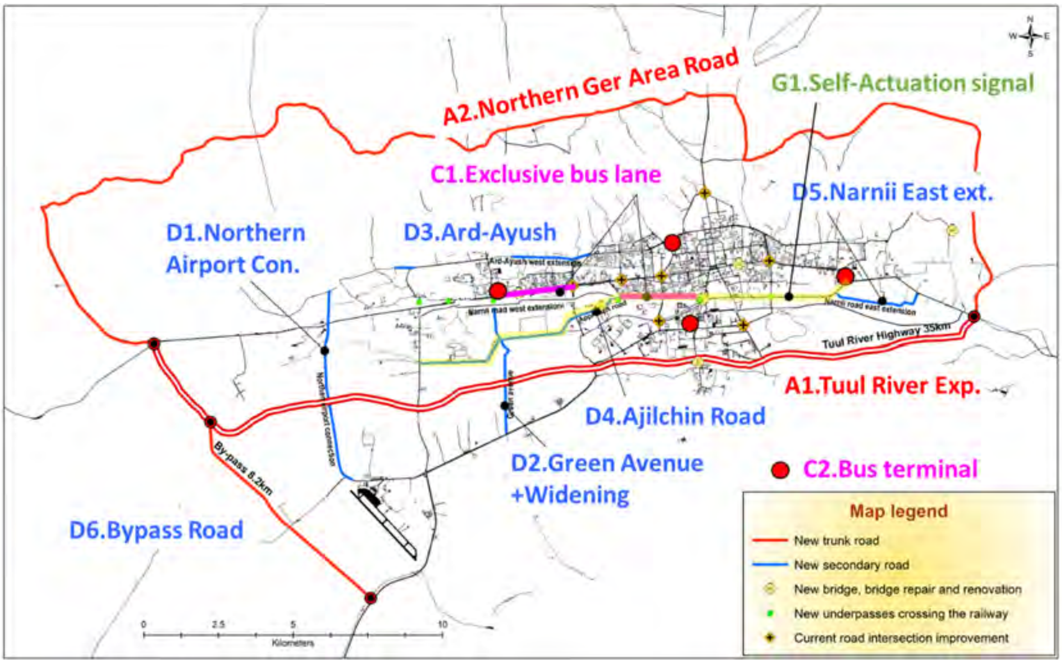
Source: JICA Study Team

Figure 4.3 Urban Transport Development Policy

5 Review of Proposed Cooperative Programs

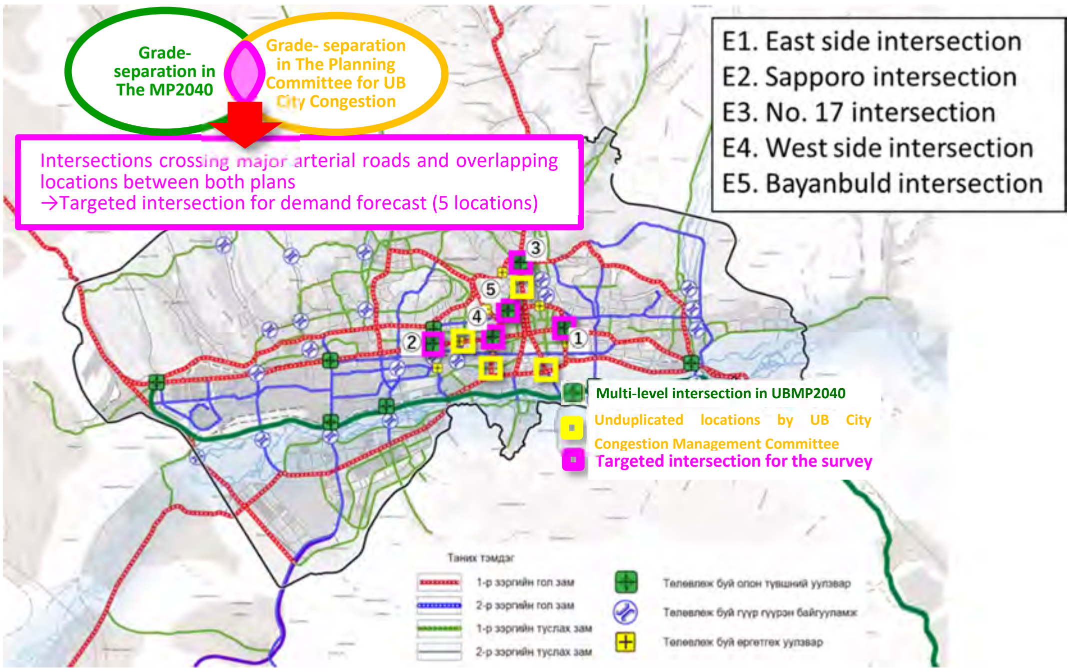
Based on Chapter 4, the target projects were selected for the following areas which can contribute to the development of transportation: “development related to traffic concentration, traffic dispersal, and public transportation conversion (development of arterial roads for traffic dispersal, elimination of missing links, elimination of traffic bottlenecks, and development of a drastic public transportation system),” and “capacity building, management, and technology improvement by technical assistance,” as shown in Table 5.1.

In addition, the projects shown were evaluated from a viewpoint of “monitoring of traffic congestion loss and evaluation indexing,” as also described in the previous chapter. As for “project efficiency improvement and concentrated investment in highly effective projects,” the effects of combining shortlisted projects were evaluated, and the priorities were presented.



Source: JICA Study Team

Figure 5.1 Highways, Trunk and Secondary Roads, Bus Network, and Traffic Management Projects



Source: JICA survey team based on UBRD2030.

Figure5.2 Intersection Leveling Project

Source: JICA Study team

Figure5.3 Railway Transportation Infrastructure Development Route

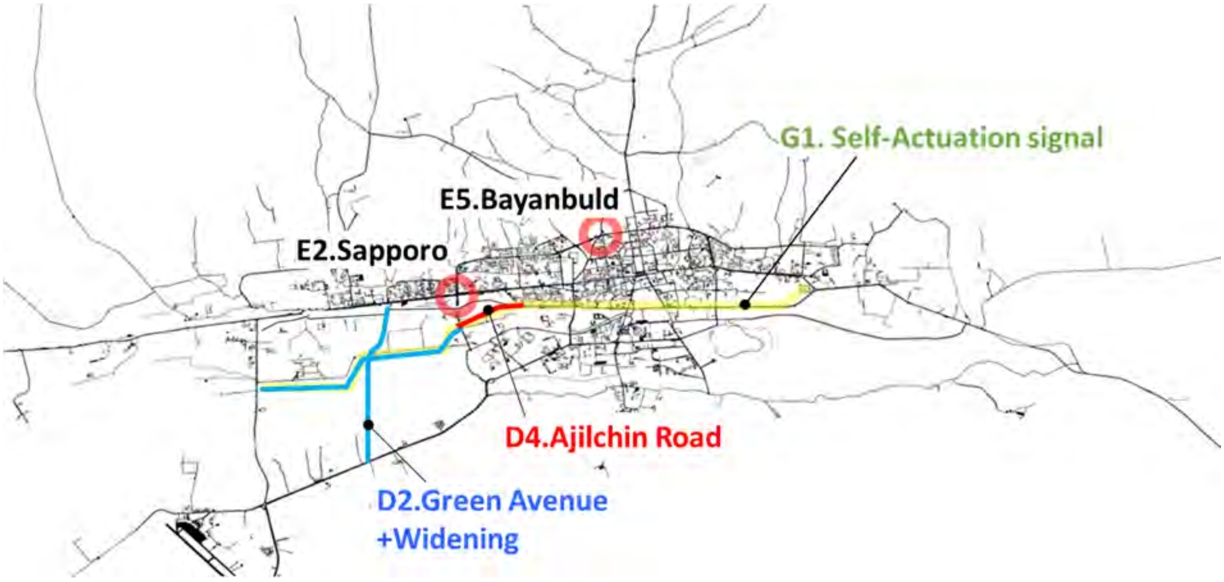
Table5.1 Evaluation Results of the Target Project List

Projects	Development effect	investment effect	Application possible Technology	Implementing Organization Capacity of city	Environment society consideration	Total	Other Donner	Approx. cost (Mil.USD)	EIRR (%)	year	Benefit (Bil.Tg/Year) Total	TTC	VOC	ENV	Short list
A. Development of highways and major arterial roads															
A1. Tuul River Expressway	5	4	3	2	2	16		902	19.7	'40	706.8	748.5	-27.3	-14.4	
A2. Northern Ger Area Road	3	4	1	3	2	13		141	18.5	'40	105.9	105.0	-7.3	8.2	
B. Urban railroad development															
East–West Line (Narnii Ave.)	5	5	3	3	3	19		P1:835,P2:566,P3:168	-	'40	444.8	338.0	25.3	81.5	
East–West Line (Peace Ave.)	5	5	4	3	3	20		1,362	-	'40	456.2	347.7	25.7	82.8	
B3. North–South line	4	4	4	3	3	18		995	-	'40	427.7	339.6	21.6	66.5	
B4.UB city alignment East–West	3	3	3	3	3	15		-	-	'40	330.4	283.3	8.3	38.8	
B5.UB city alignment North–South–West Side	3	2	3	3	3	14		-	-	'40	236.5	225.4	0.0	11.0	
B6.UB city alignment North–South East Side	3	3	3	3	3	15		-	-	'40	225.7	209.8	3.1	12.7	
C. Bus transportation improvement															
C1. Exclusive bus lane	4	4	3	3	2	16		11	-	'30	196.6	-84.9	70.9	196.6	
C2. Advancing bus terminal	4	3	3	3	2	15			-	'25	-	-	-	-	
D. Development of secondary arterial roads															
D1. Northern airport connection	3	1	3	4	4	15		92.2	-	'30	0.6	7.4	-5.4	0.6	
D2. Green Avenue (N-S+E-W) Project	**5**	**3**	**4**	**4**	**4**	**20**		**117**	**13.0**	**'30**	**31.4**	**31.0**	**-2.2**	**31.4**	✓
D3. Ard–Ayush west extension	3	5	1	3	2	14		23	33.2	'30	53.7	50.0	-1.1	53.7	
D4. Ajilchin Flyover Project	**5**	**5**	**5**	**4**	**4**	**23**		**89**	**23.9**	**'30**	**75.9**	**66.5**	**1.0**	**75.9**	✓
D5. Narnii Road East Extension	3	1	1	3	2	10	WB	21.6	-	'30	-6.2	-4.4	-2.4	-6.2	
E. Intersection improvement and maintenance															
E1. East side Intersection	4	3	4	4	3	17		33	12.5	'25	7.1	7.3	1.0	-1.2	
E2. Sapporo Intersection Grade Separation Project	**4**	**2**	**4**	**4**	**4**	**18**		**33**	**10.7**	**'25**	**40.6**	**28.3**	**2.1**	**10.2**	✓
E3. No. 17 Intersection	2	3	4	4	4	17		33	13.1	'25	11.2	8.0	0.6	2.7	
E4. West side Intersection	4	2	4	4	3	17		70	5.4	'25	5.2	9.4	-0.8	-3.4	
E5. Bayanburd Intersection Grade Separation Project	**5**	**4**	**4**	**4**	**4**	**21**		**33**	**15.0**	**'25**	**17.1**	**15.8**	**-0.1**	**1.3**	✓
F. Technical Cooperation Program															
F1. Improve public transportation	-	-	-	-	-	-	-	-	-	'30	1,131.8	828.8	61.6	241.5	
F2. Road Traffic	-	-	-	-	-	-	-	-	-	'30	724.8	611.5	4.1	109.2	

Improvement Technology Enhancement Project														
F3. Improvement of technology for planning and maintenance of urban drainage facilities	-	-	-	-	-	-	-	-	-	'30	-		-	-
G. Traffic management and maintenance														
G1. Self-Actuated Signal Project	**4**	**5**	**5**	**4**	**5**	**23**	**-**	**11.4**	**-**	**'30**	**-**		**-**	**-**	✓

Source: JICA Study Team

As a result, the location map of the five selected projects is shown in Figure 5.4.



Source: JICA Study Team

Figure 5.4 Location of Shortlisted Projects

5.1.1 Technical Cooperation Projects

The organizations in UB City currently lack coordination, knowledge and expertise in detailed technologies that any prior considerations are impossible, and analysis and decision-making skills based on objective evidence, etc., leading to worsening traffic congestion and reducing project effectiveness.

Therefore, it is very important to develop the capacity in technology and management through technical cooperation projects, so efficient investments can be made in the end. Three cooperation projects are presented: (i) Capacity Development for Public Transport Improvement, (ii) Capacity Development Project for Road Transport Improvement and Enhancement, and (iii) Capacity Development Project for Urban Drainage Planning and Management.

6 Proposals for Priority Projects Supported by JICA

6.1 Project for Improvement of Secondary Arterial Road and Congested Intersection

Among the shortlisted projects, the following were chosen as priority projects. The longlisted projects might be regarding urgent and important projects from the Mongolian side because such have been discussed a long time ago and have not changed. They suggested are based on the UB City Traffic Congestion Mitigation Measures, UBMP2040, and UBRD2030 as the upper plans. The priority projects suggested to Mongolia are the (i) Ajilchin Flyover Project, (ii) Green Avenue

(N-S+E-W) Project, (iii) Sapporo Intersection Grade Separation Project, (iv) Bayanburd Intersection Grade Separation Project, and (v) Self-Actuation Traffic Signal Project. This chapter summraizes the outline, project cost, project schedule, implementation system, maintenance system, Japanese technology expected to be utilized, project effect and consideration for social environment, and consideration for natural environment for these projects.

(1) Cost Benefit Analysis

Table 6.1 shows the cost benefit analysis result. The EIRR is more than the standard threshold 10%, the result shows these projects are effective from an economic analysis.

Table 6.1 Results of Economic Analysis

	Project Cost (mill. USD)	EIRR	B/C	NPV (mill. USD)
(1) Ajilchin Flyover Project	87.6	23.4	3.2	114
(2) Green Avenue (E–W) Project	18.6	43.0	8.1	89
(3) Sappro Intersection Grade Separation Project	32.8	11.3	1.1	2.8
(4) Bayanburd Intersection Grade Separation Project	32.8	15.2	1.6	12.6

Source: JICA Study Team
Note: Self actuated signals are excluded from the analysis because of microscopic project. However, the congestion reduce rate by 20% is reported averagely in the example Moscow, Russian.

(2) Mitigation of the Traffic Congestion at Surrounding Roads

Table 6.2 shows the improvement in the cases of the construction of Ajilchin Flyover Project and Green Avenue (N-S+E-W) Project. The reduced traffic volume by more than 20% on Peace Avenue and Chinggis Avenue would be expected.

Table 6.2 Improvement Effect (2030)

Project Title	Items	Improvement Effect: Before (PCU/day)	Improvement Effect: After (PCU/day)	Improvement Effect: Reduction
Ajilchin Flyover Project	Traffic after Construction	–	64,300	–
	Reduction of Traffic at Peace Ave.	121,800	96,100	-22.1%
	Reduction of Traffic at Chinggis Ave.	103,600	98,200	-5.2%
Green Avenue (E-W+N-S) Project	N–S Direction Traffic	–	37,000–44,100	–
	E–W Direction Traffic	–	48,600–83,300	–
	Traffic on Peace Ave.	96,800	85,600	-11.6%
	Traffic on Chinggis Ave.	126,800	104,900	-26.8%
	Traffic on Sonsgolon IS	66,500	64,500	-3.0%
	Traffic on Gurvalgin	82,700	75,600	-8.6%

Note: PCU: passenger car unit
Source: JICA Study Team

(3) Reduction of the Stopped Delay at Intersections

Table 6.3 shows the shortened passing time for waiting at the intersection based on the delayed time. The 102–151 second/vehicle shortened passing time in each intersection would be expected.

Table 6.3 Improvement Effect by the Project (2025)

Project Title	Item to Evaluate	Improvement Effect
Sapporo Intersection Grade Separation Project	Flyover Transit traffic volume (east–west direction)	82,200 PCU/day (2025)
	Future projected traffic volume (north-south direction)	54,200 PCU/day (2025)
	Reduction of average stopped delay at intersections (/vehicle)	102second/vehicle
Bayanburd Intersection Grade Separation Project	Flyover transit traffic volume (east–west direction)	55,000 PCU/day (2025)
	Future traffic volume (north–south direction)	67,900 PCU/day (2025)
	Reduction of average stopped delay at intersections (/vehicle)	151 second/vehicle

Source: JICA Study Team

6.2 Feedback from Mongolian Government

Discussions were held with MRTD on 8 December 2021 and with UB City on 10 December 2021 and 28 December 2021, and discussions continued about the priority projects indicated as shortlisted is in Chapter 6.1. As a result, the Ajilchin Flyover Project and Green Avenue (E-W+N-S) Project were supported. By the end of January 2022, the Japanese side is continuing discussions with UB City, MRTD, and the Ministry of Economic Development about the possibility of an F/S project.

Regarding the technical assistance, after the discussions with JICA and the Mongolian government, the study team suggested the (i) Transport Planning and Traffic Management Enhancement Project and (ii) UB City Road and Bridge Maintenance Capacity Enhancement Project. Discussions between the Mongolian government and Japan will continue in the future.

7 Review of Japan's Assistance

In Chapter 7, the strengths of Japan and its technology are discussed, and the assistance needed from Japan are categorized into (A) in terms of utilizing Japan's strengths in knowledge and experience and Japanese technology ; (B) in terms of utilizing Japan's strengths in knowledge and experience, but utilizing technology being followed in countries other than Japan; and (C) in terms of getting assistance from other countries. Categories A and B have a likely possibility as cooperation projects with Japan. The implementation of project feasibility is recommended as well in this study.

Table 7.1 Possible Future Assistance Policies of JICA

Category	Measure	Supplement
(A) In terms of utilizing Japan's strengths in knowledge and experience and Japanese technology	Introduction of priority traffic signals for public transport	Introduce signals that allow public transportation to take priority, helping to reduce congestion.
	Mass transit public transportation system construction project	Conduct a railway F/S and study for implementation. Since the study requires time, it should be implemented as soon as possible.
	Technical assistance for improving traffic management capacity	Implement systematic and technical capacity building for traffic bottleneck detection, countermeasures, and signals.
	Transportation node improvement project	Improve transportation nodes and public transportation terminals to make it more convenient to transfer between existing buses and railways.
	Technical assistance for improving public transport management capacity	As presented in 5.2.2.
	Introduction of traffic signals	As shown in Chapter 6, introduce autonomous traffic signals.
	Construction of urban expressways and elevated roads	Construction of road highways and continuous multilevel intersections, while taking into consideration the environment, to promote traffic congestion through detours.
	Introduction of road traffic information system	By introducing a traffic information system, we aim to achieve more efficient transportation by comparing parking lot fullness, congestion, and public transportation.
	BRT and express bus network development project	The introduction of an express bus system will provide an inexpensive public transportation system, especially in areas that are not congested.
	Technical assistance for TOD promotion project	Emphasis will be placed on bus and rail travel through the construction of pedestrian and bicycle paths, transit facilities, and residential, work, and commercial facilities.
	Bus route realignment project	Reorganize existing bus and post-railway bus routes to establish an efficient bus network.
	Technical assistance and facility development for barrier-free facilities	Barrier-free facilities will be built so that people of all ages, both men and women, and the unfit can get around.
	Bottleneck intersection countermeasure project	Identify bottleneck intersections, causes of congestion, and countermeasures.
	Technical assistance for improving traffic safety capacity	Traffic safety aspects and traffic facilitation aspects of traffic policing, safety facility installation, bicycle-pedestrian route planning, and pedestrian/vehicle separation will be studied to improve traffic safety capacity.
	Railway operation assistance services	The goal is to achieve accident-free and sound railway management through technical assistance in railway operation and management.
	Technical assistance for improving the financial capacity of transportation (public transportation)	Examine operation plans and facility plans for the operation of public transportation, and improve services to increase usage from a private sector perspective.
(B) in terms of utilizing Japan's strengths in knowledge and experience, but utilizing technology which is being followed in countries other than Japan	Road network improvement promotion project	The project aims to alleviate traffic congestion by providing technical assistance in planning the development of roads in the district, traffic management, traffic impact assessment for large-scale facility development and redevelopment projects, and road network planning.
	Road network improvement promotion project	The aim is to reduce traffic congestion through the development of bypasses, high-standard roads, and continuous multilevel intersections for the purpose of traffic dispersion.
	Intersection project	Development of multilevel intersections at intersections with heavy traffic concentration.
	Improvement of Tuul River Bridge	The Tuul River crossing bridge will be improved to reduce congestion by dispersing traffic.
	Suburban relocation of industry and universities	Relocate traffic concentration points to the suburbs to reduce congestion.
(C) In terms of getting assistance from other countries.	Bus vehicle maintenance	Purchase bus vehicles to increase the frequency of service.
	Road space redistribution project	Re-examine the utilization of road space and make effective use of it.
	Technical assistance to improve road management capacity	Reinforcement of pavements, especially in gel areas, and against pavement damage due to unexpected overload
	Cold region road pavement strengthening project	
	Introduction of a parking management system	The goal is to reduce congestion by improving parking facilities and promoting measures such as switching to public transportation by collecting parking fees.

Source: JICA Study Team

8 Summary

This survey identified traffic issues on the basis of existing plans, traffic survey contents, and interview survey results, and selected necessary measures based on what UB City should be in the future. After forecasting demand and evaluating projects, five projects were selected as shortlisted projects and proposed to MRTD and UB City As a result, the Ajilchin Flyover project, Green Avenue (E–W) Project, Sappro Intersection Grade Separation Project, and Bayanburd Intersection Grade Separation Project have been supported by the Mongolian side. As of February 2022, the Japanese and Mongolian governments are discussing how to proceed with them.

Thus, this study is a kind of data collection survey that identifies the necessity for assistance orientation considering the given condition in a short period. Although long-term transport plan has been considered in the long future, large and long-term plans were not the focus of this study, different from a master plan based on a long-term perspective. There were cases, found out through discussions with the Mongolian government, that short-period projects could not be decided on because long, future projects have not been either. The discussions for the overall and long-term projects based on objective evidence are not enough. Large-scale transport projects should analyze alternative cases and change of the project has a large impact. Thus, the evaluation should be used for determining and explaining the large impacts. For this reason, technical assistance focusing on project evaluation from an overall perspective and the long-term based on objective evidence is desirable.

In February 2022, other international donors discussed with the Mongolian side for ODA projects, in particular, discussions are underway for World Bank's comprehensive road renovation project, bus transportation, and transportation planning projects (100 million USD). ADB also suggested assistance related to public transport for Peace Ave., announcing they will implement 7 mil. USD, which will also include the F/S. China is also negotiating to introduce LRT. These donors pushing for recommendations and projects show how active negotiations for ODA projects have become.

In this situation, the projects suggested in this study and those suggested based on the feedback from Mongolia will be discussed with JICA and the Mongolian side to launch the implementation for F/S and technical assistance.

However, for the Mongolian side, adding ways of securing budget and maximizing transport project benefits of UB City to ease the traffic congestion is important. Therefore, assistance from Japan is implemented based on the study, and coordination between donors to ease the congestion is expected.

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Appendix 1: Project Summary and Multi-criteria Evaluation Form

1 Outline of the Survey

1.1 Background of the Survey

In Ulaanbaatar City (hereinafter “UB City”), the capital of Mongolia with a population of 1,597,290 in 2020, its rapid population growth in recent years has led to serious urban problems, such as traffic congestion and air pollution, which have had a significant impact on the lives of the residents. The number of cars in Mongolia has consistently been on an upward trend, growing at an average of 5% per year since 2015, and traffic congestion has constantly been occurring, especially at various intersections in UB City. The reasons for this traffic congestion are inadequate traffic infrastructures, such as roads and parking lots, insufficient adherence to traffic rules by road users, and insufficient management of traffic operations. Thus, operational improvement is also one of the issues to be addressed.

The Japan International Cooperation Agency (JICA) conducted the "Study on City Master Plan and Urban Development Program of Ulaanbaatar City" from 2007 to 2010. UB City used the results of the study to prepare the "Ulaanbaatar City Master Plan 2020 and Development Trends 2030" (MP2020), which was approved by the Parliament in May 2013. According to the MP2020, UB City, which is experiencing a high concentration of population and increasing number of registered vehicles, has issues such as inadequate transportation infrastructure. In addition, bus is the only public transportation for commuters and students, and the supply does not even meet the demand. Thus, MP2020 pointed out that these urgent issues needed to be addressed and that development of public transport networks as well as road networks and parking lots and improvement of quality and operations of existing transport infrastructure are necessary. After approval of the MP2020, measures have been taken to improve the road network and convenience of bus services but have not yet reduced traffic congestion. Furthermore, a review survey conducted by UB City in 2017–2018 showed that the progress of the MP2020 implementation was only at 29.6%.

On the other hand, the influx of population from the countryside to UB City has ceased, and urban issues, such as traffic congestion, are becoming severe, causing an increase in economic loss. Since about half of the Mongolian population lives in UB City, there is a great need to strengthen the urban functions of the city for the development of the entire country.

1.2 Objectives and Target Areas of the Study

1.2.1 Purpose of the Study

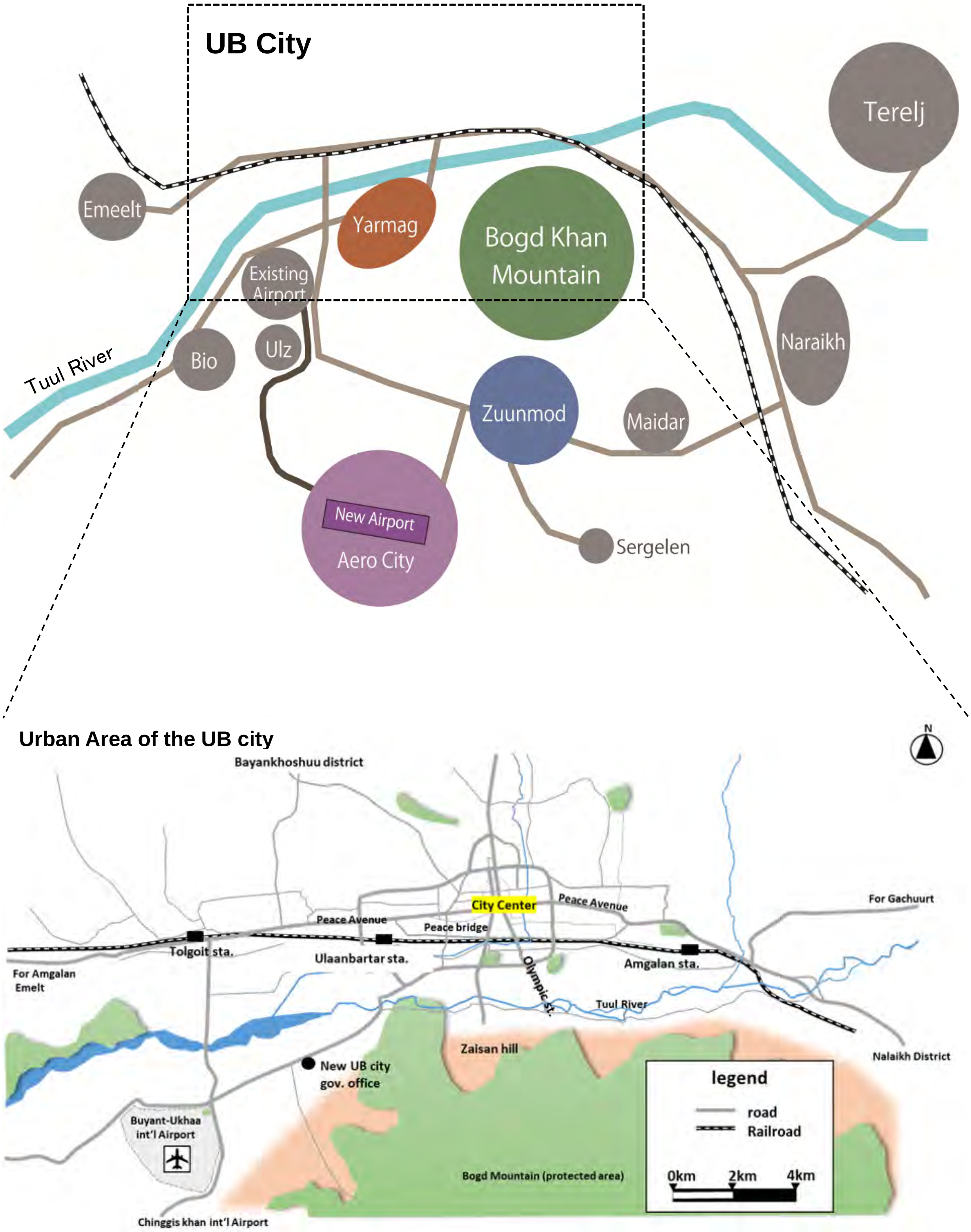
The purpose of this study is to examine the future vision of UB City by analyzing the current status and issues in urban transportation based on the existing urban planning and urban transport policy, such as MP2020, the General Development Plan of Ulaanbaatar City (hereinafter “UBMP2040”) that is currently under review by the UB City Government (UBCG), and the Countermeasure Plan by the Traffic Congestion Reduction Committee after review of existing projects, and understanding the current traffic situation and future demand forecast. It also aims to present the future cooperation policy for the urban transportation infrastructure development of UB City by organizing the solutions for the current issues.

1.2.2 Study Area

UB City is the study area, and this study reviews its existing plans and current conditions of urban transportation. Six districts (Khan Uul, Bayanzurkh, Sukhbaatar, Bayangol, Chingeltei, Songinokhairkhan) in the city center are the target areas based on the discussion with JICA. The entire area (urban area of UB City) is shown in Figure 1.1.

1.2.3 Surveyed Institutions

The institutions surveyed in this study were the Ministry of Road, Transport and Development (MRTD), organizations related to infrastructure development, UBCG, development partners, transport operators in UB City, and Japanese companies.



Source: JICA Study Team

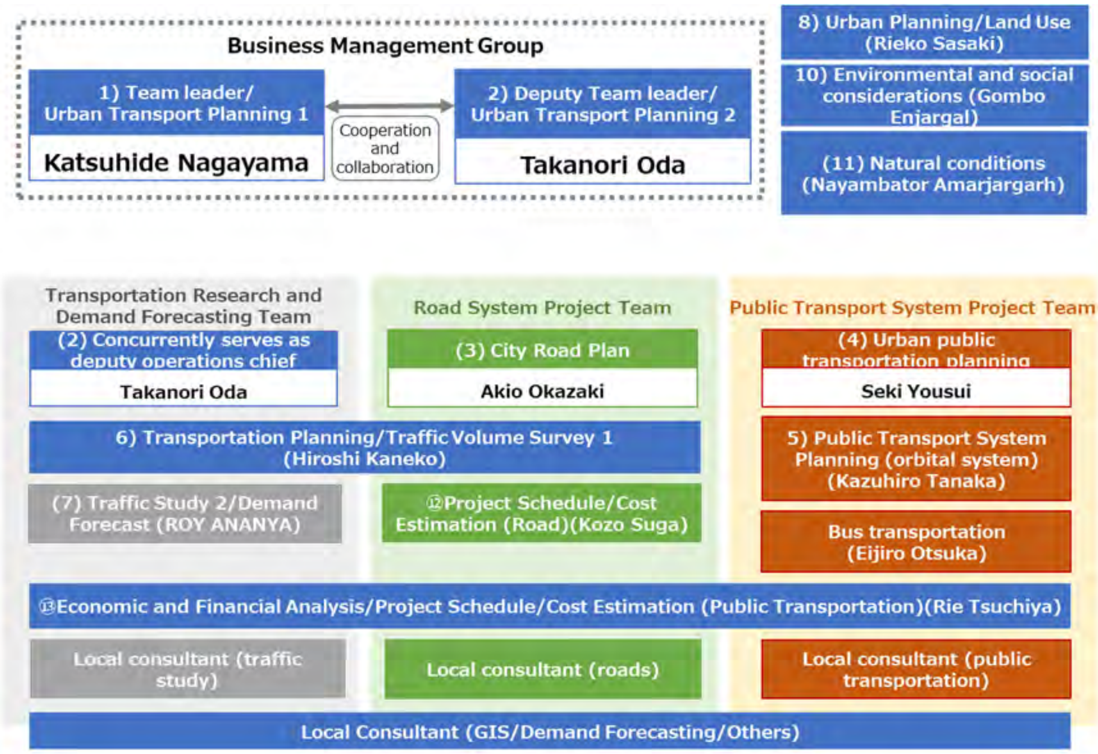
Figure 1.1 Study Area

1.3 Composition and Schedule of the Study Team

The composition and schedule of the study team are shown below.

1.3.1 Composition of the Study Team

In order to carry out the work that requires diverse and wide-ranging expertise efficiently, effectively, and harmoniously under the work management group composed of the team leader and deputy team leader, technical groups were formed for the following: (i) traffic study demand forecasting, (ii) road planning, (iii) public transportation planning, (iv) urban planning, (v) social and environmental considerations and natural conditions, and (vi) economic finance and cost estimating.



Source: JICA Study Team

Figure 1.2 Composition of the Study Team

1.3.2 Schedule

The study team conducted two domestic works and two field studies in Mongolia; however, the COVID-19 pandemic affected the schedule because of the travel restrictions. The first domestic work was conducted from April to July in 2021, and from August to September of the same year, the first field study was conducted. The second domestic work started after the first field study, which was from September to November. From November to December, the second field study was conducted. Lastly, from December 2021 to 4 March 2022 (due date of the study) is another domestic work schedule.

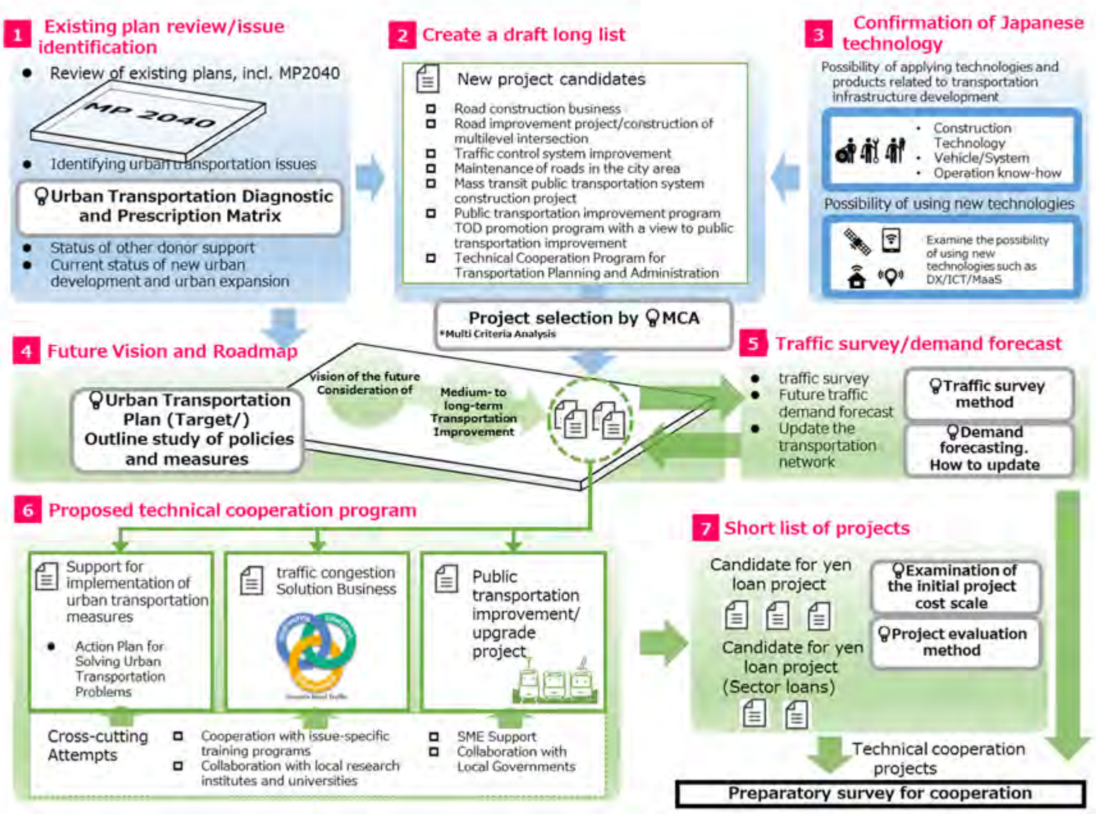
Table 1.1 Study Schedule

	work item	2021									2022		
		April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1	First domestic work												
1-1	Collection and analysis of relevant materials, information on related policies and plans, etc.												
1-2	Create an inception report												
1-3	Confirmation of technological innovation trends of Japanese companies												
1-4	Preparation of a draft long list of recommendations for future support policies												
2	First field work												
2-1	Explanation and discussion of the Inception Report												
2-2	Site surveys, interviews with relevant organizations, etc.												
2-3	Conducting a traffic survey												
3	2nd domestic work												
3-1	Organizing and Analyzing Issues in the Urban Transport Sector in Ulaanbaatar												
3-2	Forecasting future transportation demand and updating the transportation network												
3-3	Organizing urban transportation issues, examining future visions, and studying medium- to long-term improvement approaches												
3-4	Preparation of JICA cooperation program proposal												
3-5	Narrowing down the shortlisted projects to priority projects												
3-6	Gathering additional information to materialize priority projects												
3-7	Environmental and social considerations												
3-8	Gathering information on Japanese technology/DX, etc. and examining applicability												
4	Second field survey												
4-1	Explanation and discussion of priority projects												
4-2	Complementary research for materialization of priority projects												
5	Preparation and discussion of DF/R												
6	Preparation and submission of F/R												
		ICR									DFR		FR

Source: JICA Study team

1.4 Workflow

The workflow of this study is shown in Figure 1.3. Items [1] to [3] were conducted as soon as the study started. The long list of project candidates was made, and the future vision and roadmap for urban transportation in UB City in item [4] were presented to the local government for consensus. Subsequently, the technical cooperation program proposal in item [6] was prepared in parallel with the traffic survey and demand forecast in [5], and necessary data was compiled for the evaluation of the shortlisted projects and implementation of a preparatory study after the study.



Source: JICA Study team

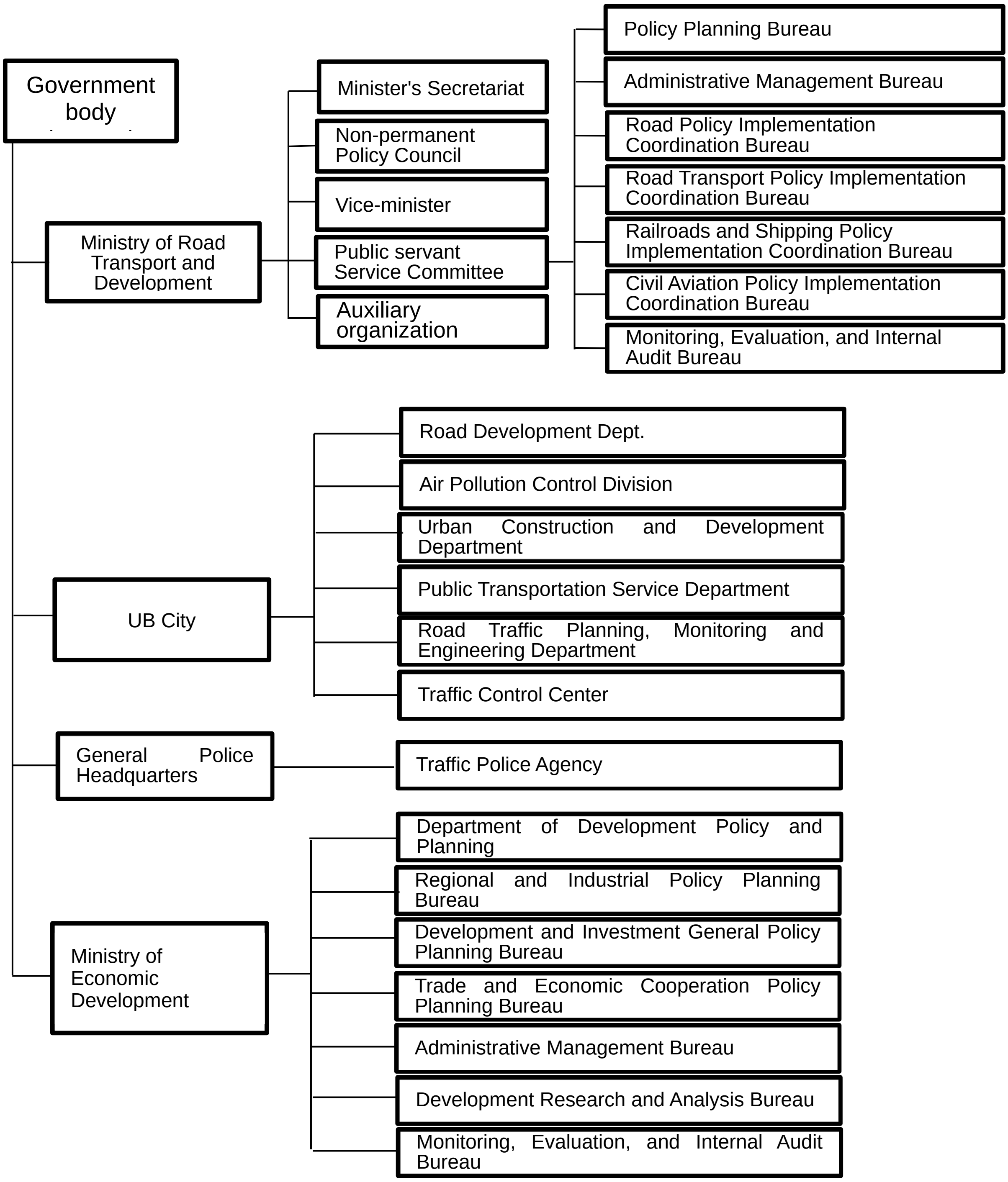
Figure 1.3 Overview of the Study

2 Fundamental Infomation related to Urban Development and Transportation in Ulaanbaatar City

2.1 Relevant Policies and Legal Systems of the Mongolian Government

2.1.1 Overview of Mongolian Government Agencies

The government agencies related to transportation infrastructure are the Ministry of Road Transport and Development (MRTD), the UB City, and the General Directorate of Police. The MRTD has seven departments, the UB City has six departments, and the Traffic Police Agency is directly under the General Directorate of Police. The Ministry of Economic Development (MED), established in January 2022, has seven departments in charge of a comprehensive policy of development and planning at the national level, by sector, by cross-sector, at the regional level, and rural level consistent with each other, as well as a comprehensive ODA policy, macro-economy, regional economy, a comprehensive policy of development projects, and international economic assistance strongly related to ODA.



Source: JICA Study Team based on information from various ministries and agencies

Figure 2.1 Government Agencies Related to Transportation and Logistics

2.1.2 Jurisdiction and Legal System for Planning, Implementation, and Maintenance of New Road Projects

In current situation, there is an imbalance between urban development, road maintenance, and public transportation maintenance, which requires cross-organizational cooperation throughout UB City. In addition, the introduction of high quality infrastructure projects in the future will require coordination with each stakeholder. The urban transportation administration will need to further improve its planning and implementation capabilities. For this reason, when implementing infrastructure development, it is necessary to examine the details of the roles, actual conditions, and planning capabilities of each of the planning administrations, and to consider the implementation of technical cooperation after clarifying the scope of responsibility and fully understanding their roles.

(1) Jurisdictional Duties and legal systems related to planning, implementation, and maintenance of new road projects

The Road Law (as amended in May 2017) provides for the planning, implementation and maintenance of new road projects in Mongolia. Article 5 of the Road Law defines the basic concept in road network development as follows:

Article 5.1	Develop national roads consistent with the Comprehensive Development Policy and Plan
Article 5.2	Construction shall be in accordance with the standards and plans of the agency having authority over the maintenance of roads and street facilities.
Article 5.3	The construction, ownership, use, maintenance and repair of roads shall not harm human health or the environment.
Article 5.4	Establish a comprehensive structure and system for national road development and maintenance

On the other hand, The Road Transport Law (in force on June 4, 1999) defines various matters concerning the transport of goods and passengers by motor vehicles, clarifies the conditions and requirements for means of transport, and provides for the purpose of coordinating the relationship between transport and the use of means of transport. In addition, the Law on Railway Transportation (in force on July 5, 2007) defines the principles of railroad transportation and provides for the purpose of handling various matters related to ensuring traffic safety. Article 5 of the said law defines the basic policy in railroad transportation activities as follows.

5.1 Rail transport activities shall be in accordance with the following basic policies:

- 5.1.1. Integrated management with comprehensive route maps
- 5.1.2. Perform regular inspections.
- 5.1.3. Ensuring the supply, quality, and safety of services
- 5.1.4. Provide ongoing activities
- 5.1.5. Ensure market competition conditions
- 5.1.6. Alignment with other transportation sectors

5.2. The government manages rail transport activities and supports rail transport development. The following is a summary of the duties under the jurisdiction of the relevant agencies as defined by the respective relevant laws.

Table 2.1 List of Related Organizations and Tasks under Their Jurisdiction

Related laws and regulations	Competent (governmental) authorities	Roles and Responsibilities
Road Law (Article11)	Ministry of Road Transport and Development (MRTD) Road Policy Bureau	• Implementation of the Road Law • Training of professionals in the field of roads • Preparation, application for approval, implementation, and management of public investment plans for the development of international and national road networks • Allow professional research institutions to take a professional view on the quality of road construction, technology and building materials, improve quotas and technical specifications, and

Related laws and regulations	Competent (governmental) authorities	Roles and Responsibilities
		scientifically promote the introduction of the latest technology and machinery. ・ Construction, repair work, maintenance, consultancy, commissioning and technical management of international and national roads, special-purpose roads and road facilities with state budget, foreign aid, cooperation and other financial resources. ・ Construction, repair, and maintenance of roads and road facilities; preparation of blueprints, quotas for machinery and technology, approval of technical documents, and implementation management. ・ Develop, approve, and manage the implementation of regulations for the construction, repair, and use of special-purpose roads. ・ Provide professional guidance and methods for the formulation and implementation of policies and master plans for capital and regional road development. ・ Comprehensive management of the use, repair, and maintenance of international, national, and special-purpose roads, providing professional guidance and coordination, and ensuring the safe and stable use of roads. ・ Manage the approval, registration, and entry into the database of new international, national, and special-purpose roads and related facilities. ・ Allocation of work to related organizations for the maintenance, management and stable use of roads, and implementation management ・ Identify the causes of accidents at points of high traffic accidents on international, national, and special-purpose roads, assess the risks, and implement necessary countermeasures. ・ Contracting out road maintenance, inspection, and repair work to licensed corporations.
Road Law (Article 12)	Center for Road Transport Development (CRTD)	・ Implement road-related laws and regulations, cabinet resolutions, etc. ・ Formulate, publicize, and implement procedures related to quotas for roads and road facilities. ・ Repair and maintenance of international and national highways and related facilities ・ Build a database of quotas for roads and road facilities ・ Retrain, train, and certify professionals in the field of roads ・ Formulate scientific research and technology policy in the field of roads ・ Manage, verify, and approve construction materials, contents, and quotas used in the construction and renovation of roads and road facilities. ・ Verify road, road facility, railroad, and aerodrome blueprints, and implement selection tests for individuals and corporations ・ Construct and register information databases on roads and road facilities ・ Compare analysis of budgets, cost items, and reference estimates for roads and road facilities. ・ Manage and approve technical specifications for roads and road facilities ・ Engineering and mechanical management of roads and road facilities can be outsourced. ・ Patrol for the purpose of ensuring the convenience and safety of

Related laws and regulations	**Competent (governmental) authorities**	**Roles and Responsibilities**
		roads and road facilities. ・ Conduct surveys to determine the quality and frequency of use of roads and road facilities, and determine the frequency and duration of inspection and repair work.
Road Law (Article13)	Authority of the Mayor	・ Consistent with the national policy to develop the road network, the city's road network development plan will be developed in cooperation with MRTD. ・ Formulate, approve, and implement under consultation. ・ Implement in accordance with laws and regulations on roads, cabinet resolutions, and decisions of central government agencies. ・ Administer funds to the city's street fund. ・ Construct and maintain roads to be constructed by the city budget. ・ Provide instructions to relevant agencies regarding the maintenance of international, national, and local roads and special-purpose roads. ・ Develop and approve ordinances for the funding, construction, maintenance, and management of city streets. ・ Repair road damage caused by natural disasters, natural phenomena, or accidents as soon as possible, or as needed. ・ Secure subsidized transportation and communication tools and human resources from private companies and citizens. ・ Control road traffic in the city in accordance with relevant laws and regulations. ・ Reflect the opinions of the central government in the formulation of land use plans.
Railroad Transportation Law (Article10)	Ministry of Road Transport and Development (MRTD)	・ Enact a set of general rules for railroad transportation. ・ Decree on rail transport, loading and unloading, and storage of dangerous goods jointly issued with the Secret Intelligence Service. ・ determine ・ A special train for the President of Mongolia, the Speaker of the Parliament, the Prime Minister, foreign leaders and other dignitaries. ・ Jointly establish a travel schedule with the Secret Intelligence Service. ・ Dispatch an investigator to take charge of the investigation of railroad engineering accidents. ・ Mongolia's representative in the international railroad cooperation project ・ Specific types of transportation (passengers, mail, cargo of special significance to the country's economy and society, etc.) ・ Give priority to ・ Special transport and military transport regulations will be established in consultation with other authorized agencies. ・ Other powers as provided by law.
Railroad Transportation Law (Article11)	Governor's authority	・ Ensure orderly operations at railroad sites, facilities, stations, and station buildings in cooperation with railroad agencies. ・ In the absence of other instructions in the regulations, take turns in positions that are directly related to rail traffic. ・ Exempt personnel serving in the military from recruitment other than conscription. ・ Remove damages caused by natural disasters and accidents, and ensure the normal and continuous operations of the railroad system. ・ Distribute wood, gravel, stone, sand, water, etc. in accordance with the law ・ When necessary, seize machinery, equipment, etc. from local

Related laws and regulations	**Competent (governmental) authorities**	**Roles and Responsibilities**
		companies, organizations, and individuals with compensation to reduce damage from natural disasters, railroad accidents, and defects, and ensure safety. Coordinate for human resources support.
Railroad Transportation Law (Article13)	Authority of the Rail Transport Administration	・ Ensure the safety of railroad transportation, and manage and supervise the enforcement of transportation-related laws and regulations and other decisions related to their enforcement. ・ Inspect machinery, equipment, and facilities used in railroad transportation, as well as the operational, service, and technical conditions related to railroad transportation, regardless of ownership or location, to ensure that they meet railroad transportation safety standards ・ Control the operational safety of trains and connected vehicles, and take measures to restrict or suspend the use of railroad facilities in the event of accidents or defects.
Railroad Transportation Law (Article14)	Authority of the Central Coordination Bureau for Train Operation	・ Establish a comprehensive route map ・ Coordinate and guide train operations between various foundation structures to ensure traffic safety ・ Ensure consistency in operation management and coordination among occupants of basic structures. ・ Propose and resolve opinions and results regarding train operation management ・ Professional and methodological guidance to the occupants of basic structures for the implementation of train operation management ・ Prepare comprehensive technical conditions for railroad organizations participating in transportation operations ・ Other powers as specified in laws and regulations
Road Transport Law (Article6)	Ministry of Road Transport and Development (MRTD) Authority of Road Transport Policy Coordination Bureau	・ Formulate national policy on road transport ・ Develop and implement regulations, standards, and quotas for transportation activities and mechanical use of transportation means. ・ Participate in international road transport activities, negotiating with relevant countries on conditions for inter-country transport, passenger safety and quality of service. ・ Set transportation fees for passengers and cargo according to transportation distance and cargo type. ・ Manage and report on the implementation of national policies and laws related to road transportation. ・ International passenger and cargo, public transportation, mail, tourist transportation services, vehicle inspection ・ Register transportation means, build a database, and share information with relevant organizations. ・ Register vehicles used in Japan.
Road Transport Law (Article7)	Governor's authority	・ Ensure the implementation of road transport laws and regulations, cabinet resolutions, central government agencies with road transport jurisdiction, and city council resolutions in the area of jurisdiction ・ Manage regional road transport consistent with national policy on road transport. ・ Manage regional road transport in cooperation with the central government agencies with road transport jurisdiction ・ Coordinate and implement public and postal transportation in the region.

Related laws and regulations	Competent (governmental) authorities	Roles and Responsibilities
		・ Enter into contracts with carriers under conditions that subsidize areas that are not competitive due to population settlement, location characteristics, or passenger and mail transportation needs. ・ Determine the start and end periods of transportation on frozen roads according to local weather conditions in cooperation with the local meteorological office. ・ Appoint officials of road transport bureaus in provinces and cities in consultation with the central government. ・ When appointing the cadres of the Road Transport Bureau, the cadres will be selected from candidates specializing in roads and economy in accordance with the Civil Service Law ・ Decide on changes to the names of bus stops that are announced or posted in written form for people with disabilities who use public transportation.

Source: JICA Study Team

(2) Environmental and Social Consideration

The following subsections show the legal systems and processes related to environmental impact assessment, acquisition of environmental standards and land, preparation of resident resettlement plans, related organizations, data including natural conditions, etc.

1) Laws and Regulations for Environmental and Social Consideration

Tables 2.2 and 2.3 contains a summary of the laws and regulations for environmental and social consideration in Mongolia.

Table 2.2 Laws and Regulations for Environmental and Social Consideration

Field	Laws and regulations	Approval date, Relavant chapter	Responsible Ministry/Agency
General	1.Law on Environmental Protection	1995/3/30	MET (Ministry of Environment and Toursim)
	Rights and obligation of citizen with regard to environmental protection	4	
	Immunity of natural resources	6	
	Protection of environment from pollution	21	
	Rights and obligations of entitie and organizations	31	
	Compensation for damage to environment	49,57	
EIA	2. Law on Environmental Impact Assessment	2012/5/17	MET
	EIA	8	
	Environmental Management Plan	9	
	Obligations of program and project proponents	14	
	Rights and obligations of the licensed EIA entity	15	
	Financing institutions shall refrain from supporting project with adverse environmental and public health impacts	17	
	Public consultation process in EIA	18	
	Compensation for damages from non-compliance with EIA and EMP	20	
Air	3. Law on Air	2012/5/17	MET
	Rights and obligations of individuals and organizations	9	
	Air quality data	12	
	Principles and measures to reduce air pollution	13	

Field	Laws and regulations	Approval date, Relavant chapter	Responsible Ministry/Agency
	Critical zone to improve air quality	15	
	List of prohibited activities in the critical zone	16	
	Air emissions	20	
	Technical requirments for construction works to protect air quality	21	
	4. Law on Fees for Air Pollution	2010/6/24	MET
	Registration of air polluters	4	
	Physical factors to determine air polluters fee	7	
	Exemptions and discounts of fees	8	
Water	5. Law on Water	2012/5/17	MET
	Protection of water resources	22	
	Protection of water resources from pollution	24	
	Fees for water pollution and depletion of water resources	25	
	Conditions for termination of the water use contracts	29	
	Obligations of water users	30	
	Water use fees and tariffs	31	
	6. Law on Fees for Water Pollution	2012/5/17	MET
	Determination and registration of water polluters	4	
	Subjects for water pollution fees	5	
	Exemptions and discounts from water pollution fees	8	
Land	7.Law on Land	2002/6/7	MET, Ministry of Construction and Urban Development (MCUD)
	Transfer of the land title	39	
	The land leaser shall release land on the expiraition of land possession certificate	41	
	The public land owner shall pay compensation for premature termination of the land lease agreement	43	
	Use of land for special and public purposes	46	
	Use of third party land for temporary and tranist uses	48	
	The requirements for proper use of land	50	
	Proper use and protection of urban land	56	
	8. Law on Land Privatization	2002/6/27	MCUD
	Rights and obligations of the land owner	27	
	Termination of the land ownership rights	31	
	Re-possession of the land right by the state	32	
	Confiscation of the land	33	
	Conditions for resettlement	37	
	9. Law on Land Fees	1997/4/24	MCUD
	Determination of the Land Use Fee payers	3	
	Exemptions from land fees	8	
	Liabilities of land fee payers	12	
Public Health	10. Law on Health and Hygiene	2016/2/4	MOH (Ministry of Health)
	Conditions for Environmental health	4	
	Safety requirements for urban development and construction	5	
	Conditions for health and hygiene on work place	6	
Plant	11. Law on Plant Protection	2007/12/10	MET
	Obligations of individuals and organizations on plant protection	13	
	Plant quarantine	14	
Wildlife	12.Law on Wildlife	2012/5/17	MET
	Protect wildlife	6	
	Compensation for damage to wildlife	37	
Cultural	13. Law on Protection of Cultural Heritage	2014/5/15	MOC (Ministry

Field	Laws and regulations	Approval date, Relavant chapter	Responsible Ministry/Agency
heritage	Registration and database on cultural heritage	21	of Culture)
	Any activities related to mining, agriculture and construction of infrastructure are prohibited in historical sites.	38	
Waste	14.Law on Waste	2017/5/12	MET
	General rights and obligations of citizen and entities with regard to solid waste	9	
	Disposal of solid wastes	11	
	Collection and transportation of solid wastes	12	

Source：JICA Study Team

Table 2.3 National Standards for Environmental and Social Considerations

Standards	Approval year
MNS 0017-0-0-06: Environmental protection standard system.	2000
MNS 0017-5-1-13: Rehabilitation of destroyed lands. Terminology and determination	1979
MNS 0017-5-1-18: Rehabilitation. Classification of disturbed lands	1993
MNS 0017-5-1-19: General requirements for rehabilitation of disturbed lands	1983
MNS 3473: Environment. Land. Land use. Terminology and determination	1992
MNS 4191: Environmental protection standard system. Climate of Mongolia. Main parameters	1983
MNS (ISO) 4226: Air quality. General subject and general requirements	1993
MNS 4585: Air quality parameters. General requirements	2007
MNS 17-2-0-07: Environmental protection. Air emissions. Classification.	1979
MNS: 0017-2-3-16: Air. Rules of air quality monitoring of city and settlements	1998
MNS 4586: Indicator of water environment quality. General requirements	1998
MNS (ISO) 4867: Water quality. Sampling third part. Recommendation for storage and protection	1999
MNS 3342: General requirements for protection of groundwater	1982
MNS0 900: Drinking water. Hygienic requirements and quality control	2005
MNS 4943: Water quality. Effluent standard.	2000
MNS 3297: Soil. Volume of hygienic parameters of soil of city and settlements	1991
MNS 4917: Environment. Requirements for determination of the fertile soil layer standard disposal while performing earth-moving activities	2000
MNS 5850: Soil quality. Soil pollutants elements and substances	2008
MNS 4990: Workplace atmospheres. Hygienic requirement.	2000
MNS 5803: Occupational safety and health. General requirements for lead content in workplace air and the workplace.	2007

Source: JICA Study Team

2) Environmental Impact Assessment (EIA)

2)-1 EIA Requirement

EIA in Mongolia is guided by the Law on Environmental Impact Assessment (2012), which is administered by the Ministry of Environment and Tourism (MET). The EIA protocol for all projects is two-tiered, initially defined by a general EIA (GEIA) initial screening, followed by either a full detailed EIA (DEIA) or an Environmental Management Plan (EMP). For major projects, the GEIA prescribes a DEIA requirement, whereas, for minor impact projects, the GEIA can only prescribe an EMP to prepare for the project. In the EMP, the impact that may occur before the start of the project is predicted and evaluated, and the countermeasures are clearly presented.

The initial application in the screening comprises (i) an original baseline description of the affected environments, (ii) a description of the detailed design of the project including drawings, and (iii) F/S on technical and economic analysis. As introduced above, the possible outcomes of the GEIA are as follows:

1) project may be implemented without conducting a DEIA or EMP;
2) project may be implemented without conducting a DEIA, but with specific conditions and/or impact mitigation measures specified in an EMP;
3) project rejected on grounds of non-conformity with relevant legistation, or the adverse impact of the equipment and technology on the environment are too great, or absence of the project in the land management; and
4) project requires a full DEIA.

The projects with the conditions of the category applicable for DEIA are cases with significant negative impacts that affect the health of the people and environment or cases with unpredictable impacts. It will require further detailed study as it develops and uses large amounts of natural resources. DEIA can only be implemented by companies designated by the MET to perform such. The outline of the revised EIA law is shown in Table 2.4.

Table 2.4 Summary of Mongolian EIA Law

Related Law	Summary
EIA (Article 4)	1. EIA shall include: ・Strategic Environmental Assessment (SEA); ・Environmental Baseline Assessment; ・Environmental Impact Assessment (EIA); and ・Cumulative Impact Assessment. 2. Technical Board with responsibilities to regulate issues that may arise in connection with EIA: review assessments and reports based on SEA, cumulative impact assessment and EIA shall work with at MET. Technical Board Member shall be appointed by the MET.
Environmental Baseline Assessment and Cumulative Impact Assessment (Article 6)	1. The project implementer is responsible for commissioning the environmental baseline assessment to identify potential impacts. 2. The project implementer shall ensure that the environmental baseline assessment is performed with the due participation of a licensed professional entity or research institution and, if necessary, shall seek guidelines from the MET. 3. MET shall conduct a Cumulative Impact Assessment in specific regions and basins from various projects implemented by the individuals and business entities with due inputs from a licensed professional entity. 4. If deemed necessary, the cabinet member in charge of nature and environment may appoint a team of experts to conduct the assessment. 5. The cost associated with the Cumulative Impact Assessment shall be borne by the project implementers according to its range of impacts. 6. The professional licensed entity shall submit the Environmental Baseline Assessment report and Cumulative Impact Assessment report to the Technical Board at the MET for review.
EIA (Article 7)	1. EIA shall consist of a General Environmental Impact Assessment (screening) and Detailed Environmental Impact Assessment (DEIA). 2. Applications for a license for the use of natural resources, extraction of petroleum and minerals, possession and use of land for business purposes, and approval for any other projects are subject to screening. 3. The project implementer shall apply for an EIA screening to MET, the province or Ulaanbaatar city governor’s office, whichever is applicable according to the classification, by submitting a brief description of the project, a feasibility study (F/S), the engineering design and drawings, baseline description of the proposed project environment, written opinions of the relevant district district governor and other related documents. 4. The screening shall be performed by an assessment expert who shall complete the assessment within 14 working days and issue a formal opinion as to whether, (if deemed necessary, it can be extended once for additional 14 days for the assessment according to a

Related Law	Summary
	decision by the head of assessment experts): (1) The project should be rejected on the grounds that it is likely to cause considerable harm to the environment by virtue of its proposed technology, technique and activities; that its activities are inconsistent with the state policy, strategic assessment results or relevant legislation; (2) The project may be implemented without a DEIA subject to specific conditions; (3) The project requires DEIA.
DEIA (Article 8）	1. The results of the screening define the objectives, areas, scope and duration of the work for the DEIA. 2. The DEIA shall be conducted by a Mongolian entity authorized to do so. 3. The entity authorized to conduct the DEIA shall prepare a report presenting the findings of the DEIA and develop an Environmental Management Plan. 4. The DEIA report shall include the followings; (1) The baseline data and indicators of the environment in which the project is proposed to be implemented; (2) Estimations and findings of studies that are conducted to identify a potential as well as the major impact of the project; (3) Recommendations for measures to mitigate and eliminate potential as well as major impact of the project. (4) Recommendations for alternative methods and technology that may potentially reduce the pollution level expected from the proposed project and for environmental considered method and technology. (5) Risk assessment of impact of the proposed project on human health and the environment. (6) Objectives, scope and indicators of the Environmental Management Plan. (7) Notes of consultations made with local authorities and communities likely to be affected bythe proposed project; (8) Other issues pertaining to the cultural stratum and nature of the project. 5. The project implementer shall be officially asked to comment on the DEIA report. 6. The project implementer shall bear the cost associated with the conduct of the DEIA. 7. The entity that has conducted the DEIA shall keep the original copy of the data and information collected in the field and findings of the investigation carried out by the assessment specialist. It shall be prepare a DEIA report in 4 copies, one of which is to be submitted MET,another to the project implementer, and third to the province or district governments having jurisdiction over the proposed project. The entity shall retain the remaining copy.
EMP (Article 9)	1. An EMP shall form an integral part of DEIA. 2. The entity that performed the DEIA shall develop an EMP in order to protect and ensure sustainable use and conservation of the nature and environment where the proposed project is to be implemented, ensure the realization of recommendations outlined in the SEA, mitigate, eliminate and prevent adverse impacts that are identified by the detailed impact assessment, and monitor and identify potential negative consequences that may arise in the proposed project environment. 3. The MET shall approve the EMP for the proposed project and grant the permit to go ahead with the project. 4. An EMP shall consist of an Environmental Protection Plan and Environmental Monitoring Program. 5. The Environmental Protection Plan shall address measures to mitigate and eliminate adverse impacts identified during the EIA and provide the timeframe and estimated budget for implementation of those measures. 6. The Environmental Monitoring Program shall address the monitoring and analysis of changes made to the state of the environment as a result of the project activity and shall clarify reporting requirements and ways to implement the plan as well as provide the timeline and estimated budget.
Appraisal of DEIA （Article 10）	1. The licensed entity having completed the DEIA shall submit it and related documents to the entity that performed the screening within the period specified. 2. The entity that received the report shall appraise its quality and issue an opinion within 18 working days. (The chief assessment expert of the MET may extend the appraisal period only once within 18 days.) The chief assessment expert of the MET may exclusively appoint a team of experts due to an appraisal of the assessment report. 3. The MET shall decide whether the project should go ahead based on the DEIA and the

Related Law	Summary
	opinions of the expert and the Technical Board that appraised the quality of the report. 4. The DEIA report shall be advertised and presented by the project implementer and the assessor of the DEIA to communities likely to be affected by the project.

Source：JICA Study Team based on EIA law

2)-2 Public Consultation Process

Implementing agencies shall be accountable to locals around the location and affected stakeholders by the project. The EIA law requires briefing the city and soum, having a consultation with the council at the screening stage, and submitting a resolution. In the DEIA stage, the project implementer and professional organization that conducted the assessment shall jointly present the DEIA report to the locals affected by the project (Article 10.5). The state central administrative body responsible for the nature and environment shall inform the public through its website about the development program, plans, and projects included in the EIA that will be evaluated strategically (Article 18.1). The deadline for public (oral and written) comments on the strategic assessment shall not exceed 30 working days (Article 18.3). During the preparation of the report, the legal entity conducting the detailed impact assessment of the project shall receive official comments and organize discussions from the administration of the project area and locals affected by the project (Article 18.4).

2)-3 Resettlement Plan

The EIA law does not describe the need to formulate a relocation plan. At the same time, Mongolia is currently drafting a land expropriation bill, but the timing of the enactment of laws has not been specified.

(3) Difference from JICA’s Guideline for Environmental and Social Considerations

The EIA law of Mongolia was developed based on the guidelines of donors and hardly differs from the “Guidelines for Environmental and Social Considerations” by JICA. The Revised EIA law, dated May 2012, includes SEA and descriptions on stakeholders and public participation. Mongolian EIA can be said to be equivalent to the Initial Environmental Examination (IEE) level because it is conducted in two stages. However, the target of Mongolian EIA law is the physical environment, and social considerations and Resettlement Action Plan (RAP) are not stated. Even if land resettlement occurs, the necessity of preparation of RAP is not regulated at present in the other laws. Currently, the draft Land Acquisition Law of Mongolia is being worked on, and its constitution period is not yet clarified.

Projects such as those proposed in this survey are the base development and classified as environmental category B under the "Japan International Cooperation Agency Environmental and Social Consideration Guidelines (revised in January 2022)". The project will implement underground construction and sufficient considerations on possible negative effects related to topographical and geological features, such as land subsidence, air pollution, noise/vibration, and accidents during construction and when operations begin. The project will be defined at the screening stage based on the estimated negative effects to human health and the natural environment (or if impossible to estimate), if a detailed investigation is necessary, or a huge amount of natural resources need to be developed through the project implementation that will require DEIA.

The implementation of the project is assumed, and the EIA is usually conducted immediately before the project implementation. Prediction and analysis on the negative effects in each evaluation item do not seem to be emphasized. Environmental monitoring is regulated in Article No. 9 of the EIA law. The implementation report, mentioned in next year's plan, needs to be submitted by December every year.

Stakeholder meeting is described in Article 18 of the EIA law in Mongolia, which is stipulated in the JICA Guidelines but not emphasized. Also, the public notice of the report to complete within 30 days to acquire public comment is shorter than its period stated in the JICA Guidelines.

2.1.3 Procedures related to Construction and Land Acquisition permit

The following are the laws, rules, and regulations regarding the issuance of construction permits.

- Law on Construction, 2016
- Law on Land, 2002
- Regulation for issuing the certificate for land ownership and use rights (Ordinance of Head of the Land Affairs, Geodesy, Cartography Agency No. 83 of 2008)
- Rules for developing building and facility design and conducting probability assessment (Government Resolution No. 108 of 2019)
- Rules for issuing building permits to start and continue construction (Government Resolution No. 68 of 2017)
- Regulations on Construction and Facility Use Permits (Government Resolution No. 212 of 2021)
- Regulation for granting land permits for construction in the capital city, approval of sketch drawing, the commencement of construction works and commissioning (City Council Resolution No. 5/14 of 2014)

Process of project implementation, construction, land acquisition permit are following below:

(1) Process to Project Implementation based on the Urban Planning Law

1) Based on the road master plan, the Construction, Urban Development and Planning Department of the city government conducts the bidding of the detailed design. A private company, including the UPRI, prepares the design under supervision by the department.
2) Approval of design by the Chief Architect (the director of the Construction, Urban Development and Planning Department) of the city government
3) Submission to Expertise (including Urban Development and Planning Division of ALACGaC).
4) Approval by the Residential Committee of Ulaanbaatar City.
5) Bidding by private companies for construction.

(2) Process of Road Construction Project

1) Based on the road master plan, the Road Department of the city government conducts the bidding of the detailed design.
2) Approval of the prepared detailed design from the Land Department of the city government and related departments and offices, including the Public Safety Committee, the Vice Mayor, and Chief Architect of the city government.
3) Calculation of the land acquisition costs and the acquisition of land by the Land Department
4) Communication with residents by the Land Department (no building permit is issued after the approval of the detail design by the Chief Architect)
5) Bidding/Construction of road by the Road Department

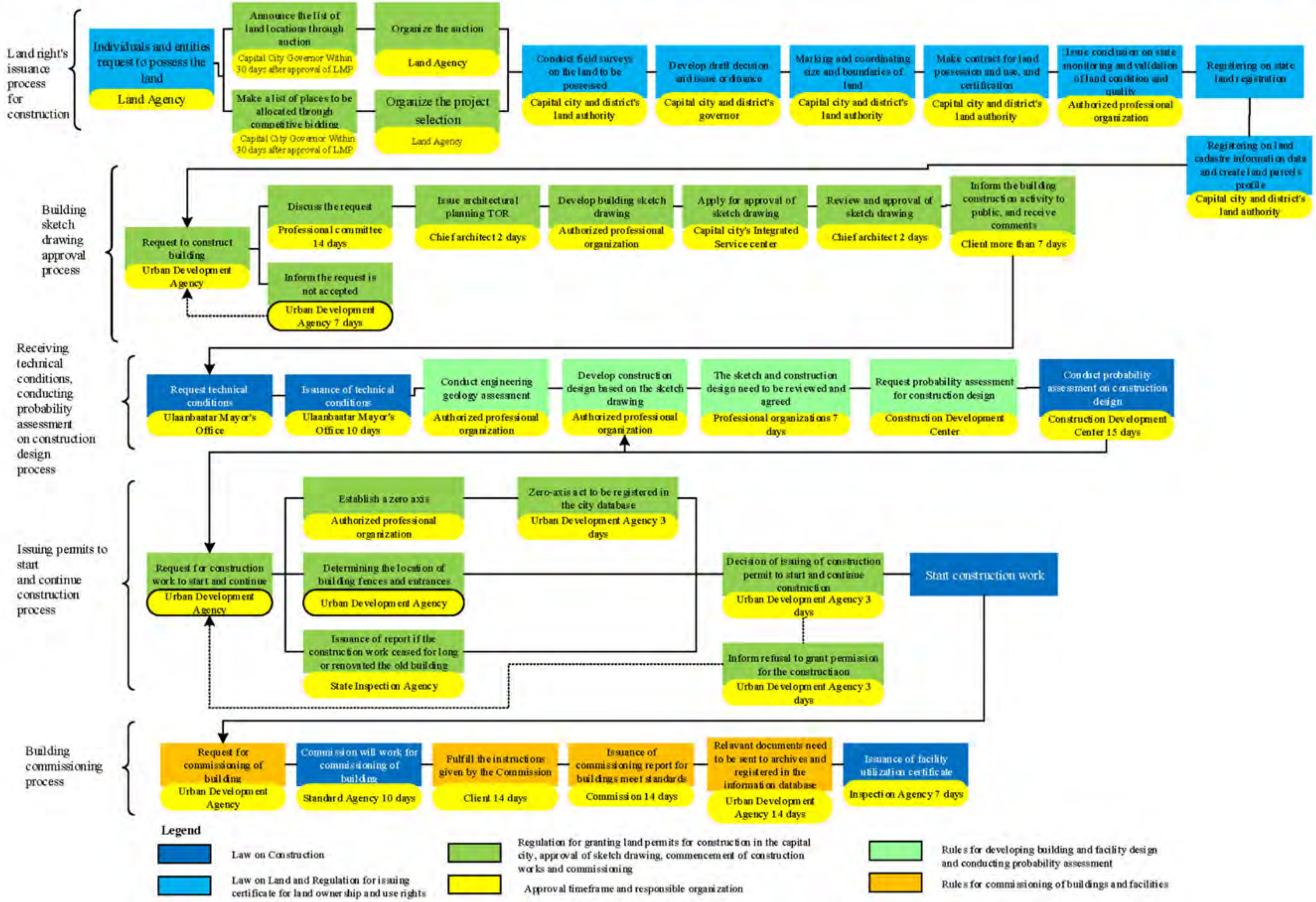
(3) Procedure of Land Acquisition for Public Purposes

1) Following the director of the Land Department of UB City announces the implementation of the project, the Land Acquisition Division of the Land Department informs residents about project implementation
2) The Land Acquisition Division sends the necessary documents (e.g., road development plan, land registration map) to the Property Relations Department of UB City
3) The Land Evaluation and Land Fee Division of the Land Department appraises and estimates the compensation for the land acquisition
4) The Property Relations Department appraises and estimates the property values
5) The Land Acquisition Division receives the documents of appraisals from the above two departments, then submits the documents to the City Governor for his approval, and explains and discusses the process with residents
6) After agreement with residents, the Land Use and Registration Division of the Land Department registers the land as a state property
7) The Land Acquisition Division prepares the report on the land registration

(4) Land Price

The government determines the land price. Per Cabinet Resolution No. 182 of 2018 on pricing, the Department of Urban Development and Land-related Policies (under MCUD) responsible for land-related matters is in charge of land price.

The Department of Land Evaluation calculates the land price based on the appraisal by the Land Registration Section of the Land Department and the land price set by the government. The Department of Property Relations is in charge of the real estate appraisal.



Source:A consultant WB Technical Assistance for housing

Figure 2.1 Procedures Related to Construction and Land Acquisition Permits

2.1.4 Legal Framework related to Infrastructure Investment

The legal framework related to infrastructure investment includes the Law on Debt Management and Law on Fiscal Stability, as well as the Law on Development Policy and Planning and its Management. An overview is given below.

Table 2.5 Laws related to Infrastructure Investment

Laws	Provisions related to infrastructure investment
Law on Debt Management (2015)	Provisions on debt (external borrowing, domestic bonds, government guarantees, PPP, Development Bank of Monglia [DBM], etc.)
Law on Fiscal Stability (2010)	Provisions on debt cieling.
Law on Development Policy and Planning and its Mnagement (2020)	Provisions on Public Investment Program (PIP) (attachment to the 5 year development plan)
Regulation on the Utilization of Government Foregin Loan Proceeds, Implementation, Administration, Financing, Monitoring and Evaluation of Projects Funded by These Proceeds (January 2021)	Provisions regarding procedures for external borrowing.

Source: JICA Study Team

(1) Law on Debt Management

The Law on Debt Management aims to set out a debt management policy to ensure an appropriate level of public debt. The law shall apply to relations that incur debt with repayment conditions from the state and local budgets and its management (Article 3.1) and stipulate government debt guarantees (Article 3.3), whereas it shall not apply to contingent liabilities or other assistance.

The law defines the scope of jurisdiction of relevant agencies as well as debt management policies and principles. The roles and responsibilities of the relevant agencies with respect to external loans are in Table 2.6.

Table 2.6 Roles of Relevant Institutions Stipulated by the Law on Debt Management

Organization	Authority and roles
Parliament (State Great Hural)	7.1.4 Define the state policy on external loans of the Government. 7.1.5 Ratify agreements on external loans of the Government. 7.1.6 Projects and measures to be financed by government borrowing, those are socially beneficial, but not viable to repay its financial obligations to the state budget, shall be defined, whether will approve without repayment conditions, with approval of the Budget Law of a particular fiscal year or case by case basis.
Government (Cabinet)	8.1.2. Based on the strategic document, shall submit an upper limit of new borrowing of the Government for the particular fiscal year with the budget proposal and submit the government new debt guarantee separately to the State Great Hural; 8.1.3. Issue authorization to sign on external loan agreements after consensus with the State Great Hural as stated in the Law on International Treaty; 8.1.4. Decide the matter to issue new debt and debt guarantee according to conditions and requirements of this law;
Ministry of Finance (MOF)	9.1.19. Prepare proposals for projects and measures to be funded by the government borrowing and debt guarantee to reflect in the medium-term investment program; 9.1.20. on behalf of the government of Mongolia, issue an official request to the international organizations and partner countries, for government external loans, and make negotiations, conclude contracts, coordinate and monitor it. 9.1.21. Organize evaluation, selection, and conclusion on projects and measures funded by the government borrowing and government debt guarantee

Source: JICA Study Team

External borrowing is stipulated in Chapter 4.1 on the "External loan of the Government" in chapter four. According to the provisions on obtaining and entering into an agreement with external loans in Article 25, the MOF shall propose to lenders and agree on those projects and measures included in the public investment program (25.1). In the loan agreement negotiations stated in Article 25.1 of this law, the MOF shall include the respective state central administrative body responsible for the sectoral policy issues, its subordinate agencies, and if necessary, other relevant professional agencies (25.2).

Article 25 stipulates that the MOF has the authority over proposals and contracts, but the following three points must be observed when concluding contracts: (i) the debt ceiling must not be exceeded, (ii) opinions of the MOF staff in charge of the proposal must be obtained, and (iii) opinion of the implementing ministries or agencies must be obtained (25.4).

The detailed procedures for loan agreements are stipulated in the “Regulation on the Utilization of Government Foreign Loan Proceeds, Implementation, Administration, Financing, Monitoring, and Evaluation of Projects Funded by These Proceeds,” as shown in Table 2.7.

Table 2.7 Procedures for Loan Agreement with Relevant Agencies in Mongolia

Step	Details
Proposal preparation	● Implementing agencies shall prepare their proposals. ● Proposals shall be submitted by the implementing agencies to the relevant sector ministries.
Proposal review in sector ministries	● Sector ministries shall review proposals. ● Sector ministries shall submit proposals to MOF with a General Introduction.
Procedures in the MOF	● The MOF shall review proposals, and if any proposal does not meet requirements, it will be returned to the sector ministry within 30 days. ● Project proposals that meet the requirements under the government's consolidated foreign loan policy and management, Government Debt Management Strategy and cooperation priorities of the development partner shall be prioritized and submitted to the Cabinet. ● In case the Cabinet decides to support the financing of the proposed projects with foreign loan proceeds, the MOF shall propose such project to the development partner. If the Cabinet does not support the proposal, it shall be returned to the sector ministry. ● The MOF may directly propose to the development partner of the projects, which are listed in the PIP to be financed by foreign loan proceeds.

Source: JICA Study Team

As part of the amendments to the relevant laws in line with the Annual Budget Law in 2022, a new article was added to the Debt Management Law, “25.9. The central administrative body in charge of finance and budget matters shall draft a regulation on the preparation of the government's external loans and the Cabinet shall approve the regulation” (date of effectivity: 1 January 2022). In the past, contracts of many ODA projects were concluded without sufficient discussion, resulting in reaching the debt ceiling. The new regulation is expected to clarify the process and ensure that loan agreements are concluded in accordance with the necessary procedures.

(2) Law on Fiscal Stability

The Law on Fiscal Stability is intended to establish fiscal management principles and special fiscal requirements to ensure fiscal stability; to determine the rights, duties, and responsibilities of state bodies regarding implementation and monitoring of these principles and requirements; and to regulate the relations that may arise out of or in connection with creating renewable wealth, making investments that support economic development and generating financial savings with mineral revenues (Article 1.1).

In relation to infrastructure investment, a debt ceiling[1] is stipulated for fiscal stabilization in 6.1.4, which specified that the net present value of the outstanding government debt should not exceed 60% of the gross nominal domestic product of the particular year. In addition, the debt ceiling was set higher than 60% until 2020, and it was scheduled to apply 60% from 2021. However, due to the increase in outstanding debt, the schedule was changed, extending the grace period up to 2023 in the July 2021 amendment. As a result, the debt ceiling is 70% in 2021 and 2022 and 65% in 2023. Application of 60% will start in 2024.

(3) Public Investment Program (PIP) under the Development Policy Planning and its Management Act

The PIP is a medium-term program of large-scale public investment projects with more than MNT 30 billion. According to the Law on Development Policy and Planning and its Management (hereinafter "Development Law"), which was amended in May 2021, the PIP is an attachment document of planned investment projects and actions required for the implementation of the five-year development policy of Mongolia in conformity with their budget, estimation, and source of finance in greater detail (4.1.10). The five-year development guideline shall attach a PIP, which is a detailed plan of public investment projects and measures to realize its objectives and, in accordance with the fiscal and financial calculations and financial resources. (6.7.1.c.). Thus, the PIP is considered as an attachment to the Medium-Term Development Plan for five years, requiring the approval of the Parliament.

In addition, Article 28.1 of the Law on Budget defines that infrastructure and development investment projects and activities aimed at ensuring economic and social development for the long term with a value of more than 30 billion togrogs, which are to be implemented for more than one year, shall be included in the PIP. Article 28.2 also specifies that implementing agencies, including ministries and local governments, shall prepare proposals of PIP and apply to National Development Authority (NDA). Article 28.3 stipulates that NDA determines the priority and implementation order of PIP projects based on selection criteria.

However, the PIP status has changed with the amendment of the Development Law. The Law on Budget was also amended. In its draft, the provision of PIP formulation every four years and annual review (28.8), the provision of annual updates of the PIP by NDA (28.9), and powers of NDA related to the annual budget application process for projects with less than MNT 30 billion were deleted. In November 2021, the amendment was approved by the Parliament; therefore, the legal framework that stipulates the PIP as a budget document has been lost, and formulating appropriate laws and regulations and systems for coordination with the budget is beneficial.

As for the detailed regulations on PIP formulation, the PIP formulation guidelines (Attachment No.2 of the Cabinet Secretary Order No.42)[2] was formulated and approved in June 2021. It stipulates the requirements for PIP projects, formulation procedures, evaluation and prioritization methods and procedures, revision, and operation and management. For the time being, PIP formulation proceeds in accordance with the Development Law and the Cabinet Secretariat Order No. 42.

There are separate procedures for project formulation and application of ODA and PPP. The process and regulations for securing financial resources are still under development but based on the PIP, an Annual Development Plan (ADP) is formulated for a single year, which becomes a basis of a single-year budget.[3] The ADP is a list of multi-year projects. Therefore, a project

[1] Government debt includes government foreign debt (government foreign securities and government foreign loans), government domestic debt, government debt guarantees, and Build Transfer Concessions. Foreign debt is appropriated in accordance with the disbursement plans of each project.
[2] The PIP Guidelines were developed with support from the JICA project and approved by the NDA Director General in June 2020.
[3] Currently, there is a lack of common understanding among related organizations on the positioning and formulation process of the PIP. It is still under development, including the legal framework. As a result, the PIP is not reflected in single-year plans and budgets.

included in the PIP list[4] is considered a medium-term development project to be prioritized for implementation by the government.

2.1.5 Policies on Natural Environment in UB City

Major policies and laws related to the natural environment in UB are as follows.

(1) Vision 2050

"Vision 2050," the long-term development policy of Mongolia, was approved by Parliament Resolution No. 52 on May 13, 2020. "Goal 6. Green Development" shows the promotion of green development and assurance of environmental sustainability.

(2) Five-Year Development Policy of Mongolia (2021–2025)

The Five-Year Development Policy of Mongolia (2021–2025) was approved under the Resolution No. 23 of the Parliament on 28 August 2020. The contents related to the natural environment are shown in the table below.

Table 2.8 Evaluation Index of Five-Year Development Policy of Mongolia and Related Items in Achievement Goals

No.	Index	Unit	Baseline	Achievement Goal (2025)	Explanation of Indicators	Frequency of Information Gathering	Institution in Charge
77	Greenhouse gas emissions	%	Base scenario	12.3	-	Once every two years	MET
85	Extension of new flood embankments, waterways, and drainage facilities	Kilo meter	432.5	636.9	Base as of 2019	Once a year	MCUD
87	Newly designed regional transportation and logistics center	place	-	4	The index refers to the new center and is displayed in total. The baseline starts at 0.	Once a year	MRTD
94	Annual average of PM 2.5 in the atmosphere of UB City	$\mu g/m^3$	64	40	Baseline as of 2018	Once a year	MET
95	Annual average of PM 10 in the atmosphere of UB City	$\mu g/m^3$	141	88	Baseline as of 2018	Once a year	MET

Source: Five-Year Development Policy

Table 2.9 Five-Year Investment Program of Mongolia

No.	Project Name	Period	Budget amount /Million MNT/	Funding Source	Institution in Charge
107	Improvement of the capacity of Natural Environment Research Center	2021–2024	42,562.00	Korean Soft Loan	MET
108	Tuul and Selbe River flow improvement, environmental improvement project	2021–2024	170,355.00	China Soft Loan	Ministry of Finance
			7,896.00	National budget	
144	UB City Clean Air Project-2	2021	34,071.00	World Bank Soft Loan	Governor's Office

Source：Five-Year Development Policy

[4] The PIP 2021–2025, which was prepared in 2020 based on the Development Law, consists of three lists: (i) the main list of projects for which the F/S have been conducted and financial resources have been determined, (ii) a monitoring list of projects on the main list, (iii) a list of projects for which financial resources have not yet been determined, and (iv) a list of projects for which the F/S have not yet been conducted. However, the position of each list is not clear, details such as the positioning of each list and the transfer between lists are not specified, and laws and regulations need improvement.

(3) Ulaanbaatar Mayor's Four-Year Roadmap (2020–2024)

Ulaanbaatar Mayor's Four-Year Roadmap is approved by the Resolution of the City council No.02/10, 4th December 2020. The contents related to the natural environment, aims to reduce air pollution in the capital city of UB by 80% and to implement policies to reduce air pollutants from vehicles.

(4) Five-Year Development Plan of Capital City (2021–2025)

The Five-Year Development Plan of Capital City was approved by the Resolution of the City Council No. 02/9, 4 December 2020. The table below lists the items related to the natural environment.

Table 2.10 Five-Year Development Plan of Capital City

Five-Year Development plan of Capital city (2021-2025)	Target 6: Conservation of natural resources, reduction of environmental pollution by ensuring ecological balance, adaptation to climate change ・Reduce air pollution by supplying improved fuel to households in Ger area (reduce the annual average of $PM_{2.5}$ in UB to 40 $\mu g/m^3$ and PM_{10} to 88 $\mu g/m^3$) ・Increase in the number of air quality monitoring stations ・Promote participation in air pollution reduction and provide information

Source：Five-Year Development Plan of Capital city

(5) National Program for Reduction Air and Environmental Pollution

The National Program for Reduction Air and Environmental Pollution approved in 2017 includes the following measures to be taken in 2017–2025: (i) traffic-related measures to gradually ban traffic in the city that does not meet emissions standards, (ii) supporting import and use of EURO5 standard fuel, (iii) strengthening fuel quality control systems, (iv) switching to gas fuels and electricity in transportation, (v) introducing environmental-friendly technologies and transportation, expanding the road network, (vi) introducing a traffic control smart system, (vii) reducing pollutant emissions through the quality and maintenance of public transportation services, (viii) gradually restricting the import of aged vehicles, and (ix) legal environment development to promote electric and gas vehicle and to investigate actual situation of noise and other negative impacts, and to establish a management system.

2.2 Overview of Urban Development and Urban Transport Planning in UB City

UB City has formulated various master plans in the field of urban development and transportation planning, including "UB City Urban Planning Master Plan 2020 and Development Trend 2030 (MP2020)" and "UB City Urban Planning Master Plan 2040 (MP2040)" as urban development master plans, "UB City Road Network Development Medium and Long Term Master Plan (UBRD2030)" as urban transportation plans, " UB City Traffic Congestion Mitigation Measures", and master plans by other donors. This chapter presents an overview of these plans besides the higher government policies and shows their relevance to this study.[5]

[5] In Mongolia, the implementation of national and municipal policies and plans often did not proceed as planned due to the lack of budgetary considerations in the plans and the lack of a mechanism to ensure the funds of approved plans.

2.2.1 UB City Master Plan 2020 and Development Trends 2030 (MP2020)

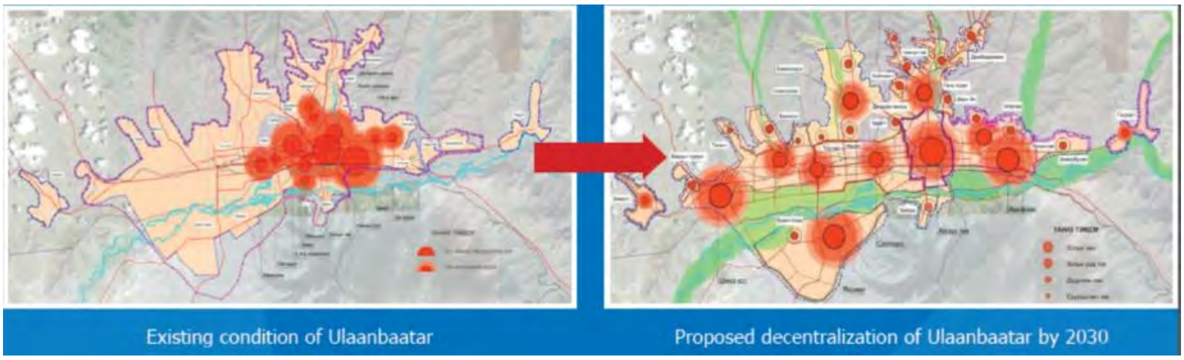
The MP2020 is a master plan developed by the local government based the "Ulaanbaatar Urban Planning Master Plan for Mongolia" conducted by JICA in 2007. It was approved by the Parliament (Resolution No. 23) on 8 February 2013. The urban issues identified at the time of preparation are shown in Figure 2.3.

Source: General summary for public, MP2020 (2014).

Figure 2.3 Urban Challenges of MP2020

The future vision to address the challenges is to become a smart city with Mongolian characteristics as the capital of the country, respecting nomadic culture, placing value on people, taking advantage of geological features, being environmentally friendly, and having industry and economy that is globally competitive and equipped with state-of-the-art technology. The six priorities for achieving this vision were: (i) a safe, healthy, and green city; (ii) a livable environment; (iii) good governance and legal environment; (iv) residential, urban, and satellite city development; (v) an Asian tourist destination; and (vi) a capital city that meets global standards. The strategies to achieve this include: (i) reducing population concentration; (ii) improving the planning system by introducing a land-use zoning system; (iii) improving the road and public transport network; (iv) improving the existing socio-economic infrastructure; (v) redeveloping ger areas into apartment areas and developing apartment areas; (vi) improvement of basic infrastructures such as utilities and telecommunications, and (vii) creation of sustainable environmental management.

In the field of transportation, the plan was to create a multi-core urban structure to reduce traffic congestion and connect the city center and sub-centers with six east-west corridors, nine north-south corridors, and four ring roads (see Figures 2.4 and 2.5). In addition, as a wide-area development, satellite cities were planned to be developed to disperse the population of UB. As well as a wide-area transportation network to connect UB to the world economy, the Bogdkhan railway, road network connecting satellite cities and villages, Asian Highway No. 3 (AH-3) bypass, and development of four logistics centers were planned (see Figure 2.6).

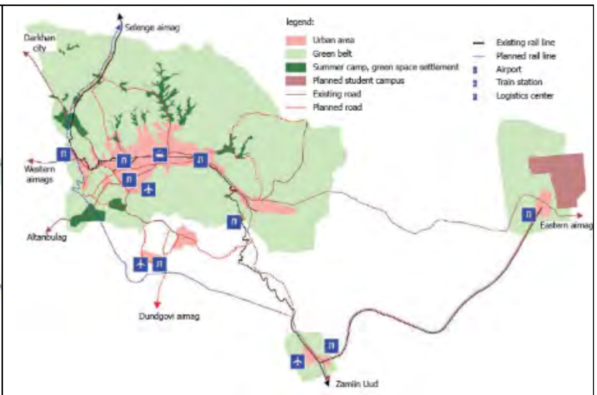


Source: General summary for the public, MP2020 (2014).

Figure 2.4 Urban Structure of MP 2020

Source: General summary for the public - UBMP2020 (2014)

Figure 2.5 Road Network plan in MP2020



Source: General summary for the public - UBMP2020 (2014)

Figure 2.6 Wide-area Road Network Plan in MP2020

2.2.2 Review of Upper-Level policies on Urban Development in UB City

There are three high-level related policies in the UB City Urban Development Plan: the "Long-Term Development Vision 2050," the "Five-Year Development Policy for Mongolia 2021–2025," and the "Long-Term Development Vision 2050 Action Plan for 2021–2030." Mongolia is consistently following the policy of the "Long-Term Development Vision 2050" and aiming to build a multi-nuclear city through the development of sub-centers, promote the redevelopment of the ger areas, and decentralize industry and population by transferring urban functions to satellite cities and other areas outside the six central wards of UB City.

(1) Long-term Development Vision 2050

The country's "Long-Term Development Vision 2050" was prepared by the NDA (became the Ministry of Economic Development since January 2022) under the leadership of the Chief Cabinet Secretary and approved by the Parliament in Resolution No. 25, 2020. In the policy, "UB City and Satellite Cities" is addressed in Chapter 9.

Goal 9.1 of "human-centered city" includes the construction of a medical service network, the development of sports facilities, and the construction of schools and kindergartens as comprehensive development centers. As for Goal 9.2 of “environment-centered solutions,” it includes the construction of parks, the formulation of an organic food supply network, and the introduction of climate change countermeasure technologies, green building standards, recycled water systems, eco-electric public transportation, and renewable energy. Goal 9.3 of "urban development based on planning" includes infrastructure development, such as the construction of the Bogdkhan railway, introduction of e-banking and other e-finance technologies, development of a passenger transportation network around Mount Bogd and highways connecting satellite cities, and introduction of AI-based smart technologies into urban development. Goal 9.5 is to “create tourism, cultural services, and industries based on the characteristics of the country, and to develop satellite cities that will become transportation, logistics, and international hubs in Northeast Asia.” It includes development infrastructure, utility facilities, and housing in New Zuunmod and Maidar and utilizing the international airport to make UB City a passenger and cargo transportation hub in Northeast Asia.

(2) Mongolia’s Basic Development Policy 2021–2025

Based on Stage 1 activities in Goal 9 of the lont-term development vision 2050, Mongolia’s Basic Development Policy 2021–2025 (Parliament resolution No. 23, 28 August 2020) addresses the following: reduction of 80% of air pollution in UB City (9.2.1); introduction of innovative technology in the transportation services to reduce pollution (9.2.2); construction of new urban center and sub-centers (9.3.1); introduction of smart public transporation system (9.3.4); implementation of F/S for the development of the Bogd Mountain Round Trip Passenger Transportation Network (9.3.5); intensive development for UB City to become a hub for passenger and cargo transportation in Northeast Asia centered on the new international airport (9.5.2); development of basic infrastructure and residential areas in New Zuunmod and Maidar (9.5.1); relocation of factories and companies that have a negative impact on the environment in UB City (9.5.3); relocation of enterprises and business entities that have a negative impact on UB to satellite cities (9.5.5); and relocation of universities and research institutes to satellite cities (9.5.6), etc.

(3) Long-Term Development Vision 2050 Action Plan for the Years of 2012‐2014

The following activities will be undertaken In order to achieve Goal 9.5 of the Long-Term Development Vision 2050: decentralization of urban functions in UB through the development of new urban centers and sub-centers (9.3.2); housing supply through redevelopment (9.3.3); implementation of housing programs by constructing 150,000 units based on various needs (9.3.4); relocation of factories and companies that have negative impacts on the environment in UB (9.3.7); decentralization of industries to satellite cities (9.5.1); and development of basic infrastructure and residential areas in New Zuunmod and Maidar (9.5.2). In addition, with regard to transportation and roads in particular, the following are addressed.

- Utilization of underground space for road, transportation and infrastructure development (9.3.8)
- Introduce multimodal and smart public transportation (9.3.12)
- Introduce high-capacity electromagnetic transport modes on high-capacity arterial roads with large passenger capacity (9.3.14)
- Introduction of a ropeway and associated parking lot development (9.3.15)
- Construction of a bus network (9.3.16)
- Implementing Smart Systems in Road Networks (9.3.18)
- Establishment of a unified automobile service registration and information database and improvement of the warranty service system in the automobile service sector (9.3.19)
- Establishment of sub-center based distribution centers and promotion of large scale trucking on suburban arterial roads (9.3.20)
- Introduce high-capacity transport linking satellite cities according to passenger flows (see below9.3.21).
- Development of transit terminals and parking lots between transportation modes (9.3.22)

- Provide transportation services for commuting to schools (9.3.23)
- Build a charging network for electric and gas vehicles (9.3.24)
- Refurbishment of public transport management, information, and control center, and introduction of smart systems into the road network (9.3.25)
- Construction and expansion of sidewalks, bicycle paths, tunnels and bridges, and establishment of their monitoring systems (9.3.26)
- Formulation of an advanced parking management system (9.3.27)
- Development of road zoning and regulation of vehicular traffic (9.3.28)
- Introduction of joint ownership of automobiles and car rental services (9.3.29, 9.4.9)
- Implementation of city cab service development projects and programs (9.3.30)
- Construction of a passenger transportation network around Mount Bogd (9.3.31)
- Construction of Bogdkhan freight railway (9.3.32)

2.2.3 UB City Urban Planning (MP2040)

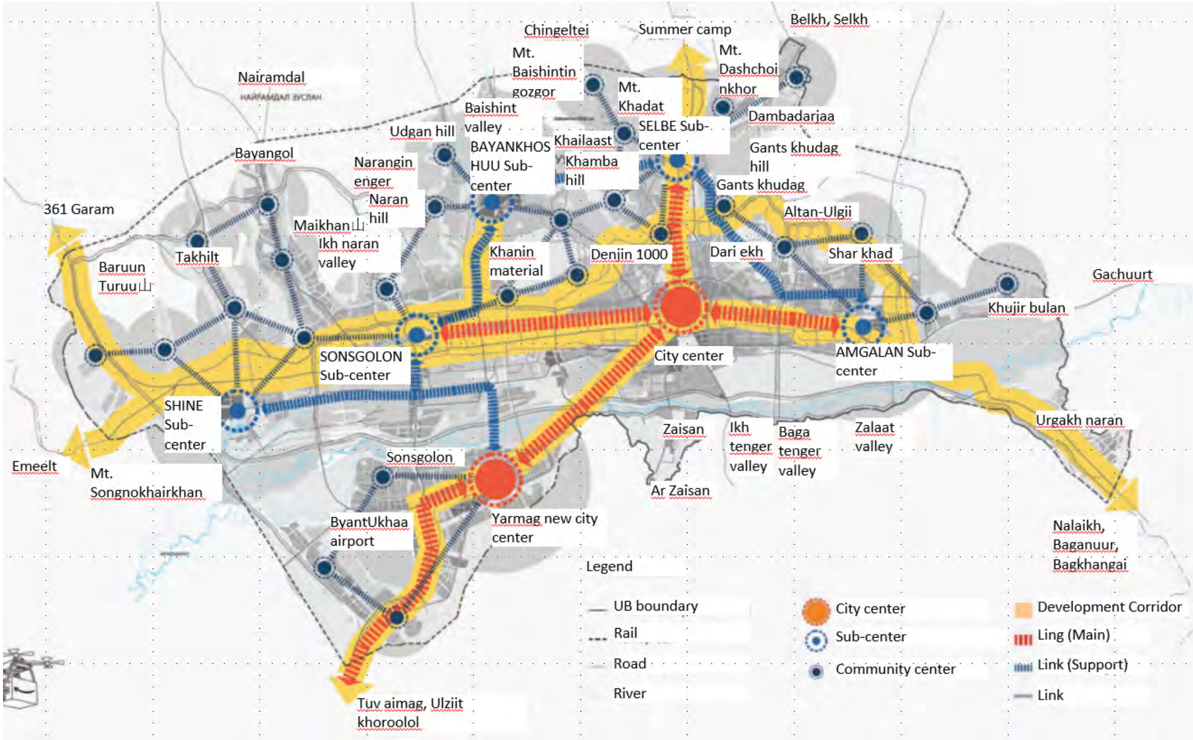
(1) Outline

The concept of MP2040, being prepared by the Urban Planning and Development Institute (UPRI), a city corporation under the UB City Urban Planning Department, was approved by the city council in October 2019 and was discussed and agreed upon by the cabinet in June 2020. UPRI is preparing MP2040.[6]

Based on the review of the previous master plan of MP2020, the city aims to be a "livable city" and has the following six policies: (i) sustainable development, (ii) a vibrant city, (ii) a city that can cope with climate change, (iv) integrated development including neighboring satellite cities, (v) a city with accessibility that is friendly to all people, and (vi) a city that contributes to energy and resource conservation. However, since MP2020 was not realized, many of its policies were acquired by MP2040.

According to the draft plan released in October 2021, the city plans to build a multi-nuclear city by developing five sub-centers and 26 community centers in addition to the central area centered on Sukhbaatar Square and Yarmag new city (see Figure 2.7).

[6] https://home.uda.ub.gov.mn/?p=8593. The ADB is assisting in the preparation process.



Source: Survey team translation of MP2040 draft

Figure 2.7 Urban Structure of MP2040

(2) Road Development Plan

In terms of roads, a total of 1,738.8 km of new roads (402.3 km of arterial roads, 768.5 km of secondary arterial roads, and 568.0 km of district roads) are planned to be developed in order to expand the road network and reduce congestion. It is expected to increase the average traffic speed from 9 km/h to 22.5 km/h at peak time by constructing 14s of new grade-separated intersections, 30 bridges, and 9 locations of underpasses (see Figure 2.8). In addition, there are plans to develop a bicycle lane (1,059.9 km) and sidewalk (633.26 km).

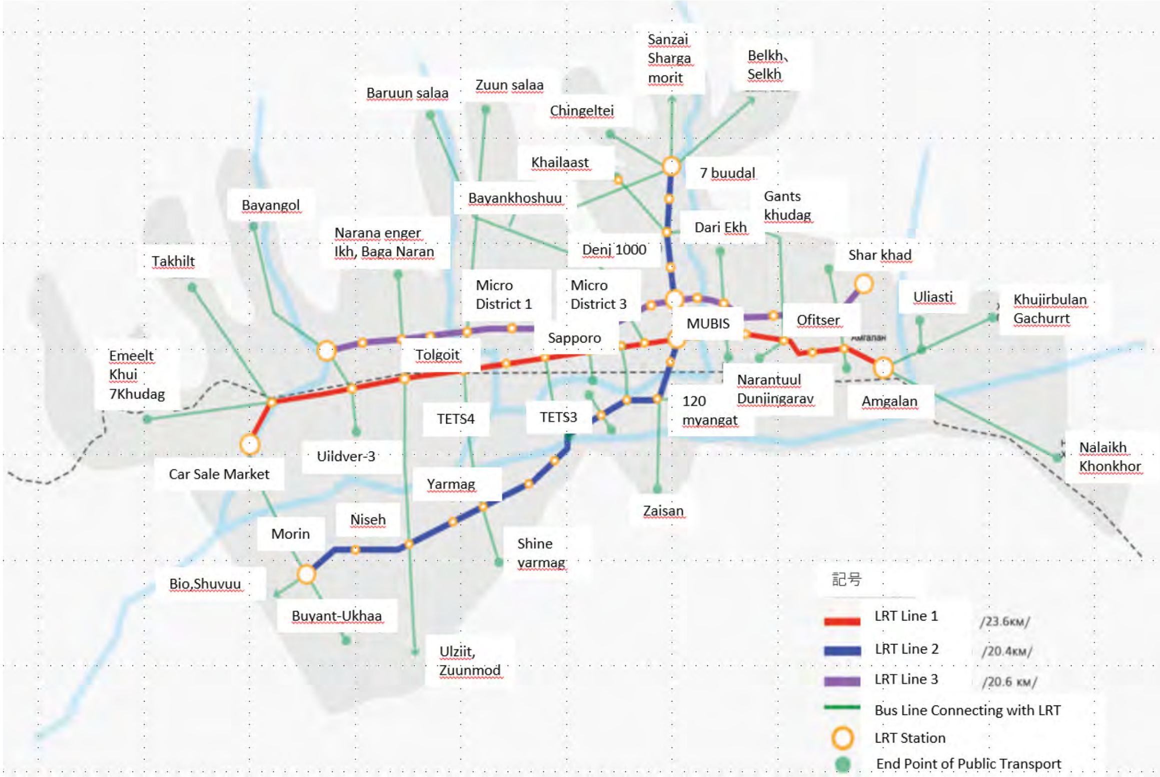
Source: UBMP2040(Draft) translated by JICA Study Team

Figure 2.8 Road Network Plan for UBMP 2040

(3) Public Transportation Development

In terms of public transportation, the plan is to transport 1,200,000 people per day, double the current capacity, by bus, electric bus, and urban railway.

UB city is planning to introduce light rail transit and consider the construction of three new urban railway lines with a total length of 64.6 km, as shown in Figure 2.9. The light rail transit (two for east–west lines and one for north–south line in total three lines) is proposed and a linkage with the bus transportation and the endpoints of public transportation is also suggested in the plan.

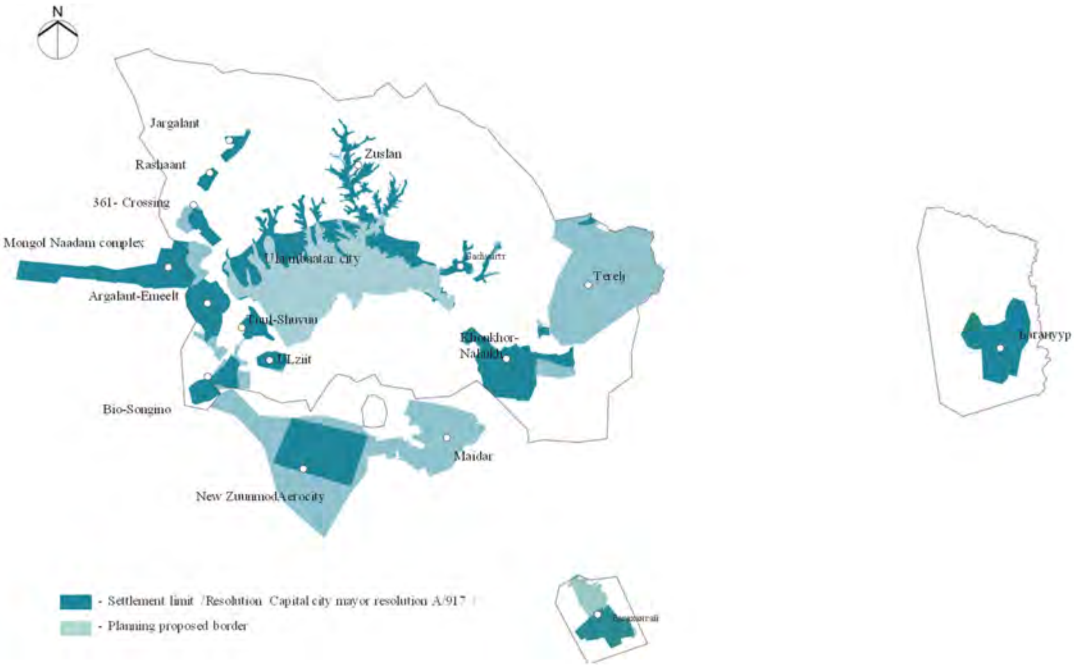


Source: Survey team translation of MP2040 draft.

Figure 2.9 Public Transport Plan in MP2040

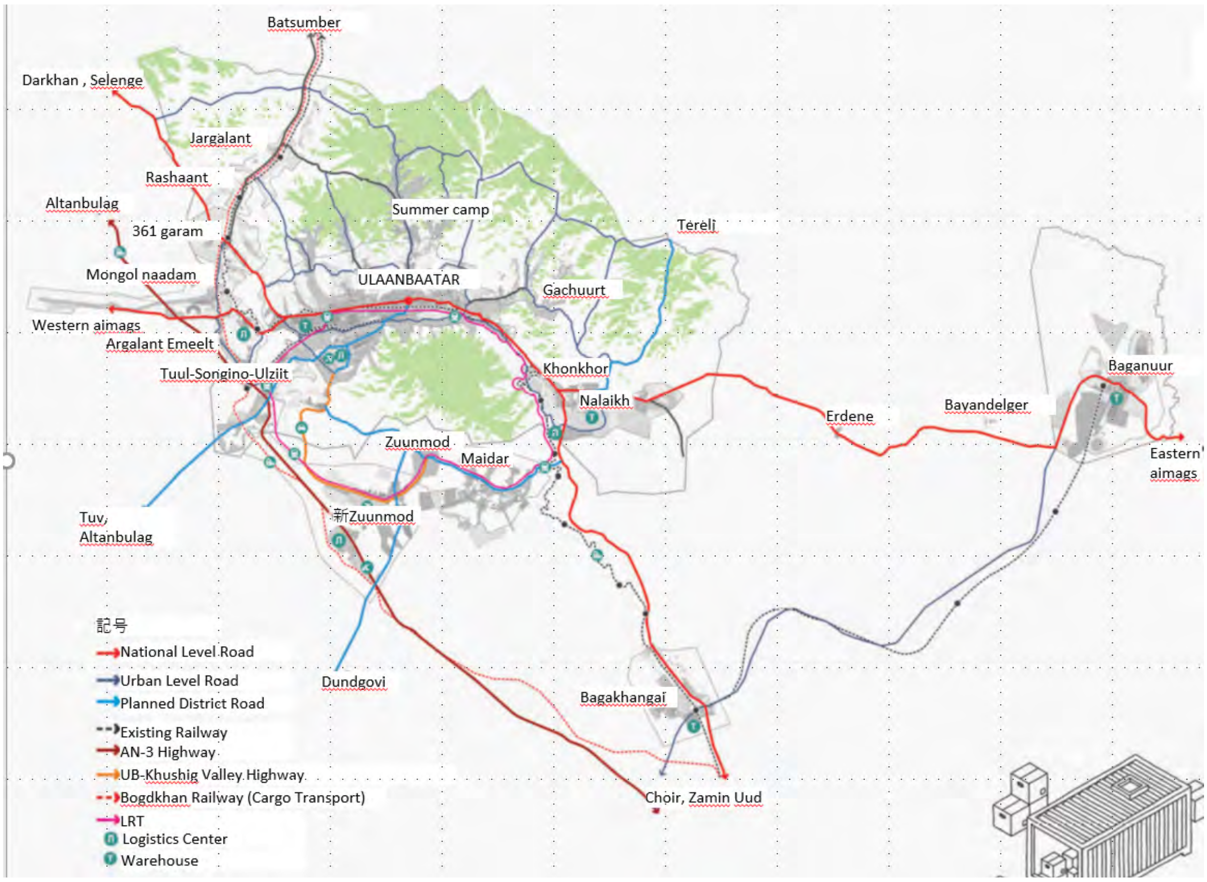
(4) Urban development

The area surrounding Bogd Mountain, including New Zuunmod and Maidar (but excluding Zuunmod), will be included in the boundary of UB City. The future population of UB City will be set at 2,089,000 in 2040, of which 440,000 will live in the satellite cities, including New Zuunmod (see Figure 2.10). The road network connecting the satellite cities is shown in Figure 2.11.



Source: MP2040 Brief Introduction

Figure 2.10 Satellite city plan in MP2040



Source: JICA Study Team translation of MP2040 draft.

Figure 2.11 Regional Road Network Plan in MP2040

2.2.4 UB City Road Network Development Medium and Long Term Master Plan (UBRD2030)

(1) Overview

The UB City Road Network Development Medium and Long Term Master Plan (UBRD 2030) was prepared in 2018. The outcome of UBRD2030 has been utilized as the basic data for the 2020–2024 Capital Governor and Mayor's Action Program issued on 4 December 2020 (City Council Circular 02/10) and UB City Urban Plan MP2040, which is currently under preparation. Based on the detailed analysis of the current situation, the UBRD2030 consists of 8 policies, 26 major targets, and a 128-implementation program for road network development, as shown in the table below. A total amount of 9,605 billion MNT investment was estimated for the implementation of all programs to be completed by 2030.

Table 2.11 List of Implementation Program under UBRD2030

Priority Policy	Major Target	Implementation Program
1. Plan and develop road network based on technical analysis in accordance with social, economic growth, needs of the nation and the metropolitan area,	1.1 To scientifically study and plan a road network to mitigate traffic congestion,to ensure balanced traffic and to meet traffic demand in UB. [4,451,135 M.MNT].	1.1.1 Road network planning
		1.1.2 Development of new primary arterial roads
		1.1.3 Development of new secondary arterial roads
		1.1.4 Development of new district roads
		1.1.5 Widening and rehabilitation of primary arterial road
		1.1.6 Widening and rehabilitation of secondary arterial roads
		1.1.7 Widening and rehabilitation of district roads

Priority Policy	Major Target	Implementation Program
		1.1.8 Construction of new bridges
		1.1.9 Widening and rehabilitation of bridges
		1.1.10 Grade separation of intersection
		1.1.11 Improvement of intersections
		1.1.12 Land acquisition and utility relocation for road construction
	1.2 To connect road network with satellite cities [349,089 M.MNT].	1.2.1 Promote maintenance of paved roads in suburban and satellite cities
		1.2.2 Improve transportation capacity to satellite cities
	1.3 To enhance the capacity of international cargo traffic	1.3.1. Develop international roads and expressways
2 Compliance with international standard for road networks and infrastructure	2.1.To establish a comprehensive technical infrastructure by widening, rehabilitationg and constructing new road network that conforms with the international standards. Preparatory works in compliance with appropriate requirements and close coordination with on-ground and under-ground network facilities when expanding, improving and constructing new roads. [2,479,759 Million MNT].	2.1.1 Preparation for construction works in compliance with requirements
		2.1.2 Provide maintenance points on the hot water pipe network.
		2.1.3 Reinforcement of the heating pipe network under the existing roadway
		2.1.4 Relocation of the heating pipe network from existing roadway
		2.1.5 Reinforcement of water supply pipe network under roadway
		2.1.6 Reinforcement of sewerage pipe network under roadway
		2.1.7 Provide power supply and lighting along streets and roads
		2.1.8 Rehabilitation of communication cables along with roadway
		2.1.9 Relocation and installation of communication cables along with roadway
	2.2 To develop vehicle parking facilities and improve its operation and management capabilities. [277,268 Million MNT].	2.2.1 New development of outdoor parking lot
		2.2.2 Improve and upgrade the capacity of existing outdoor parking lots
		2.2.3 Construction of underground parking lot
		2.2.4 Construction of multi-story parking lots
		2.2.5 Establish a database of parking information
		2.2.6 Improving the operation and management of parking lots
		2.2.7 Smart system for parking lot operation
		2.2.8 Legislation for parking lot operation
	2.3.To improve walking space at sidewalk [66,101 Million MNT].	2.3.1 Development of walking space
		2.3.2 Ensuring the safety of pedestrian and disabled people
		2.3.3 Establish a database of sidewalk space information
		2.3.4 Introduction of smart system for crosswalk.
	2.4 To develop bicycle traffic space [67,518 Million MNT]	2.4.1 New Bicycle Road Development
		2.4.2 Ensuring the safety of pedestrians and cyclists
		2.4.3 Establish a bicycle road database.
		2.4.4 Promotion of "Bicycle road Sub-Program”
		2.4.5 Develop bicycle parking and its operation
		2.4.6 Education on bicycle traffic safety
		2.4.7 Implementation of the “Ubike” program.

Priority Policy	Major Target	Implementation Program
	2.5 To develop green belt [56,098 Million MNT]	2.5.1 Green space development in urban areas
		2.5.2 Capacity development of urban green development
		2.5.3 Improve the legal environment for green spaces and update standards
	2.6.To improve integrated traffic control systems [18,813 Million MNT]	2.6.1 Repairing of existing CCTV camera
		2.6.2 Improve congestion at intersections without traffic lights
		2.6.3 Development of Smart Traffic Control
	2.7 Maintenance of urban roads facility [1,274,477 Million MNT]	2.7.1 Road maintenance and repair work
		2.7.2 Implementation of periodic maintenance
		2.7.3.Implementation of major renewal work
		2.7.4 Emergency work
		2.7.5 Survey of road surface condition
		2.7.6 Identification of required service level of road and the role of the agency of road surface condition verification agency
		2.7.7 Monitoring of road and bridge maintenance
		2.7.8. Improve enforcement of Road Fund management
	2.8 To comply with the requirements of relevant standards in the construction of roads and bridges. [4,010 Million MNT]	2.8.1 Apply geographic features and weather data to road construction
		2.8.2 Quality survey of materials for road construction
		2.8.3 Conduct audits of road construction quality control and standards, and establish its database
		2.8.4 Properly schedule construction and maintenance works according to climatic conditions and introduce the latest technology
		2.8.5 Update technical standards for sidewalk traffic and bicycle paths
3 Develop road infrastructure which efficiently suffices the demand of passenger and/or freight traffic	3.1 To improve the public transportation system [8.7 million MNT]	3.1.1 Develop a public transportation master plan for UBC
		3.1.2 Establish a BRT system.
		3.1.3 Establish Bus Priority Lane
		3.1.4 Construction of bus stop
		3.1.5 Appropriate bus network including its routes and bus stops
		3.1.6 Improve the bus fare system and establish an integrated database of transport services.
		3.1.7 Construct a bus terminal
		3.1.8 Review public transportation route plans
		3.1.9 Update vehicles for public transportation
		3.1.10 Improve accessibility to public transport services for people with disabilities
		3.1.11 Improve taxi service
	3.2 To improve the freight transport business [499,220 million MNT]	3.2.1 Establish an international logistic center
		3.2.2 Establish district logistic centers
		3.2.3 Identify and reinforce heavy vehicle road
		3.2.4 Establish a logistic information database
		3.2.5 Improvement of cargo receiving, delivery, and stock
		3.2.6 Improve delivery service by using dedicated

Priority Policy	Major Target	Implementation Program
		vehicles
4 Establish an optimal traffic control system and road network to ensures road safety	4.1 To strengthen road traffic safety [6,400 million MNT]	4.1.1 Natural disaster risk assessment and drainage facility improvement
		4.1.2 Prevent potential risks to residents and environment
		4.1.3 Identify ROW, flood risk areas, preservation areas, etc.
		4.1.4 Development and maintenance of road facilities in response to the natural environment
		4.1.5 Conform road facilities and lighting to international standards
	4.2.To reduce traffic accident [3,690 million MNT]	4.2.1 Ensure the safety of road structures and related facilities
		4.2.2 Identify reason of traffic accident and take measures
		4.2.3 Improvement of vehicle inspection system
		4.2.4 Restrict import of right-hand drive vehicles and used vehicles.
		4.2.5 Ensure the safety of cargo and passenger transportation with dedicated vehicles.
		4.2.6 Road safety training and education
		4.2.7 Strengthen the content of examination for the driver's license
5 Develop an environmentally friendly road network that does not adversely affect the lives, health, nature, or environment of residents.	5.1 To consider the health of residents and the natural environment [1,780 million MNT]	5.1.1 Promote environment-friendly construction
		5.1.2 Eliminating poorly maintained vehicles to reduce air pollution
		5.1.3 Standardize limit of noise and vibration
		5.1.4 Review cleaning and maintenance systems for public facilities
	5.2 To decentralize the traffic in the center of UBC [300 million MNT]	5.2.1 Billing system based on vehicle type and area.
6. Develop a smart system for road transportation.	6.1 To introduce smart systems for traffic control [21,813 million MNT]	6.1.1 Introduction of smart systems to road facility
		6.1.2 Introduction of smart systems for traffic control center
		6.1.3 Operation of parking lot by smart systems
		6.1.4 Inroduction of smart system for crosswalks
		6.1.5 Introduction of Alarm, GPS & smart management system
		6.1.6. Introduction of RFID system
	6.2.To introduce advanced management software to traffic control system [4,295 million MNT]	6.2.1.Update existing traffic control system (TSM)
		6.2.2 Discourage illegal parking (PES, etc.)
		6.2.3 Implement mobile control devices to control double-turn vehicles
		6.2.4 Development of application for checking traffic conditions
		6.2.5 Develop software to improve operation of toll collection stations
		6.2.6 Develop and promote the I-Report program
		6.2.7 Develop management software for road construction and maintenance
	6.3.To develop smart systems for public transportation	6.3.1 Implementing a Bus Information System (BIS / BMS)
		6.3.2 Improve smart card system operation

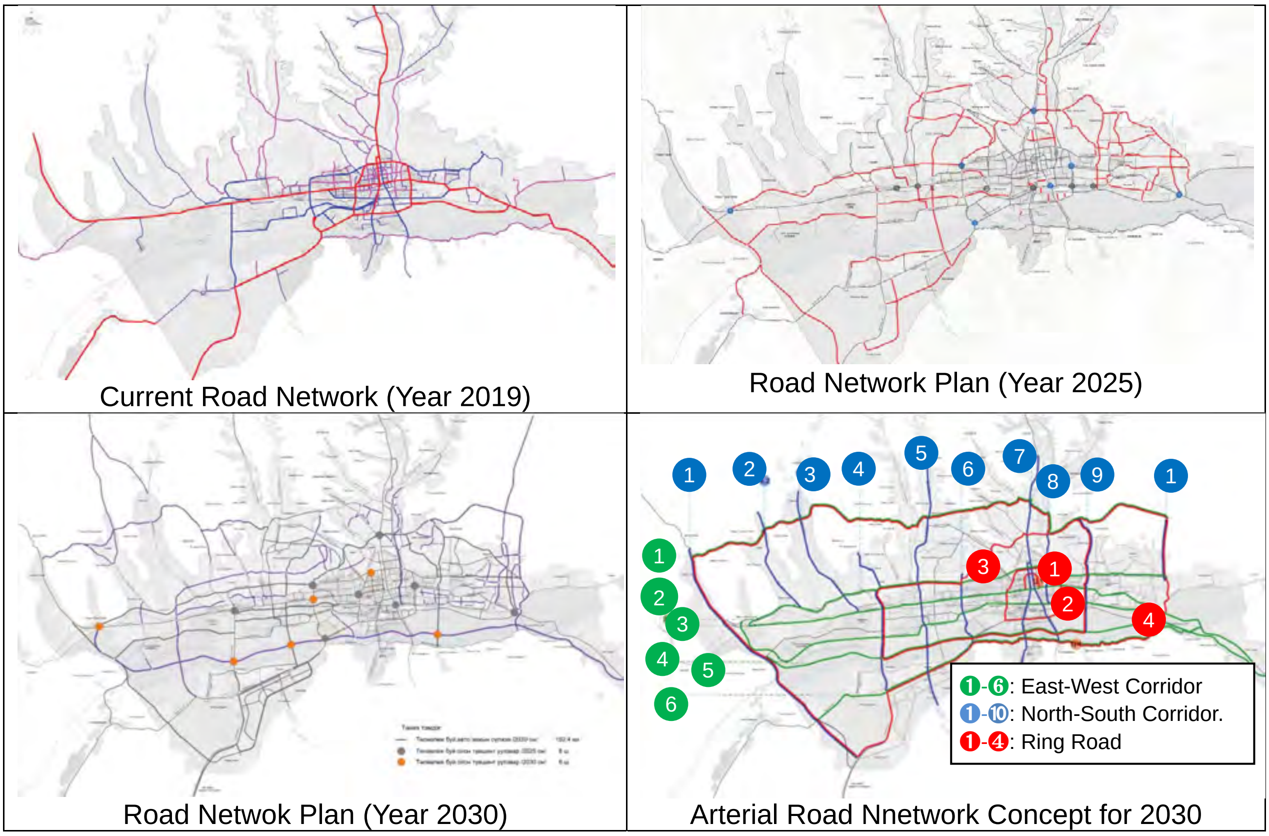
Priority Policy	Major Target	Implementation Program
	[150 million MNT].	management
	6.4 To develop smart system for freight transportation business. [1,980 million MNT]	6.4.1 Establish a spatial information database for cargo distribution
		6.4.2 Introduction of RFID system
7. UB Strengthen and improve the capacity of the city's road transport sector	7.1 To improve the organizational structure [1,250 million MNT]	7.1.1 Improve the organization of the transportation department and planning
		7.1.2 Establish a specialized organization to formulate road transport policy
		7.1.3 Clarify the role and responsible of entity for road maintenance and management.
	7.2 To strengthen the institutional capacity of public transportation [7,370 million MNT]	7.2.1 Renewal of vehicles for public transportation
		7.2.2 Strengthen the human resource capacity of the road transport sector
		7.2.3 Human resource development based on the experience of developed countries
8. Formulate the legal environment and its coordination	8.1 To improve the consistency of the purpose,regulatory,and coverage of laws and regulations in the road sector [1,445 million MNT]	8.1.1 Harmonization of Road Law and related laws
		8.1.2 Optimization of the system, structure, and function of the road sector
		8.1.3 Improve the legal environment for effective road construction financing
		8.1.4 Improve the legal environment for road maintenance and management costs
	8.2 To address and improve the issues related to the enforcement of laws and regulations in the road transport sector [2,110 million MNT]	8.2.1 Develop standards and criteria for the design and construction of urban roads
		8.2.2 Update existing codes and standards
		8.2.3 Develop guidelines and implementation procedures
		8.2.4 Update UB City road classification

Source: UBRD2030

(2) Road Plan

To address the issue on the future severity of traffic congestion in UB City, the road network improvement was proposed, as shown in Figure 2.12, to strengthen the traffic capacity of arterial roads, mitigate traffic congestion at the major intersections, and shorten the travel time in UB City under UBRD2030. The implementation has already started.

Six corridors in the East–West direction, 10 corridors in the North–South direction, and 4 ring road system will be developed, and the current road network with a length of 779.3 km is scheduled to be extended to 1026.2 km by 2025 and 1726.3 km by 2030.



Source: UBRD2030

Figure 2.12 Future Road Network based on UBRD 2030

Once the road network is formulated as proposed in the UBRD, traffic volume on arterial roads will drastically be diversified and reduced. As shown in Table 2.12, traffic volume in the East-West direction concentrated on Peace Avenue as well as the South-North direction such as Chinggis Avenue, will be reduced, and a large effect on the mitigation of traffic congestion has been expected.

Table 2.12 Effect of Road Network Improvement Plan

Road	2019 (current status)		2030 (do nothing)		2030 (after improvement)	
	Daily Traffic Volume	VCR	Daily Traffic Volume	VCR	Daily Traffic Volume	VCR
Peace Avenue	27,500	2.15	46,009	3.51	22,750 (0.49)	1.78
Narrny Road	12,500	1.25	20,500	2.05	17,300 (0.84)	1.73
Chingis Avenue	18,500	1.85	27,000	2.70	16,000 (0.59)	1.60

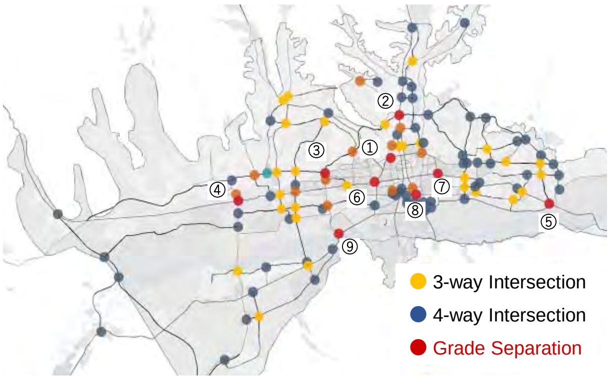
Note: Daily traffic volume: route average of 24 hourly traffic volume (one-way),
VCR: Vehicle Capacity Ratio; traffic volume/capacity ratio

Source: UBRD2030

(3) Intersection Improvement Plan

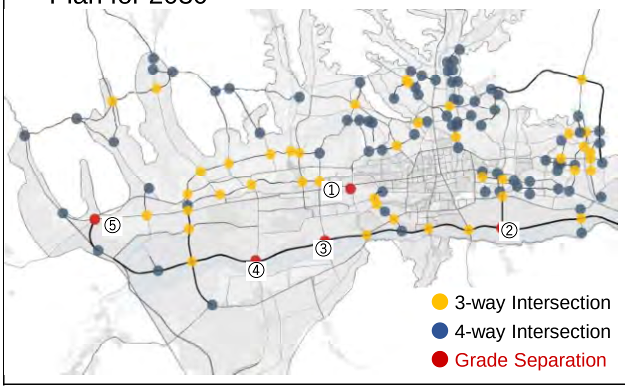
The improvement of intersections and the installation of grade-separation have also been proposed in the UBRD2030, in association with the construction of the new road network mentioned above. Specific locations of the grade-separation are indicated by red circles (●) in Figure2.13, and the type of crossing for other intersections is going to be examined in the future.

Plan for 2025



No	Intersection	Remarks
①	Geser Temple Intersection	(Bayanburd Intersection)
②	New construction	
③	New construction	
④	Tovchoo Intersection	FS was implemented (2013)
⑤	Gachuurt Intersection	
⑥	West Crossroads	DD by China
⑦	East Crossroads	DD by Korea
⑧	Fly-over in front of Traffic Police	Under construction by China
⑨	Yarmag Intersection	Chinese Gannt (2019)

Plan for 2030



No	Intersection	Remarks
①	Sapporo Intersection	
②	Ikh Tenge Intersection	Tuul River Express Way
③	Tuul Yarmag Intersection	Tuul River Express Way
④	Tuul Songsgolon Intersection	Tuul River Express Way
⑤	Tuul Tovchoo Intersection	

Source: UBRD2030

Figure 2.13 Planned future intersection improvements and multilevel intersections

(4) Bridges and Other Road Facilities

In addition, the construction of road facilities, such as railway overpass/underpass, river crossing bridges and new pedestrian bridges required for the extension of the road network, have been scheduled in the UBRD2030. Table 2.13 shows the number of planned facilities, together with the target year, and Figure 2.14 shows the construction sites for these facilities.

Table 2.13 Number of Bridges and Road Facilities to be Constructed by 2030

No.	Type of Facilities	2017 (Existing)	2025 (New-Construction)	2030 (New-Construction)
1	Bridges of River Crossing	66	10	13
2	Fly-over crossing Railway	4	3	4
3	Railway Underpass (Road)	5	9	9
4	Culvert (Road)	0	24	17
5	Pedestrian bridges on roads	9	25	24
6	Pedestrian bridge on the railway	2	6	0

Source: UBRD2030

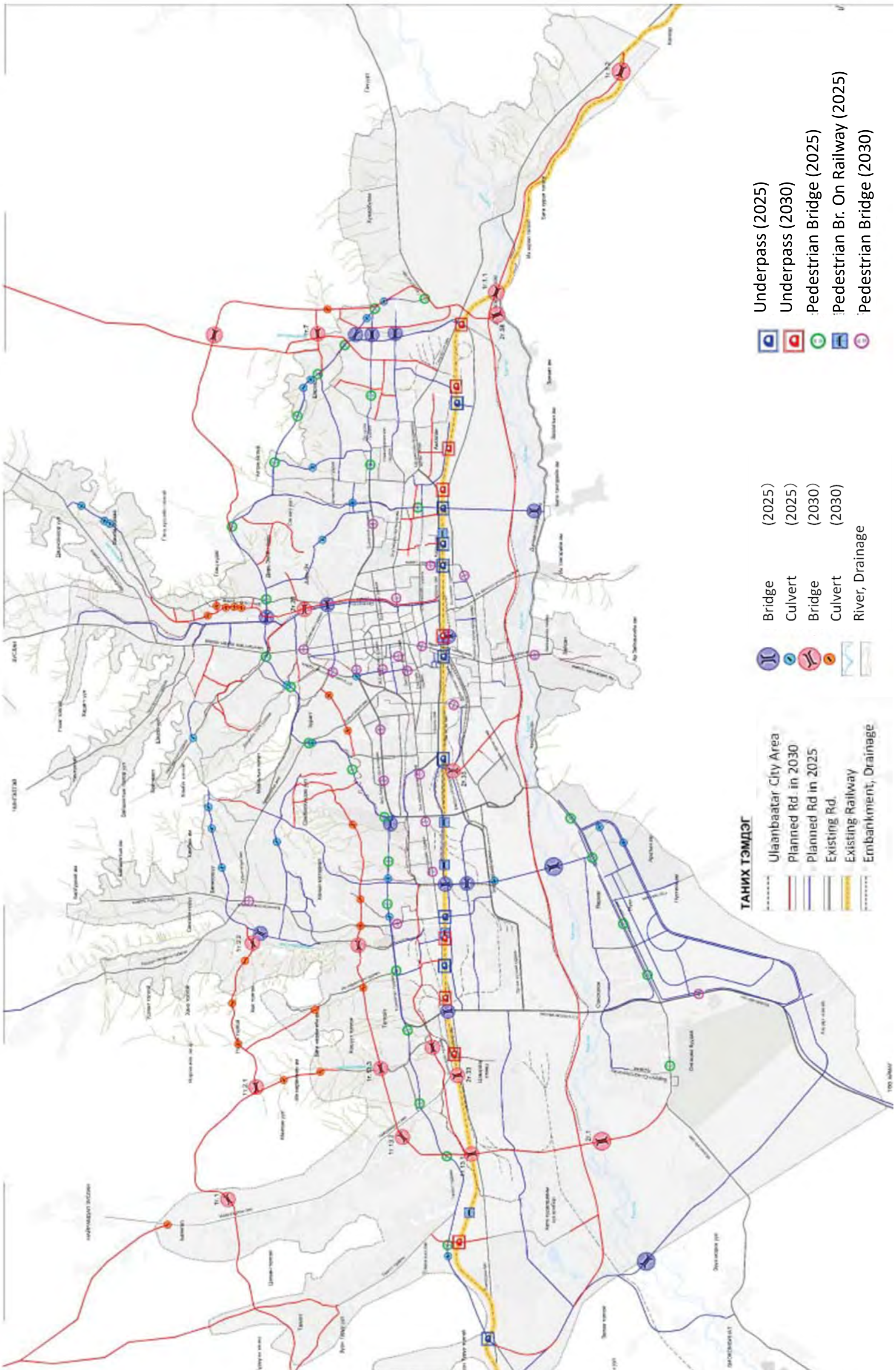


Figure 2.2 Road Facility Construction Plan in UBRD 2030

Source: UBRD2030

2.2.5 Outline of the plan of the Investment and Development Planning Committee for Traffic Congestion Management in UB City

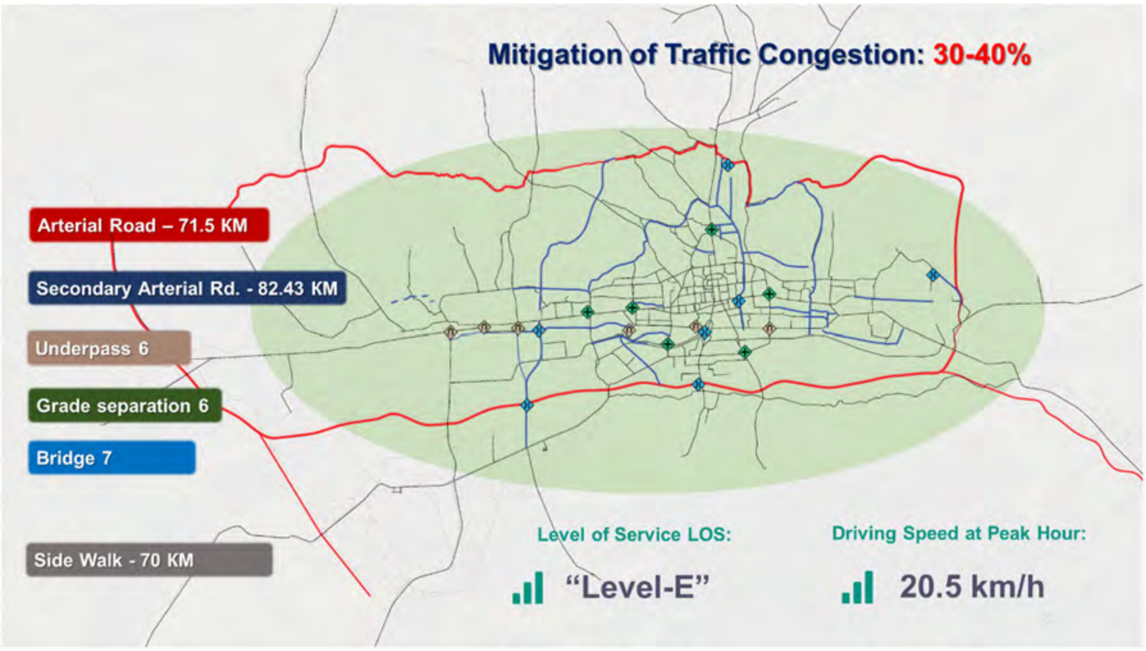
(1) Overview

On May 2021 (Capital Governor's Order No. A393 of 27 May 2021), UB City Congestion Management Committee (the plan of the Investment and Development Planning Committee for Traffic Congestion Management in UB City) was formed and headed by the UB Mayor's Advisor for Projects and Programs in order to reduce congestion in the city. It is composed of relevant departments from UB City Hall. The committee proposed a project to combat traffic congestion, and the Cabinet approved its implementation and a budget of MNT 460 billion MNT/year for 3 years from 2022 to 2024. The National Committee for Ensuring Urban-Regional Balance, Reducing Concentration, and Reducing Road Congestion was then formed during the cabinet meeting on 18 August 2021. The chair of the committee is the Prime Minister, the vice-chair is the Minister of MRTD, Governor of the Capital, and Mayor of UB. Its members are the Minister of Justice, Minister of Finance, Minister of Construction and Urban Development, Minister of Education and Science, Advisor to the Prime Minister, Director General of the Management Coordination Bureau of the Cabinet Office, Director General of the National Development Agency, the Director General of the National Police Agency, Director General of the Professional Audit Agency, Director General of the Public Relations Division of the Prime Minister's Office, Director General of the Traffic Police Department, and Director General of the National Television. The deputy mayor heads the secretariat. As the secretariat, a project team in charge of roads and transportation in UB City headed by the Deputy Mayor has been formed.

(2) Road Development Plan

The road development plan proposed by the Committee includes the following contents although the specific contents are still under discussion, and additions and changes are being made as needed; UB City has already started working on some F/S of the following projects under the budget of UB City.

Title	Number of extensions and locations	Remarks
Construction of a new circular bypass road	Total length: 71.5 km	Tuul River Expressway Northern Crossing of Ger District
Development of secondary trunk roads	Total length: 82.43 km	Green Avenue, etc.
Multilevel intersections	6 locations	Bayanbuld crossing is also under discussion
Plane intersection improvement	25 places	Under consideration for additional
Bridge widening and replacement	7 locations	
Railway underpass	6 locations	China loan
Traffic control system improvement	Control center improvement / signal maintenance	WB support schedule



Source; UB City Congestion Management Committee (2021)

Figure 2.15 Road network proposed by the UB City Congestion Control Committee.

(3) Public transportation system development

The Mongolian Government is now discussing the development of the public transportation system under a common understanding of the necessity of the railway system as a mass public transportation system. The implementation plan will be made by the UB municipal government though financing will be decided by the national government with the decision by the Parliament.

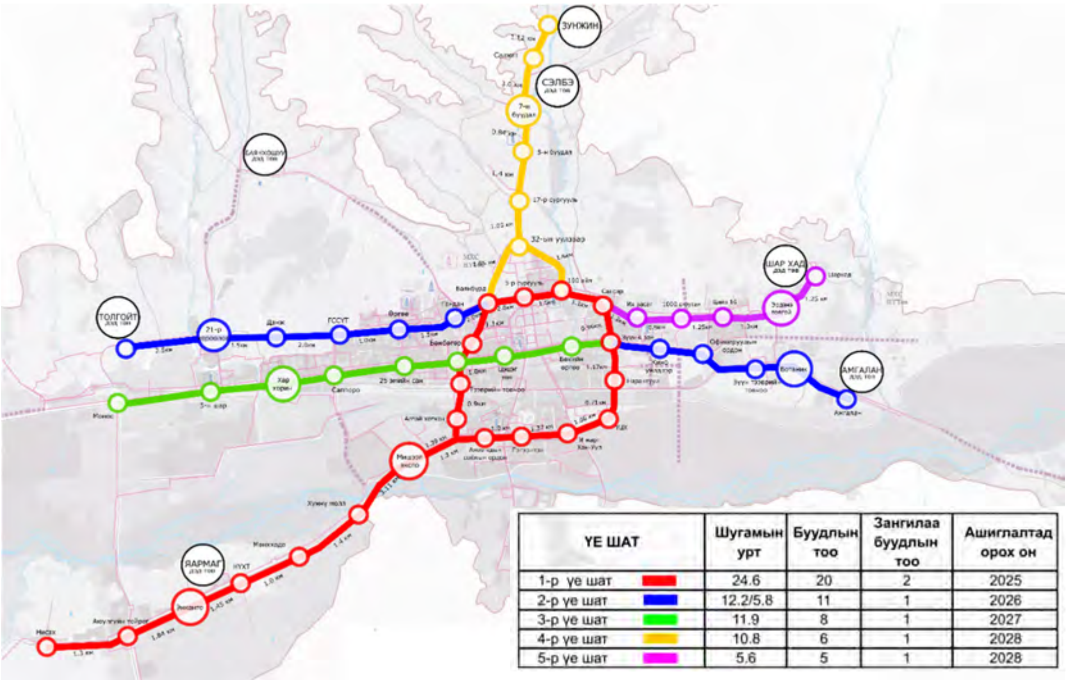
As of December 2021, these have been discussed by the UB municipal government.

- They understand that East–West Line along Peace Avenue proposed by JICA PPP F/S implemented in 2012 has the most demand. But its construction has two problems. The construction cost is expensive because of the underground structure in the central area, and the closing road for construction of the underground structure will influence many people. To avoid these problems, they started studying another route.

- They consider the North–South direction before the East–West direction since the latter already has plural roads and a designated bus lane on Peace Avenue. On the North-South direction, it only has one road with a serious traffic jam caused by recent urban development. In addition, they study different routes on the north side of Peace Avenue in the East–West direction.

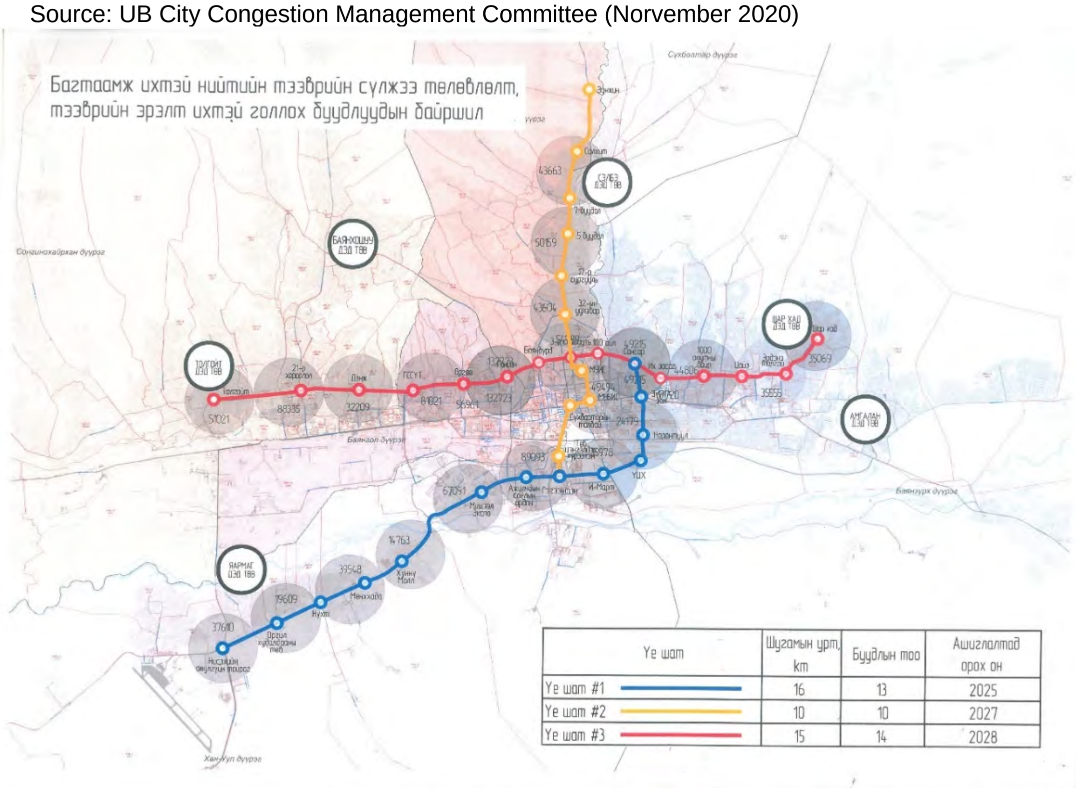
- The route that can open in a short period was studied as they aim to open/first operate by 2025.

Based on the above, Figure 2.16 shows UB City's plan under discussion.



ҮЕ ШАТ	Шугамын урт	Буудлын тоо	Зангилаа буудлын тоо	Ашиглалтад орох он
1-р үе шат	24.6	20	2	2025
2-р үе шат	12.2/5.8	11	1	2026
3-р үе шат	11.9	8	1	2027
4-р үе шат	10.8	6	1	2028
5-р үе шат	5.6	5	1	2028

Source: UB City Congestion Management Committee (Norvember 2020)



Үе шат	Шугамын урт, km	Буудлын тоо	Ашиглалтад орох он
Үе шат #1	16	13	2025
Үе шат #2	10	10	2027
Үе шат #3	15	14	2028

Source; UB Municipal Government (Norvember 2021)

Figure 2.16 Urban Railway Plan of UB City

Regarding the railway specifications, there is the impression that it could not be realized due to the high construction cost of the name "Ulaanbaatar Metro (UB MRT)" during the JICA PPP F/S implementation in 2013. They tried to use "LRT" instead.

Although the railway specifications have not been decided, it is difficult to reduce the number of lanes on existing roads because of the narrow road width in most sections and occurring chronic traffic congestion. According to the interviews with UB City during this survey period, it seems that the construction as the cheapest tram will be limited to a part, and most of them will be elevated railways. However, as for vehicles, some local consultants recommended "tram type" vehicles, as shown in Figure 2.17, regardless of the track structure.

Souce: Mongolian Consultant

Figure 2.17 Image of rolling stock recommended by some mongolian consultants

(4) Traffic Demand Management (TDM) measures

At this point, no clear implementation details have been determined, and discussions have been continuing. The following are the main issues being discussed.

1) Strengthen parking lot management (improve government buildings, charge fees, review fees, introduce smart systems)
2) Road pricing (introduce RFID to set new fees, review road fund)
3) Encourage staggered work hours and remote work
4) Relocate school facilities and commercial facilities

2.2.6 Status of Assistance by Development Partners

The assistance of each international donor for the transport sector is summarized in Table 2.14. In public transport and roads, the international donors are becoming more active. WB and Asian Development Bank (ADB), for example, propose comprehensive plans, and individual projects are suggested, such as by China. As for individual projects, many cases are unclear on the effect of the development on future traffic.

Table 2.14 Activetis of international donor (a selection related to the transport sector project)

Donor	Projects	Trend
France	Cable car	The "Ropeway" project plans to draw two ropeways, the first connecting the Bayankhoshuu area with the 3rd and 4th Districts, and the second connecting the Doloon buudal area with the City center. According to the Department of Public Transportation Services of the UB City Government (UBCG), the first line construction plan was proposed with a special loan from France.
China	Urban rail	BYD, a Chinese company, is proposing a rail project to install 14 stations along Peace Avenue. 210,000 pax/day are estimated and reduce congestion on the street by 68%. However, according to the UB City Public Transportation Service Bureau, it has not been decided whether China will provide the loan.
	Underpass	The project is funded by a preferential loan from the Export-Import Bank of China, which was signed in 2018. It is planned to construct six underpasses. The Development Initiative-Infrastructure project (DIIP), which is under the direct control of the Ministry of Finance, will be in charge of project management, and detailed design is scheduled to start in 2021.
ADB	Mongolian Railway Bypass	Based on the results of the alignment selection study in 2017, a preparatory study for the Bogdkhan Railway Bypass Investment Program (TA-8935 MON) has been conducted since 2021.
	BRT (Bus Rapid Transport)	In 2012, the provision of a Multitranche Financing Facility (MFF) was promised by the Mongolian government, but there was no significant movement until the project unit was established and basic study was conducted in 2017. The bid for the following F/S was canceled because it is strongly believed within UB City that it will not alleviate traffic congestion.
World Bank	Urban transportation (mainly roads)	Ulaanbaatar Sustainable Urban Transport Project (P174007): The project will be implemented from 2021, including rehabilitation of existing roads and technical assistance on asset management.

Source: JICA Study Team

The following sections show the contents of the projects proposed by the WB, ADB, and China Development Bank, which are currently active.

(1) World Bank

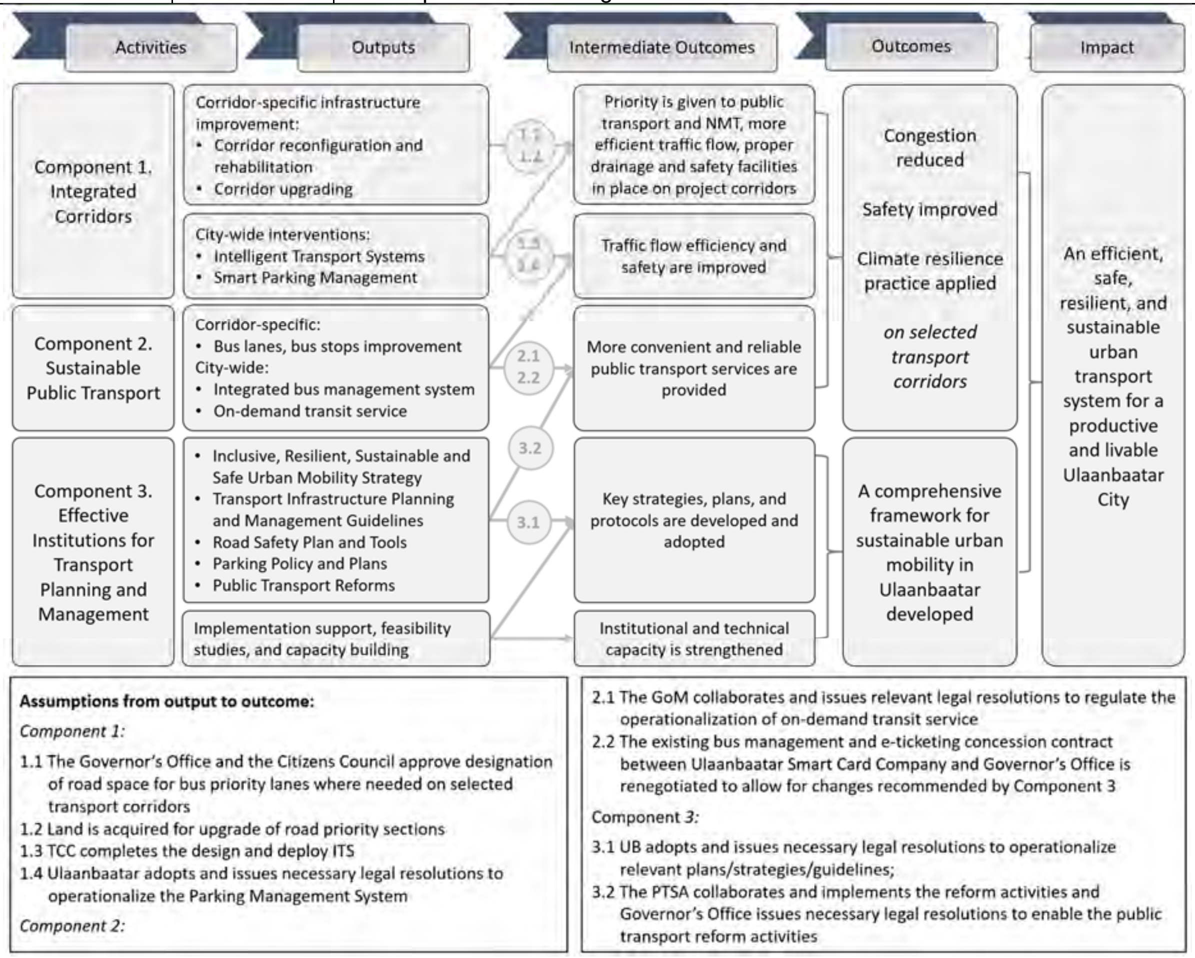
In June 2021, the WB released “The International Bank For Reconstruction and Development Project Appraisal Document on a Proposed Loan in the Amount of US$100 Million to Mongolia,” approved by the MOF. The project is currently implemented.

The development orientation is easing traffic congestion in the selected corridor and improving traffic safety, considering climate change for sustainable urban mobility in UB City. The support components include (i) the comprehensive road rehabilitation projects; (ii) bus transportation system improvement; (iii) improving the efficiency of road transportation planning and the capacity of the management system, conducting design and FS studies; and (iv) contingency planning.

Details of the support are described in Table 2.5.

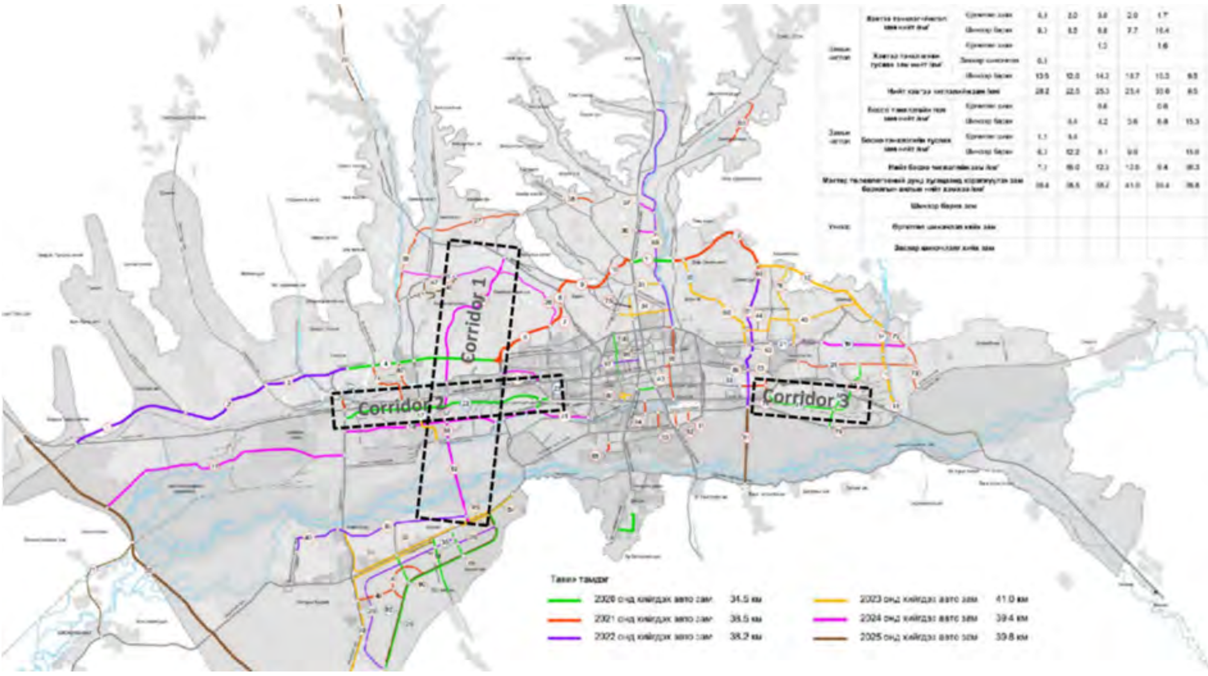
Table 2.15 WB100 Million USD Support Details

Implementation Component	Investment amount Miilion USD	Details of the study
Integrated corridors	81.00	• Reconfiguration and restoration of priority road sections with Non Mortorized Transport/Public Transport facilities, the content of which is under discussion, but the "Sun road" extension plan is determined (Corridor 3 of Figure 2.19). (Corridor 2 needs to discuss with the conflict the connection of corridor 2 and Ajilchin flyover project this study suggested.) • Upgrade and construct priority road sections with Non-Mortorized Transport/Public Transport facility equipment. • Area-based traffic control and updating of equipment at the traffic control center • Upgrade of roadside ITS equipment. • Development and operation of smart parking management systems
Sustainable Public transport	10.00	• Capacity building on public transportation systems • Upgrade bus lane and bus stop in specific corridors • Technical assistance under discussion: development of bus priority infrastructure, upgrade of bus management system, monitoring of demand and its reflection on services
Efficient the road traffic planning, capacity of the management system, and conduct design and FS studies	9.00	• Sustainable Mobility Strategy Development • Parking lot management plan development • Transportation infrastructure investment planning and management documents (conduct cost-benefit analysis, conduct F/S, conduct traffic analysis and demand forecasting, cost estimation, guidelines) • Development of the platform for the traffic safety evaluation report (DRIVER) platform begins • Operational training



Source: WB

Figure 2.18 Contents of the WB 100 Million USD Support



Source: WB

Figure 2.19 Reconstruction of the Road Corridor

(2) ADB

The ADB developed a comprehensive master plan for UB City, “Planning for the Road and Transport Future Development of the Ulaanbaatar City 2040,” in 2021, and is currently having discussions with the Mongolian side. In the plan, the development outcomes are (i) economic efficiency, (ii) accessibility, (iii) traffic safety, (iv) environmental friendliness, (v) sustainability, (vi) service reliability, (vii) coordination among transportation modes, (viii) comfort, and (ix) productivity. The concept-level proposals are made from the perspective of public transportation, road planning, logistics planning, traffic safety measures, pedestrian traffic safety, and others. On the other hand, the individual projects discussed are BRT and LRT.

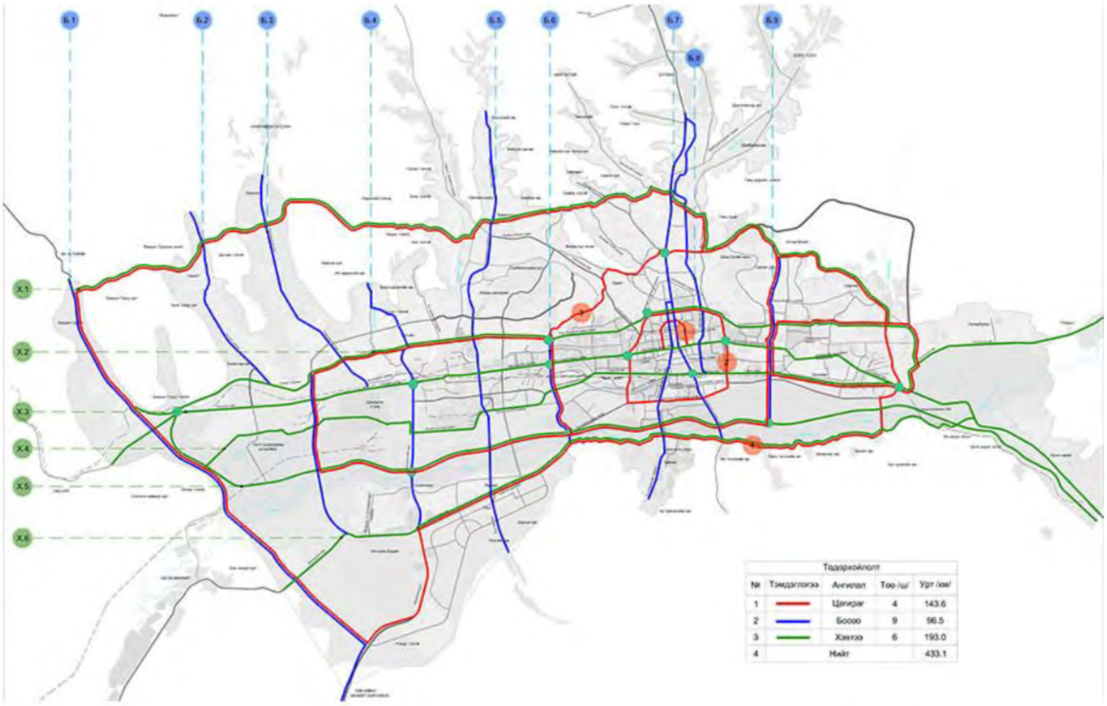
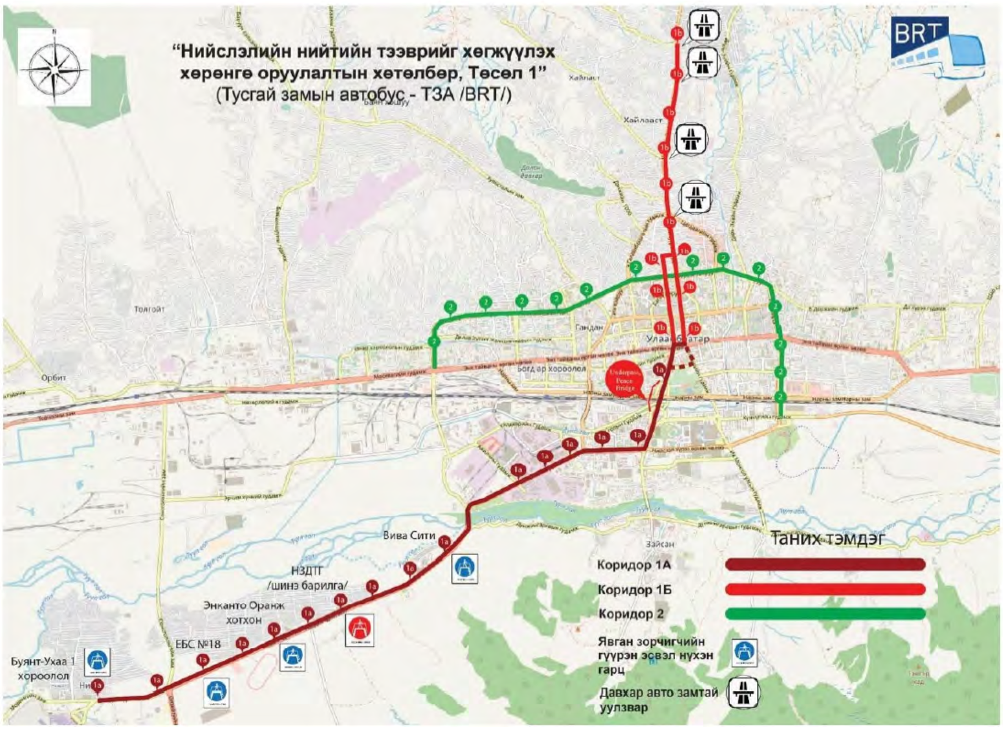


Figure 5: UB road Master Plan by CCRDC

Source: ADB

Figure 2.20 Proposed Road Network Plan.



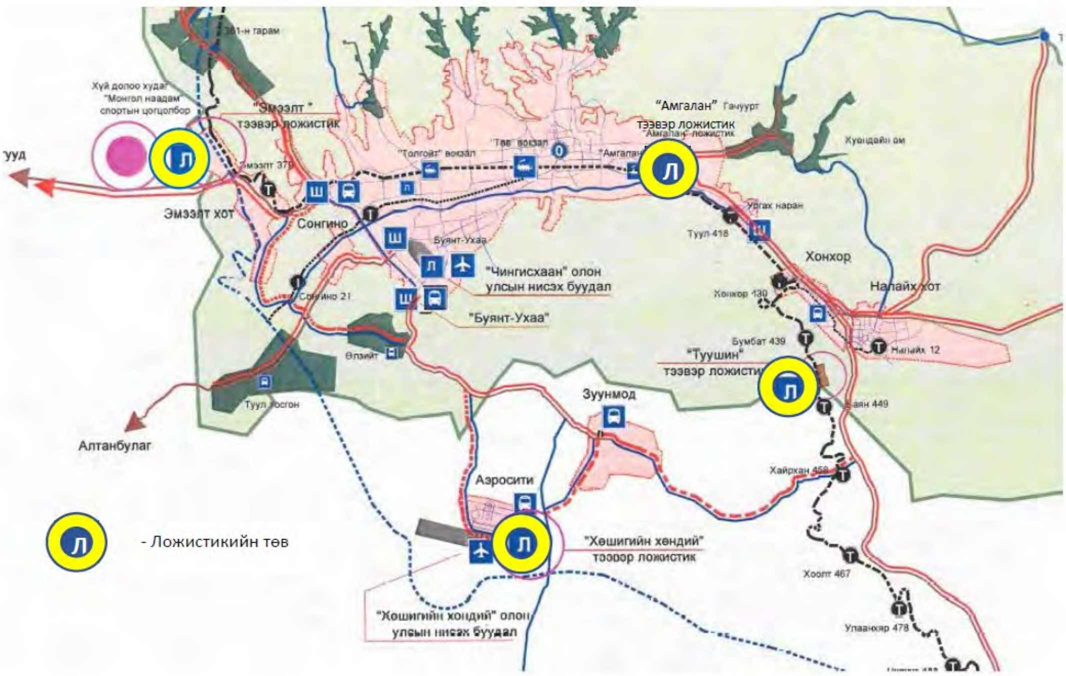
Source: ADB

Figure 2.21 Proposed Public Transport Plan (BRT)

Figure 9: Proposed LRT line (only draft)

Source: ADB

Figure 2.22 Proposed Public Transportation Plan (LRT)



Source: ADB

Figure 2.23 Logistics Network Plan

The ADB has proposed a comprehensive transportation project list up to the 2040. Some projects have specific locations mentioned in thier reports but the feasibility of the projects has not been discussed yet.

Table 2.1 UB City Congestion Mitigation Action Plan2040 (1)

Codes	POLICY OR ACTIONS	Short 2021-2025	Medium 2026-2030	Long 2031-2035	Long 2036-2040	Responsible Agency
CP	CITY PLANNING AND LAND USE					
CP-1	Create several more transit corridors or increase number of main roads like Peace Avenue in Ulaanbaatar. (82 km of main roads will be expanded).					GOCC, MCUD, CCRDD
CP-2	Prioritize and encourage a dense and diverse mix of services, jobs, and housing types in areas well-served by frequent, high-capacity transit					GOCC, UPRI, CCRDD
CP-3	Locate major trip generators near transit stations or along transit corridors					GOCC, UPRI
CP-4	Design buildings to contribute to a public realm that feels interesting and safe					MCUD, UPDI
CP-5	Make streets safer for walking:					MCUD, MRTD, TP
CP-5.1	Address pedestrian safety "black spots," starting by implementing recommendations from the 2021 Pedestrian Safety Study and through future safety assessments as needed					MCUD, MRTD, TP
CP-5-2	Implement pedestrian-oriented designs as streets are rebuilt and infrastructure is replaced to improve safety for all modes of travel. (Consider more rapid implementation for measures that demonstrate significant safety gains.) Specific measures include:					MCUD, MRTD, UPDI
	a) minimizing crossing distances and curb radii, while considering needs of other road users;					MCUD, MRTD
	b) installing countdown timers and reviewing signal timing to ensure adequate crossing time for people with limited mobility;					MCUD, MRTD
	c) maximizing visibility at crosswalks through appropriate lighting, high-visibility pavement markings, and clear sight lines;					MCUD, MRTD
	d) implementing raised sidewalks or other treatments to prioritize safe walking across lanes, driveways, and some local streets; and					MCUD, MRTD
	e) reducing vehicle speeds through traffic calming measures as appropriate at school and residential areas					MCUD, MRTD, TP
CP-5-3	Implement a spot improvement program to address emergency situation such as firefighting and medical first-aid services in residential and ger areas					GOSS, MCUD, MRTD
CP-5-4	Minimize the width and number of new driveways that cross sidewalks and other walking paths. Create a pedestrian island in case of more than 2 lanes of roads					MCUD, MRTD
CP-5-5	Continue to maintain and rehabilitate sidewalks and pathways so they are free of trip hazards and debris; use smooth materials and designs that are comfortable for users of strollers, wheelchairs, or other mobility aids.					GOCC, MCUD, MRTD
CP-6	Make streets and public spaces rain-friendly and anti-snow and slippery measures					GOSS, MCUD, UPDI
CP-6-1	Review and expand weather protection guidelines to encourage or require appropriately wide, continuous, well-designed awnings (shades) or canopies for all development in commercial areas throughout the city.					GOCC

Source : ADB

Table 2.2 UB City Congestion Mitigation Action Plan2040 (2)

CP-6-2	Implement anti-icing and slippery measures in Ulaanbaatar: selection of proper equipment, training personnel, selection of appropriate chemicals, and accurate forecasting					MCUD, GOCC
CP-6-2	Include strategies to reduce ponding (staying water on road) in street maintenance guidelines. Prioritize maintenance at locations with more walking and street activity and improve drainage on the road network					MCUD, GOCC
CP-7	Review zoning and development standards in order to allow more flexibility in accommodating demands for different land uses and to increase the areas that allow for mixed land uses. Land use regulations should be used as a means to encourage density levels that make the provision of infrastructure more affordable through the efficient use of urban land, rather than supporting development through allocating vacant land in fringe areas or satellite towns far from infrastructure and services.					MCUD, GOCC
CP-8	Finalize the surveying and registration of publicly owned land. Conduct legal documentation and on-the-ground audits of land held by all city government entities, including budgetary organizations and municipal enterprises, as well as land allocated for possession to individuals, NGOs, and similar enterprises.					MCUD, GOCC
CP-9	City agencies responsible for developing both land use plans and public transportation planning need to closely coordinate ongoing activities and partner with ongoing street improvement projects aimed at enhancing capacity and connectivity.					MCUD, GOCC
CP-10	The practice of land valuation needs to be revised so that taxes and fees better reflect market values of land and property, as is international practice. This will require significant changes in current laws and the city will have to cultivate long-term strategic partnerships with other government ministries and parliament in order to develop and support these reforms.					MCUD, GOCC
RN	ROAD NETWORK					
RN-1	Continue studies on expanding and new construction of road networks					GOCC, CCRDD
	a) Construct a bigger ring road: Bayanzurkh bridge- Zaisan-Yarmag- Sonsgolon- Baruunturuun-Takhilt- Nairamdal-Bayankhoshuu- Dambadarjaa-Uliastai- Bayanzurkh bridge (71.5 km).					GOCC, CCRDD
	b) Construct the Tuul river Highway					GOCC, CCRDD
	c) Construct bridges over the Railway line crossing the city					GOCC, CCRDD
RN-2	Continue to optimize network operations such as signal timings and rush-hour parking regulations to manage congestion while supporting other plan goals.					GOCC
RN-3	Explore opportunities to normalize bridge ramps and arterial intersections that have highway-style loops, odd angles, slip lanes, or other features that create a hostile pedestrian environment					GOCC, CCRDD
RN-4	Continue to monitor collision rates across the city, and address locations with a high number of incidents.					GOCC, MRTD, TP
RN-5	Monitor vehicle volumes to understand traffic trends and potential spare capacity. Where improvements to the walking and/or cycling environments are needed but the ability to reallocate road space is limited, consider alternative approaches such as property acquisition or building setbacks.					GOCC, CCRDD
RN-6	Introduce a new Road asset maintenance system (RAMS) in the Capital city road development department (PAVER application recently installed) for road maintenance planning					MRTD, CCRDD
RN-7	Introduce Road safety audit system in road design, construction, operation period.					MRTD, CCRDD
PE	PARKING & END-OF-TRIP FACILITIES					
PE-1	Develop and implement a strategy to: (a) eliminate minimum parking requirements downtown, near rapid transit stations, and for guaranteed rental residential developments, and (b) revise minimum requirements elsewhere based on target mode shares.					GOCC, CCRDD

Source : ADB

Table 2.3 UB City Congestion Mitigation Action Plan2040 (3)

PE-2	Clarify the parking bylaw to reflect broader City transportation objectives, and to actively encourage strategies that reduce parking demand.					GOCC, CCRDD
PE-3	Require demand management plans in all rezoning, multi-family, office, and mixed-use developments. Encourage demand management strategies in all other developments, and allow staff to reduce minimum parking requirements in response.					GOCC, UPRI, CCRTCED
	Develop and implement design guidelines for larger developments to enable non-occupant parking access (for example, mechanical parking, multiple levels of security). Construct parking facilities for 290 buses and 5000 for passenger cars in Ulaanbaatar city.					GOCC, CCRTCED
	Develop a long-term strategy for Downtown parking, considering total parking supply, future demands, and other potential uses					GOCC
	Provide real-time availability information for City-owned off-street parking, through electronic signage and mobile device applications					GOCC
TN	TRANSIT NETWORK AND INTEGRATION OF PUBLIC BUS SERVICES WITH RAILWAY LINES					
TN-1	Continue studies and work with international financial institutions and donors to improve the frequency, capacity, reliability, and service span of transit, prioritizing high-demand corridors (on establishing new urban public transportation modes such as light rail (LRT), BRT, metro (MRT and others)					MRTD, GOCC
	a) BRT lines-ADB project					MRTD, GOCC
	b) LRT lines					MRTD, GOCC
	c) Metro (MRT)					MRTD, GOCC
	d) Bogdkhan bypass railway line (174 km) -FS of the Project is being prepared now					MRTD, GOCC, UBTZ
	e) Bogd-Ar railway (from Songino valley to new airport. To use existing railway track to Songino and construct missing 13 km lines to new airport)					MRTD, GOCC, UBTZ
	f) Renew former Railbus services by improving connectivity with bus network between Tolgoit and Amgalan station					MRTD, GOCC, UBTZ
TN-2	Continue to use smart card payment system for all modes of transportation including railways					MRTD, GOCC
TN-3	Explore wider and consistent stop spacing on the city routes to attract more riders and provide faster and more frequent service, while balancing the need for access					MRTD, GOCC
TN-4	Support existing and strategic expansion of the bus and trolley network, including extensions as well as mid-route turnaround facilities on busy routes to improve reliability and renewing bus fleet					MRTD, GOCC
VE	VEHICLES					
VE	Advocate for zonal road pricing to reduce congestion and help fund transit and other sustainable transportation improvements					MRTD, GOCC
VE	Reduce and prohibit import of second-hand vehicles older than 7 years and vehicles with right hand steering wheel					MRTD, GOCC
VE	Continue to require all new developments to include electric vehicle charging infrastructure and CNG, LPG filling stations					MRTD, GOCC
VE	Partner with private industry to provide charging locations throughout the city, including retail locations, existing parking lots, and other under-utilized land					MRTD, GOCC
VE	Convert the City's own fleet to electric, hybrid, or fuel cell vehicles as feasible. Renew fleet of buses with 500-1000 eco-friendly buses.					MRTD, GOCC

Source: ADB

Table 2.4 UB City Congestion Mitigation Action Plan2040 (4)

VE	Support incentives for car-sharing in new developments					MRTD, GOCC
	Support the adoption of low-carbon and electric vehicle technology for car-sharing vehicles					MRTD, GOCC
	Approve "Green Transport Act"					MRTD, GOCC
TM	**TRAFFIC MANAGEMENT**					
TM-1	Introduce "Park & Ride" system at the suitable intersections such as Zuun dorvon zam and Buruun dorvon zam					MRTD, GOCC
TM-2	Continue to use traffic management measures:					MRTD, GOCC
	a) Bus lane					MRTD, GOCC
	b) One way traffic, especially in residential areas					MRTD, GOCC
	c) Traffic calming measures: sleeping policeman, speed limits etc.					MRTD, GOCC
	d) Restriction of vehicle use by license plates					MRTD, GOCC, TP
	e) Restriction by mode, by time period and by size or weight					MRTD, GOCC, TP
	f) Parking and loading/unloading restrictions					MRTD, GOCC, TP
	g) Installation and use of Area Traffic Control (ATC) and traffic signals					MRTD, GOCC
TX	**TAXI**					
TX-1	Through the Ulaanbaatar Taxi Roundtable, continue working with partners to improve taxi services by:					MRTD, GOCC
	a) exploring measures such as low-carbon vehicles, fleet optimization, centralized dispatch systems, use of GPS and other technologies, ride sharing, and flat-rate fares for certain trips;					MRTD, GOCC
	b) encouraging the Ministry of Road and Transport Development and city Governor's office to implement innovative service improvements;					MRTD, GOCC
	c) supporting the development of a District-wide taxi service data collection and monitoring system;					MRTD, GOCC
FR	**FREIGHT TRANSPORT & LOGISTICS**					
FR-1	Revise parking requirements for new development to ensure sufficient off-street loading and parking spaces for smaller service and delivery vehicles.					MRTD, GOCC
FR-2	Review the benefits and implications of late-night deliveries, as well as the bylaw and policy requirements for potential implementation of related strategies					MRTD, GOCC
EE	**ENCOURAGEMENT, EDUCATION & ENFORCEMENT**					
EE-1	Promote walking and cycling as fun, practical, and healthy transportation choices					MRTD, MESS
EE-2	Support education and awareness programs to improve safety and reduce conflicts					MRTD, MESS
EE-3	Support enforcement practices that can help to manage congestion impacts					MRTD, MESS
EE-3-1	Enhance enforcement, education, and awareness approaches targeting behaviors that contribute to congestion, such as blocking the intersection box, illegal turn maneuvers, and violation of no-stopping zones					MRTD, MESS

Source: ADB

On the other hand, a USD 7 million loan project by ADB was approved in the Cabinet meeting on 10 January 2022. According to interviews by the study team, the outline of the project is as follows. The ADB will discuss the detailed contents with the Mongolian side in the future.

Table 2.20 Overview of Approved ADB Project in the Cabinet

Items	Description
Objective	(1) Preliminary preparatory study for ADB's upcoming mega projects (2) Introduction of smart systems to improve road traffic (3) Digitalization of parking lots (4) Improvement of public transportation (5) Detailed data analysis for the introduction of new mass transit
Survey contents	(1) Improvement of Peace Avenue with heavy traffic (2) Improve public transportation on Peace Street
Implementention period	2022–2027
Loan amount	USD 7 million

Source: Interview with ADB by JICA Study Team

(3) Export-Import Bank of China

1) Railway planning

According to an information shared by UB City, the BYD Automotive Industry from China is conducting a technical F/S with a monorail. According to this report, the plan is based on Peace Avenue as the route plan, and the estimated number of passengers per hour from morning to night (7 AM to 8 PM) in the short term is RMB 1,898.2 billion (317.4100 million yen with a JICA rate of 16.7216 yen per RMB).

Source: Engineering Feasibility Study Report on Rubber-tyred Tram Line 1 in Ulaanbaatar

Figure 2.24 Outline of the Route

Table 2.21 System configuration

System Composition	Essential	Optional	Program Planning	Suggestion
Transmission System	●		IP Ethernet	○
Wireless Communication System	●		LTE-U Comprehensive Carrying Capacity	○
PIS		○	Ground + On-board	×
PA	●		Digital and Analog Combining Method	○
Emergency Interphone System	●		OCC + Stations + On-board	○
Clock System	●		Primary Master Clock in OCC	○
CCTV	●		Full Digital HD, 15-day Centralized Storage	○
Phone System		○	Office-private Syncretism	×
Power & Grounding system	●		Integrated UPS（1h)	○
Integrated Office System		○	Set in OCC	×
Access Control System		○	Set in OCC and Depot	○

System Composition	Essential	Optional	Program Planning	Suggestion
Security system		○	Pulse Electron Fence in Depot	○
AFC	●		Clearance + Central Level + Terminal, Bus Card + Two-Dimensional Code	○
BAS		○	Set in Depot	○
Integrated Supervisory Control System		○	Set in OCC	○

Source: Engineering Feasibility Study Report on Rubber-tired Tram Line 1 in Ulaanbaatar

2) Railway Underpass Project

The project is funded by the Export-Import Bank of China, which was signed in 2006, and plans to invest about 40 million USD to construct underpass roads crossing at 6 locations of railway. The DIIP (Development Initiative-Infrastructure Project) under the direct control of the Ministry of Finance has been in charge of the project management. At the beginning of 2020, it was decided that the 6 locations ((1) to (6) showing in Figure 2.25) would be implemented with Chinese assistance. After that, due to the shortage of budget and other reasons, discussions are underway to implement the 4 locations ((2), (3), (4), and (6) in Figure 2.25) with Chinese assistance. The bidding process (design-build method) is scheduled to start in early 2022. However, future implementation of the project is still unclear, as it is believed that sufficient confirmation and coordination has not yet been made regarding road planning, land acquisition, and utility relocation, etc.

Source: DIIP

Figure 2.25 Proposed Locations of the Railway Undrpass Project Financed by China

Selected Location ②

Selected Location ③

Selected Location ④

Selected Location ⑥

Source: DIIP

Figure 2.26 Selected Four Locations of the Railway Underpass Project

2.3 Current Status and Issues of Urban Planning and Urban Transportation Planning

2.3.1 Status of MP2020 and Challenges in Implementation

This part describes the urban planning and urban transportation master plan, legal system, government financial situation, financial resources, the cost-sharing ratio of the national government and UBCG, etc., and analysis of current issues in urban public transportation (including bus services currently in operation), especially whether the projects proposed in MP2020 are being implemented (including the status of implementation, issues, etc. if implemented and the causes and consideration for countermeasures if not).

As described in Section 2.2, the Government of Mongolia formulated the “National Policy on Road Transport Sector (2018–2026)” in the resolution of Cabinet 321 No. 1 of 2018. Also, in November 2018, UB City has formulated the “UB City Road Network Development Medium- and Long-Term Master Plan.” The National Policy lists the policy objectives, such as the introduction of mass transit to ease traffic congestion, the development of cab services based on smart transportation systems, and the shift to smart systems for road traffic management in UB City to improve accessibility. Although there is no policy or legal system unique to the public transport sector and no public transport master plan has been formulated, measures related to public transport have been proposed in the road master plan.

The medium- and long-term policies, which are the top-level policies of the government, set the development of UB City and the Sanitation City with the goal of comfortable, eco-friendly, human-centered smart urban development. In addition, the Government Action Plan (GAP) 6.1.6 states that comfortable, smart, eco-friendly, electric buses, double-decker buses, streetcars, and cable cars will be introduced in phases.

The PIP 2018–2021 includes the “Ulaanbaatar City Public Transport Enhancement Program 2015–2023” with a budget of MNT 62,896.8 million, financed through an ADB loan. However, the "UB City Public Transport Vehicle Replacement Project" has not been implemented due to the inability to secure funding as well as for the "UB City Public Transport Vehicle Replacement Project."

The PIP 2021–2025 lists a project to introduce a ropeway for public transportation in UB, financed by the UB City budget. According to a city official, the city was negotiating to build the ropeway with a special loan from the French government, but it has been postponed due to the COVID-19 pandemic. On the other hand, the "UB City Public Transport Vehicle Replacement Project" (with a budget of MNT 678.7 billion) is on the list, but it is still impossible to secure financial resources. The Bogdkhan Railway Bypass Project is on the F/S list and is currently under preparatory study with the cooperation of ADB. Normally, it is necessary for UB City to conduct F/S to secure financial resources for the projects with high social and economic benefits, but due to the limited budget allocation, UB City has difficulties it among other infrastructure projects.

It is recognized that the implementation of policies and plans related to public transportation is an important issue for reducing traffic congestion due to the concentration of traffic in one area of UB City and reducing air pollution such as exhaust gas due to the increase in used cars. However, it is difficult to secure financial resources from the national budget and the city budget alone, and although UB City has made requests to donor countries and international organizations for the improvement of public transportation, it has not been a final solution due to the different project contents proposed by donors from other countries and the duplication of project locations.

Therefore, it is necessary to reorganize the current issues and comprehensively examine alternative solutions from the perspectives of socio-economic benefits, environmental and social considerations, and related policies and plans. Once the priorities have been clarified through the examination of alternative solutions, financial resources should be considered, as well as technical support for system building and human resource development.

The Urban Planning Research Institute conducts an annual implementation review of MP2020 and 2030 in 2016. According to this report, the implementation rate is calculated by assigning a score to the projects that have been implemented at 100, and to those that have not been implemented at 0 and other than those was scored according to their progress. The achievement level of the implementation of the MP2030 Progress Development Project is 11% as of 2016, which is "extremely insufficient.

Table 2.22 Implementation status of MP

Field	Degree of target achievement
Natural (physical) environment	10%.
Urban development	0%
Road and Transportation	18%
Social infrastructure	5%
Housing	17%
Manufacturing industry	0%
Freight transport	0%
Engineering infrastructure	15%
Sightseeing	8%
Total	11%

Source: Based on data from Urban Planning Research Institute

Table 2.22 shows the evaluation, as of 2016, for comparison with other sectors. In this study, interviews were conducted for the breakdown related to road and transportation and freight transportation, and results are shown in Table 2.23. Many of the completed projects are road projects, completed with support from China and ADB. However, on the other hand, there is no progress in public transportation, multilevel crossing, and other rather complex structures, and many of them are not implemented due to the lack of attached financial resources. In addition, there is a lot of political involvement, and policies change frequently or with the government change, making managing the implementation of a project and securing financial resources hard.

Table 2.23 Progress of Projects in Road Transport and Freight Transport (2021)

Category	Project name	Status of implementation	Cause of delay
Road Transportation	"Gachuurt-Terelj" road project	100%	Implemented
	"Gachuurt- Nalaikh" road project	81.2%	Slow to secure financial resources, but we have borrowed USD 36.5 million via Chinese government soft loans Implementation period is from 30 April 2019 to 31 July 2020
	"Emeelt - Ulziit" road project	100%	Implemented
	"Bayangol-Jargalant" Road Project	100%	Implemented
	"Jargalant- Yargait" road project	100%	Implemented
	"Jargalant- The 361Crossing" road project.	100%	Implemented
	Crosswalk	80%	Under implementation.
	Multi-level (multilevel) intersection	50%	Frequent policy changes make it impossible to manage project implementation. There is a lot of political involvement, and it is difficult to secure financial resources
	Overpass	0%	
	"Vehicle Renewal" Project	30%	
	Vehicle Diagnosis and Maintenance Center" Project	30%	
	"Public Transportation Stations" Project	0%	
	"Autopark" Project	30%	
	"Electronic Passenger Registration and Information" Project	70%	Bus smart cards have been introduced with support from the Korean government
	Eco-transportation" project	30%	Integrated as a component of the BRT project
	Expressway / National Highway	100%	Implemented.
	Highways /Local roads	100%	Implemented.
	Main street/road-1	100%	Implemented.
	Main Street / Road -2	100%	Implemented.
	Sub-street/road-1	100%	Implemented.
	Sub-street and Road-2	100%	Implemented.
Cargo Transport	Argalant - Emeelt Transportation Logistics Center	0%	Unable to secure financial resources
	Naraiha Transportation Logistics Center	0%	Unable to secure financial resources
	Baganuur Transportation Logistics Center	0%	Unable to secure financial resources
	Bagahangai Transportation Logistics Center	0%	Unable to secure financial resources
	Torgoit Logistics Center	0%	Unable to secure financial resources
	Amgalang Logistics Center	0%	Unable to secure financial resources
Overall		56%	

Source: Urban Planning Research Institute data, based on interviews with research team

2.3.2 Issues on Land Acquisition

With regard to the acquisition of land for public use, the legal environment is inadequate, and the law on land expropriation has not been passed. Provisions related to the Land Law, Construction Law, and Urban Redevelopment Law are set forth but are expressed in abstract terms. As a result, in many cases, negotiating and reaching a consensus on land sites takes a long time due to the large difference between the land market price and the land price and compensation amount offered by the government. In urban redevelopment projects, expropriation of land includes not only compensation but also the requirement to exchange land for compensation, yet in most cases, land negotiations are not concluded due to the lack of infrastructure and suburban land. In order to provide appropriate and fair compensation, it is necessary to establish and revise land price evaluation standards and compensation standards.

In addition, by holding project briefings and public hearings in public works projects and repeated dialogue with citizens, land negotiations and consensus building acceptable to citizens can be achieved. It is important to reflect this in specific regulations and standards regarding site negotiations and consensus building with citizens.

2.3.3 Issues on Securing Financial Resources

(1) Budget and Financial Resources of UB City Stipulated by Laws

The budget and financial resources of UB City are mainly regulated by the Law on Budget and the Law on Legal Status of Ulaanbaatar City (Capital Law).[7]

1) Local budget (Budget of Local Government)

The Law on Budget stipulates that the budget for the functions of local governments shall be financed by the following sources (Article 58.5):

- tax and non-tax revenues of aimags, the capital city, soums, and districts;
- revenue transfers allocated from the state budget (transfers for development projects and delegated functions[8]); and
- financial support allocated from the state budget.

In addition, the Law on Budget stipulates that local budgets shall be planned, approved and implemented without a deficit (Article 57.2). On the other hand, local budgets are prohibited from incurring debts or issuing guarantees, but short-term borrowing from upper level agencies within the same fiscal year as stipulated in the Debt Management Law and the Budget Law is allowed.

As for Aimags and UB with excess revenue, in accordance with the Budget Law, i If the portion of the basic budget surplus of lower level (Aimag/UB level) is less than or equal to the base expenditure, then the 70% of the basic budget surplus will be deposited to that level budget and the remaining will be mobilized to the upper-level (natioanl level) budget. If the portion of the basic budget surplus of lower level (Aimag/UB level) is more than the base expenditure, then the 70% of the portion that equal to the base expenditure will be deposited to that level of budget and remaining will be mobilized to the upper-level (natioanl level) budget. (Article 56.2).

2) Public investment and Local Development Funds

(i) Public investment in Local Government

Public investment in local governments can be classfied into (i) projects implemented with local budgets (including revenue from the national government) and (ii) projects implemented with the Local Development Fund (LDF).

(ii) LDF

The LDF is not a fund defined in the Law on Special Government Funds but a fund for local development defined in the Law on Budget. Article 4.1.28 of the Law on Budget stipulates that the “Local Development Fund” means funds reallocated from the state to local budgets

[7] The Mongolian Administrative and Administrative Circle and the Law on Management also serve as the basis for the UB Municipal Budget, but specific provisions are in the Budget Law and the Capital Law.
[8] Financing sources for delegated functions are stipulated as special purpose transfer in 56.1.3 and 61.2.

to support local development and ensure equity of regions. LDF includes the General Local Developement Fund (GLDF) stipulated by Article 59 of Law on Budget, and the LDF established in each local government stipulated by Article 60 of the same law. Article 60.1 specified that a particular level's general budget governor[9] should have LDF aimed at supporting local development.

The financial resources for the GLDF are as follows (Article 59.1).

- 5% of VAT of goods and services, except for imported goods and services
- 5% of the mineral resource exploitation tax revenue expect specified in provision 473 of Law on Minerals
- Grants and donations rendered by domestic NGOs or ODA (foregin aid) to the LDF
- 30% of revenue from petroleum royalties

The financial resources of the LDF are as follows (Article 60.2)[10].

- Transfers from GLDF
- Additional sources generated through increasing tax rates and saving expenditures
- Grants and donations rendered by domestic and foreign organizations and incentives and support from the projects, programs of international organizations implemented jointly with higher authorities to support local development
- 50% of revenue from license fees for exploration of mineral resources in the fiscal year of 2019, the 100% starting from the fiscal year of 2020, 50% of revenue from license fees for mining of mineral resources starting from the fiscal year of 2020.
- Livestock tax (used for pasture management, livestock industry development, irrigated agriculture, fodder, environmental protection, training for nomads, etc.)

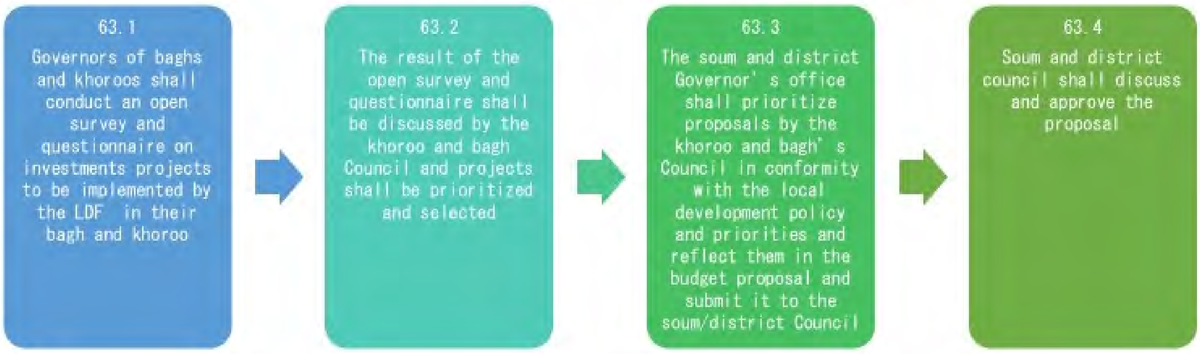
The amount of transfer from the GLDF to the LDF is determined based on (i) the local government development index, (ii) population, and (iii) population density, remoteness, and size of territory[11] (Article 59.3).

In addition, according to Article 60.3 of the Law on Budget, the LDF shall not be used for such purposes:

- programs and activities other than those authorized by law to be financed from the local budget;
- expenditures of political parties and NGOs;
- holidays, festivals, an anniversary celebration, and religious events other than national festivals;
- activities that are not in the common interest of the public;
- issue loans, issue guarantees with financial consequences, and commit to cover loss or damages; and
- expenditures and measures that do not reflect local community opinions and not reflected and approved in the local budget.

On the other hand, according to Article 63 of the Law on Budget, expenditures from the LDF is determined by the following process.

[9] "General budget governor" means an official who is authorized to plan budgets for the area within his authority and allocate, oversee, manage, and report on the execution of the approved budget by legislation (Article 4.1.36 of Law on Budget)
[10] "Funds specified in the Article 59.2 (redistribution from the capital/Aimag level to the county/district level)" was removed by the amendment on November 11, 2021(in effect on January 1, 2022).
[11] Article "59.3.4. Tax initiatives of local government " was removed from the criteria by the amendment in November 12, 2021 (in effect on January 1, 2022).



The amendment to the Law on the Legal Status of Ulaanbaatar City (Capital Law) in July 2021 changed the provisions pertaining to the roles and authorities of the UB City (came into effect in Janualy 2022). The amended Capital Law stipulates that the national and local budgets shall fund the expenditures for the roles in Article 8.2, and the local budgets shall fund the roles in Article 8.3.

Table 2.24 Roles of UB City Defined by Article 8 of the Capital Law

Article number	Roles
8.2 Special Roles	8.2.1. Assistance in ensuring the normal activities of the Parliament, the President, the Cabinet, the Supreme Court, the Constitutional Court, administrative management and administrative agencies, foreign embassies, and international organizations 8.2.2. Organization of national and international ceremonies, festivals, conferences, arts and sports, and other events, unless otherwise provided by law 8.2.3. Management and coordination of international passenger and cargo transportation and logistics 8.2.4. Preservation and protection of national historical and cultural heritage in the capital. 8.2.5. Construction of international-level roads passing through the capital's lands, their maintenance, and related activities. 8.2.6. Investment in the implementation of capital development policy 8.2.7. Maintenance, cleaning, servicing, and protection of facilities, roads, public spaces, green areas, lighting, and other infrastructure necessary to carry out the special role of the capital city as defined in this law.
8.3 Other Roles	8.3.1. Management of the Capital Development Fund 8.3.2. Human resource policy, planning, and implementation in the capital 8.3.3. Ensure the safety of the surrounding area 8.3.4. Food supply, agro-pastoral, industrial programs, general coordination 8.3.5. Redevelopment of urban areas 8.3.6. Maintenance and planning of capital roads 8.3.7. Centralized supply of potable and domestic water for the population 8.3.8. Individual water and heat supply in the capital 8.3.9. Coordinate and manage the activities of the apartment management association 8.3.10. Coordination and management of outdoor and mobile advertising materials 8.3.11. Projects and measures to reduce road congestion, improve the type, quality, and availability of public transportation services, and resolve issues the capital is facing 8.3.12. Payment of interest on funds and loans for which the capital is responsible for projects implemented in the capital by ODA 8.3.13. River protection and spatial development in the capital's land 8.3.14. Project to develop and protect nature reserves, natural resources, and historical heritage in the capital's lands for tourism and leisure. 8.3.15. Operation and sale of Toei housing 8.3.16. Other roles as defined by law

Source: Excerpt from Amended Capital Law

As for financial resources, Article 13 specifies that UB City has the right to issue bonds and Article 14 on the concession contracts by UB City. Article 16 stipulates that UB City can establish public enterprises and outsource UB City's operations to these enterprises.

Furthermore, Article 17 provides for the establishment of a new Capital Development Fund, which will be used for the following activities. The assets of this fund shall be a part of the capital city budget, and the rules for the composition, operation, and management of the fund's assets shall be approved by the UB City Council, which shall also manage its implementation. But the details of the financial resources are not specified and will be determined in the future. The following activities include the promotion of urban development and infrastructure, which could be a source of funding for transportation infrastructure projects.

- Improve urban standards and manners
- Promote the development of smart, digital cities
- Promote industry and innovation
- Promote investment
- Promote public-private partnerships
- Promote urban development and infrastructure
- Promote green development
- Promote tourism
- Mitigate risks

(2) Securing Financial Resources

Financial resources for investment projects in UB City are the national budget and UB City budget, as well as bond financing, assistance by donors, and PPP. The following is an overview of the overall annual budget for investment projects in UB City in 2020, followed by a summary of the current status and potential of individual funding sources.

1) UB City Investment Project Budget Summary (2020)

Looking at the breakdown of UB City's budget for investment projects in the fiscal year of 2020, 52.8% comes from the national budget, 41.3% from the UB City budget, and 3.7% from the LDF, showing more than half of the budget comes from the national budget. By sector, road projects accounted for 15.4%, public transportation for 7.2%, and transportation projects accounted for 22.6% of the total.

Table 2.25 Breakdown of Financial Resources for Investment Projects in UB City

Resources	Amount (10 billion MNT)	Share
National budget	384.5	52.8
UB City Budget	301.1	41.3
District budget	15.8	2.2
Local Development Fund	27.3	3.7
Total	728.7	100.0

Source: Ulaanbaatar Citizen Budget 2020

Table 2.26 Budget by sector

By sector	Amount (million MNT)	Percentage	Number of projects
Urban development and infrastructure improvement	186.6	25.6	130
Education	165.8	22.8	261
Road	112.4	15.4	213

By sector	Amount (million MNT)	Percentage	Number of projects
Urban development and maintenance	64.4	8.8	346
Public transportation	52.3	7.2	46
Public service	35.3	4.8	161
Health	33.9	4.7	108
Culture and sports	29.9	4.1	37
City public services	28.3	3.9	159
Natural (physical) environment	13.6	1.9	13
Social protection	6.1	0.8	16
Total	728.6	100.0	1,490

Source: Ulaanbaatar Citizen Budget 2020

The breakdown of the LDF is shown in the table below. Road projects account for 14.1% of the total budget. The number of projects is 43, while public transportation projects is 6 and account for 0.5%.

Table 2.27 Breakdown of LDF

Sector	Amount (million MNT)	Share	Number of projects
Landscaping	13,441.2	49.3	201
Road	3,829.2	14.1	43
Municipal utilities	4,490.3	16.5	51
Public service	692.9	2.5	19
Education	1,178.6	4.3	28
Urban development and infrastructure	1,604.5	5.9	19
Natural (physical) environment	493	1.8	4
Culture and sports	815.8	3.0	6
Hygiene	425	1.6	18
Social protection	145	0.5	5
Public transportation	134.2	0.5	6
Total	27,249.7	100.0	400

Source: Ulaanbaatar Citizen Budget 2020

The investment cost of road projects by funding source is shown in the table below. Overall, the UB City budget is the largest source with 60%, and the state budget is 35%. The LDF accounts for about 5%.

Table 2.28 Breakdown of Budget for Road Projects

Unit: million MNT

Business	Total	National budget	UB City	District budget	LDF
Road	77,071	30,299.2	44,686.8	600	1,485
Road repair and maintenance	18,330.2	5,786.5	10,649.2	651.2	1,243.3
Road camera maintenance	130	0	130	0	0
Parking lot	535	0	0	64	471
Bridge	2,813.8	2,600	0	0	213.8
(Roadway) underpass	3,533.5	200	3,333.5	0	0
Pedestrian bridge	140	0	0	140	0
Stormwater drainage on roads	3,000	0	3,000	0	0
Road junctions, lanes, searchlights, speed	1,400	0	1,400	0	0

Business	Total	National budget	UB City	District budget	LDF
bumps					
Road sign	2,817	0	2700	50	67
Asphalt concrete mixture recycling plant	500	0	500	0	0
Traffic signals, fiber optic cables, traffic control equipment, digital systems	2,150	0		180	
Bus stop	988.2	0		268.0	
Total	112,420.5	38,886	66,400	1,685	3480.1

Source: Ulaanbaatar Citizen Budget 2020

2) National Budget

The overall tax revenue of Mongolia has been rising year by year due to the improvement of tax collection capacity. As shown in Table 2.29, the tax revenue is expected to be 1.7 times more in 2024 compared to 2018. The share of the development budget is also expected to rise to over 25% again, although it fell in 2020. At the same time, however, the budget deficit continues and is 12.0% of GDP in 2020, due in part to the COVID-19, and is expected to be 2% of GDP in 2024. In addition, the ratio of government debt to GDP continues to be high, and its repayment is also planned in the near future. As such, the use of the national budget for development projects is considered to be limited.

Table 2.29 National Budget Trends

Unit: 10 billion MNT

Basic fiscal indicators		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023 (Forecast)	FY 2024 (Forecast)
	Total budget revenue	10,173	12,040	10,402	13,134	14,781	16,230	17,768
	Stabilization fund	207	95	66	156	553	576	542
	Future Heritage Fund	621	1,040	914	1,180	1,022	1,139	1,268
1	Equilibrated total income	9,345	10,906	9,422	11,798	13,206	14,515	15,958
	Tax revenue	8,228	9,813	8,502	10,754	11,849	12,956	14,286
	Non-tax revenue	1,117	1,092	920	1,043	1,357	1,560	1,673
2	Total budget expenditure	9,317	11,662	13,961	13,952	14,852	15,925	17,113
	Current expenditure	7,350	8,229	10,872	10,969	11,327	12,104	12,709
	Capital expenditure	1,680	3,017	3,052	3,542	3,769	4,152	4,761
	Net loans	287	416	38	-559	-244	-331	-357
3	Equilibrated budget balance	28	-756	-4,539	-2,154.	-1,646	-1,410	-1,155
	Percentage of GDP	0.1	-2.0%.	-12.3	-5.1%.	-3.6%.	-2.8%.	-2.0%.

Source: Medium Term Fiscal Framework (MTFF)2022-2024

Table 2.30 Ratio of Current Expenditure and Capital Expenditure in National Budget

National Expenditures	2018	2019	2020	2021	2022	2023	2024
Current expenditure	78.9	70.6	77.9	78.6	76.3	76.0	74.3
Capital expenditure	18.0	25.9	21.9	25.4	25.4	26.1	27.8

Source: MTFF 2022–2024

Table 2.31 Government Debt and Ratio of Government Debt to GDP

Unit: 10 billion MNT

	2018	2019	2020	2021	2022	2023	2024
Government debt (NPV)	18,955.9	20,525.6	23,024.3	25,491.2	31,439.4	32,727.2	34,839.6
Ratio to GDP (%)	58.5	55.1	62.3	59.9	67.2	62.9	59.4

Source: MTFF 2022–2024

3) UB City Budget

The sources of funding for development projects in UB City are city revenue (tax and non-tax revenue) and the LDF. As shown in the table below, the finances of UB City have grown significantly in terms of revenues and expenditures, and the share of the development project budget in expenditures has remained at 40–50%, dropping in 2021 but increasing significantly to 63% in 2022. This is due to the addition of expenditure for measures of traffic congestion from 2022.

Table 2.32 UB City Revenue (of which tax and non-tax revenue)

Unit: million MNT

	2018	2019	2020	2021	2022
Total revenue*	812,482	953,176	980,055	1,020,720	1,498,903
Capital city revenue**	647,254	796,251	734,193	820,726	482,044
Tax revenue[12]	565,368	628,488	570,665	717,050	263,103
Non-tax revenue	65,299	144,601	140,929	74,479	204,588

*Includes UB City's tax and non-tax revenue, plus the amount transferred or carried over from the district.
**Total tax and non-tax revenue of UB City.
Note: 2018~2021 is the amended budget
Source: JICA Study Team based on UB City budget

Table 2.33 Ratio of Current Expenditure to Capital Expenditures in UB City Budget

Expenditure	2018	2019	2020	2021	2022
Current expenditure	53.1	47.6	54.5	66.9	36.9
Capital expenditure	46.9	52.4	45.5	33.1	63.1

Note: Year 2018~2021 is the amount after correction
Source: JICA Study Team based on UB City budget

The breakdown of the capital expenditure is shown in Table 2.34. The financial resources are divided into two major categories: the capital city public investment and the LDF investment. Furthermore, the capital city public investment budget is divided into two categories: investment from the UB city budget and investment from the Road Fund. Road projects are implemented through the budget of the Road Fund.

In addition, there has been a change in the budget structure of UB City since the fiscal year of 2022. At the plenary meeting of the National Traffic Congestion Mitigation Committee held in early November 2021, it was announced that about MNT 416.3 billion will be allocated for traffic congestion measures from the fiscal year of 2022, and traffic congestion measures expenses have been added to the items of expenses. The funding will be from

[12] Due to the amendment of the Law on Budget, the source of tax revenue has changed and corporate tax, real estate tax, etc. are now included in the district's budget instead of UB City's, so tax revenue is much lower than the previous year. On the other hand, transfer payments from the district have increased, resulting in an increase in total revenue for UB City.

the decrease in the surplus previously refunded to the state and the increase in the transfer of surplus from the district to UB City, which will increase the burden of the state budget.

Table 2.34 UB City Capital Expenditure

Unit: million MNT

Item of Capital Expenditure		2018	2019	2020	2021	2022
Total		244,985	336,624	299,323	188,976	854,502
Capital city public investment	Total	174,554	259,225	176,404	115,022	355,657
	Capital city budget investment	137,691	221,555	124,706	55,892	270,045
	Large-scale renovation work	0	0	0	0	20,000
	Road fund investment	36,863	37,670	51,698	59,130	65,612
	Road fund current	0	0	0	0	0
LDF investment	Total	16,259	26,509	23,201	33,036	28,580
	LDF UB	11,471	18,640	17,977	23,063	14,353
	LDF districts	4,787	7,869	5,224	9,973	14,227
Traffic congestion relief[13]		0	0	0	0	**416,260**
Investment carryovers	Total /Capital city public investment	53,234	48,233	91,586	30,969	40,247
	LDF	938	2,656	8,132	9,948	13,758

Note: Amended budget from 2018–2021.
Source: JICA Study Team based on UB City budget

Table 2.35 and Table 2.36 show the breakdown of the capital city budget investment (UB City budget investment and Road Fund investment). In 2021, the city planning, construction, and infrastructure projects accounted for more than 40% of the total UB City budget investment, while public transportation (other than road projects) accounted for only 5.5%. In 2022, the share of each sector in UB City budget investment was calculated, including the expenditure for traffic congestion relief. Traffic congestion relief accounts for 60%, followed by urban development projects at 16.3%, and public transportation at 1.6%.

As for road projects, whose budget from the Road Fund, the total amount has increased year by year and increased in 2022, as shown in Table 2.34. The share of repair costs have remained the same at about 30% in both 2021 and 2022, but the share of road construction has dropped from 67% in 2021 to 50% in 2022.

Finally, the traffic congestion relief projects added in 2022 are divided into main road, access road construction, and school and kindergarten construction, as shown in Table 2.32. The total project cost is 616.8 billion MNT, of which about half is for the access road project. The access road project will be completed in 2022, and the remaining main road and school/kindergarten construction will be continued after 2023.

[13] The congestion relief project cost is included in the UB City budget investment (Capital city budget investment), but since it was added this year, it is shown separately in the UB city budget and in this report as well.

Table 2.35 UB City Budget Investment by Sector (2021)

Unit: million MNT

Sector	Budget	Share (%)
City administration	6,189	11.1
City planning, construction, new infrastructure	23,785	42.6
City owned building renovation, new construction, investment	13,040	23.3
Welfare, social protection	1,300	2.3.
Water, sewage, treatment plant	1,587	2.8
Housing	1,978	3.5
Flood enbankment	225	0.4
Public transport services	3,073	5.5
Infectious disease prevention, veterinary services	300	0.5
Disaster prevention	228	0.4
Cityscape, street lamp	2,814	5.0
Maintenance and construction of high-voltage power lines, grids, and substations	1,373	2.5
Total	55,892	100

Source: JICA Study Team based on UB City budget

Table 2.36 UB Municipal Budget Investment (including Congestion Relief) by Sector (2022)

Unit: million MNT

Sector	Budget	Share (%)
City-owned property	80,300	11.7
Clean water and well	7,552	1.1.
Museums, libraries, gymnasiums and cultural centers	6,762	1.0
Public transport services	11,000	1.6
Planning of road and terminals	8,000	1.2
Power transmission, heat supply, water and sewage	5,823	0.8
Urban development, construction, standard, management, coordination	111,890	16.3
Sewage treatment, embankment, and drains	3,249	0.5
Address registration and city signs	184	0.0
Development and maintenance of public roads, parks and green spaces	31,171	4.5
Waste disposal, operation and management	4,000	0.6
Others	114	0.0
Traffic congestion relief	416,260	**60.7**
Total	686,306	

Source: JICA Study Team based on UB City budget

Table 2.37 Breakdown of road fund investment (2021 and 2022)

Unit: million MNT

Item	2021		2022	
Road construction	39,679	(67%)	33,026	(50%)
Repair and maintenance	17,033	(29%)	20,080	(31%)
Related research and analysis	1,050	(2%)	4,908	(7%)
Consulting and management fees	685	(1%)	-	-
Others	684	(1%)	7,598	(12%)
Total	59,130		65,612	

Source: JICA Study Team based on UB City budget

Table 2.38 Breakdown of Congestion Mitigation Project Costs

Unit: million MNT

Traffic congestion relief projects	Total Project Cost	2022 Budget
Main road construction	225,114	60,977
Access road construction	334,483	334,483
Construction of schools and kindergartens	57,170	20,800
Total	616,768	416,260

Source: JICA Study Team based on UB City budget

4) Municipal Bonds and PPP

As mentioned above, the amended Capital Law also increases the possibility for UB City to raise funds through municipal bonds and PPP. Furthermore, the law also provides for the establishment of a Capital Development Fund, which could be used for transportation infrastructure. However, raising funds in the financial markets, such as through bond issues, requires a certain level of public financial management and a high level of creditworthiness.

On the other hand, although there is a growing trend toward the use of private capital at the national and UB City levels, the process of PPP project formation, evaluation, and approval is not in coordination with the public investment projects, and national budget approval is not required at the preparation stage. This has many institutional challenges. The Ministry of Economy and Development (MED), newly established by the National Development Agency in January 2022, is responsible for PPP, but the MOF has been preparing the draft Law on PPP, which will replace the Law on Concessions. Therefore, the division of roles related to PPP is not clear at this moment.

Although the PPP process is schedued to be established, including coordination with the PIP formulation process and funding by PPP expected in the future, it will take time.

5) ODA

As for ODA projects, in the provisions of the attachment to the Order Minster of Finace (Regulation on the Utilization of Government Foregin Loan Proceeds, Implementation, Administration, Financing, Monitoring and Evaluation of Projects Funded by These Proceeds) explained in Section 2.1.4 (1), the procedures for implementing foreign loans and the scope of jurisdiction of the relevant agencies are set forth. However, currently, in many cases, the MOF and the donors consult with each other and decisions are made without sufficient discussions with sector ministries and related agencies. Regulations on the preparation of loan projects (project formulation) are also scheduled to be formulated, and it is necessary to develop a legal framework as well as a mechanism to ensure that operations are carried out in accordance with the regulations.

Particularly an important point in terms of securing financial resources is the debt ceiling. As shown in the Table 2.31, the government debt to GDP ratio is at the full ceiling set by the Law on Fiscal Stabilization up to 2024, making it difficult to obtain additional loans. As described in 2.1.4 (2), the grace period for the ceiling has been extended from 2020 to 2023 in the past and strict debt management will be desirable. Since 2025, GDP growth may be higher than expected due to prgress of mining developemnt of Oyu Tolgoi which make more rooms for external borrowing. However, grace period will end in 2023 and debt ceiling will be set at 60% and thus it needs to watch the situation more carefully.

(3) Summary of Issues on Securing Financial Resources

The information on financial resources obtained in this survey is published by different organizations and, thus it is inconsistent with each other. For instance, the actual information is different from the plan, has no details, and has different years. This section summarizes the current issues on securing each financial resource previously mentioned in (2) and presents the common issues.

As seen above, the financial resources for the transportation infrastructure projects of UB City include the national budget, UB City budget, utilization of private funds (PPP/municipal bonds), and ODA. The national budget accounts for more than half of the investment project budget of UB City, but due to the COVID-19 pandemic, the budget deficit is expected to continue until 2024, and the ratio of government debt to GDP maintains high. The capital expenditure ratio is expected to rise from 18% in 2018 to about 28% in 2024, emphasizing development projects. Additionally, due to the increase in tax revenue and greater economic growth by the progress of mine development, there is a possibility that revenues will increase significantly, but the immediate assumption is that the utilization of the national budget will be limited.

On the other hand, as for the UB City budget, the Road Fund, which is the financial resource for the road projects, has been increasing every year, and in the 2021 budget, a new budget for eliminating traffic congestion is added, accounting for 60% of the UB City budget investment. Thus, there is a tendency to allocate more budget to projects to eliminate traffic congestion. However, the budget for public transportation is limited to about 7% of the investment project budget in UB City (about 15% for road projects), including all financial resources, and it is about 0.5% in the LDF investment. In addition, as a new budget, the establishment of the Capital Development Fund is also stipulated by law, but the specific financial resources have not been decided, and the outlook is unclear.

Regarding utilizing private funds, the central government and UB City are considering active utilization because public funds are limited. With the revision of the Capital Law, it will be possible to issue municipal bonds of UB City, which will be considered as a new source of financing together with PPP. However, most PPP projects were previously build-transfer concession projects, and the financial pressure due to deferral of government debt has become a problem. In addition, regarding the project formation process, the establishment of a new system such as the formulation of the Law on PPP[14] has begun. Issuing bonds is legally possible in UB City, but it will take time, as well as obtaining obtain high creditworthiness.

With regard to ODA, it will be difficult to receive external borrowing until at least 2024 due to the problem of debt sealing. Behind this, there is the process of project formulation and selection that is not in accordance with the process of the public investment projects, and the loan has been decided even with insufficient discussions among related organizations such as the project implementing agencies. Currently, the legal framework is being reviewed, and it is expected that appropriate projects will be selected by improving the process of selecting external borrowing.

[14] As of January 2022, MOF drafted Law on PPP, which is scheduled to be approved by the Parliament.

Regarding the possibility of loans after 2025, it is necessary to determine the loan limit and the government's repayment capacity in consideration of the possibility of national economic growth in addition to appropriate debt management.

As mentioned above, UB City has been shifting to allocate the budget that focuses on improving traffic congestion, and the entire country has the potential for significant economic growth through mining development and for UB City to utilize private funds. Although there are such positive factors for securing financial resources, under the current difficult financial conditions, it is important to increase options for financing while improving the systems and procedures to utilize PPP, municipal bonds, the capital development fund, and ODA.

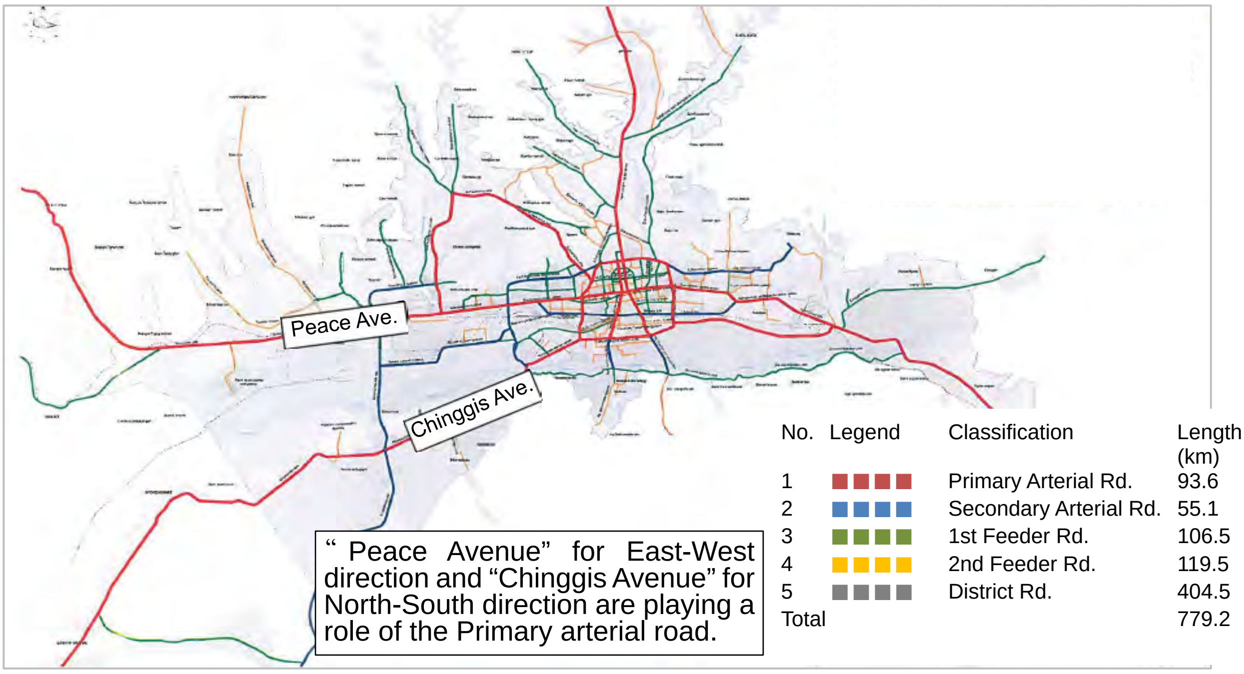
3 Ulaanbaatar City Urban Transport Condition

3.1 Road Transport Condition and Issues

3.1.1 Road Transport Condition

(1) Status of Road Network Development

The road network in Ulaanbaatar City (UB City) and neighboring satellite cities has a total length of 1,051.0 km. As shown in Figure 3.1, the total length of the road network in the center of UB City is 779.2 km, consisting of 148.7 km of arterial roads, 226.0 km of feeder roads, and 404.5 km of district roads. There are 70 bridges with a total length of 3,956 m, crossing rivers and railways.



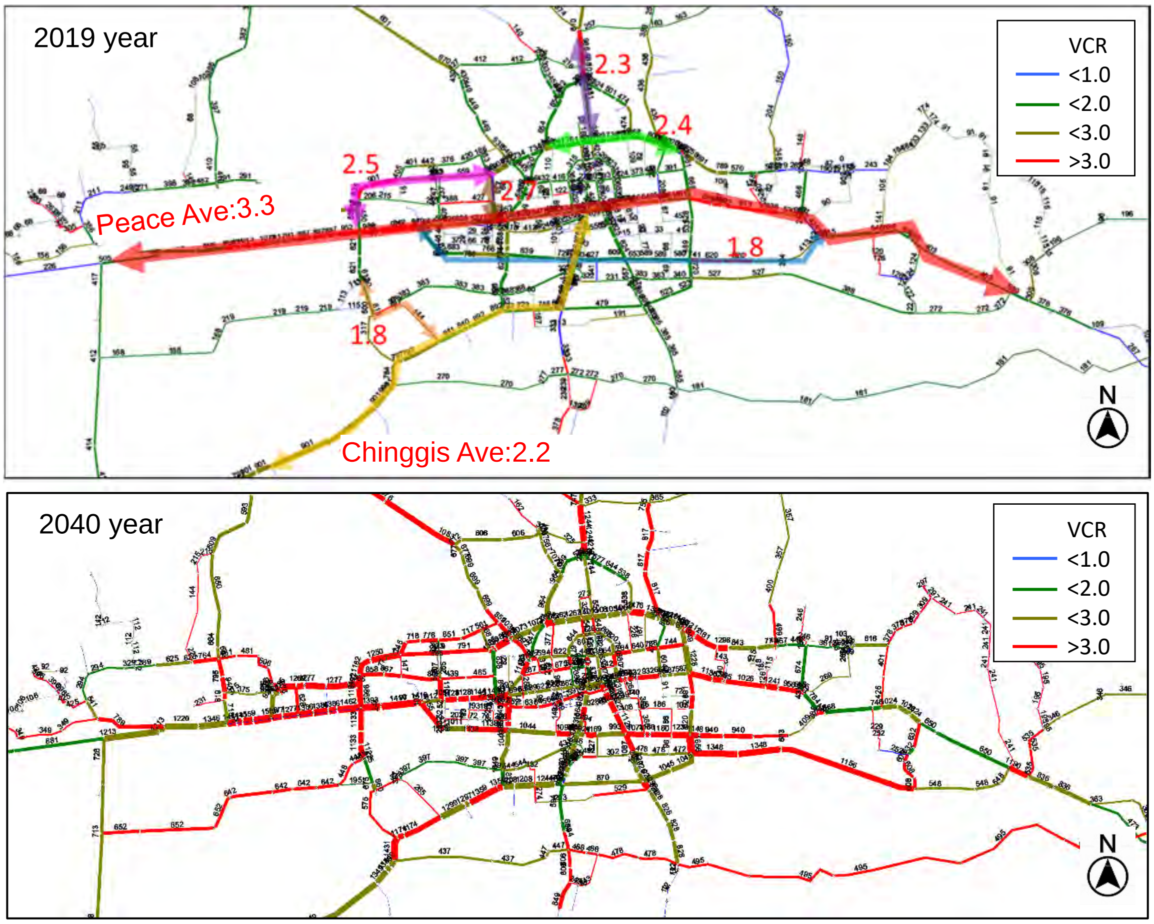
Source: UBRD2030

Figure 3.1 Existing Road Network in UB City

(2) Condition of Traffic Congestion

Figure 3.2 shows the congestion situation in UB City as of 2019 and the forecast results for 2040. Peace Avenue (Peace Ave.), the major east–west corridor in 2019, has many sections with congestion at a evel (Vehicle Capacity Ratio [VCR])[15] exceeding 3.0 in addition to chronic traffic congestion. UB City is expected to have chronic traffic congestion throughout the city by 2040, so the development of road transport infrastructure is urgently needed.

[15] VCR was calculated by traffic volume/traffic capacity
Less than 1.00: Not congested. Vehicles can move smoothly.
More than 2.00: Chronic congestion. About 70% of the 12-hour daytime is congested.
More than 3.00: Abnormal level. Congestion on all roads for 12 hours during the day.



Source: Upper Figure by UBRD and Bottom Figure by JICA Study Team

Figure 3.2 Situation of Traffic Congestion in UB City in 2019 and 2040

(3) Vehicle Condition

1) Trend of Increased Vehicle Registrartion Number

The total number of vehicles registered in UB City as of 1 October 2020 is 604,818 units, which has increased 2.7 times in about 10 years. It has been increasing at a high rate in the past five years, 2016–2020, with an average annual increase of 7.7%.

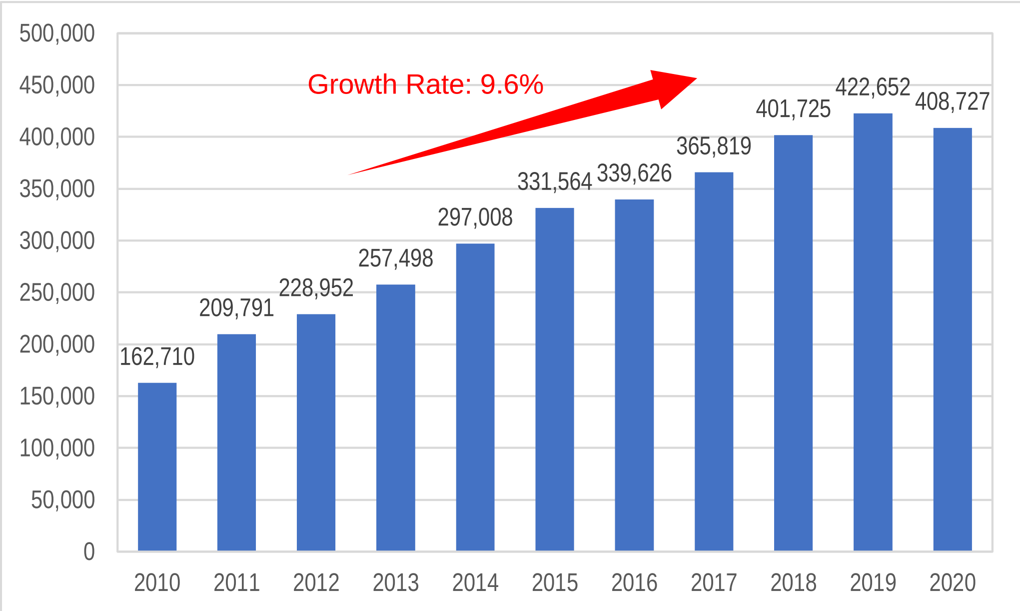
Source: Study on Traffic Congestion Improvement Measure in UB City, UB City, Year 2020

Figure 3.3 Number of vehicles registered in UB City（2010 to 2020）

2) Vehicle Maintenance Condition

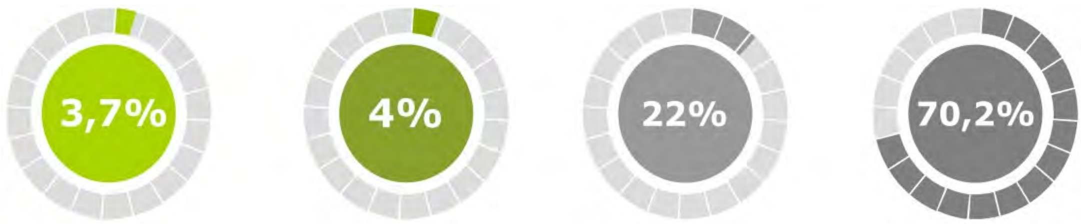
As shown in Figure 3.4, the number of vehicles inspected has been increasing at an annual rate of 9.6%, from 162,710 in 2010 to 408,727 in 2020. In addition, according to UBRD 2030, about 80% of the registered vehicles in UB City are running with completed vehicle inspections.

Figure 3.5 shows the age of the vehicles in UB City, showing that 70% of the total vehicles are over 10 years old and 22% are 7 to 8 years old. In 2 to 3 years, it is expected that more than 90% of the vehicles will be more than 10 years old. The increasing number of old vehicles on the road and the increasing number of broken-down vehicles on the streets have also been stated as one of the causes of traffic congestion.



Source: Study on Traffic Congestion Improvement Measure in UB City (2020)

Figure 3.4 Number of vehicles inspected（2010 to 2020）



Less than 3 years
22,549 Vehicles

4 to 6 years
24,353 Vehicles

7 to 9 years
133,648 vehicles

Over 10 years
424,268 vehicles

Source: Study on Traffic Congestion Improvement Measure in UB City (2020)

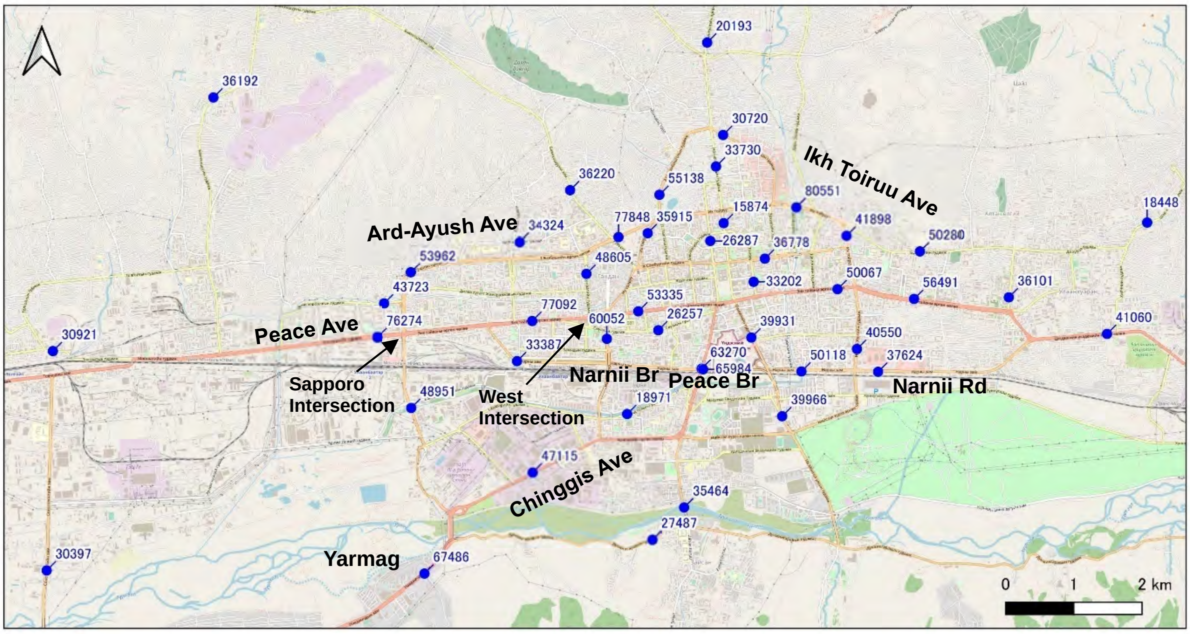
Figure 3.5 Number of years the car has been in use

3) Traffic Volume in UB City

The traffic volume at key locations in UB City is shown in Figure 3.6. The traffic situation shown is based on the results of the traffic survey in the JICA project "Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 3."

- Traffic volume on Peace Ave. was observed to go from 50,067 to 77,094 vehicles/day. In addition, traffic volume exceeds approximately 70,000 vehicles/day, causing chronic congestion near the West Side Intersection and Sapporo Intersection.

- The number of vehicles exceeds 60,000 a day on Narnii Road and near the city center.
- The location with the highest traffic volume is Ikh Toiruu Street, an east–west road on the north side of UB City where the number of vehicles exceeds 80,000 a day.
- Traffic volume on Chinggis Ave. near Yaarmag exceeds 60,000 vehicles/day, which is the same as in Narnii Bridge and Peace Bridge, resulting in traffic congestion.



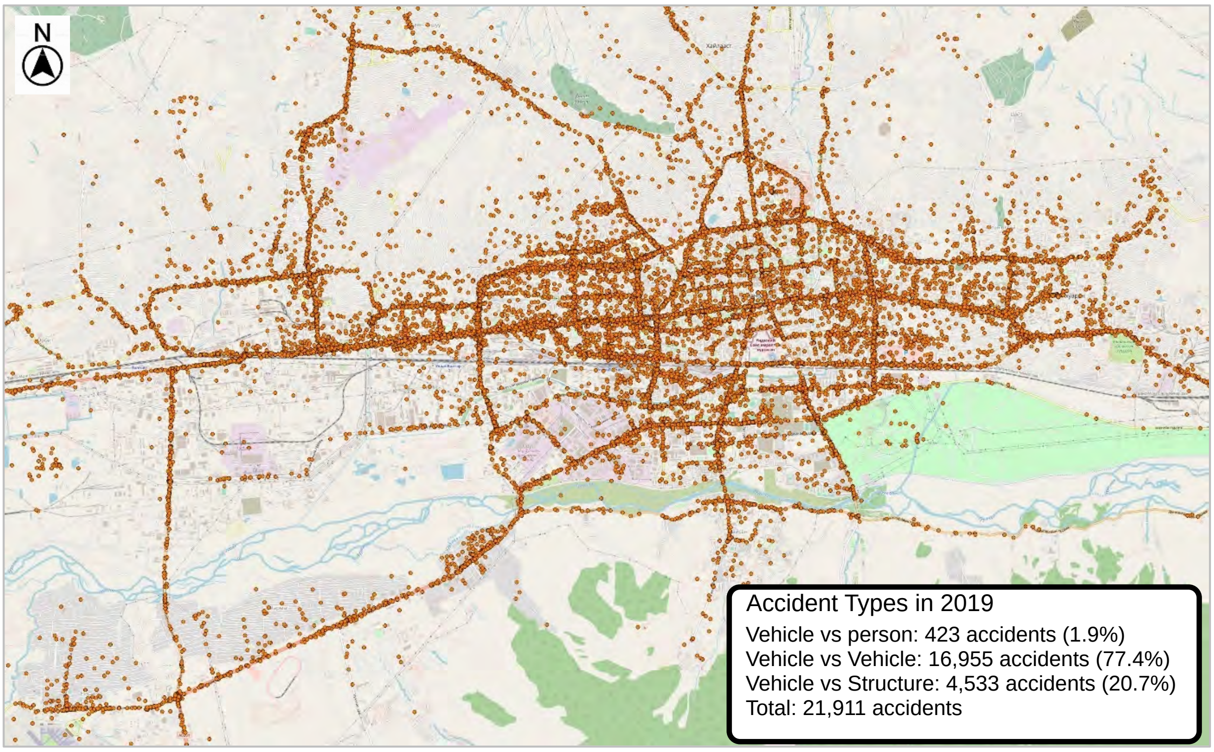
Source: Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 3

Figure 3.6 Traffic Survey Locations at Key Locations in UB City（year 2019）

(4) Traffic Accident Situation in UB City

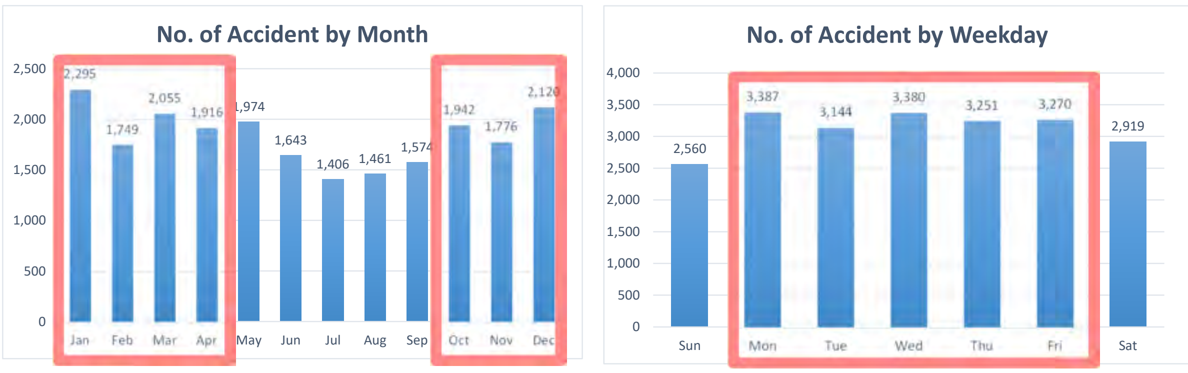
The traffic accident situation in UB City is considered low, based on the World Bank (WB) traffic accident data.

- According to the traffic accident data of the World Bank in 2019, as shown in Figure 3.7, there are 21,911 traffic accidents per year in UB City. It is high across all routes in the city.
- Vehicle vs. vehicle traffic accidents accounts for more than 70%. The increasing number of private vehicle users is expected to affect traffic accidents.
- Although the traffic volumes are increasing, the number of traffic accidents in 2018's WB data is 25,472 per year, which is a decreasing trend.
- As shown in Figure 3.8, the number of traffic accidents by month is high during the winter season, and weekday numbers are higher than the weekend when there are more commuters and students.



※Number of accident in 2018 was observed at 25,472 accidents/year
Source: WB

Figure 3.7 Traffic Accident Date in 2019



Source: WB

Figure 3.8 Traffic Accident Data in UB City in 2019 (by Month and by Day)

(5) Traffic Management Situation in UB City

Traffic management in UB City is under the jurisdiction of the Traffic Control Center that collects traffic information, provides information (by apps, etc.) on controlled traffic signals, manages traffic violations, and regulates traffic. Table 3.1 shows the jurisdiction of the Traffic Control Center and Traffic Police.

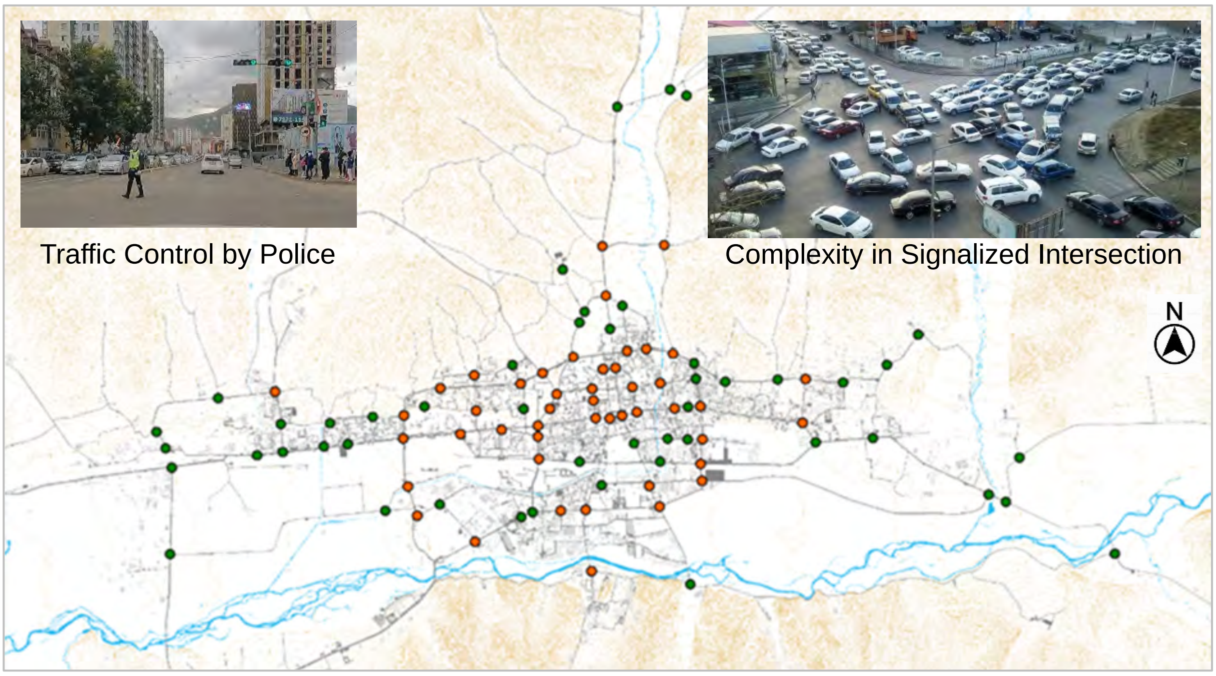
Table 3.1 Jurisdction of Traffic Control Center and Traffic Police

Item	Traffic Control Center	Traffic Police
Signal Control	・ Plan and installation of Traffic Signal ・ Setting and Adjustment of Signal Phase ・ General works of O&M for Traffic Signal	・ Advice on signal installation plans and signal phase ・ Traffic control by traffic police in situation

Item	Traffic Control Center	Traffic Police
		of traffic lights accident ・ Traffic control by traffic police to prevent traffic congestion
Enforcement of violating vehicle	・ The LPR camera automatically captures images of speeding, red light violations, and bus lane violations, which are provided to the traffic police after confirmation of the data.	・ Determine penalties for violating vehicles based on photo data from the UB Traffic Control Center ・ Enforcement of violating vehicle on the road ・ Enforcement of tow truck

Source: Traffic Control Center

The current total number of intersections is 408 intersections. The number of signal-controlled intersections is 154 intersections, and the number of controlled signalized intersections is very low (Refer to Figure 3.9). Even at signal-controlled intersections, there is disorderly operation due to ignorance of traffic rules and bad manners. In such cases, manual traffic control by the traffic police is implemented for intersection operation.



Source: Traffic Control Center in UB City

Figure 3.9 Intersection Location in UB City

The operational status of the traffic control system and signal system at the traffic control center in UB City are shown as follows.

- The traffic control system provided by Korean and signals were installed in 2010.
- Initially, 47 LED signals, 29 CCTV cameras, 52 sensing devices, and 12 speed-sensing surveillance cameras were installed (now increased to 154 LED signals and 44 CCTV cameras).
- The control of traffic signals was conducted on a trial at two intersections, West Side Intersection and East Side Intersection where installed loop coil detectors are not in operation because they did not work in winter.
- Signal control using a sensor is not in operation.
- The 88 traffic signals installed in the city can be controlled directly from the traffic control center. The 66 traffic signals are off-line, so police officers are in charge of traffic control.

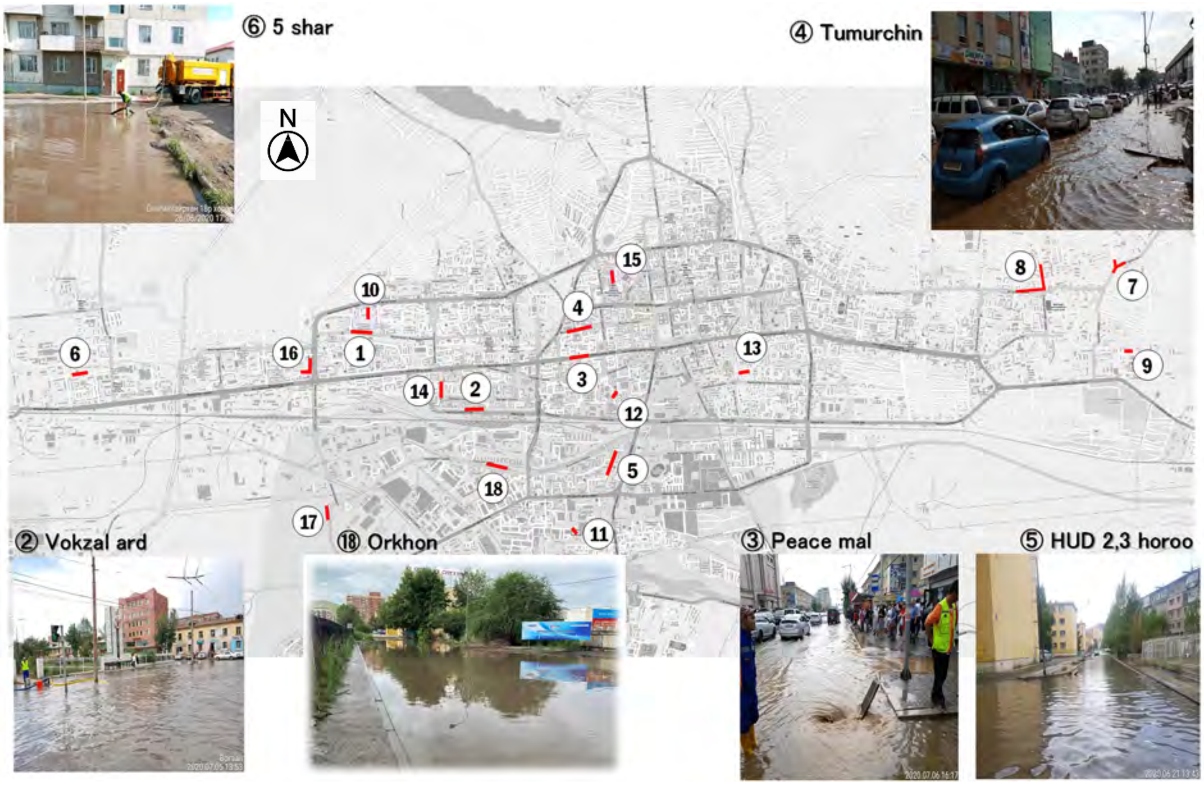
Source: Photos by JICA Study Team

Figure 3.10 Traffic Control Center in UB City

(6) Traffic Effect by Flood

Figure 3.11 shows the situation of road flooding in UB City. The rainy season is from June to August, when flooding in UB City is frequent. Flooding occurs due to heavy localized rainfall from 10 to 20 minutes. When there is a lot of rainfall, some areas remain flooded by rainwater for about a week. The flooding has become an impediment to traffic. When the roads are flooded, the Bureau of Surveying and Drainage Facilities of UB City sends out pump trucks to drain the rainwater.

The main reasons for flooding are (i) insufficient maintenance of rainwater drainage pipes and insufficient drainage capacity; (ii) inadequate road drainage planning and drainage facilities; and (iii) blockage of drainage pipes and drainage facilities (clogged by sand, soil, and domestic waste) due to aging, damage, and insufficient maintenance. An essential urban drainage improvement plan is necessary to solve the problems.



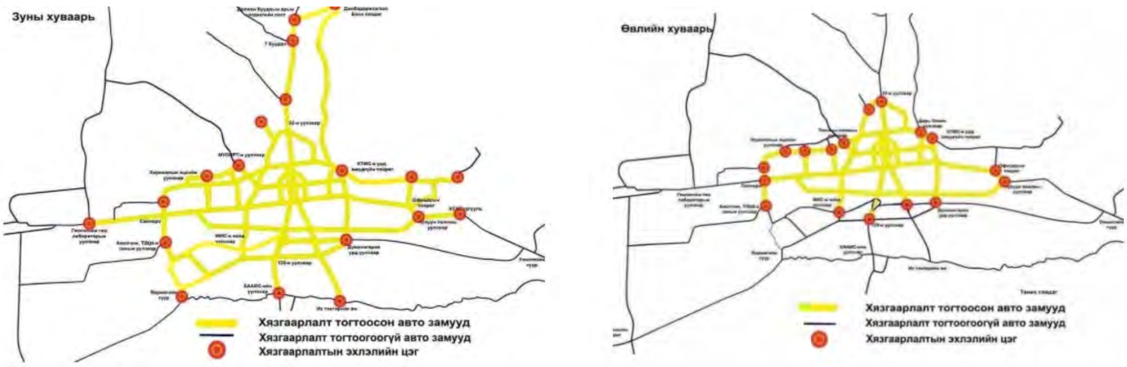
Source: :UB City Surveying and Drainage Facilities Bureau

Figure 3.11 UB City Flood Situation

3.1.2 Traffic Congestion Measure implementing by UB City

(1) Number Coding Measure

Based on the "Comprehensive Congestion Reduction Program in UB City," the city has implemented number coding since 22 August 2012. Figure 3.12 shows the area coverage of the number coding depending on the season. The flow of vehicles is based on the vehicle number (Monday (1, 6), Tuesday (2, 7), Wednesday (3, 8), Thursday (4, 6), and Friday (5, 0)), and the traffic control time is 12 hours, from 8:00 a.m. to 8:00 p.m. A fine of 20,000 MNT will be imposed on violators. However, even with the implemented countermeasures, the traffic volume is still increasing. Measures have not been effective in reducing congestion.



Summer (4/15 to 10/15) Winter (10/15 to 4/15)

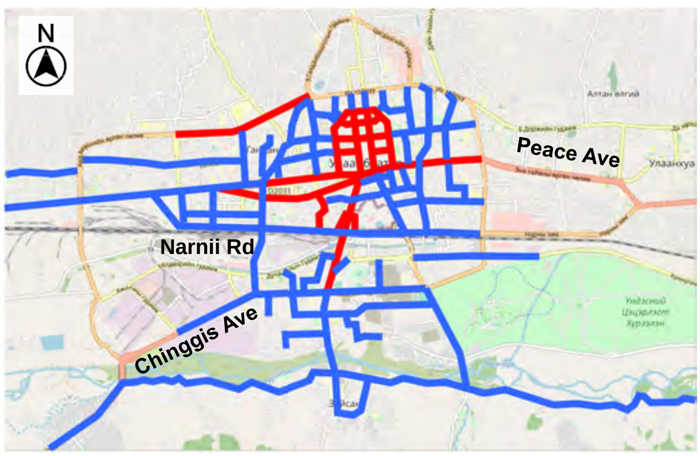
Source: Comprehensive Congestion Reduction Program

Figure 3.12 Area subjected to number coding

(2) Traffic Restriction for Truck

Heavy vehicle traffic (truck) in UB City is restricted on certain routes, as shown in Figure 3.13. In the figure, city center routes in red trucks are restricted from the for a whole day; however, trucks of 3.5 tons or less are allowed with a permit application. During the nighttime, trucks are concentrated on the routes in blue. Thus, main roads, such as Narnii Road and Chinggis Ave., are congested until nighttime.

On the other hand, the distribution centers of logistics hubs for heavy vehicles are outside the regulated area, as shown in Figure 3.14. Only a few distribution centers are within the regulation area. Since the industrial area is on the west side of UB City, the number of heavy vehicles there is high due to the constant movement of large trucks.

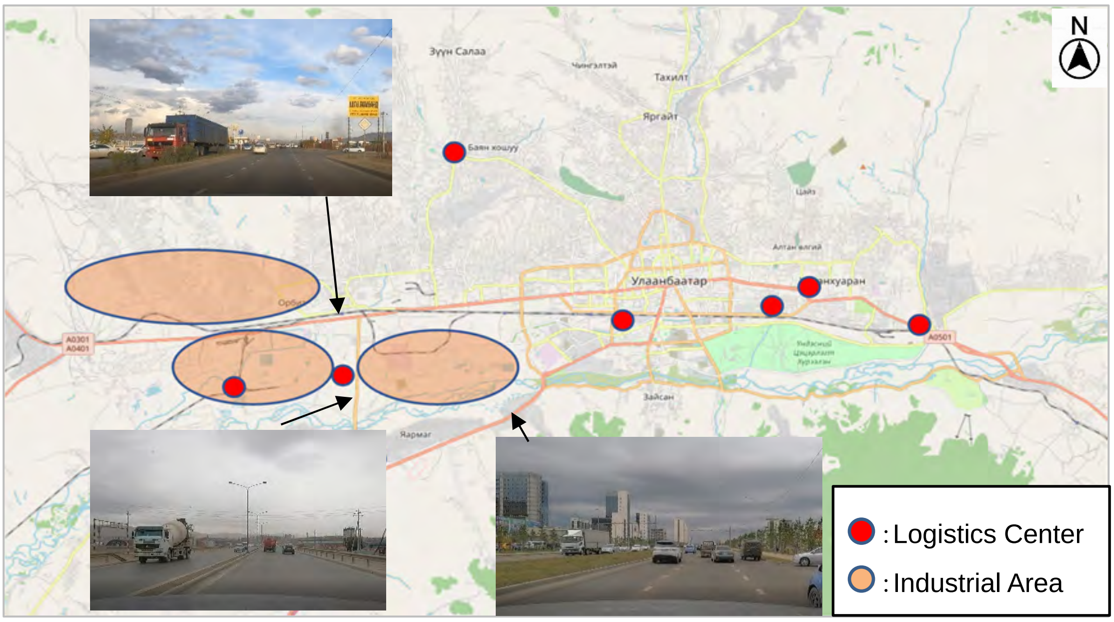


Closed to trucks all day (trucks of 3.5 tons or less can pass through with a permit)

Closed to traffic only between 11:00 and 20:00 (passable with a permit)

Source: UBRD2030

Figure 3.13 Roads restricted to large vehicle traffic

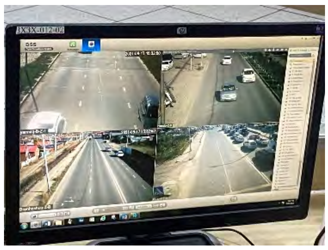


Source: JICA Study Team

Figure 3.14 Delivery center and industrial area in UB City

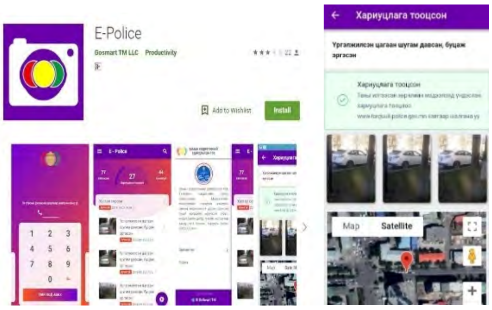
(3) Enforcement of Traffic Violation Vehicles

The traffic enforcement situation in UB City has the highest number of passenger vehicles entering the bus lane due to traffic congestion. The number of bus lane entries is the highest at 460,000 per year or 88.7% of the total. Other violations were stop sign violation (7.4%), parking violations (2.1%), violation of stop inside intersection (1.7%) and signal disregard (0.1%). Enforcement methods include a visual inspection by the police (traffic zone violations, jaywalking, etc.), checking with license plate recognition (LPR) at roads and intersections (parking violations, jaywalking, etc.), notifying the police using a privately developed mobile app (E-Police Apprication) (parking violations), and towing by a tow truck when parked on the street. On the other hand, many violators do not pay their fines, and the deterrent effect is not sufficient.



Source: Traffic Control Center in UB City

CCTV and LPR cameras on road and intersections



Source: Traffic Police

E-Police Application

Source: Interview with the president of the tow truck union (September 2021)

Towing of parked vehicles by tow truck

Figure 3.15 Traffic Enforcement Situation

Table 3.1 Number of Traffic Violations Enforced in 2019

	Signal Disregard	Entry to Bus Lane	Stop Sign Violation	Parking Violation	Violation of Stop inside Intersection	Total
			Police (Administaration Office in Kholoo)	e-Police	Yellow box	
Numer of Vilolation	781	465,799	38,778	10,807	8,854	525,019
%	0.1%	88.7%	7.4%	2.1%	1.7%	100.0%

Source: UB City Traffic Control Center

(4) Parking Issues and Measures in UB City

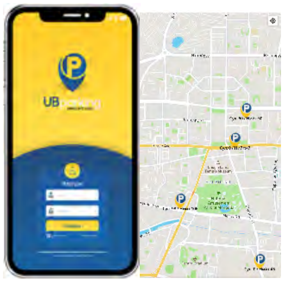
The number of arrests for parking violations in UB City may be low at 2.1%, but parking on the roadside is frequent that it causes traffic congestion problems. Street parking in UB City is frequent and very common because there are not enough parking spaces. People park illegally in the right lane of the road, and restrictions on on-street parking are not strictly enforced. Instead of visitors, employees of nearby ministries and private companies mostly occupy the free public parking areas for long periods. Therefore, the turnover rate of the parking lots is very low, and visitors often end up parking illegally on the main road line. Additionally, parking lot users often park illegally instead of using a nearby paid parking (about 1000 MNT per hour) because they are conscious of wanting to park for free.

Since parking spaces in residential areas are overwhelmingly inadequate, common spaces such as roads and sidewalks are often used as parking spaces. The residential areas have no strict police enforcement, so vehicles commonly occupy the streets around residences. In some cases, visitors park their cars without permission, so condominiums had to install remote-controlled gates, using repair money, that can be opened and closed by the management association. Most parking spaces in the city are flat, and only a few are multi-story parking lots. Underground parking lots can only be found in commercial complexes and recently built shopping centers. However, these have little capacity and often have queues of vehicles waiting to park. Vehicles often occupy lanes of existing roads, which becomes the reason for traffic congestion.

Parking on Walkway Parking in Playground Installation of Retractable Gates

Figure 3.16 Parking Situation in Residential Area

As a measure to reduce illegal parking in UB City, the “Parking Smart Application” has been going through a trial phase since June 2021. The app allows users to check the availability of parking spaces on a map in advance and make a reservation. Parking fees can be paid using QR codes. However, it has not been widely used due to issues, such as few available parking lots in the city and the app not being launched properly.



Application for Smartphone

Example of Effect: In front of Central Tower

Source: UB Parking Company

Figure 3.17 Measure to reduce illegal parking by Parking Smart Application

3.1.3 Issue of Road Transport Sector

(1) Lack of road network

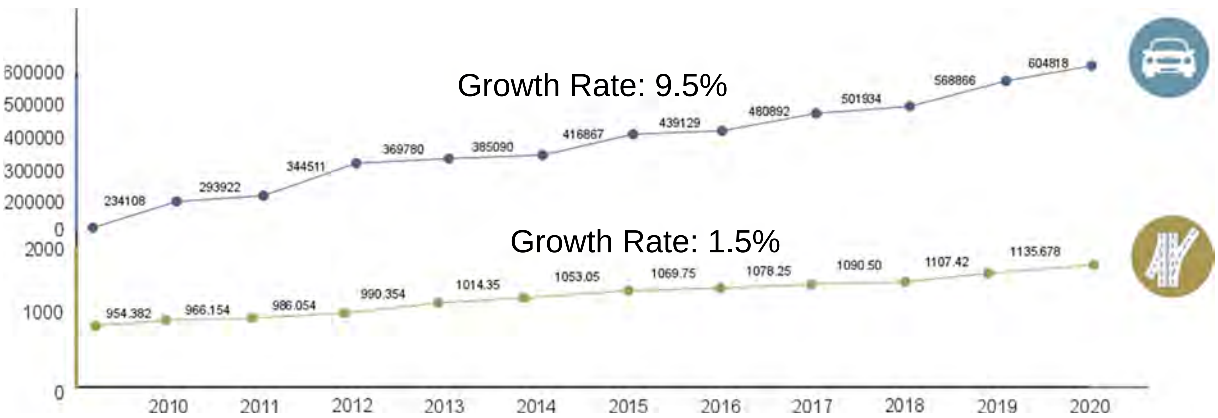
1) Status of road network development

The road network in the UB City metropolitan area has a total length of about 780 km and a road network density of 2.1 km/km^2. These were compared with the road density of Sendai City, Japan, which has a similar number of registered vehicles, UB City has about 41% of the number of registered vehicles and less road density in Japan. In addition, the number of registered vehicles and road network extension trend in UB City were delineated in the span of 10 years, from 2010 to 2020; the number of vehicle registrations has increased at an annual rate of 9.5% since 2010. However, the average annual growth rate of the road network is only about 1.5%, and the road network is lagging.

Table 3.1 Comparison of Road Density

	UB City	Sendai City
Population (person)	1,597,290	1,092,659
Vehicle Registration Number (thousand vehicle)	605	655
Road Density (km/km^2)	2.1[16]	5.1
Road Density (%) (Sendai City: 100%)	41%	100%

Source: Sendai City, UBRD2030



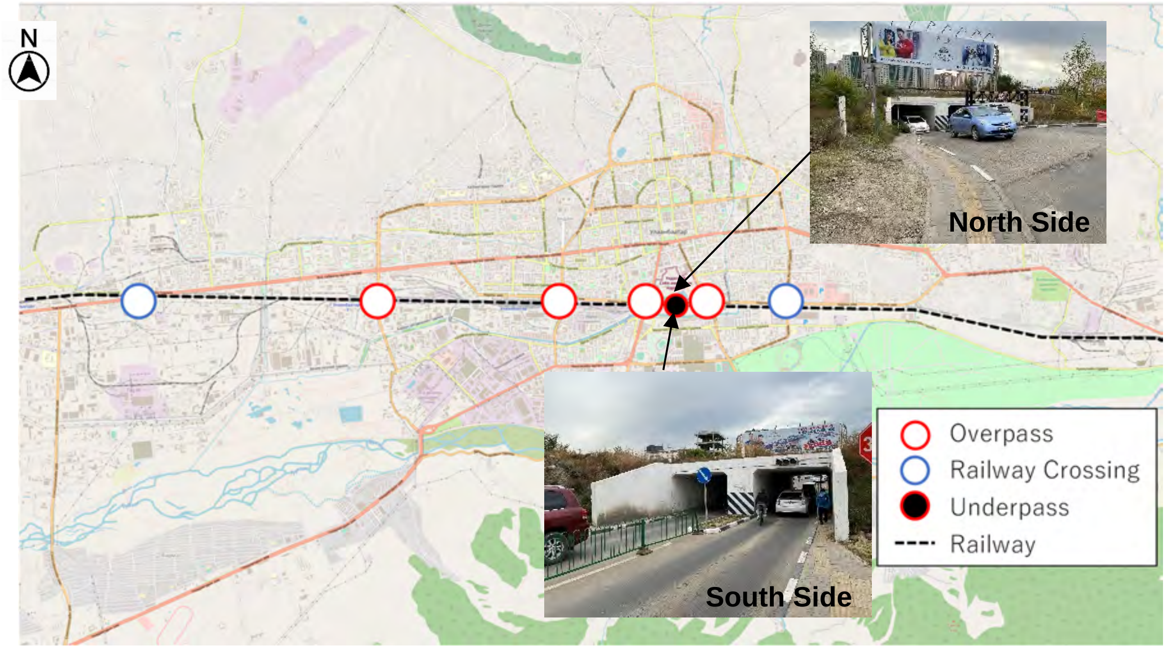
Source: UBRD2030

Figure 3.18 Changes in the Number of Cars Owned and Road Network Development Over Time

[16] The density was calculated using the area of Khooro (376 km^2) in the center of UB City.

2) Lack of Railway Crossing Road

As shown in Figure 3.19, the UB railway that runs through the center of UB City lacks crossing roads. The traffic volume is concentrated at the existing four railway overpasses and two flat crossing intersections, creating a bottleneck.[17] In recent years, an underpass has been constructed near the Narnii Bridge that crosses the railway, but it does not adequately function since it is a box culvert with a height limit of about 2.2 meters. Large vehicles cannot pass.



Source: JICA Study Team

Figure 3.19 Location of Railway Crossing

3) Existence of a missing link[18]

Figure 3.20 shows there are several missing links in the east–west direction. Since there are few continuous corridors in that direction, traffic is concentrated on Peace Ave., causing traffic congestion. Three east-west corridors will be developed by connecting the missing links shown in the figure. As the roads are constructed, the dispersion of traffic will be expected on each road. Also, in the north-south direction, considering the future traffic volume, it is expected that traffic will be concentrated on the existing Chinggis Avenue and Olympic Street.

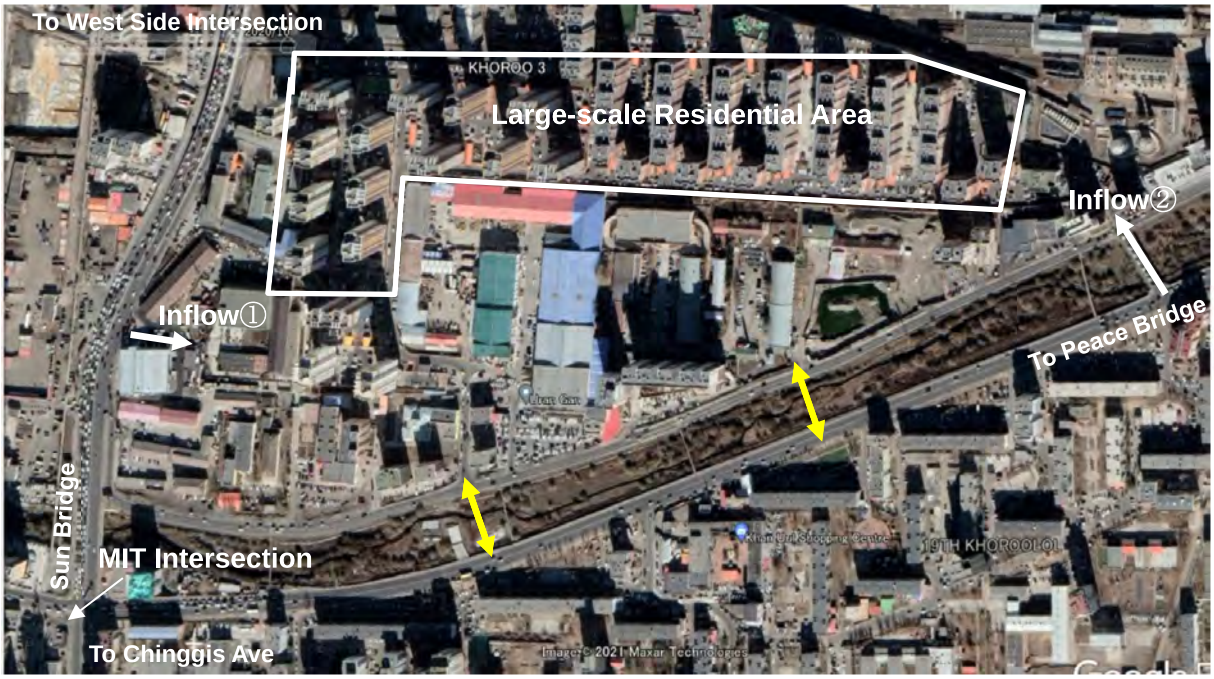
[17] A bottleneck is when there is a minimized traffic capacity section or location on the road, and when traffic demand is over the capacity of the road, traffic congestion occurs on that section. Signalized intersection, merging section, weaving section, sag, and tunnel in the expressway are also called a bottleneck.
[18] Missing link: The section doesn't function as a part of the road network because the section cannot secure the connectivity

Source: JICA Study Team

Figure 3.20 Missing Link Location

4) Lack of District Road Connectivity

There are many U-turns at intersections causing traffic congestion due to the road crossing. UB City has few community roads; hence, drivers must make large detours around the roads to reach their destinations. This is due to the lack of road connectivity. Figure 3.21 shows the reasons for the high number of U-turns for the MIT intersection. The MIT intersection is located after moving south from the West Crossroads intersection and passing the Narnii Bridge. Also, past the MIT intersection is a connection to Chinggis Avenue, which is one of the north-south corridors of UB City. When vehicles move south on the Narnii Bridge to the large-scale residential area, they need to turn left at the MIS intersection and then a large detour to the inflow road (2). On the other hand, since making a U-turn at the MIS Intersection and moving from the inflow road (1) saves time, many vehicles make a U-turn within the intersection, and this is a factor that impedes traffic at the intersection.



Source: JICA Study Team

Figure 3.21 Lack of Connectivity due to Insufficient District Roads (Case of MIT Intersection)

(2) Traffic Management Issues

Issues related to traffic management are as follows.

(i) There are currently 408 intersections in the city, 154 of which (38%) are not signalized. The number of signalized intersections needs to be increased. In addition, due to budget shortage, the city has not been able to update the facilities related to traffic signals, and the accuracy of the management of CCTV and other systems has deteriorated.

(ii) The problem is that the signal phase setting as the intersection is not optimized according to the traffic conditions, and there is a lack of knowledge to optimize the signal phase. In addition, all red is not set for the signal phase. As a result, there is no time to remove vehicles from the intersection, causing complications in the intersection.

(iii) UB City has an extremely high rate of traffic manner violations, such as disregarding signals vehicles stopping within intersections. Traffic signal control is also not functioning adequately. In addition, even if exposing violators, the unpaid fines and lack of enforcement do not have a sufficient deterrent effect on the violating behavior.

(3) Issues caused by the Urban Structure

1) Traffic Congestiion in the District

In paticular, the area that private company purchases the land and the residense building is developmed, road development is not enough in the district which is surrounded by the arterial road. Comparing the 13th District in UB City with a similar scale area in a Japanese city clearly shows the low road density and the lack of intra-district roads and auxiliary highways in UB City. In addition, the auxiliary arterial and intra-district roads are narrow, and road capacity is overwhelmingly insufficient due to parked vehicles on the roads in UB City.

Source: JICA Study Team based on Google Maps

Figure 3.22 Comparison of Intra-District Roads in UB (leftside: 13th District) and Japan (rightside: Urayasu)

2) Issue of Parking Lots in an Apartment Compound

As mentioned earlier, buildings, especially those in ger areas where private companies have purchased land and where the building apartments are, have high density, usually have only one entrance and exit to the complex from the street, and have either basement or walkway parking. Cars parking on the roadsides of buildings block alleys as well as traffic from the road into the compound. In many cases, alleys have no sidewalks and are quite narrow that vehicles can barely pass each other, and movement within the complex is not smooth. In the case of Japan, there is usually a private parking lot in the housing complex, which is separate from the alleys. The figure below compares the 13th District in UB City with Urayasu city in Japan with a similar scale area. The areas marked in red are parking lots.

Source: JICA Study Team based on Google Earth

Figure 3.23 Comparison of Parking Space (Red box) in an Apartment Compound in UB and Japan

3) Access Problems with Main Roads

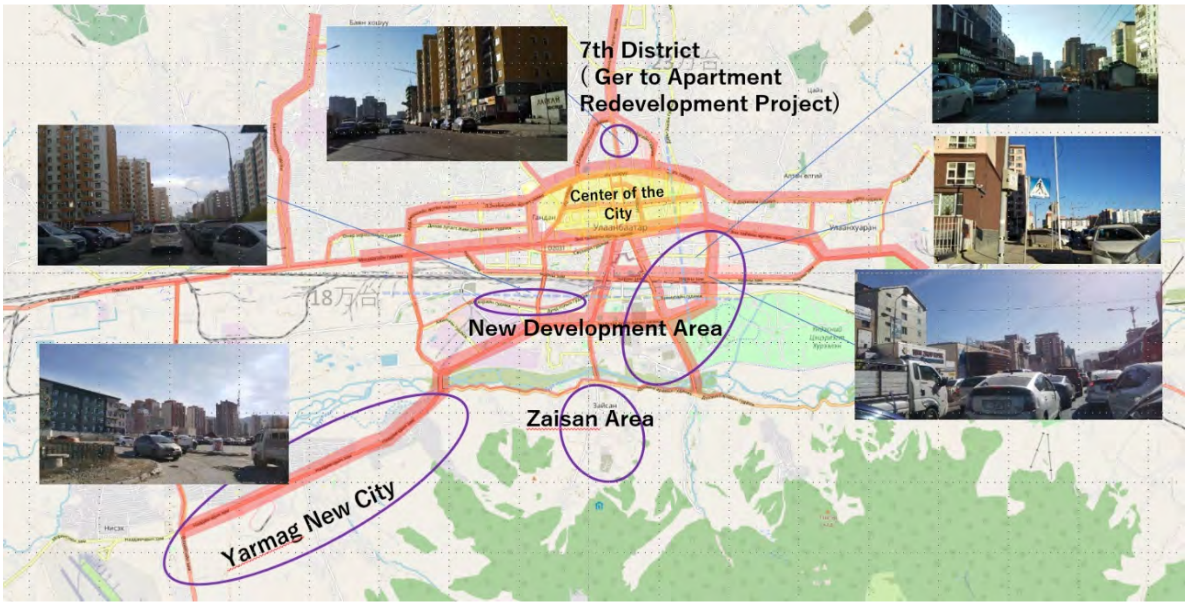
In the above-mentioned areas where private companies have purchased land in the ger area and have been constructing apartments without considering access to the arterial roads. On the other hand, most main roads are only accessible on one side of the road due to the median strip, and it is often necessary to drive extra distance to reach the other side. In order to reduce the number of passing vehicles, it is necessary to improve the access to the main roads of the roads in the block.

Source: JICA Study Team based on Google Earth

Figure 3.24 Access Problems with Main Roads

4) Traffic Congestion on Major Roads Around New Real Estate Development Areas

Traffic congestion on the main roads in UB City is getting worse every year, and one cause is the new and intensive real estate development. As mentioned in the analysis of population and urban development trends in Chapter 4, the Bayanzurkh District has apartment development between the south side of the Sun Road and the National Park and residential development around the Natur Market, as well as the conversion of the ger area at the north of the Sun Road into apartments in Districts 13 and 14. In Khan Uul District, the rapid development of residential areas in the Zaisan area and Yarmag New City Center quickly increased the residential population. The residential population of Bayanzurkh District and Khan Uul District increased by about 1.8 times from 2000 to 2010 and 2010 to 2020, respectively. However, the capacity of arterial roads is not enough to cope with the rapid population growth and traffic congestion is only getting worse.

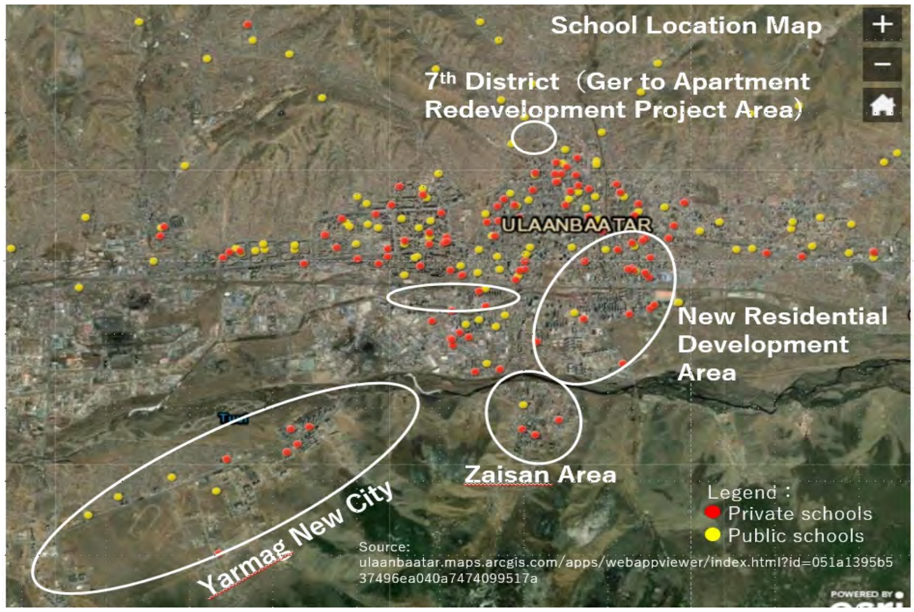


Source: JICA Study Team based on Google map

Figure 3.25 Location of New Residential Area Development and Traffic Congestion in the Arterial Roads

5) Traffic Congestion around the Public Service Facilities

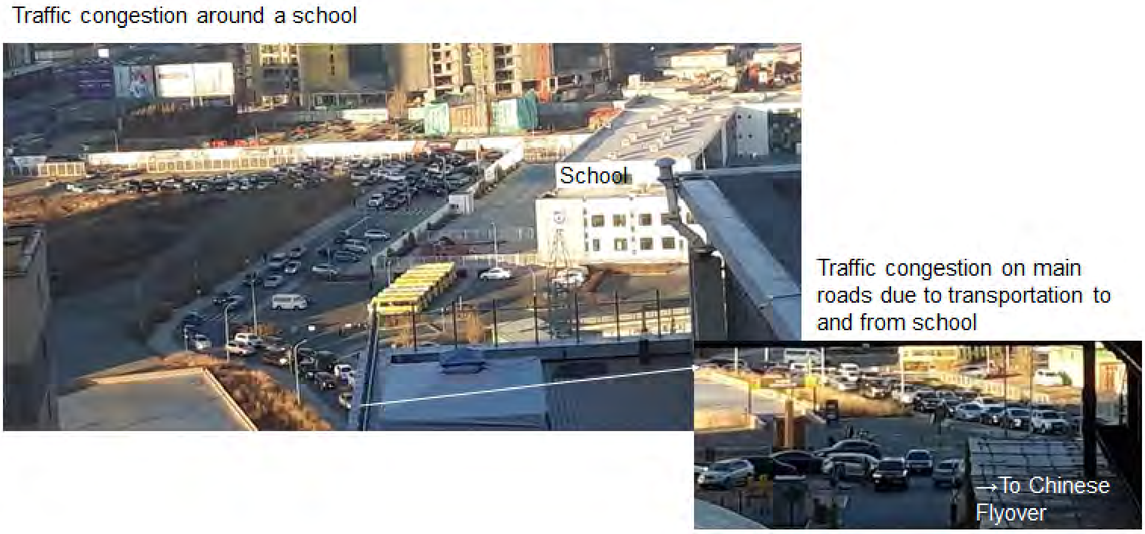
The next figure shows the distribution of schools and the location of new real estate development areas. Schools are concentrated in the city center, while the ger area has few. The new residential areas also have an insufficient availability of schools compared to the population. Students do not necessarily attend schools in UB City neighborhoods, mainly because those are mostly public schools. Many students attend schools in the city center for having a better quality of education than those in the ger area. The factor of commuting to school brings up the issue of increasing the traffic volume.



Source: JICA Study Team based on Google Earth[19]

Figure 3.26 Locations of School and New Residential Development

[19]URL: ulaanbaatar.maps.arcgis.com/apps/webappviewer/index.html?id=051a1395b537496ea040a7474099517a



Source: JICA Study Team

Figure 3.27 Traffic Congestion Caused by Transportaion to and from School

6) Traffic Congestion Caused by Large-scale Commercial Facility near an Intersection and Arterial Roads

Large commercial facilities in UB City cause traffic congestion around the main intersections close to them due to the inflow and outflow of traffic into and out of the facility parking lots, lane occupation, and diverting traffic due to waiting for parking spaces. Improvements are needed in terms of transportation operations and cooperation with commercial facility development. As examples, Figure 3.28 and Figure 3.29 show the large commercial facilities of E-Mart and Narantuul Market.

Source: JICA Study Team based on Google Earth

Figure 3.28 Vehicle Flow to and from a Commercial Facility (E-Mart) near an Intersection and Arterial Roads

Source: JICA Study Team based on Google Earth

Figure 3.29 Traffic Congestion around a Commercial Facility (Narantuul)

3.2 Status and Issues of Public Transport

3.2.1 Status of Bus Transport

(1) Bus Route

Although 98 buses operate in UB City, many roads mainly in the ger area are unpaved and road maintenance is not progressing. So multiple bus routes operate on one road because bus company wants to expand the market, as shown in Figure 3.30, with a maximum of 31 bus routes overlapping. Especially on Peace Avenue, 28 bus routes use one bus stop. Although the city center has a 7-km bus priority lane, once there is road congestion, private cars also pass through it. The bus priority lane is not used for its purpose and it is causing traffic congestion.

Source: Excerpts from traffic congestion mitigation measures, implementation, and related survey materials in UB City

Figure 3.30 Overlapped Bus Route

(2) Bus Vehicle

UB City has 19 bus companies operating about 980 vehicles. Except for electric buses manufactured in China, secondhand buses made in South Korea are imported. In Mongolia, buses cannot be used for more than 12 years, so 524 vehicles were planned for replacement in 2021, but importing that year was difficult due to the COVID-19 pandemic. Therefore, as an exception, buses over 12 years are also still used, and UB City plans to replace about 500 cars in 2022. It has not been finalized whether the purchase of bus vehicles will be new or secondhand.

(3) Bus Operation

Most of the bus operators in UB City were privatized due to the transition to market economy in 1990, but some still operate as a state-owned enterprises. Now, both public and private enterprises coexist.

In 2020, UB City posted a deficit of 8.8 billion MNT for bus operations. The main factors of the deficit are the pandemic that reduced income due to a decrease in passengers, the increase in fuel price and social insurance premiums in terms of expenses, and the increase in repair and parts purchase costs due to deterioration of bus vehicles. UB City subsidizes the operating costs of bus operators an equivalent of 57%, accounting for 15% of the total budget of the city.

In addition, ICT in bus operations in UB City is growing, such as fare settlement by IC card and provision of location information by GPS through an application. However, a Korean-owned company manages all information through the UB Smart Card, and not all information is shared with UB City. Therefore, UB City cannot obtain data related to bus operation, such as the number of users and delay status for each route, and cannot reflect in the bus operation planning.

(4) Bus Transportation Planning

The UBMP2030 indicates the plan of operating BRT in line with the construction of the metro (LRT), but no movement has been seen toward its realization. Bus route reconstruction and review are suggested. However, these have not been done, and issues remain because of differing opinions on BRT. Others say that BRT should be introduced because it is inexpensive and can contribute to alleviating traffic congestion. But according to the interviews with UB City in September 2021, some were against BRT because bus would be involved existing traffic congestion and cause further congestion and operations would be difficult. The BRT project itself has not progressed due to those discussions, and the interviews with ADB in January 2022 no progress with the local government.

3.2.2 Bus Transportation Issues

In order to solve the problem of traffic congestion in UB City, a drastic plan such as developing mass transit like a metro (subway) is effective and considered to be an urgent task. On the other hand, it is a long-term plan that can easily be restricted by the financial resources of UB City, technology, and land use. It can be said that it is a difficult infrastructure plan to put into practice.

Bus transportation is a terminal means of transportation for citizens that can be implemented in the short term when there is road maintenance. Therefore, the later a drastic plan, such as mass transit, is implemented, the more effective the bus transportation. In originally, mass transit is introduced initially as a trunk line axis, the bus operation itself, which is the foot of daily life of people in UB City, is indispensable as a branch line axis from the station and will never disappear.

In addition, it is indispensable to enhance the convenience of alternative or converted public transportation to implement the policy of restraining private traffic such as restraining private car registration. There is a good chance that bus transportation will be an alternative public tranport, so precise planning should be prepared.

In summary, when examining two different transport policies, such as mass transit development and bus transportation improvement, or restricting the use of private transport and enhancing public transport in UB City, it is important to consider both approaches rather than promoting only one.

From the above perspectives, the issues for improving public transportation services are (i) operational issues and (ii) planning issues. This section summarizes the issues from these two aspects.

(1) Bus Operation Issues

UB City has 98 operating bus routes. The route length has reached more than 2,000 km, which is well-established as a foothold for citizens in UB City to move, but there is a huge room for improvement in terms of convenience and some operational issues. Furthermore, the increasing number of private cars often affects bus operations.

1) Current status of bus convenience

Buses in UB City operate mostly on main roads and are the main means of transportation for citizens, so the habit of taking buses has been made to some extent. On the other hand, since the population in UB City has been increasing, mainly in the ger area, the bus capacity is insufficient. Buses depart and leave some passengers at bus stops to wait for the next bus, usually in the morning rush hours, because buses quickly become full. In other words, the supply of bus services is constantly insufficient.

In addition, some users change buses at bus stops on where many routes are concentrated. However, it is necessary to improve bus stops considering bus transfers. Some bus stops are far and without any facility for the comfort of commuters from the cold temperature in winter, rains, and strong winds.

2) Current status of Bus Priority Lane

Bus priority lanes have been developed and partly installed on Peace Avenue, which connects the center of UB City from east to west. Ideally, it prevents private cars from affecting bus operations even when they add to the traffic congestion. Whether there is traffic congestion or not, private cars do not pass the bus priority lane conspicuously except when turning right. However, when traffic congestion occurs in Mongolia, which is daily, private cars also start using the bus priority lane, causing more traffic congestion. As a result, the original purpose of the bus priority lane cannot be achieved, and punctual bus operations cannot be guaranteed.

Additionally, many private cars visit commercial stores located along the road on weekends. The parking lots of the stores become full that the queue for parking of private cars sometimes extends on the bus priority lane. As a result, buses are forced to change lanes.

Among private vehicles, electric cars, such as the Nissan Leaf, are not subject to license plate number coding, and driving on the bus priority lane is permitted.

3) Current Status of Bus Stop

In the suburbs, either there are no bus stops or there are but without facilities or route information. Meanwhile, bus shelters have been constructed (funded by French company JC Decaux) in the city center with advertisements. It has route information that is also maintained. It could still be improved with facilities such as to keep out the winter cold and a bus-approaching display system that utilizes GPS.

Although multiple routes operate in the UB City, bus stops are also not often divided according to destination. Users rush to the bus as soon as it arrives at the stop. Therefore, not only is the convenience low, but the risk of contact accidents is high. There is a capability for operational improvements, such as distributing bus stops by direction.

Bus bays in the city center are generally long with space for about three buses to stop, so it is expected that the mentioned bus stop development for each direction will be possible to some extent. On the other hand, since there is space, private vehicles illegally park, so buses cannot get to the stops. Sometimes, it is seen that passenger loading and unloading are away from the sidewalk.

4) Current Status of Bus Operation

A bus terminal has not been developed in UB City, and some bus routes sometimes turn around on the road. Turning a bus on a congested road requires advanced driving skills, but this becomes a factor in inducing traffic accidents. In fact, forcibly entering an intersection full of private cars makes turning around difficult, yet this often occurs. In the absence of a guide, there are concerns about contact and personal injury when buses go backward.

As for bus drivers, this study confirmed the following situations. As professional drivers, the lives of the people are in their hands. Raising their awareness and morals is not only for accident prevention but also for legal compliance.

・ Using a mobile phone while driving, which is prohibited even in private vehicles
・ Smoking while driving
・ Unreasonable changing lanes (not using blinkers)

- Turning left from the lane supposedly going straight
- Departing bus stops before closing the door

(2) Status of Bus Operation Planning

Buses operating in UB City are greatly affected by traffic congestion. There are problems like being unable to provide the planned number of operations. In addition, there is bus location information utilizing GPS, on-boarding data that can be acquired from IC card data, and information from the on-board surveillance camera. Despite these, there is a technical problem with data provision from UB Smart Card to the UB City Public Transportation Service Bureau based on the contract between them, and the data are unutilized in bus operation planning.

1) Ensuring Speed and Punctual Operation

In UB City, bus location information by bus route number is available from the UB Smart Bus App. But information at bus stops, such as bus approaching information, is insufficient, especially for users without mobile phones. Knowing the estimated arrival time of the bus is not possible.

Roads in UB City are congested persistently, and although the bus departure time is set at the starting point, departing on time is sometimes not possible. Even if a bus departs on time, a delay may still occur on the way. Operation interval is also inconsistent. Short intervals happen, and the planned number of operations cannot be operated.

For this reason, guaranteeing the speed and punctuality of bus operations in UB city is difficult. If this situation continues, there is a risk that trust in public transportation will eventually be lost, leading to further conversion to private car use.

2) Lengthening of Bus Routes

One of the characteristics of the bus route in UB City is that many bus routes start from the suburban area, enter the city center, and connect to another suburban area, mainly because most suburban residents head for the city center. It is also unavoidable, considering the current situation that terminals and turnaround facilities cannot be built in the city center.

However, the traffic volume in the city center is particularly heavy, and there are places where traffic congestion occurs during the daytime besides in the morning and evening. It greatly affects and delays bus operations. As a result, as mentioned above, the number of operating buses become less than the scheduled number, and stable services is not secured. Therefore, even if the bus route plan and operation plan are affected by road congestion, it is necessary to redesign them to absorb the effect.

3) Redesigning the Bus Routes

While many bus users go to the city center, bus routes gather on Peace Avenue, which is the main line of the east–west axis, due to insufficient road development. So, bus routes overlap on Peace Avenue and buses, and passengers concentrate on the area. As a result, buses may line up bumper to bumper, especially during rush hours, resulting in loss of speed. Therefore, it is necessary to carry out a major redesign of existing routes and provide appropriate routes and a number of bus operations.

At the same time, the population growth of UB City is remarkable in the suburban ger area, and the road environment must be given consideration. However, service improvement, such as creating new bus routes in the suburban area, rerouting existing routes, and increasing the number of bus operations, will curtail the use of private cars, which is expected to increase further.

However, information such as operations by GPS, user information by IC card, and road situation from surveillance cameras attached to some buses have not been utilized particularly in the bus operation plan. When redesigning bus routes, it is necessary to redesign the routes after the avail of information properly.

UB City has already identified lengthening and overlapping bus routes as problems. The study team obtained information through interviews that around October 2021, they have decided to launch a project redesigning bus routes in collaboration with universities and other organizations.

3.2.3 Necessity of Mass Public Transportation and Issues to be Considered

(1) Necessity of Mass Public Transportation

1) Solution for Difficulty to Transfer on Heevy Traffic Jam

The VCR on many major roads in UB City, such as Peace Avenue, presently shows higher than 3.0. The demand forecast in 2040 shows that cars on most roads will be unable to move if no counterplan is implemented in the future, meaning anyone can hardly move in UB City.

Traffic jams cannot be eliminated by the development of roads and a railway, but people in UB City need to get some means of transport for socio-economic activities.

Development of railway is the only best solution because it does not add to traffic jams. It may not eliminate traffic jams but still effectively ensure Ensureing punctual transfer by development of railway will be greatly effective though it cannot eliminate traffic jam.

2) Countermeasure for Enviromental Issues such as Decresing CO_2

If every vehicle in UB City becomes electric, energy consumption will be very bad as the transit system is only small, such as private cars and buses. In a situation where most electric power supply is from coal power plants in UB City, it might be essential to reduce CO_2 by introducing mass public transportation, which can reduce energy consumption. Even if electric power from coal power plants changes to green energy, reducing electric vehicles use is still important.

(2) Issues to Consider in Mass Public Transportation Development

1) Suitable System for Transport Demand

The mass public transportation system should have enough capacity for transport demand to be forecast.

2) Consideration to Severe Conditions in Low Temperature

UB City is the coldest capital city in the world, yet people should still be able to use mass public transportation. A system to run stably in severe cold conditions should be introduced. Also, facilities of mass public transportation should be considered to the comfortable condition for the passengers not only to take the train but also to wait for the train in stations.

3) Consideration to Various People

The design and operation of mass public transportation facilities should be convenient for various people, such as the aged or handicapped, with constraints on transfer.

4) Consideration to Better Environment

A system should be designed to reduce power consumpution supplied from outside by reducing power consumption not only for running of rolling stocks but also for operation of stations and generating clean energy by itself. System also should be designed with no environmental impact such as noise, vibration and wastewater.

3.3 Traffic Survey

During this study, the COVID-19 pandemic largely impacted the traffic situation. It was not a normal situation and the quality of survey results is not enough to reflect on the demand forecast model; thus, the traffic count survey and cordon line survey was not conducted. Instead, the previously conducted traffic survey was utilized. In this section, the household interview survey (hereafter "HIS"), travel time survey, and traffic analysis based on the review of existing traffic survey results are shown.

3.3.1 HIS

In order to examine the reduction of traffic congestion in UB City, a HIS was conducted to check the traffic situation in UB City in 2019 that aims to identify the key issues to be addressed for the formulation of Ulaanbaatar's 2040 Master Plan.

(1) Survey objective

The objectives of the survey are:

- to understand the preferences of an individual for daily transportation and traffic modes;
- to understand household composition, living environment, and satisfaction with traffic services;
- to understand the current situation of parking facilities and the flexibility of parking fees; and
- for demand forecast modeling.

(2) Survey Overview

1) Target Area

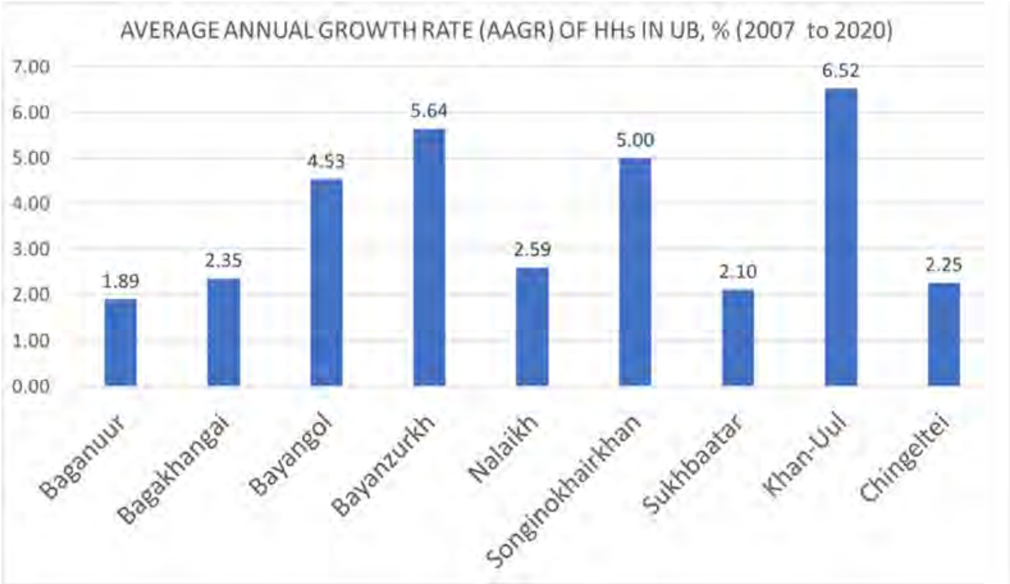
The study area for the HIS covers UB City, consisting of nine districts (Duuregs) and 171 sub-districts (Khoroos). Six of the nine districts are in the center of UB, and the three not in the center, Nalaikh, Bagakhangai, and Baganuur, were also surveyed. The administrative divisions of UB City and the locations of the study areas are shown in Figure 3.31. The suburbs of Sharga Morit, Gunt, Nairamdal, Gachuurt, and Konkhor are also included in the study areas.

Source: JICA Study Team

Figure 3.31 Administrative boundaries of UB City

2) Survey Size

The sample size was 600 households for the 9 Duuregs of UB City and 171 Khoroos. The number of household samples in each district and Khoroos were checked for population and household growth in the nine Duuregs and surrounding areas of UB City. Figure 3.32 shows the average annual growth rate (AAGR) of HHs in UB City from 2007 to 2020 (%). The four districts of Khan-Uul, Bayanzurkh, Songinokhairkhan, and Bayangol showed higher growth rates than the other districts.



Source：JICA Study team based on Mongolian Statistical Information Service[20]

Figure 3.32 AAGR for Growth Rate of Households from 2007 to 2020

Based on these growth rates and the current number of households, this study analyzed the increase in households in each Khoroos between 2014 and 2020 and set the percentage of targeted households in each Khoroos as shown in Table 3.4.

Table 3.4 Number of Sample Households in Each Duureg (District) (2020)

	Duuregs	Average annual growth rate (AAGR) of HHs in each Duuregs, 2007 to 2020 (%)	% Share of HHs/ Duureg	Existing Khoroos / Duureg (2020)	Sample HHs/ Duureg
1	Khan-Uul	6.52	0.20	21	119
2	Bayanzurkh	5.64	0.17	28	103
3	Songinokhairkhan	5.00	0.15	43	91
4	Bayangol	4.53	0.14	25	83
5	Nalaikh	2.59	0.08	8	47
6	Bagakhangai	2.35	0.07	2	43
7	Chingeltei	2.25	0.07	19	41
8	Sukhbaatar	2.10	0.06	20	38
9	Baganuur	1.89	0.06	5	35
	Total		1.00	171	600

Source：JICA Study Team based on Mongolian Statistical Information Service[3]

3) Preparation of survey materials

An HIS Manual with instructions for the data collection method and five HIS forms were prepared for this survey. Form 1 contains the questions regarding the household information, Form 2 is about household income and vehicle ownership, and Form 3 is about the employment conditions of every household member. Form 4 collects data on travel behavior and daily activities in a unique diary format. Form 5 gathers opinions from UB City residents about their current and desired living conditions. The list of survey forms are as follows:

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[20] Mongolian Statistic Information Service, http://www.1212.mn.

- Form 1: Household Information
- Form 2: Current Living Condition of Household
- Form 3: Individual Household Member Information
- Form 4: Daily Activity Information
- Form 5: People's Assessment/Satisfaction on Living Environment

4) Survey Methodology

The survey was conducted based on a questionnaire. The researcher visited each household of the target population and collected data.

(3) Basic Analysis

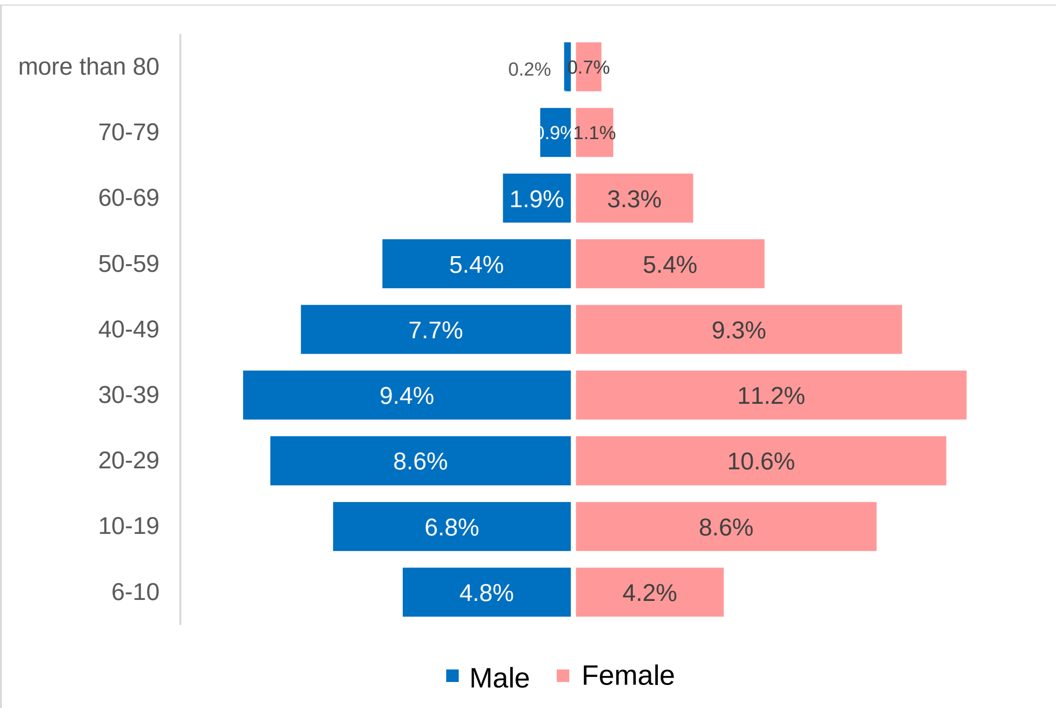
1) Overview

Table 3.5 Basic Information from HIS, 2019

	Survey Items	Survey reuslts
1	Number of households surveyed	600
2	Gender	Male: 68.8% Female: 31.2%
3	Age range	6 to 88 years
4	Vehicle ownership	72.2% HHs had vehicles

Source: JICA Study Team

As a result of the survey, the age distribution is shown in Figure 3.33. The majority of respondents (about 40% of the total population) fell into the 20–39 age group.



Source: JICA Study team

Figure 3.33 Population structure by sex and old in 2019

2) Data Analysis

This section shows simple data analysis results using the survey results.

2)-1 Improvement in Income Level

According to the recent household socio-economic survey (HSES) and national statistics office (NSO) of Mongolia, the national monthly average income per household in 2019 was 1.23 million MNT, and in 2007, was 0.24 million MNT. In UB City, the average in 2019 was 1.44 million MNT and 0.29 million MNT in 2007. As for the average monthly income of an individual in 2019, the national level was at 1.00 million MNT and in UB City at 1.12 million MNT (Table 3.6).

Table 3.6 Average monthly income per household and per individual (2007, 2019)

	Average monthly income (million MNT/ month)		HIS	
	2007	2019	2007	2019
National average	0.24	1.23		
Ulaanbaatar	0.29	1.44	0.80	1.84

Source：JICA Study Team based on Mongolian Statistical Information Service [3]

The income levels are grouped based on income quintiles, as shown in Table 3.7, for the analysis. The income groups are divided into five quintiles. Group I consists of the bottom 20% of the HIS respondents with the lowest incomes, and Group V consists of the top 20% respondents with the highest incomes. Hence, income Group I to V represents low-to high-income groups.

Table 3.7 Income Groups based on Annual Average Income (million MNT/ month) per HH and per Individual

<table>
<tr><th rowspan="3">Group No.</th><th rowspan="3">Income Quintiles</th><th colspan="4">Monthly HH income in the HIS sample (million MNT/ month)</th><th colspan="2">Monthly individual income in the HIS sample (million MNT/ month)</th></tr>
<tr><th colspan="2">2019</th><th colspan="2">2007</th><th colspan="2">2019</th></tr>
<tr><th>From</th><th>to</th><th>from</th><th>to</th><th>from</th><th>To</th></tr>
<tr><td>L</td><td>80%～100</td><td>0.10</td><td>0.97</td><td>0.00</td><td>0.33</td><td>0.00</td><td>0.02</td></tr>
<tr><td>LI</td><td>60%～80</td><td>0.97</td><td>1.42</td><td>0.33</td><td>0.55</td><td>0.02</td><td>0.35</td></tr>
<tr><td>LII</td><td>40%～60</td><td>1.42</td><td>1.90</td><td>0.55</td><td>0.80</td><td>0.35</td><td>0.65</td></tr>
<tr><td>lV</td><td>20%～40</td><td>1.90</td><td>2.57</td><td>0.80</td><td>1.10</td><td>0.65</td><td>1.00</td></tr>
<tr><td>V</td><td>Top 0 to 20%</td><td>2.57</td><td>10.55</td><td>1.10</td><td>4.50</td><td>1.00</td><td>12.00</td></tr>
</table>

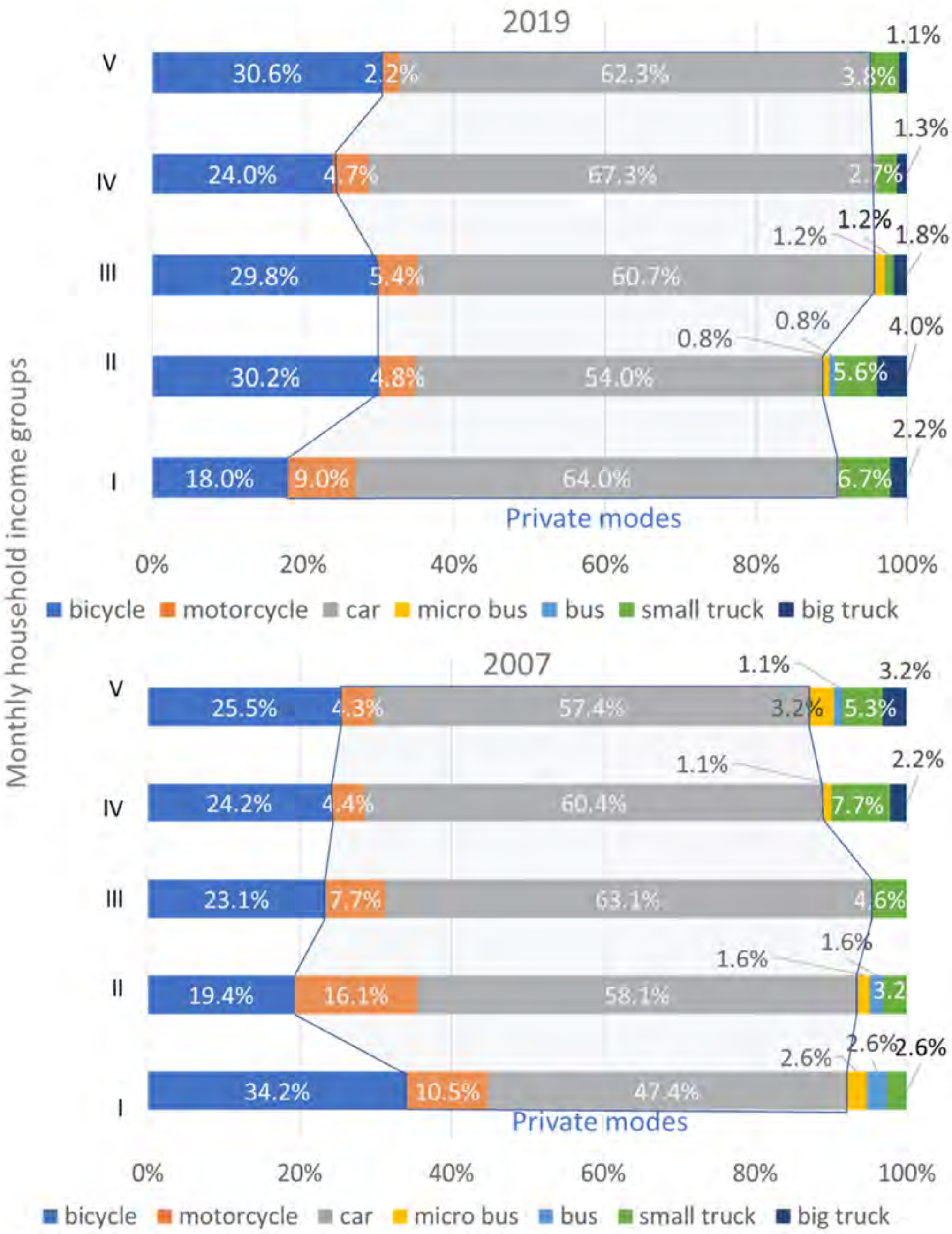
Source: JICA Study Team

Table 3.8 shows private car ownership. In 2007, 57.8% of households in Income Group I owned cars. By 2019, the percentage increased to 73%. For Income Group II, the share of car ownership went from 74.2% down to 58.7% and Income Group III from 70.8% down to 66.1%. Meanwhile, Income Group lV showed an increase in the share of car ownership from 64.8% to 72.0% and Income Group V from 61.7% to 64.5%. The percentage of car ownership in Income Group I has been increasing with the rising incomes, which in turn opens more travel opportunities. Figure 3.34 shows that private vehicle ownership has increased the most among households from Income Group I (up from 47.4% to 64%).

Table 3.8 Share (%) of Private Vehicle Ownership Rate by Income Groups

	Income levels	2019 Car+Motorcycle Ownership	2007 Car+Motorcycle Ownership
L	80%～100	73.0%	57.9%
LI	60%～80	58.7%	74.2%
LII	40%～60	66.1%	70.8%
lV	20%～40	72.0%	64.8%
V	Top 0 to 20%	64.5%	61.7%

Source: JICA Study Team



Source: JICA Study Team

Figure 3.34 Comparison with Household Income (MNT/month) and Car Ownership Rate(%)

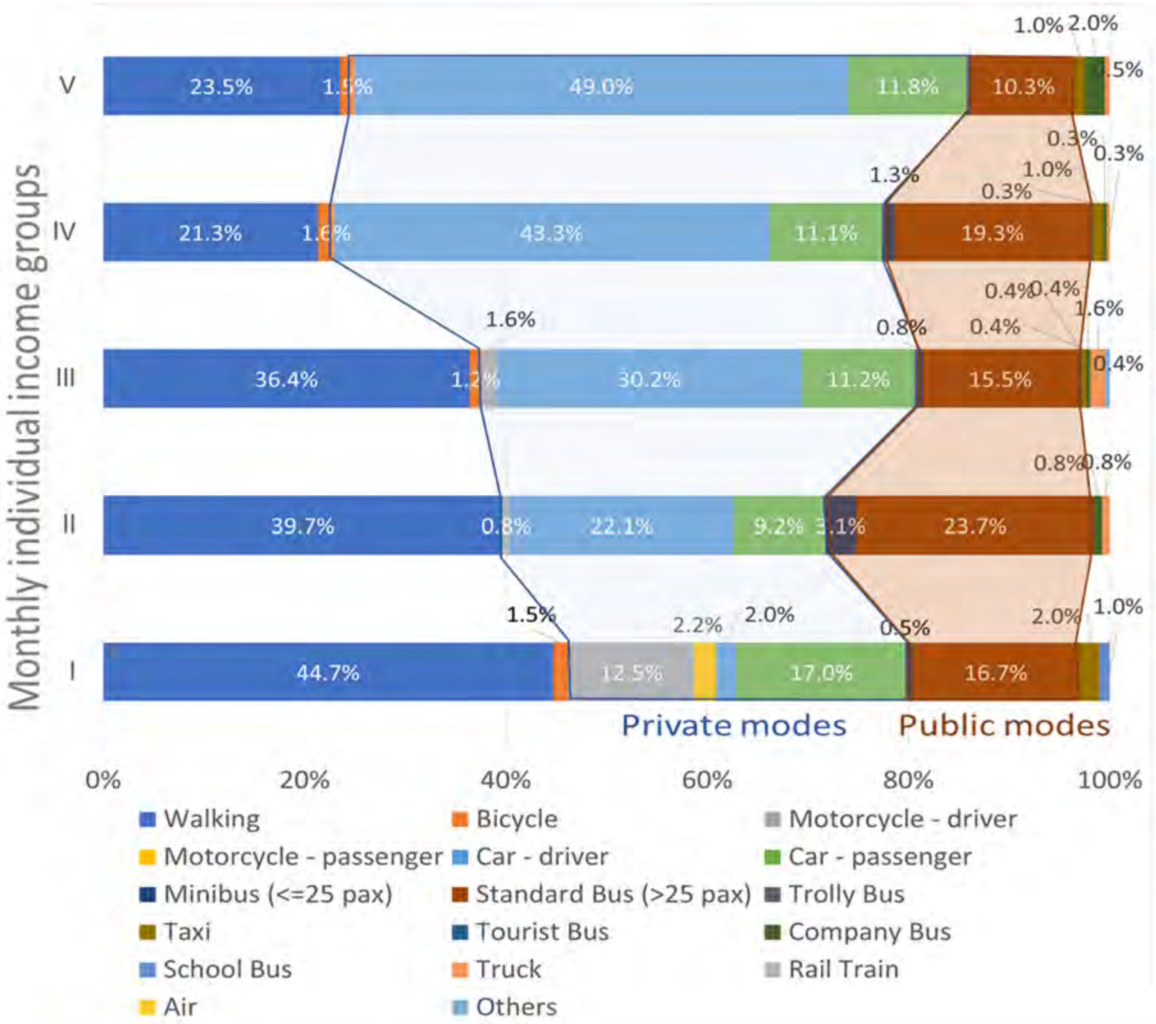
(4) Increase of Commuter Vehicle Use

Table 3.9 shows the percentage of trips by income level. The percentage of private trips of Income Group I is 33.7%, 32.1% in Income Group II, 43.0% in Income Group III, 54.4% in Income Group IV, and 60.8% in Income Group V. It shows the rise of car use with income level. Public transportation users do not show a monotonic trend because public transportation might be used in accordance with the public transportation service level in each local area.

Table 3.9 Share (%) of public and private modes by income groups

	Income levels	2019	
		Public modes	Private modes
I	80%～100	17.2%	33.7%
II	60%～80	26.7%	32.1%
III	40%～60	16.7%	43.0%
IV	20%～40	21.0%	54.4%
V	Top 0 to 20%	10.8%	60.8%

Source: JICA Study Team



Source: JICA Study Team

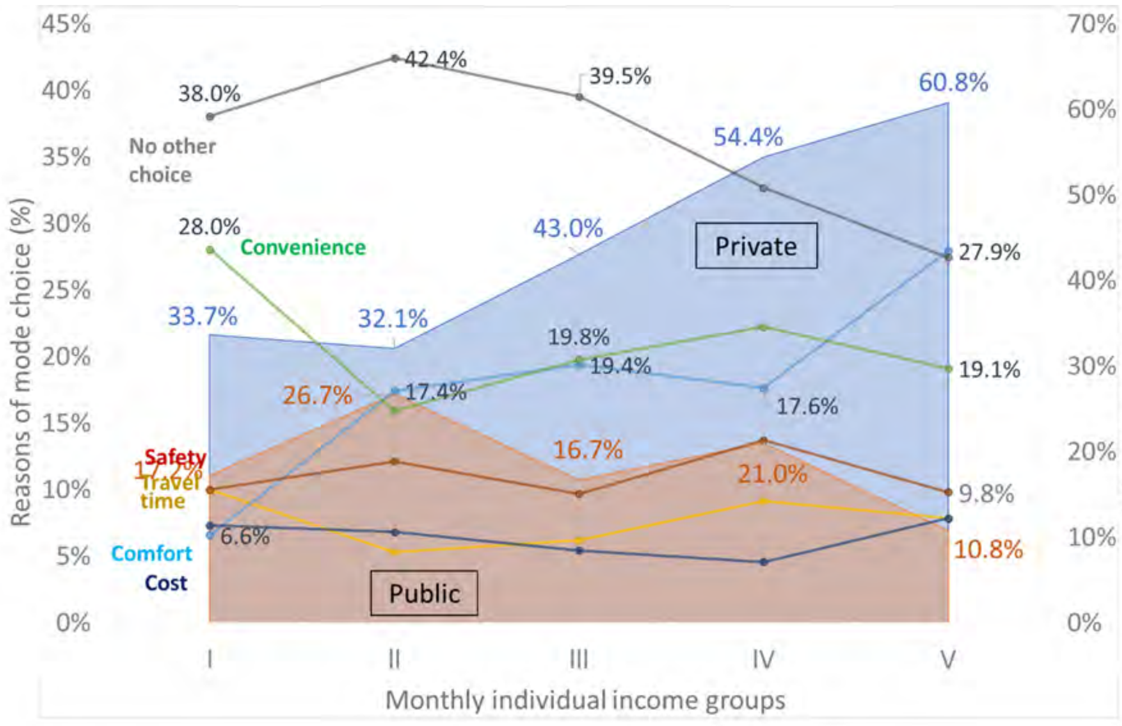
Figure 3.35 Individual Income Groups vs. Modes of Daily Commute (%)

(5) The Reason of Mode Choice

Figure 3.36 shows the mode choice (and reason) by income group. The left vertical axis shows the share (%) of reasons for mode choice, and on the right vertical axis is the private car and public transportation use. The blue area shows the share of private cars and the orange area is the share of public transportation use. As mentioned above, as the income level rises, the share of private cars (%) has increased, and the share of public transportation (%) has been selected according to the service, but the overall trend has decreased. The share (%) of private transportation for the high-income group (Group V) is 60.8%, while for the low-income group (Group I) is 33.7%.

The reasons for mode choice were aggregated by each income level. In Group V, the main reasons for choosing private transportation were comfort (27.9%) and convenience (19.1%), and similarly, for Groups II to IV, convenience and comfort were prioritized. However, Group I shows different preferences that are convenience (28.0%), travel time (10%), and safety (10%).

In all income groups, "No other mode options" is 38% in Group I, 42.4% in Group II, and 39.5% in Group III. It indicates the need for more expansion of bus services due to the lack of public transportation options. Cost and safety are of lower importance for all income groups, when the average percentages are 6.4% and 11.1%, respectively.

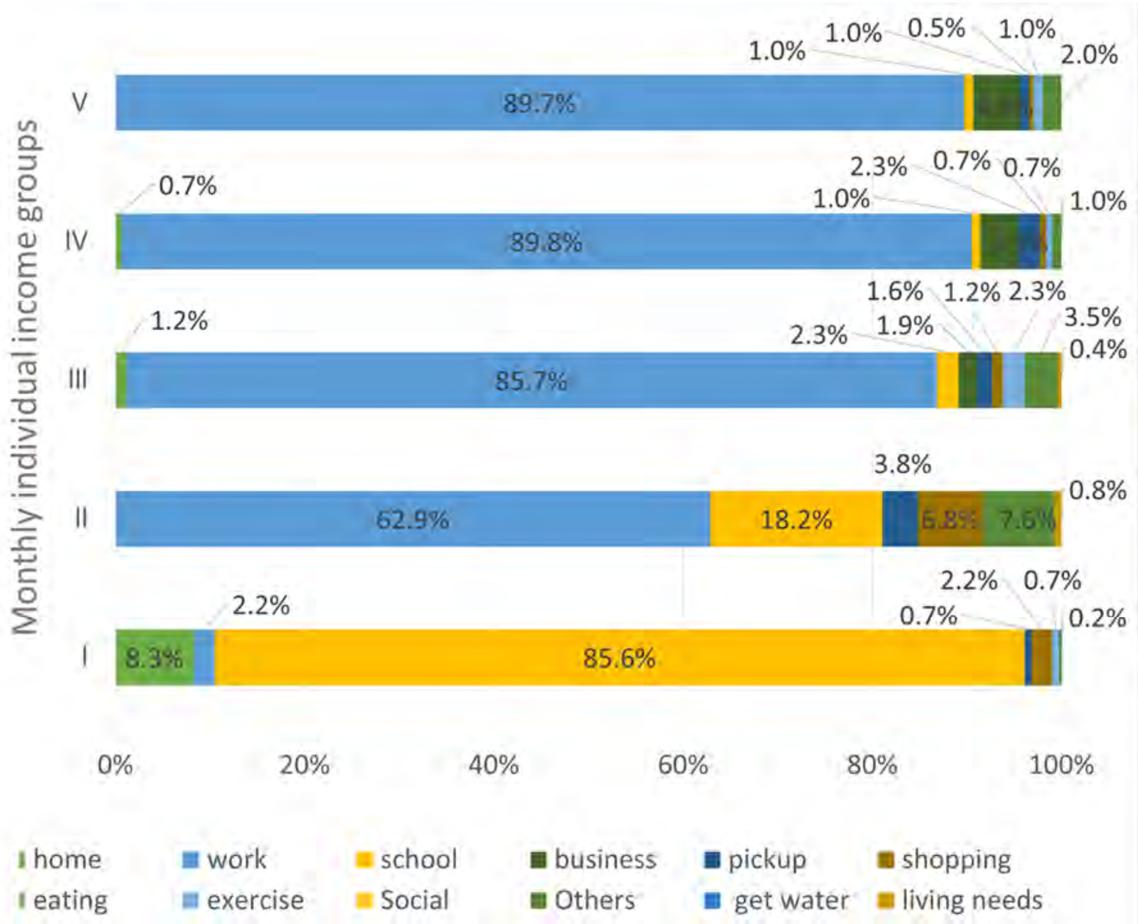


Source: JICA Study Team

Figure 3.36 Reasons of mode choice (%) by different individual income- levels (million MNT/ month)

(6) Trip Purpose by Income Levels

Figure 3.37 shows the percentage of trip purpose by income group of the respondents. It seems that the majority of the respondents in Income Groups II to V travel for work, while the majority of Income Group I travel for school. It indicates that Income Group I has a different preferences from other income groups in terms of transportation choices of means of transportation (convenience (28.0%), travel time (10%), and safety (10%), which largely reflect the preferences of students.



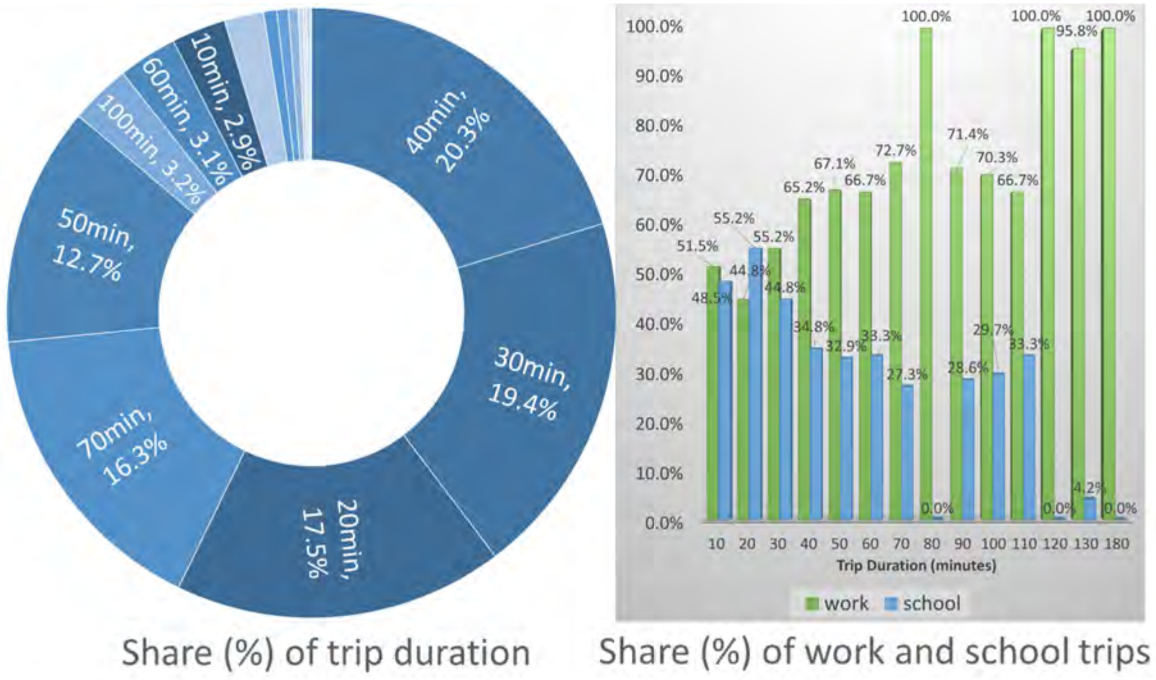
Source: JICA Study Team

Figure 3.37 Trip Production Rate by Trip Purpose (%) by Individual Income Groups

(7) Short Length Trip to Go to School

Figure 3.38 shows the share (%) of trip duration for work and school trips combined. From the figure, it is evident that most trips had a duration of 40 minutes (20.3%), the duration of the second most taken trip was 30 minutes (19.4%), the third was 20 minutes (17.5%), and the fourth was 70 minutes (16.3%).

In this HIS, there were more work trips than school trips with trip durations between 10 to 180 minutes (Figure 3.38). However, for the 20-minute trip duration, 55.2% were school trips, and only 44.8% were work-related trips. About 65.2% of work trips and 34.8% of school trips had a 40-minute trip duration, 55.2% of work and 44.8% of school trips at 30 minutes, and 72.7% of work and 27.3% of school trips at 70 minutes and the longer the travel time, the higher the percentage of work trips. For this reason, it can be seen that the commuting time of work is shorter than the commuting time of school, indicating that the services required differ depending on the configuration.

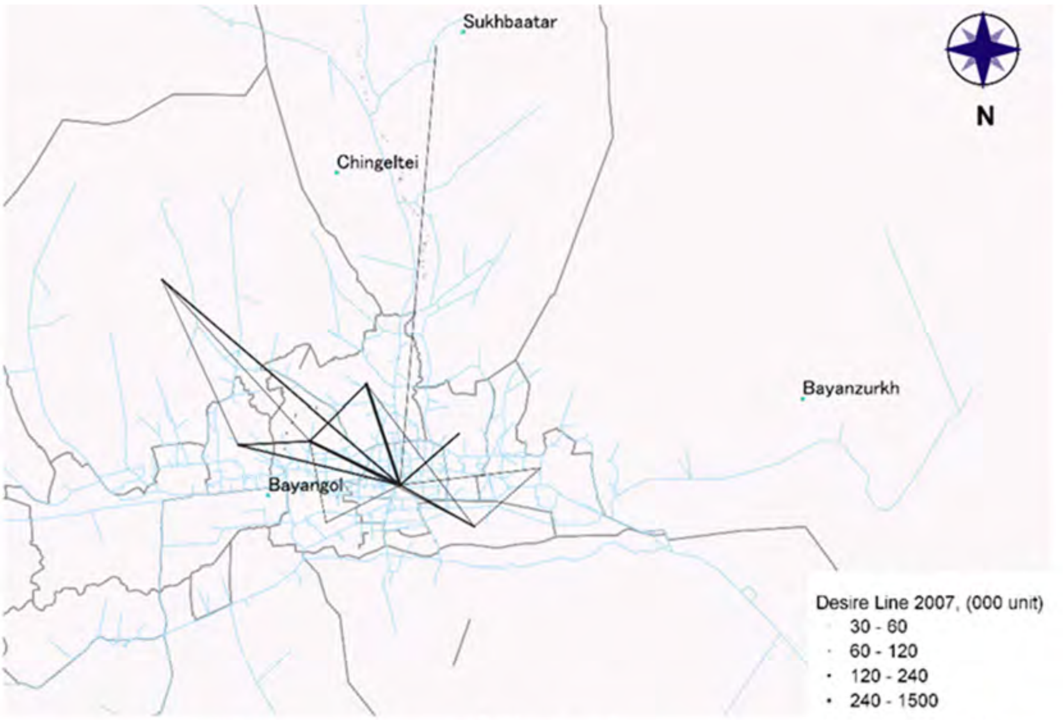


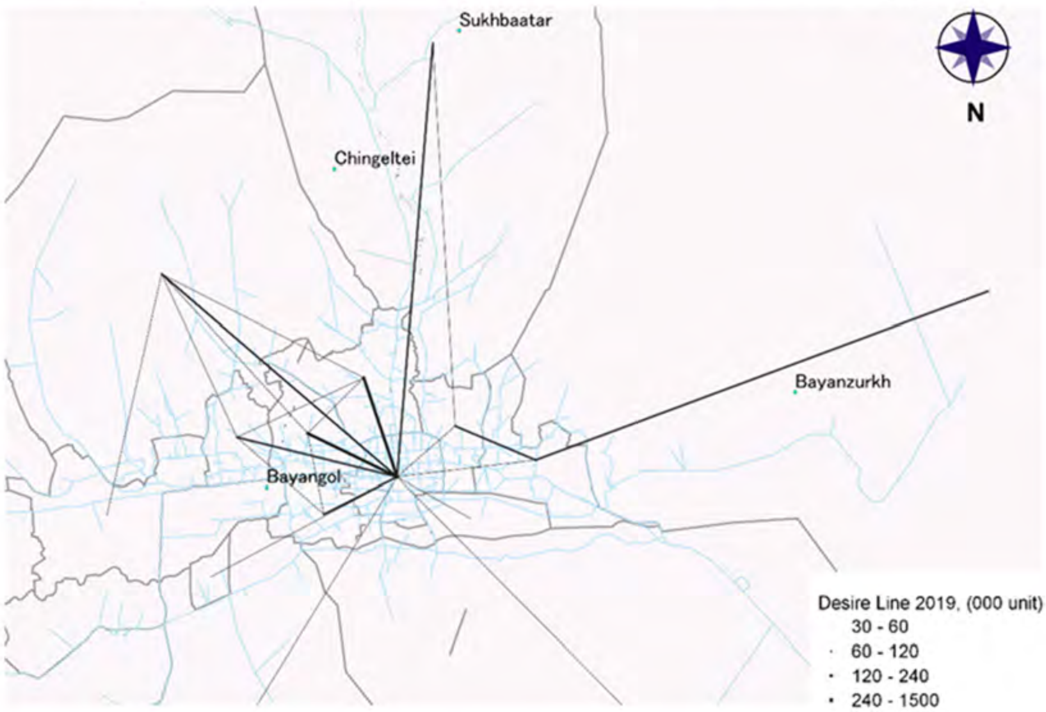
Source: JICA Study Team

Figure 3.38 The Share (%) of Trip Duration for the Work and School Trips

(8) Increase of Concentration in the City Center

Using the traffic survey results, Khoroos was consolidated into 21 zones and analyzed for OD traffic distribution (Figure 3.39). In 2007, results show most OD traffic came from relatively short distances within UB City, but in 2019, more traffic came from more suburban zones. It demonstrates the need to improve the transportation infrastructure from the suburbs to the center of UB City besides from the edge of the city.



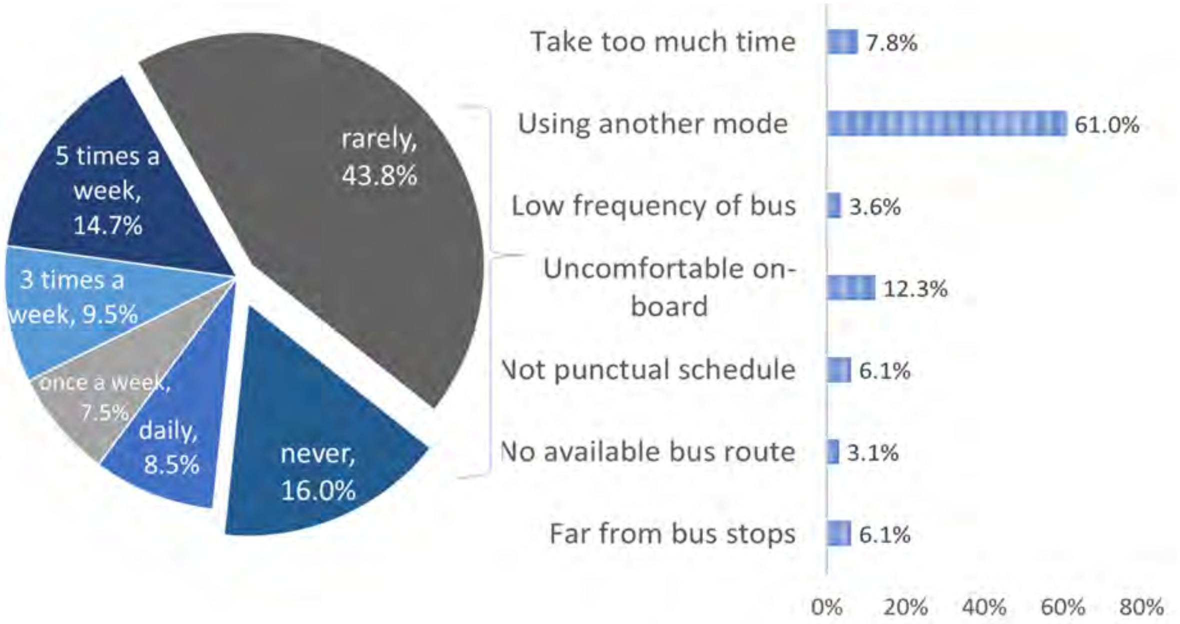


Source: JICA Study Team

Figure 3.39 Changes in the Number of Trips in 21 Zones (Total of Public Transport and Private Cars) (2007 and 2019)

(9) Increased Need for Improvements in Public Transport System

Figure 3.40 shows the frequency of use (%) of public transportation. Currently, buses, minibuses, and trolleybuses are the modes of public transportation in UB City, and according to the survey results, about 23.2% of households use public transportation more than five times a week or every day, indicating the need for public transportation in the city. However, about 59.8% of the respondents either do not use (16.0%) or rarely use (43.8%) public transportation, mainly because they prefer other means (61%), such as walking or private cars, others are uncomfortable to use it (12.3%), the travel time (7.8%), and other factors. Persons who do not use it prefer other modes, such as walking or private cars.



Source: JICA Study team

Figure 3.40 Frequency of Public Transportation Usage (%) and Reasons of Not Using Public Transport (%)

Respondents were also interviewed about the quality of current public transportation services from the following 11 perspectives. The five evaluation scores (1 for very poor, 2 for poor, 3 for fair, 4 for good, and 5 for very good) were consolidated into 1 and 2 as “poor,” 3 as “normal,” and 4 and 5 as “good.” The trends from the 11 perspectives for buses were as follows.

(i) Regarding the overall convenience of travel, 43.7% answered “normal,” which is the highest percentage.

(ii) At least 45.6% of the respondents indicated that the waiting condition at bus stops was “poor,” which is the most common response.

(iii) The attitude of the driver or conductor was rated “normal” by 45.1% of the respondents, which is the highest percentage.

(iv) Safety of the train was rated as “poor” by 46.2% of the respondents, which is the highest percentage.

(v) Comfort inside the vehicle was rated as “not comfortable” by more than 50% of the respondents, which was the most common response.

(vi) Accessibility to bus stops was rated “good” by 42.2% of the respondents, which is the most common response.

(vii) Regarding trip fares, 51.5% of the respondents answered “good,” which was the most common response.

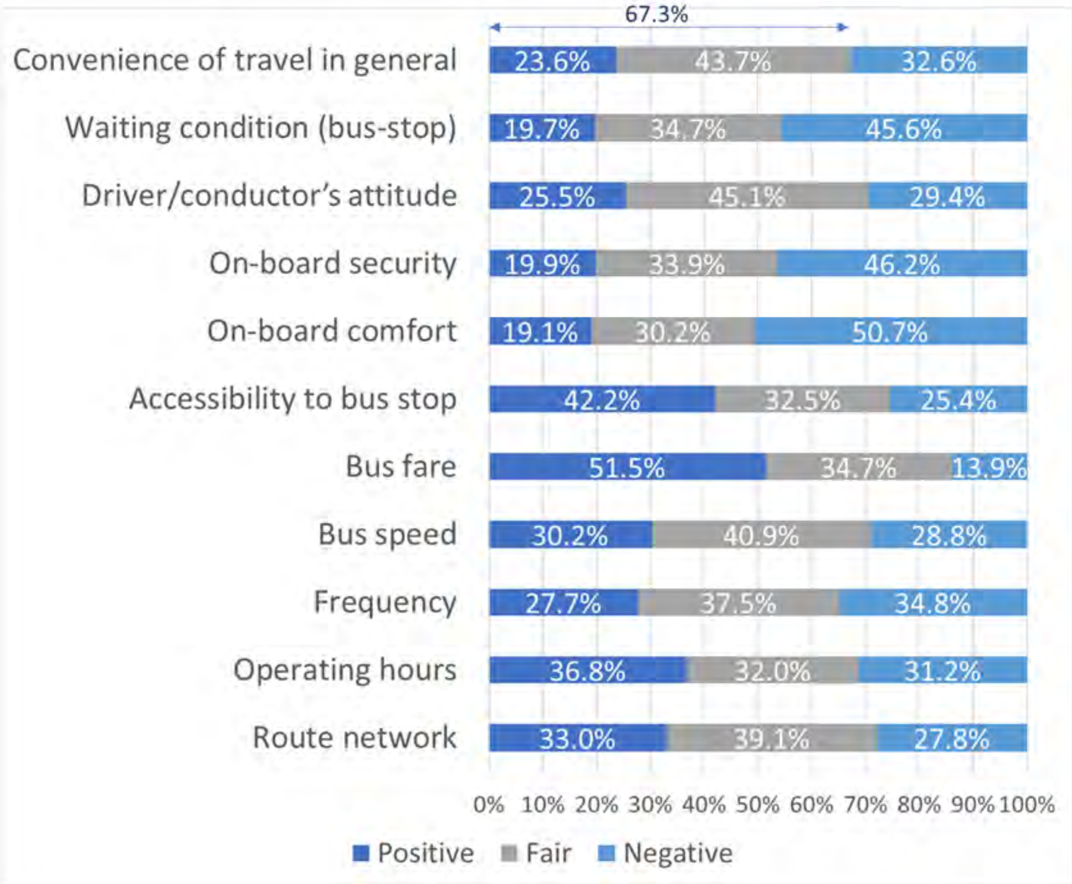
(viii) Bus speed was generally rated “normal” by 40.9% of the respondents.

(ix) Frequency of operation received a “normal” rating by most or 37.5% of the respondents.

(x) Operation time was rated “good” by 36.8% of the respondents, which was the most common response.

(xi) Route network was mostly rated with “normal” with 39.1% of the respondents.

Based on the above results and considering the necessary improvements, the facilities at bus stops in UB City vary depending on the location. For example, some bus stops have a clear waiting area with sunshades and seats, some have none of those but have the destination sign of the bus stop, and some have none of either facility. The level of satisfaction also varies depending on the type of bus stop, such as the location for loading and unloading of passengers. Therefore, to increase the bus service ratio, the bus stop facilities could be made more uniform and sophisticated. In addition, many respondents answered that on-board safety is "poor," but this is thought to be since passengers being cramped in the bus makes them uneasy, indicating the need for fast public transportation and not getting caught in traffic jams.

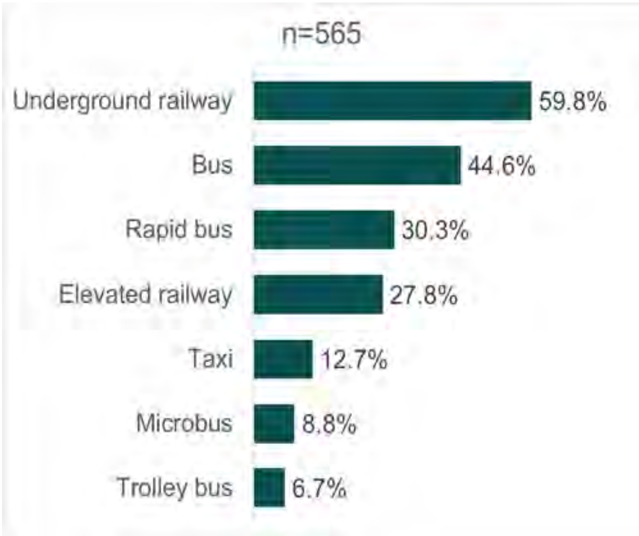


Source: JICA Study Team

Figure 3.41 Peoples' Opinion About Bus Service in UB City

(10) Needs for the Drastic Improvement of Public Transportation Infrastructure

When asked about the need for improved public transportation infrastructure, 94.2% answered that public transportation needs improvement, of which about 60% called for subway construction and 44.6% for bus improvement. Therefore, there is a general need for drastic public transportation infrastructure improvement, such as subways, but because of the huge project costs involved in development, alternatives should be considered on detailed surveys and analysis.



Source: JICA Study Team

Figure 3.42 Improvement of Public Transportation Infrastructure

(11) Willingness to Pay for Parking Price

The study team asked the willingness to pay (WTP) for parking when the hourly parking fee is 500 MNT/hour, 1,000 MNT/hour, 2,000 MNT/hour, and 500 MNT/hr, and estimated the variables that greatly affect the selective payment. The double-bounded binary choice model of the contingent valuation method (CVM) was applied, and the results are the following.

Table 3.10 Double- bounded Binary Choice Model Parameters

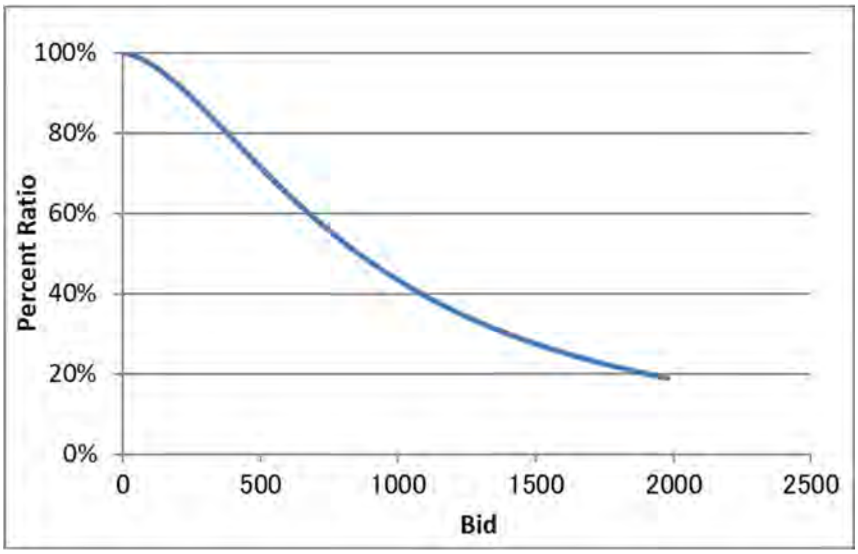
Variable	Coefficient	t value	p value
Constant	5.7620	5.586	0.000
Ln (Bid)	-1.7469	-17.500	0.000
Average Monthly income	0.7689	6.311	0.000
number of cars owned	0.3868	2.908	0.004
Samples, n	600		
log likelihood	-784.3170		

Source: JICA Study Team

Results of the parameter estimation in 10 show that as Ln (parking price) increases, the percentage of respondents willing to pay that amount decreases. The fact that the coefficients of the other variables (average monthly income and number of cars owned) are positive indicates that these variables have a proportional relationship with the parking price. In other words, it indicates that as monthly income and number of cars owned increase, the probability of choosing a higher parking price increases. The p-values for each variable are close to 0.00, confirming the statistical significance of the parameters for both variables.

Figure 3.43 shows the willingness to pay (%) by parking price. WTP decreases as the parking price increases, indicating that 50% of respondents are willing to pay 850 MNT/hour, 70% at 500 MNT, and about 42% at 1000 MNT/hour. The mean and median values were determined at 1024 MNT/hour and 876 MNT per hour, respectively. Based on the above, it is desirable to set the price of parking according to capacity and the like around the median value of 850 MNT, increase capacity and fee to manage the demand, and at the same time, provide a waiting lane to facilitate other traffic.

(Unit:Tg)



Source: JICA Study Team

Figure 3.43 Willingness to Pay for Parking Fee, 2019

3.3.2 Summary of Existing Traffic Survey Result

In this project, the results of the traffic count survey and travel speed survey undertaken in the ongoing JICA project "Ulaanbaatar City Air Pollution Control Capacity Enhancement Project Phase 3," as well as the results of the travel speed survey using a video camera by the JICA Study Team are summarized. The bottleneck areas in UB city will also be analyzed.

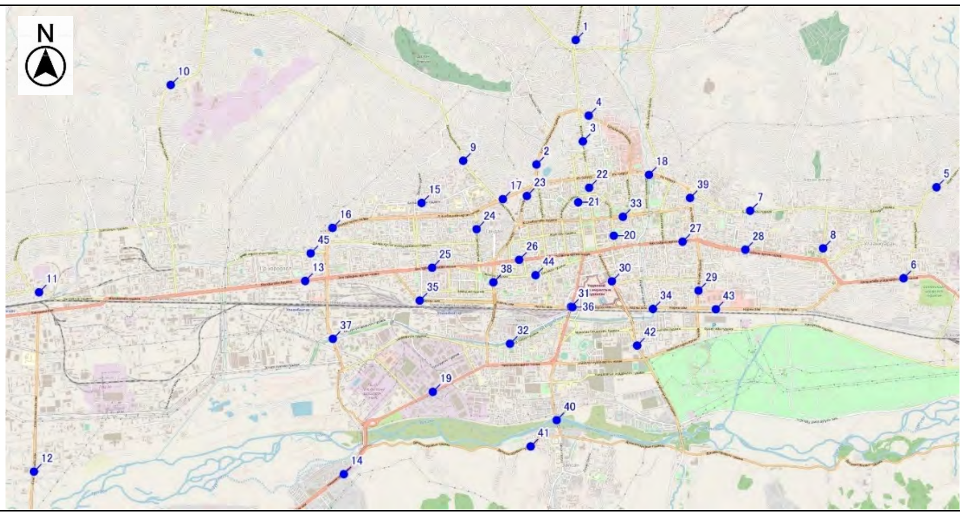
(1) Traffic Survey in Ulaanbaatar City Air Pollution Control Capacity Enhancement Project Phase 3 in 2019

In the UB City Air Pollution Control Capacity Enhancement Project Phase 3, the traffic count survey and travel speed survey were undertaken during the summer and winter of 2019 according to the following outline.

1) Traffic Count Survey

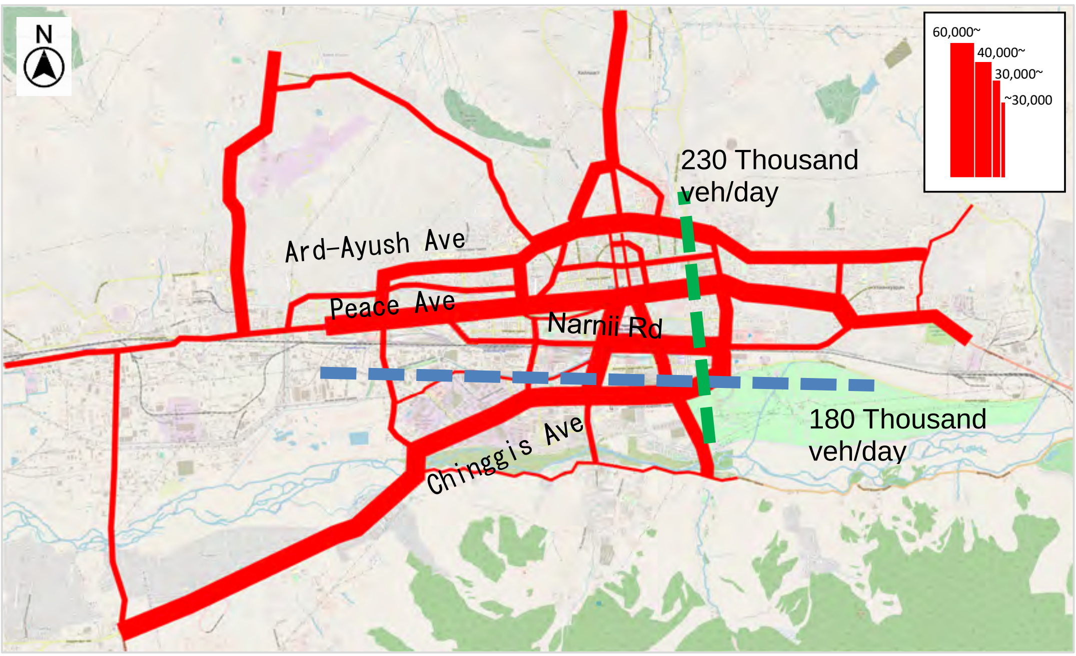
Summary of traffic count survey is shown in Table 3.11.

Table 3.11 Summary of Traffic Count Survey at Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 3

Survey Station	
Date	Weekday: 17 September 2020 and 5 December 2021 Weekend: 21 September 2020 and 7 December 2021
Vehicle Classification	8 Classifications (Motorcycle, Passenger Car, Jeep, Trailer Bus, Large Bus, 2-Axle Truck, Large Truck and others)
Method	16 hours and 24 hours Traffic Count by Manual Count

Source: JICA Study Team prepared by Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 3

Traffic flow is shown in Figure 3.44 based on the results of a traffic survey undertaken in the summer. Traffic volumes of 230,000 veh/day in the east-west direction and 180,000 veh/day in the north-south cross-section are observed in this survey. The major arterial roads of Peace Ave., Ard-Ayush Ave., Chinggis Ave., and Narnii Road have traffic volumes of over 60,000 veh/day.



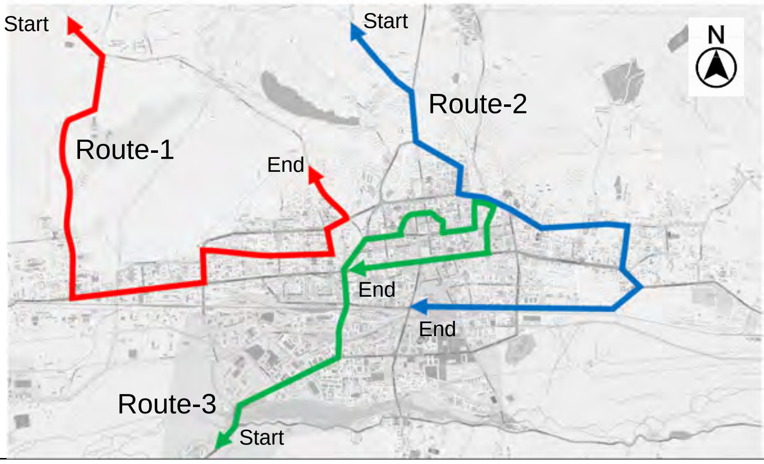
Source: JICA Study Team prepared by Capacity Development Project for Air Pollution Control in UB City Phase 3

Figure 3.44 Traffic Flow in 2019

2) Travel Speed Survey

In Capacity Development Project Air Pollution Control in Ulaanbaatar Phase 3, travel speed surveys were conducted on three routes in UB City.The travel speed survey was undertaken using GPS device at 4 time periods: morning time, evening time and 2 off-peak times.

Table 3.12 Summary of Travel Speed Survey

Travel Speed Survey	Survey Route	
	Date	Weekday: 17 September 2020 and 5 December 2021 Weekend: 21 September 2020 and 7 December 2021
	Duration	A. 7:00～9:00、B. 13:00～15:00、C. 17:00～19:00、D. 22:00～24:00
	Method	Observed by GPS

Source: JICA Study Team prepared by Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 3

Table 3.13 shows the results of the travel speed survey. The peak travel speed results by routes show average speeds ranging from 7.2 to 14.9 km/h. There is no significant difference between the summer and winter seasons. Traffic congestion occurs according to the travel speed results showing less than 20km/h. In particular, many routes show travel speed results of less than 10 km/h in the evening peak, and travel service tends to be worse than in the morning peak.

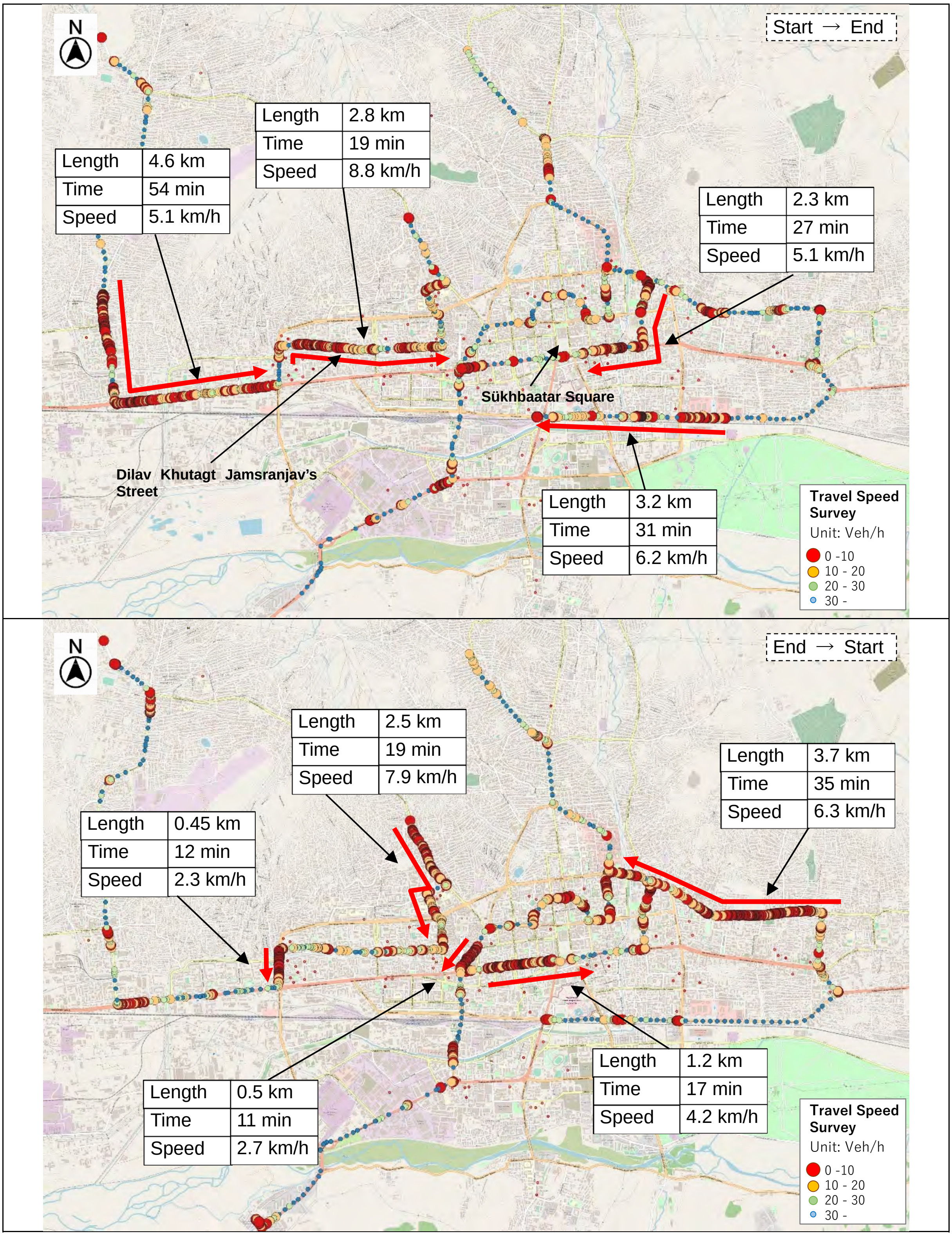
Table 3.13 Result of Travel Speed Survey

Route	Period	Length (km)	Start → End			End → Start		
			Start	End	Ave. Speed (km/h)	End	Start	Ave. Speed (km/h)
Route-1	Summer	15.9	7:00:00	8:34:00	11.4	8:34:00	9:43:00	14.0
			17:00:00	18:07:00	14.9	18:07:00	19:20:00	12.5
	Winter		7:00:00	8:26:00	10.9	8:35:00	9:29:00	15.6
			17:00:00	18:47:00	9.8	19:00:00	20:05:00	13.4
Route-2	Summer	15.2	7:00:00	8:07:00	15.5	8:07:00	9:12:00	12.9
			17:00:00	18:35:00	9.7	18:35:00	19:54:00	11.1
	Winter		7:00:00	7:45:00	18.4	7:47:00	8:48:00	14.5
			17:00:00	18:25:00	10.7	18:25:00	19:37:00	11.8
Route-3	Summer	15.5	7:00:00	8:25:00	13.2	8:25:00	10:00:00	11.0
			17:00:00	19:39:00	8.9	19:39:00	20:58:00	13.9
	Winter		7:00:00	8:03:00	14.2	8:03:00	9:25:00	11.5
			17:00:00	19:49:00	7.2	19:49:00	21:05:00	12.2

Source: JICA Study Team prepared by Capacity Development Project for Air Pollution Control in UB City Phase 3

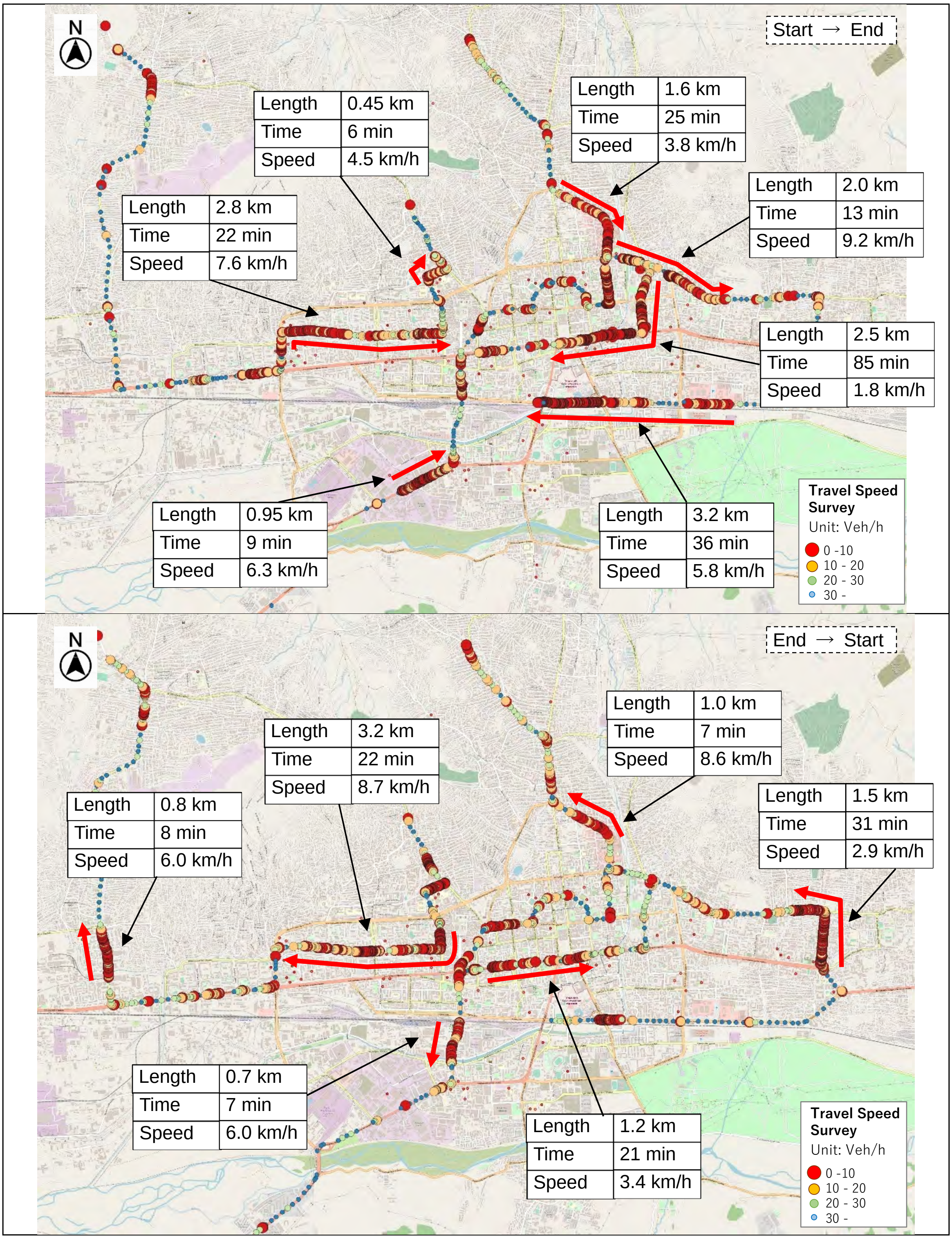
Figure 3.45 and Figure 3.46 show the travel speed situation by route during the summer. In the morning and evening peak hours, many sections were observed with speeds of 10 km/h or less, mostly the same level as walking speed (5–8km/h). The travel speed during the morning peak hour shows a decrease in the direction of the UB City center, as shown by the red arrow on the next page. In particular, the speed decreases on the route from the eastern and western suburbs is more significant. The speed also decreases in the direction of the suburban area due to traffic returning home was observed in the evening peak.

On the other hand, the speed observed on Peace Ave. around Sukhbaatar Square and Dilav Khutagt Jamsranjav's Street, where traffic congestion was observed throughout the day, decreases during morning and evening peaks.



Source: JICA Study Team prepared by Capacity Development Project for Air Pollution Control in UB City Phase 3

Figure 3.45 Results of Travel Speed Survey at Morning Peak Hour



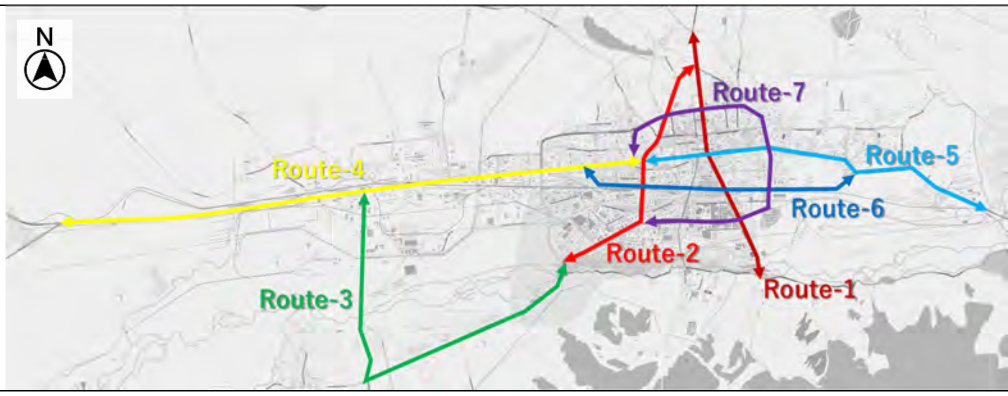
Source: JICA Study Team prepared by Capacity Development Project for Air Pollution Control in UB City Phase 3

Figure 3.46 Results of Travel Speed Survey at Evening Peak

(2) Travel Speed Survey in this Project

A travel speed survey using a video camera was undertaken but avoided the peak hours to identify bottleneck locations on major roads in UB City. In this survey, the period when traffic congestion started was the target to extract the bottleneck rather than the congested areas. Table 3.14 shows the summary of the travel speed survey.

Table 3.14 Summary of Travel Speed Survey in this Project

Route	
Time	15:00–17:00 (Off Peak Hour)
Method	Observation of travel speed and traffic situation using GoPro
Remarks	The equipment was managed not only by the drivers but also by local staff to secure a safety for undertaken travel speed survey.

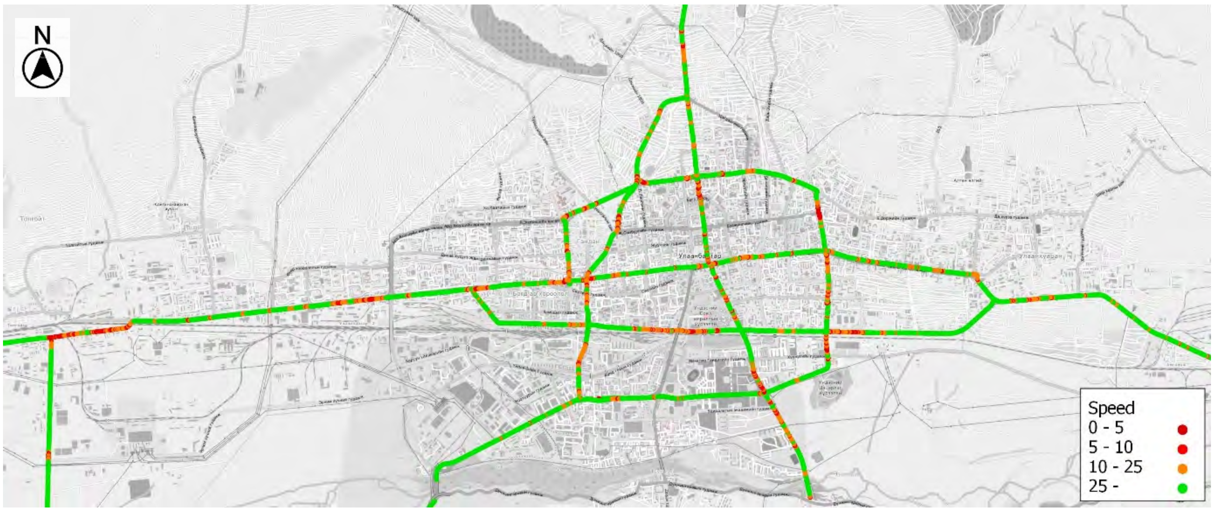
Source: JICA Study Team

The results of the travel speed survey for each route are shown in Table 3.15 and Figure 3.47. Since the travel speed survey was undertaken avoiding the morning and evening peak hours, it is not at the level of walking speed compared to the peak hours. However, since the selected routes in this survey were the major east-west and north-south arterial roads, such as Peace Ave. and Chinggis Ave. (both are chronically congested), the travel speeds were generally below 20 km/h for many routes. In particular, travel speeds on routes 1, 4, and 6 tended to be slow. In addition, the travel speed of route 2 from south to north was significantly lower due to passing through a traffic accident site on the way.

Table 3.15 Results of Travel Speed Survey

Route	Start	End	Length (km)	Travel Speed (min)	Travel Speed (km/h)
1	North South	South North	9.8	48 40	12.3 14.7
2	North South	South North	7.8	28 52	16.7 9.0
3	East North	North East	12.4	21 20	36.3 37.2
4	West East	East West	14.1	61 62	13.9 13.6
5	West East	East West	13.5	56 35	14.5 23.2
6	West East	East West	8.3	31 33	16.2 15.3
7	North South	South North	10.9	48 33	13.6 20.1

Red: Less than 20 km/h, Blue: Over 20 km/h
Source: JICA Study Team



Source: JICA Study Team

Figure 3.47 Summary of Results of Travel Speed Survey for Each Routes

(3) Intersection Flow Ratio Survey

Intersection flow ratio (peak and off-peak hour), which clarifies the congestion situation at the subject intersections, was calculated using the observed traffic volume and traffic phase data by the Traffic Control Center in UB City. The subject intersections were those observed by the Traffic Control Center using video cameras and those of the arterial roads shown in the table and the figure below, and a traffic volume count survey was conducted using video data. Since the video and roundabout traffic volume by inflow and outflow data was missing for intersections No. 1, 10, 16, 23, 24, as seen in the table and figure below, the traffic volume data for 20 of the 25 intersections were obtained. Intersection flow ratio was also calculated using the traffic volume during peak and off-peak hours. The conditions and results of the flow ratio calculation are shown in the next section.

Table 3.16 Subject Intersection for Analysis of Flow Ratio

No	Intersection Name	Type	Remaks
1	No.17 Intersection	Signalized	No Data
2	100 Ail Intersection	Signalized	
3	Ulzii center west-north Intersection	Signalized	
4	Dulguun nuur Intersection	Signalized	
5	Eh nyalhas (Ahui uilchilgee) Intersection	Signalized	
6	Urgoo movi theater Intersection	Signalized	
7	Sapporo Intersection	Signalized	
8	25 pharmacy Intersection	Signalized	
9	West Intersection (Baruun 4 zam)	Signalized	
10	Ub railway station intersection	Signalized	No Data
11	MIS (Mechanical engineering school) Intersection	Signalized	
12	120 myangat Intersection	Signalized	
13	Mongolian State University of Life Sciences Intersection	Signalized	
14	Encanto Intersection	Signalized	
15	Central post office Intersection	Signalized	
16	Mongolian State University of Education Intersection	Signalized	No Data
17	Wrestling palace Intersection	Signalized	
18	East Intersection (Zuun 4 zam)	Signalized	
19	Narantuul market Intersection	Signalized	
20	Tavan Shar Intersection	Signalized	
21	Bayanburd rotary Intersection	Roundabout	
22	Sansar rotary Intersection	Roundabout	
23	Chuluun ovoo rotary Intersection	Roundabout	No Data
24	Yarmag bridge Intersection	Roundabout	No Data
25	Nisekh rotary Intersection	Roundabout	

Source: JICA Study Team

Source: JICA Study Team

Figure 3.48 Locaion of Subject Intersections

1) Analysis for Intersection Flow Ratio

Since the intersection flow ratio means "the ratio of traffic demand to the saturation traffic flow rate," the intersection improvement was determined by the sum of the flow ratio for each phase. In addition, the field of traffic engineering generally indicates that when the flow ratio exceeds 0.9 value, the intersection processing function becomes inadequate and excessive congestion occurs. The methodology of intersection flow ratio analysis is shown below.

(i) Calculation of saturation traffic flow rate from signal indication and number of lanes

A. Basic saturation traffic flow rate for straight, straight and left turn, and straight and right turn: 2,000 PCU/Green Time

B. Basic saturation traffic flow rate for left turn and right turn: 1,800 PCU/Green Time

Calculate the saturation traffic flow rate at the intersection by multiplying A and B by the heavy vehicle ratio and the correction values for longitudinal slope and pedestrian rate.

(ii) Setting of traffic volume by diretion and lane

Set up traffic volume by direction and lane based on observed data by CCTV from the Traffic Control Center.

(iii) Calculation of flow ratio for each phase

Based on the traffic volume by phase and direction and saturation traffic flow ratio, the maximum value for each phase is selected.

(iv) Calculation of Intersection Flow Ratio

Calculate the intersection flow ratio by summing up the selected flow ratio calculated at (iii).

(v) Determine whether the intersection flow ratio exceeds 0.9 values

In addition, the intersection flow ratio at the oundabout was calculated by traffic capacity 25,000[21] veh/day/lane and daily inflow traffic volume.

[21] The number is the approximate level of traffic capacity used in Germany (Werner Brilon: Studies on Roundabouts in Germany: Lessons Learned 3rd International TRB-roundabout Conference, Carmel, Indiana, May 2011)

Table 3.17 Condition of Intersection Flow Ratio Analysis

Setting Items	Condition
Traffic Volume	Inflow traffic volume by direction collected from UB City (20 intersections) on peak and off-peak hours
Signal Phase	Signal phase of subject intersections collected from UB city (17 intersections)
Heavy Vehicle Ratio	Assumed to be 5%
longitudinal slope	Not considered (JICA Study Team did not undertake road inventory survey)
Ratio of Pedestrians	Intersections with large number of pedestrians are set as “many”
Traffic Volume	Inflow traffic volume by direction collected from UB City (20 intersections) on peak and off-peak hours

Source: JICA Study Team

2) Result of Intersection Flow Ratio

The analysis form of the intersection flow ratio is shown in Figure 3.49. In the results, as shown in the table below, 15 intersections exceed the 0.9 value during peak hour and 8 intersections reach over 1.0 value. The flow ratio at MIS Intersection was calculated at 1.369 value (high value of all intersections). The results of each intersection flow ratio are shown below.

Table 3.18 Result of Flow Ratio Calculation

No.	Intersection	Off-Peak		Peak	
		Traffic Volume	Flow Ratio	Traffic Volume	Flow Ratio
11	MIS (Mechanical engineering school) Intersection	4,114	1.317	4,277	1.369
19	Narantuul market Intersection	4,967	1.271	5,245	1.342
2	100 Ail Intersection	6,019	0.758	9,515	1.198
14	Encanto Intersection	4,286	1.013	4,890	1.155
21	Bayanburd rotary Intersection	6,213	1.076	6,213	1.076
18	East Intersection (Zuun 4 zam)	4,890	0.838	6,030	1.034
3	Ulzii center west-north Intersection	4,581	0.819	5,648	1.01
9	West Intersection (Baruun 4 zam)	5,227	0.909	5,676	0.987
12	120 myangat Intersection	3,366	0.638	5,201	0.986
4	Dulguun nuur Intersection	4,473	0.795	5,515	0.979
7	Sapporo Intersection	6,418	0.97	6,418	0.97
22	Sansar rotary Intersection	5,551	0.961	5,551	0.961
15	Central post office Intersection	5,549	0.918	5,549	0.918
6	Urgoo movie theater Intersection	4,718	0.817	5,292	0.917
23	Nisekh rotary Intersection	3,535	0.683	4,596	0.888
13	Mongolian State University of Life Sciences Intersection	2,997	0.747	3,407	0.852
8	25 pharmacy Intersection	5,530	0.739	6,003	0.802
20	Tavan Shar Intersection	5,412	0.561	6,883	0.713
5	Eh nyalhas (Ahui uilchilgee) Intersection	6,800	0.631	6,927	0.641
17	Wrestling palace Intersection	4,101	0.576	4,314	0.605

Note: Red：Flow Ratio>1.0, Green：1.0>Flow Ratio>0.9, Blue：0.9>Flow Ratio

Source: JICA Study Team

		Саппоро											
Үе		Бүтэн үе										Нийт	
		1-р үе		2-р үе		3-р үе		4-р үе		5-р үе			
Горим	Чиглэл / Хугацаа												
Тээврийн хэрэгсэл	00:00-06:00	34	сек	20	сек	28	сек	10	сек	18	сек	110	сек
	06:00-10:00	45	сек	25	сек	30	сек	10	сек	20	сек	130	сек
	10:00-16:00	45	сек	22	сек	43	сек	10	сек	20	сек	140	сек
	16:00-22:00	45	сек	22	сек	43	сек	10	сек	20	сек	140	сек
	22:00-00:00	34	сек	20	сек	28	сек	10	сек	18	сек	110	сек

		South Bound			West Bound			North Bound			South Bound				
Type of Lanes		Right	Straight	Left	Right	Straight	Left	Right	Straight	Left	Right	Straight	Left		
Number of Lanes		2	2	2	2	3	1	1	2	1	2	3	1		
Saturation Traffic Flow Rate (SA) (Units/Green Time)		3,492	3,880	3,492	3,492	5,820	1,746	1,746	3,880	1,746	3,492	5,820	1,746		
Design Capacity (q) (Unites)		404	523	603	321	886	559	280	536	547	265	953	541		
Flow Ratio of Entrance Lane		0.125	0.186	0.07	0.48	0.151	0.076	0.186	0.250	0.570	0.223	0.164	0.310	Flow Ratio of Phase	Flow Ratio of Intersection
Flow Ratio of Phase	1φ				-	0.152					-	0.164		0.164	0.970
	2φ	-					0.320	-					0.310	0.320	
	3φ							-	0.138	0.313				0.313	
	4φ							-	-					0.000	
	5φ	-	0.135	0.173										0.173	
Effective Green Time(sec)	1φ				45	45					45	45		Cycle Length(sec)	
	2φ	22					22	22					22	120	
	3φ							43	43	43					
	4φ							10	10						
	5φ	20	20	20											
Possible Capacity (Ci) (Units)		1,005	554	499	1,032	1,871	274	895	1,469	536	1,032	1,871	274		
Volume Capacity Ratio (q/Ci)		0.402	0.944	1.209	0.311	0.474	2.037	0.313	0.365	1.020	0.257	0.509	1.972		

Source: JICA Study Team

Figure 3.49 Analysis Form for Flow Ratio

3.4 Bottleneck Analysis

3.4.1 Selection of Bottleneck Location

(1) Summary of Selected Bottleneck

The causes of speed reduction from the travel speed survey results were confirmed using video data, and bottlenecks are classified into three factors: (A) road structure, (B) road user, and (C) intersection. As shown in Table 3.19, bottlenecks caused by road structure are (i) U-turn slot, (ii) railway crossing, (iii) pedestrian crossing (without traffic signal), (iv) hump, steep slope, width reduction, (v) bus stop, (vi) lane reduction, and (vii) lane reduction at junction. Bottlenecks caused by road user are (i) parking on the road, (ii) inflow and outflow of commercial area and waiting for parking area, and bottlenecks caused by intersection are (i) no signal intersection, (ii) signal control by traffic police, (iii) signal system (short green time), (iv) jammed at intersection, and (v) roundabout. The summary of bottlenecks and the number of bottleneck types for each route are shown in Table 3.19 and Table 3.20.

Table 3.19 Bottleneck Situation

Route	Situation
1	Route-1 has many bottlenecks caused by intersections without signals. Signals are manually controlled by the traffic police.
2	Fewer bottlenecks compared with other routes, however, bottlenecks in route-2 are mostly caused by traffic jams at intersections.
3	The number of bottlenecks is the lowest of all routes.
4	Route-4 has many bottlenecks caused by the road structure and intersection. There are many U-turn slots on Peace Ave. with traffic jams at intersections and vehicles speeding down near the railway crossing.
5	Route-5 has the most bottleneck locations of all routes caused by the road structure and road user. Pedestrian crossing without signal control and humps are installed on Peace Ave. There are many inflow/outflow of the commercial area and waiting on the road for parking.
6	Route-6 has many bottlenecks caused by road structure. There are many U-turn slots and pedestrian crossings without signal controls or humps.
7	Route-7 has many bottlenecks caused by road structure and intersections. There are many commercial facilities along the road between East Intersection and Narantuul Bazaar. Speed reduction and stoppage are frequent due to the entry and exit of commercial facilities and pedestrian crossing in front of commercial facilities (without signal).

Source: JICA Study Team

Table 3.20 Number of Bottleneck by Type

Route	Type													
	(A)Road Structure							(B) Road User		(C) Intersection				
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)	(xiii)	(xiv)
1					2		1	2	2	5	4	3	3	
2	2			1		1	1		1		2	1	3	
3	1			1					1	1				
4	5	2		1	1				3	1	1		2	
5	3	1	5	7	4	2		2	7	2	1		4	1
6	8		2	2		1		3	2		1		2	
7	4	1	7	1			1	2		2	1	2	3	1

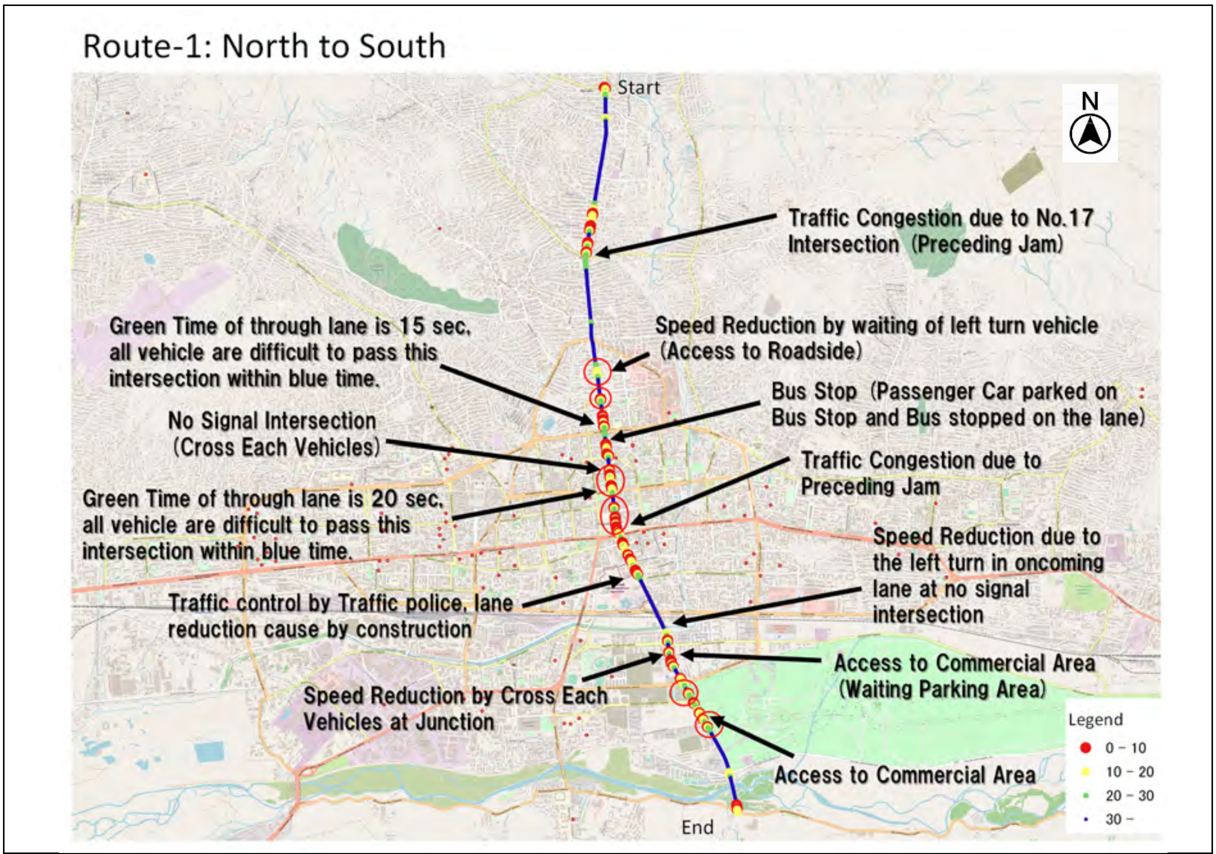
Note:
(A) Bottleneck by Road Structure: (i) U-Turn Slot, (ii) Railway Crossing, (iii) Pedestrian Crossing (Without Traffic Signal), (ix) Hump, Steep Slope, Width Reduction, (v) Bus Stop, (vi) Lane Reduction, (vii) Lane Reduction at Junction
(B) Bottleneck by Road User:(viii) Parking on the Road, (ix)Inflow and Outflow of Commertial Area and waiting for Parking Area
(C) Bottleneck by Intersection: (x) No Signal Intersection, (xi) Singnal Control by Traffic Police, (xii) Signal

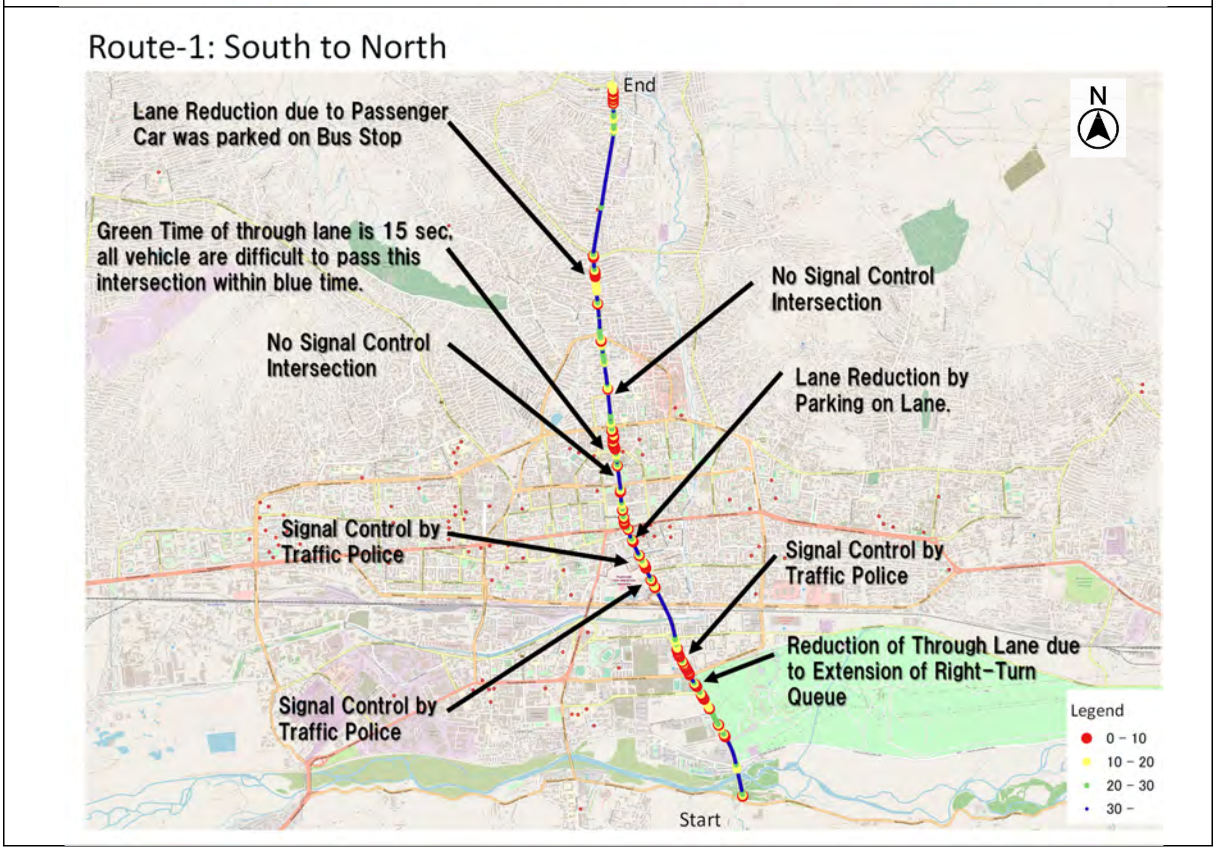
System (short green time), (xiii) Jammed at Intersection, (xiv) Roundabout

Source: JICA Study Team

(2) Detailed Bottleneck on Each Route

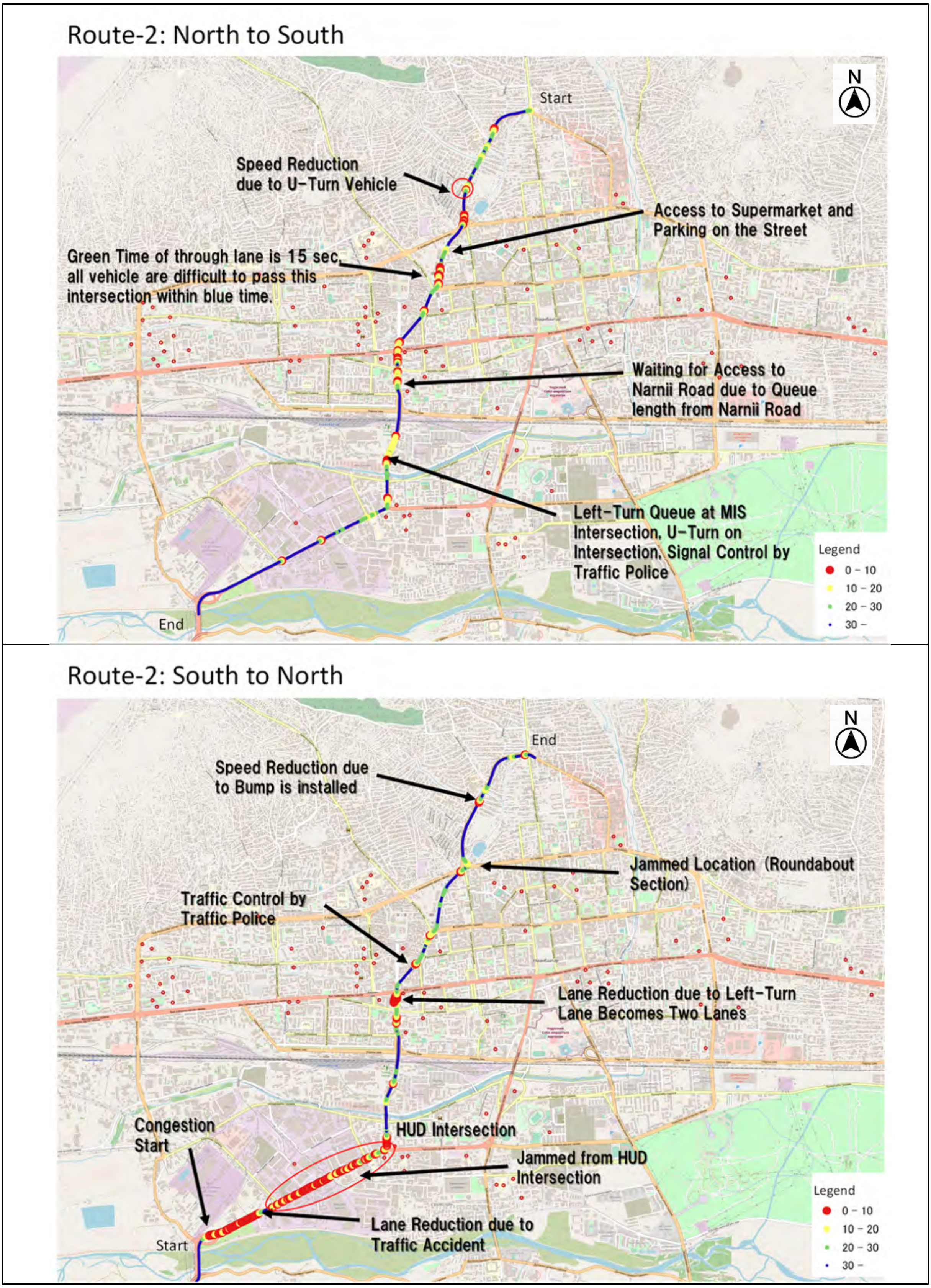
Detailed bottleneck confirmed on routes 1 to 7 by the result of travel speed survey based on video data observed travel speed survey shown from Figure 3.50 to Figure 3.56.





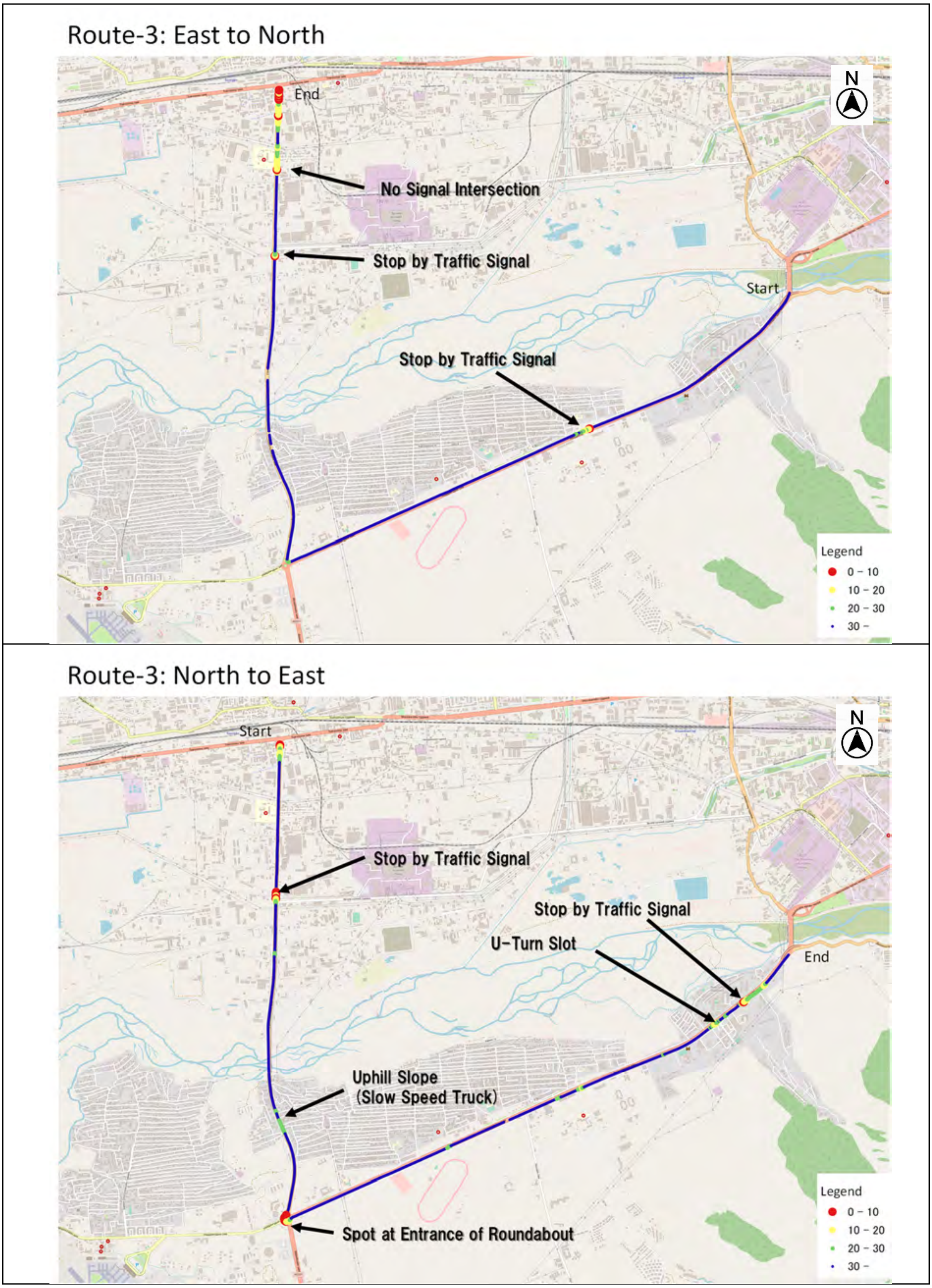
Source: JICA Study Team

Figure 3.50 Bottleneck Situation along Route-1



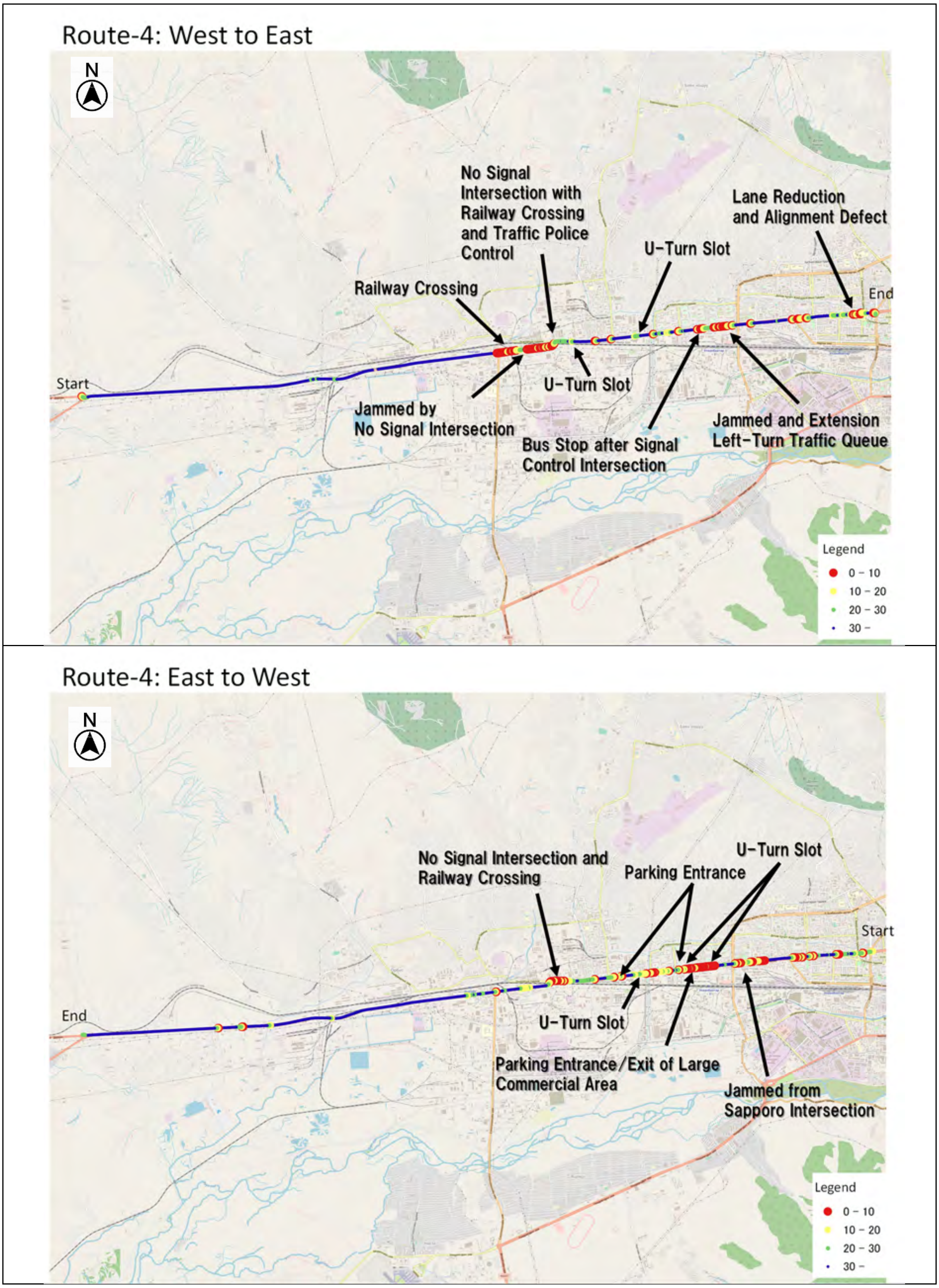
Source: JICA Study Team

Figure 3.51 Bottleneck Situation along Route-2



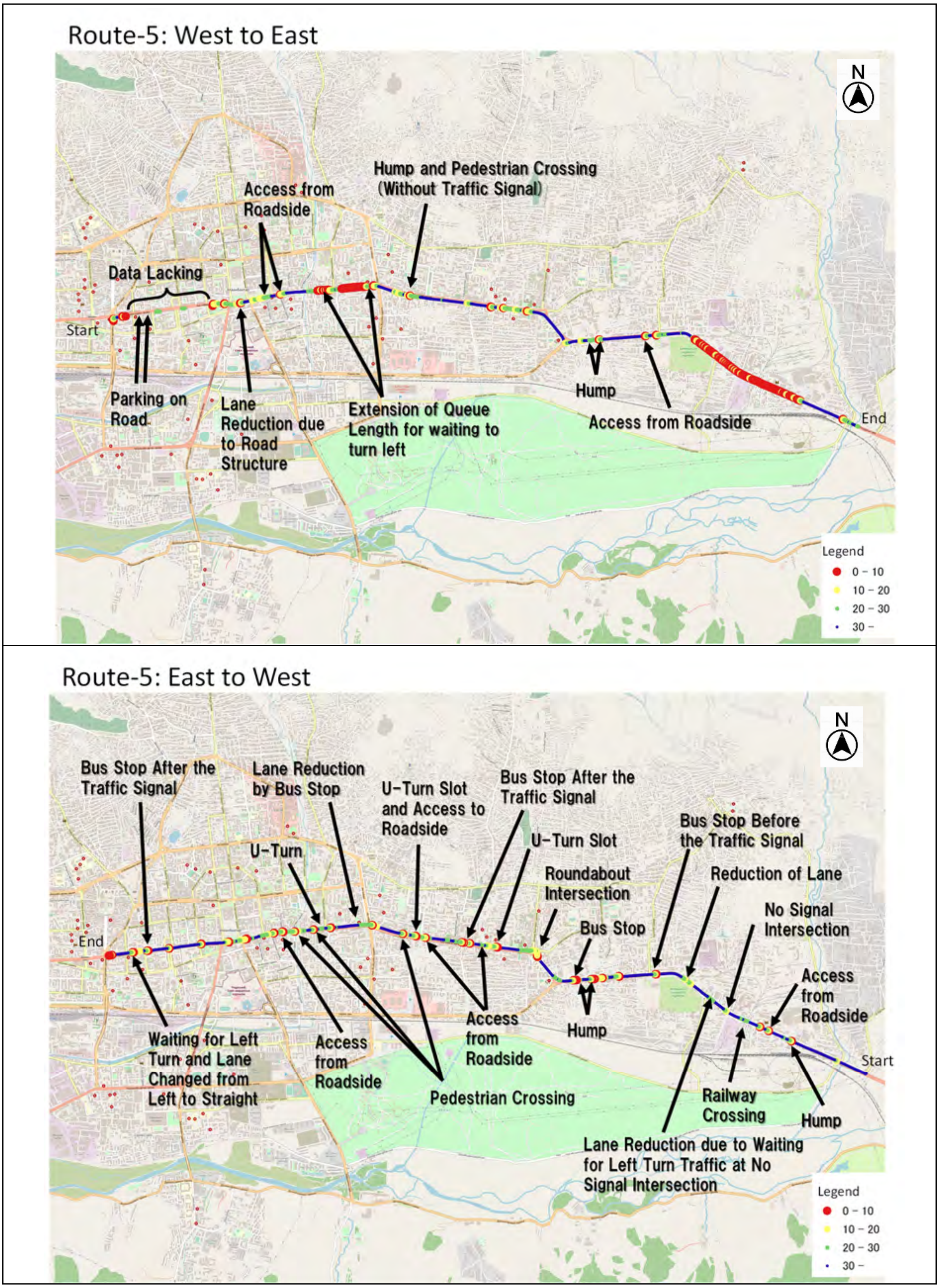
Source: JICA Study Team

Figure 3.52 Bottleneck Situation along Route-3



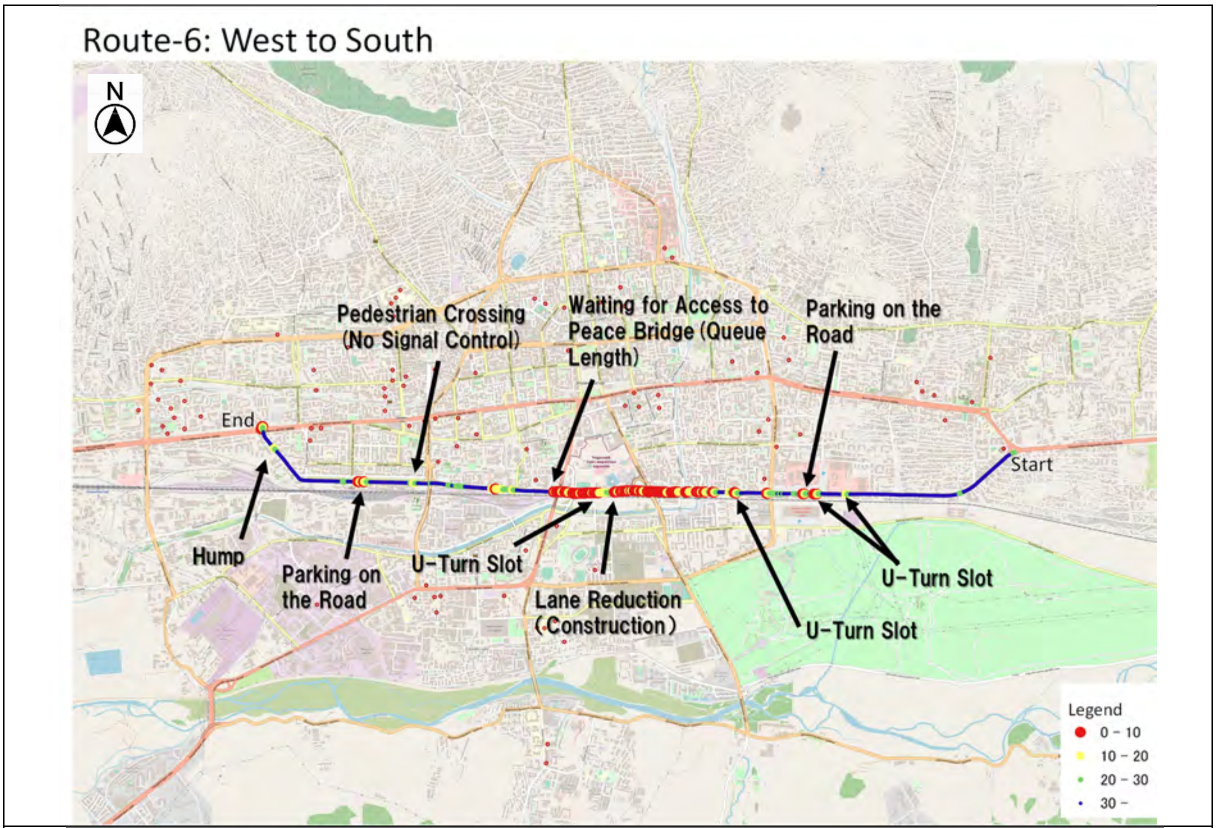
Source: JICA Study Team

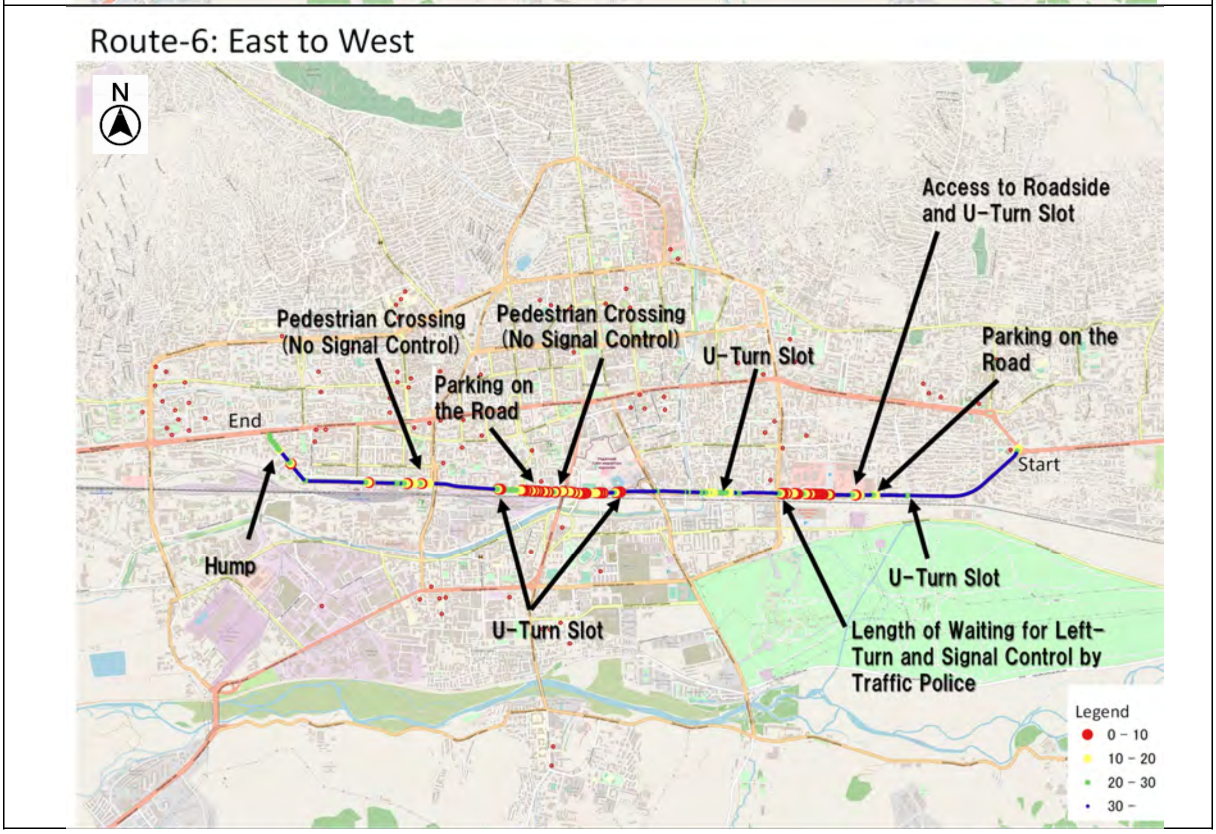
Figure 3.53 Bottleneck Situation along Route-4



Source: JICA Study Team

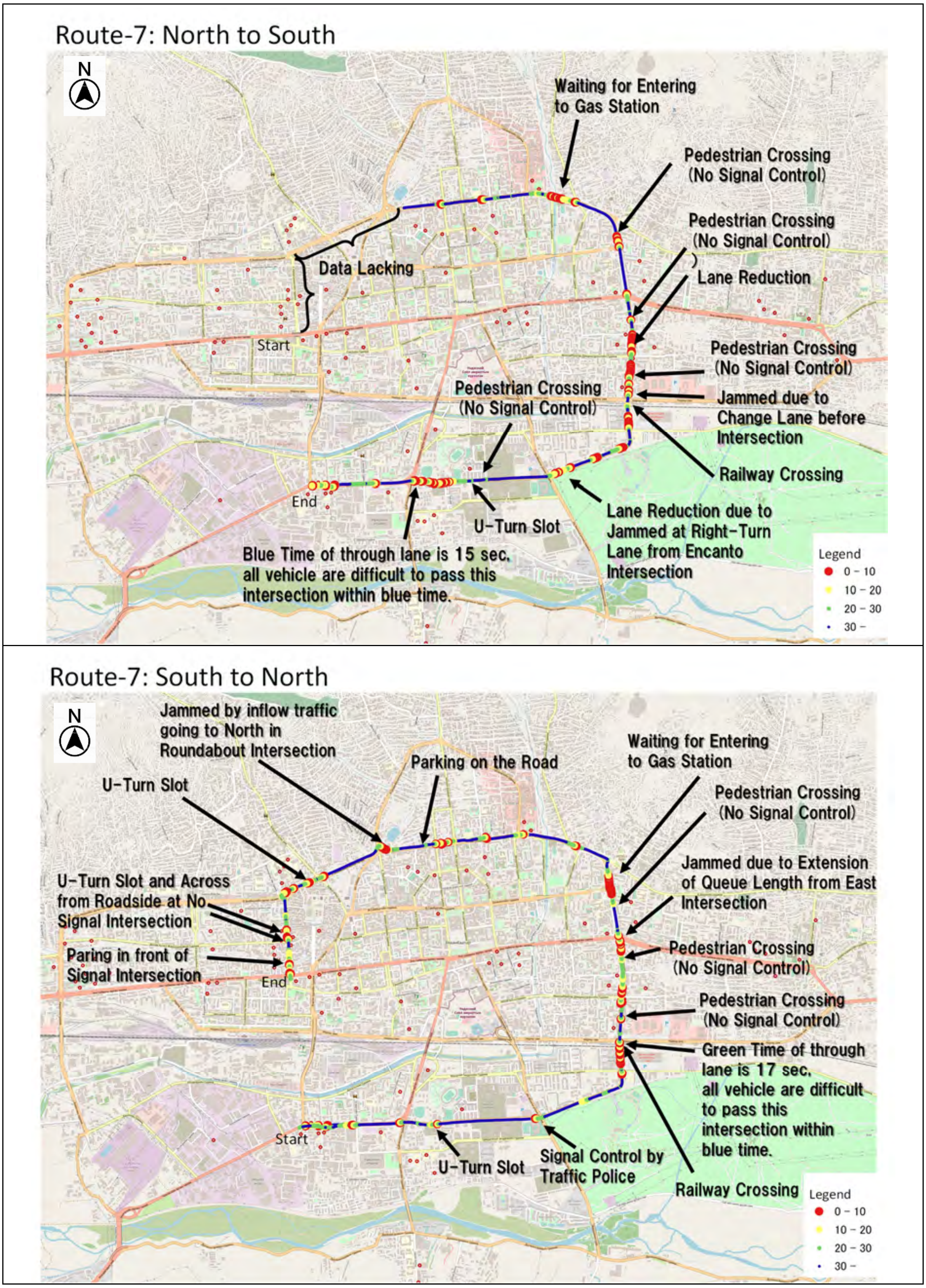
Figure 3.54 Bottleneck Situation along Route-5





Source: JICA Study Team

Figure 3.55 Bottleneck Situation along Route-6



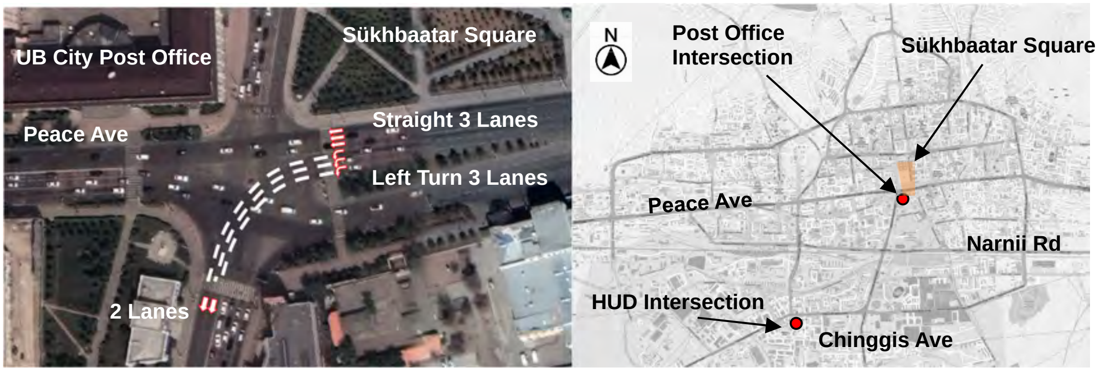
Source: JICA Study Team

Figure 3.56 Bottleneck Situation along Route-7

(3) Specific Bottleneck Cases

1) Bottoleneck Case-1 caused by Road Structure

Bottlenecks caused by road structures are in various places in UB City. The intersection on Peace Ave. that is in front of the post office and close to Sukhbaatar Square is a typical case. As shown in Figure 3.57, congestion occurs on the outbound side as it is limited to two lanes compared to the three left-turn lanes on the inbound side. When such bottlenecks are present at intersections, vehicles tend to stay in the intersection due to signal processing, which is a cause of traffic congestion.



Source: JICA Study Team

Figure 3.57 Post Office Intersection

2) Bottoleneck Case-2 caused by Road Structure

The inefficient shape of intersections is seen in various places in UB City. There is no exclusive left-turn lane for traffic coming from the east direction, and left-turning vehicles occupy one of the three lanes. Straight traffic is practically a two-lane operation. Securing left-turn lane and lane operations are extremely important at an intersection crossing major arterial roads with high traffic volume. Many congestion factors can be resolved by improving these areas.

Current Intersection Shape

Efficient Intersection Shape

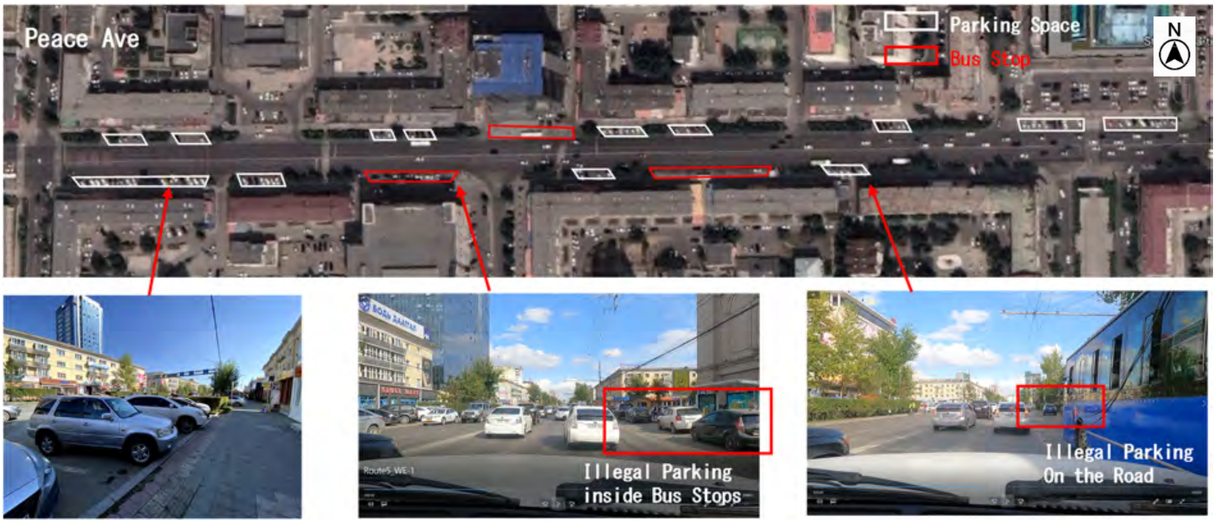
Source: JICA Study Team

Figure 3.58 Inefficient intersection shape

3) Bottoleneck Case-1 caused by Road User

There are many cars parked on arterial roads in UB City, as shown in the figure below. Therefore, the traffic capacity of the arterial roads is reduced due to the occupation of the roadway by entering and exiting parking space and waiting for parking space. As shown in Figure 3.59, there are many parked vehicles on the section of Peace Ave., from the West

Intersection to the Post Office Intersection, creating bottlenecks due to vehicles entering and exiting parking spaces and waiting for parking space. A bus stop is also near the parking space, another factor of reduced traffic capacity. The results of a travel speed survey show a situation where bus transport is blocked by illegally parked vehicles and those illegally parked inside the bus stops because the parking spaces were fully occupied.

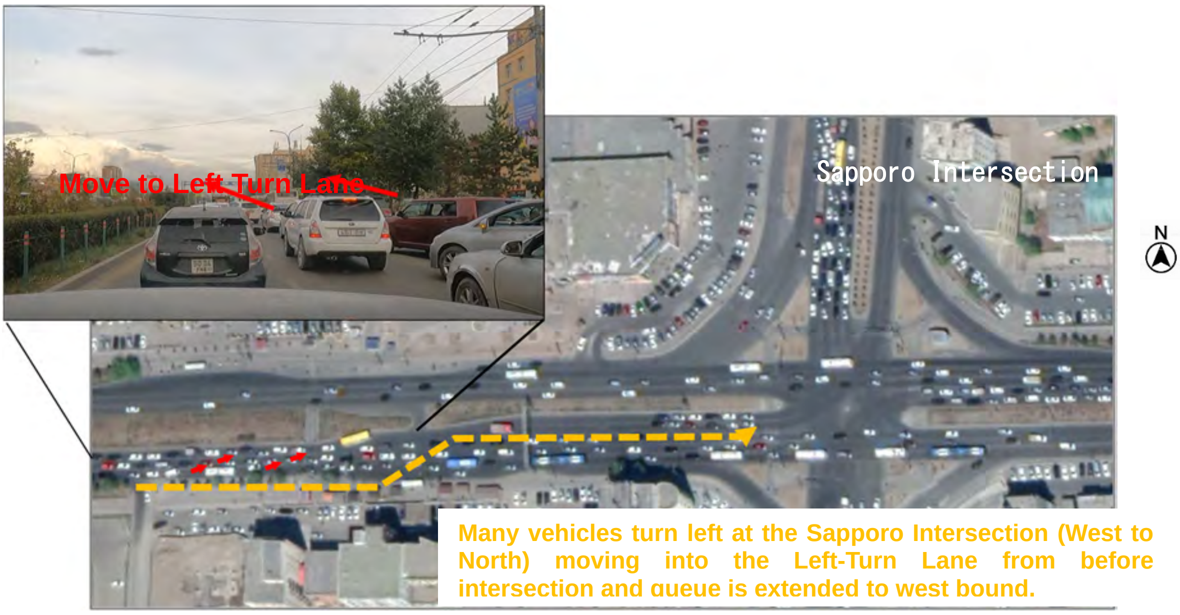


Source: JICA Study Team

Figure 3.59 Situation of Parking Space along Aretial Road and Illegal Parking inside Bus Stop

4) Bottoleneck Case-2 caused by Road User

As a case of a bottleneck caused by road users, the situation at the Sapporo intersection is shown below. Many vehicles turned to the left at the Sapporo Intersection and jammed from the intersection stop line. However, as shown in the photo below, some vehicles shifted from the main lane to the left-turn lane, and this queue was extended to the back of the former. This situation occurred daily at the Sapporo Intersection as well as at other intersections, a factor in traffic congestion.

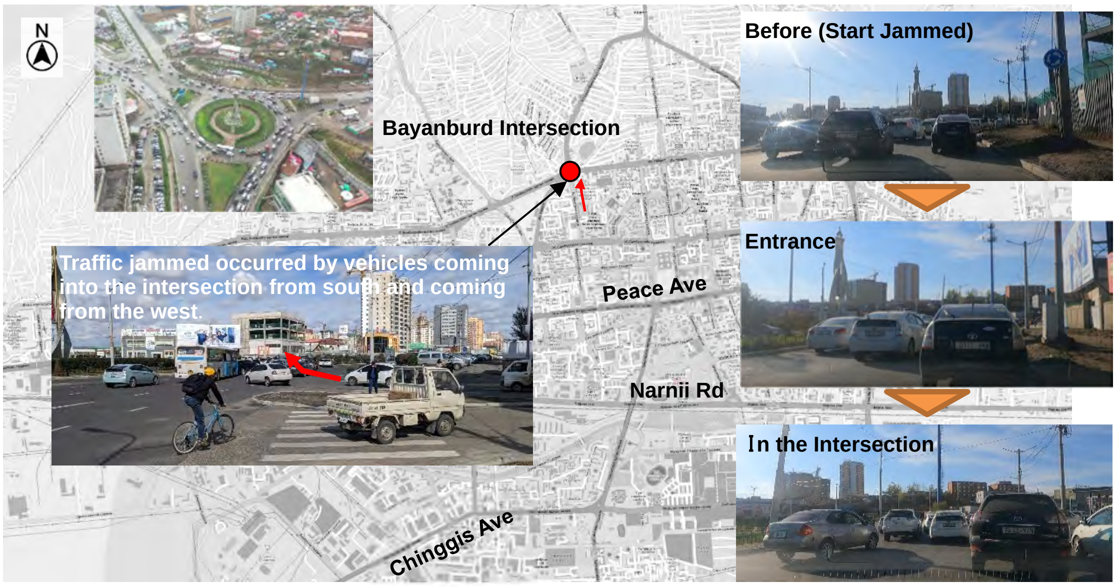


Source: JICA Study Team

Figure 3.60 Queue Length Caused by Vehicles Turned Left at Intersections (Case Study of Sapporo Intersection)

5) Bottleneck Case-1 caused by Intersection

Figure 3.61 shows the situation at the Bayanburd Intersection, which is a typical roundabout intersection. Some vehicles were stuck in a traffic jam from the front of the intersection and repeatedly stopped and started at the intersection entrance. There is also congestion on the route on the north side of the Bayanburd Intersection, affecting the inbound section of the east side. In addition, it was observed that some vehicles attempt to overtake and cross to avoid congestion in the intersections. On the other hand, the roundabout intersection has a bottleneck due to the heavy traffic flow of vehicles coming from the south and crossing with those coming from the west.

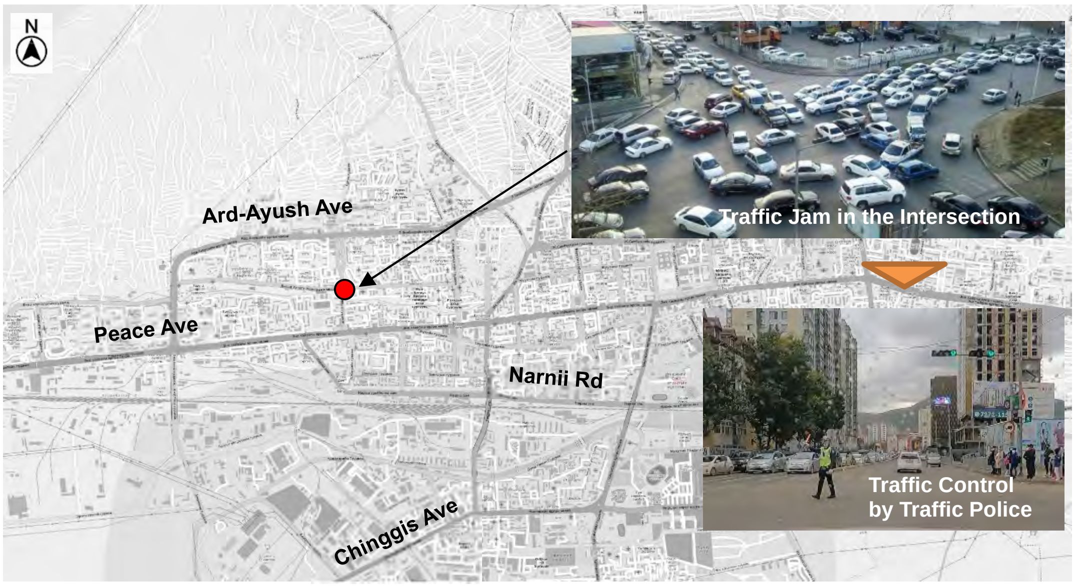


Source: JICA Study Team

Figure 3.60 Jammed and Crossing Situation in Roundabout (In the case of Bayanburd Intersection)

6) Bottleneck Case-2 caused by Intersection

This figure shows the situation in the signalized intersection of the road connecting Peace Ave. and Ard-Ayush Ave. Although the situation was captured during the evening peak hour, the traffic jam occurred in a signalized intersection. During peak hours, this kind of situation occurs everywhere at signalized intersections in UB City, and the traffic police are controlling traffic movement to resolve this situation. Therefore, measures like traffic control and grade separation based on traffic conditions are needed.



Source: JICA Study Team

Figure 3.61 Case of Traffic Jam in the Intersection and Traffic Control by Traffic Police

3.4.2 Conclusion of Bottleneck Analysis

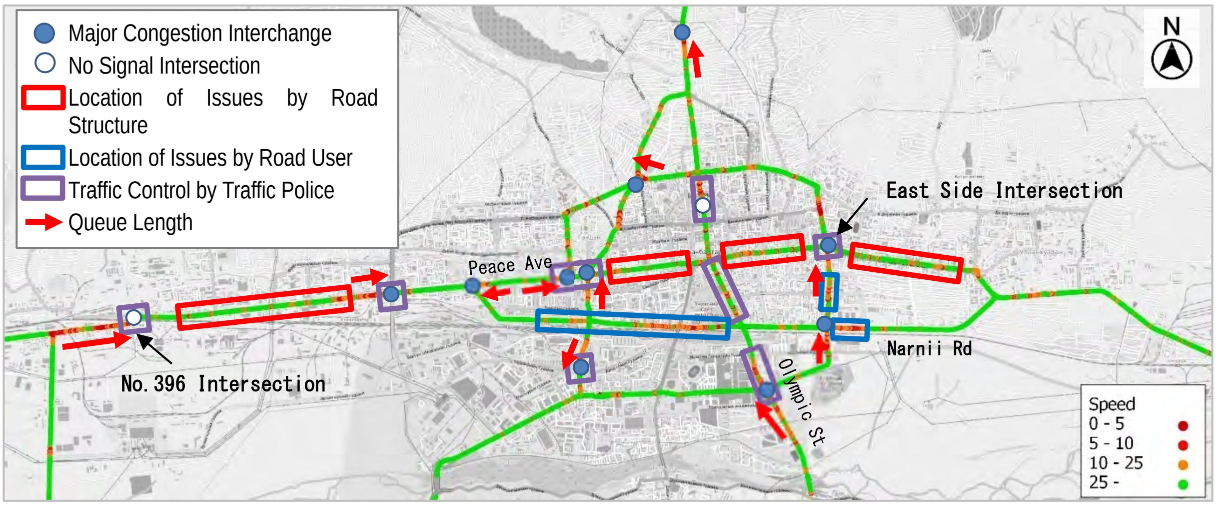
The results of the bottleneck analysis were based on the existing traffic volume data collected so far. The field survey and the travel speed survey results undertaken by the JICA Study Team are summarized as follows: (i) bottlenecks caused by road structure, (ii) bottlenecks caused by road users, and (iii) bottlenecks caused by intersections. A summary is shown below.

(i) There are many bottleneck points on Peace Ave., a primary arterial road that serves the east-west corridor, which impairs the road's function as an arterial road. The main causes of these bottlenecks are road structure, such as lane operations (lane reduction), U-turn slots, humps, and pedestrian crossings (without signals).

(ii) Shopping malls are along the roadside to the south of the East Side Intersection. Bottlenecks caused by road users occur due to the many pedestrians crossing the road to access the shopping malls and waiting for access to parking areas of the shopping malls. In addition, there are many speed reductions on Peace Ave and Narnii Road due to roadside parking by users and U-turn vehicles.

(iii) Traffic congestion occurs at signalized and non-signalized intersections due to the concentration of traffic in the city center. In addition, crossing occurs in intersections, and the police unavoidably manually control the traffic signals. An example of this situation is in the north-south corridor of Olympic Street. In addition, chronic traffic congestion occurs at the intersections on the west side of UB City (see “No. 396 Intersection” below) due to many vehicles crossing in intersections, and traffic police are often dispatched to control these intersections.

In conclusion, it is important to eliminate the bottlenecks to reduce traffic congestion, and it is highly necessary to start with priority projects that can be addressed with existing soft measures or low-cost construction work, such as lane operation, review of intersection processing, measures against on-street parking, and review of signal processing at intersections. After that, it is important to shift to hard measures, such as converting intersections with high traffic volumes that have reached the limit of their processing capacity into grade separation.



Source: JICA Study Team

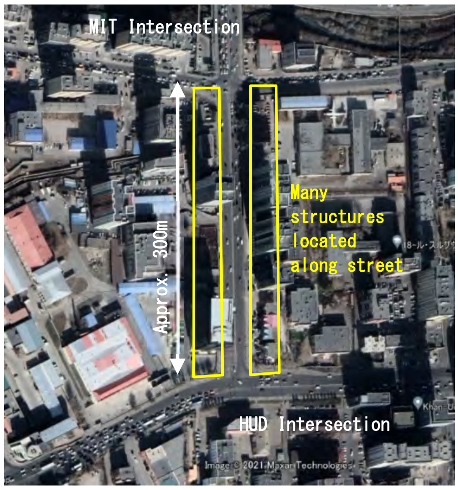
Figure 3.62 Summary of Bottleneck Analysis

3.4.3 Impact of Grade Separation Intersection

(1) Selection of Major Counter-measure Intersections

According to the data collection and site observation of the intersections, the major factors were clarified so far: (i) only 154 intersections are signal-controlled, (ii) the intersection flow ratio of 14 intersections exceed 0.9, as shown in Section 3.3.2(3); and (iii) in Section 3.4.2, signalized intersections with long congestion queue (including non-signalized intersections) are present. In this section, a more detailed intersection analysis (delay time and level of service [LOS] calculated based on signal indications and intersection geometry) will be conducted, and basic data for understanding the project evaluation when intersection improvements are implemented will also be sorted out.

Major intersections (five intersections shown in Figure 3.64) were selected based on the analyses results in the previous section and the MP2040, which is the higher-level plan of UB City, and the UB City Congestion Management Committee selected the planned countermeasure locations.

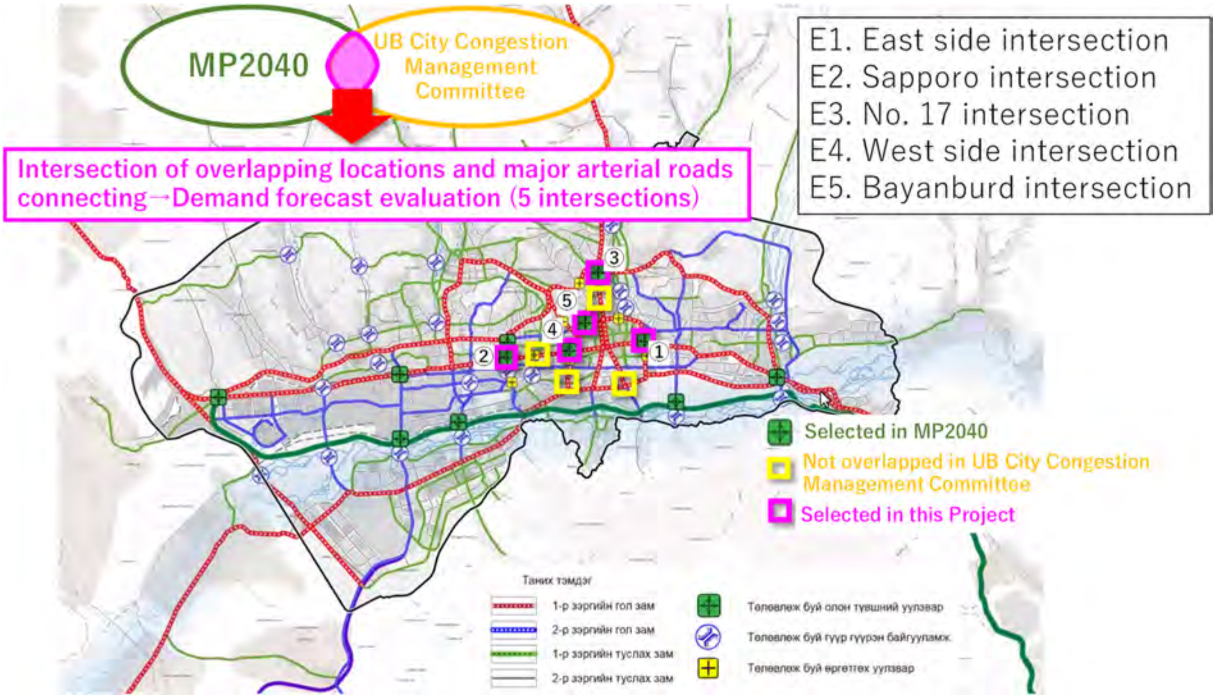


Source: JICA Study Team

Figure 3.63 Situation between MIT Intersection and HUD Intersection (Distance and Roadside Situation)

As for the MIS intersection, it has the highest flow ratio and the highest traffic volume in the north-south direction. However, as shown in the right figure, the T intersection (HUD intersection) on the south side of the MIS intersection is nearby, and if considering the approach road part (250 to 300 m), it will be close to the HUD intersection, which will cause problems in terms of road structure and operation. Even if grade separation is considered, problems such as ROW acquisition and house relocation will occur because many structures along the street and structures are derived from other parts of the road. In addition, the Narantuul Market intersection, which has the next highest flow ratio, was excluded from the selection of countermeasure because the intersection improvement will be implemented with the support of China.

The five major intersections were then selected: (i) East Side Intersection, (ii) Sapporo Intersection, (iii) No. 17 Intersection, (iv) West Side Intersection, and (v) Bayanburd Intersection.



Source: JICA Study Team

Figure 3.64 Concept of Major Intersection Selection

(2) Major Intersection Analysis by Highway Capacity Manual

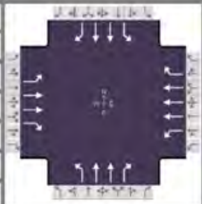
1) Contents and Methodology of Analysis

In order to determine the current level of service at the major intersections, the "delay time" of vehicles passing through the intersection is calculated by referring to the Highway Capacity Manual (HCM), which is used worldwide as a guideline for academic and practical traffic engineering. The input data are intersection traffic volume by direction, signal phase data, and intersection geometry (width, approach road, etc.) obtained from the Traffic Control Center. In the HCM, the level of service of the intersection is evaluated in six levels, and the LOS is ranked according to the delay time (delay by deceleration, acceleration, delay by stop time at signal, delay in starting, etc.), stop time for pedestrian traffic, stop time for oncoming traffic when turning left, etc. Figure 3.65 shows the calculation form of the HCM.

Based on this method, the delay time before and after intersection improvement was compared, and the effect of reducing the delay time was also calculated to study the quantitative effect of upgrading the grade separation.

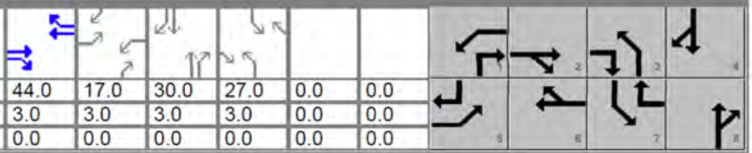
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	CTII			Duration, h	0.25
Analyst	Kaneko	Analysis Date	11/1/2021	Area Type	CBD
Jurisdiction		Time Period	13:30	PHF	0.92
Urban Street	Peace Avenue	Analysis Year	2021	Analysis Period	1> 7:00
Intersection	East Intersection	File Name	East Intersection.xus		
Project Description					



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	307	1012	225	544	993	503	318	621	132	406	502	113

Signal Information										
Cycle, s	130.0	Reference Phase	2							
Offset, s	0	Reference Point	Begin	Green	44.0	17.0	30.0	27.0	0.0	0.0
Uncoordinated	No	Simult. Gap E/W	On	Yellow	3.0	3.0	3.0	3.0	0.0	0.0
Force Mode	Fixed	Simult. Gap N/S	On	Red	0.0	0.0	0.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.0
Phase Duration, s	20.0	47.0	20.0	47.0	30.0	33.0	30.0	33.0
Change Period, ($Y+R_c$), s	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Max Allow Headway (*MAH*), s	3.3	0.0	3.3	0.0	3.3	3.3	3.3	3.3
Queue Clearance Time (g_s), s	19.0		19.0		29.0	29.1	29.0	22.9
Green Extension Time (g_e), s	0.0	0.0	0.0	0.0	0.0	0.3	0.0	1.2
Phase Call Probability	1.00		1.00		1.00	1.00	1.00	1.00
Max Out Probability	1.00		1.00		1.00	1.00	1.00	0.15

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	334	1100	245	591	1079	547	346	675	143	441	546	123
Adjusted Saturation Flow Rate (s), veh/h/ln	1423	1581	1062	1423	1508	1062	1423	1581	1014	1423	1581	1014
Queue Service Time (g_s), s	17.0	44.0	17.7	17.0	27.0	44.0	27.0	27.1	13.7	27.0	20.9	11.4
Cycle Queue Clearance Time (g_c), s	17.0	44.0	17.7	17.0	27.0	44.0	27.0	27.1	13.7	27.0	20.9	11.4
Green Ratio (*g/C*)	0.13	0.34	0.55	0.13	0.34	0.55	0.21	0.23	0.36	0.21	0.23	0.36
Capacity (c), veh/h	186	1070	601	186	1531	601	296	730	386	296	730	386
Volume-to-Capacity Ratio (X)	1.793	1.028	0.407	3.177	0.705	0.909	1.169	0.925	0.371	1.493	0.748	0.318
Back of Queue (Q), ft/ln (50 th percentile)	667.2	580.7	119.2	1495.3	270.8	240.6	478.5	325.8	87.3	761.5	225.2	73.2
Back of Queue (Q), veh/ln (50 th percentile)	25.7	22.3	4.6	57.5	10.4	9.3	18.4	12.5	3.4	29.3	8.7	2.8
Queue Storage Ratio (*RQ*) (50 th percentile)	0.00	0.00	0.00	8.80	0.00	0.00	2.81	0.00	0.00	4.48	0.00	0.00
Uniform Delay (d_1), s/veh	56.5	43.0	16.9	56.5	37.4	25.8	51.5	48.9	30.2	51.5	46.5	29.6
Incremental Delay (d_2), s/veh	377.4	34.9	2.0	993.5	2.8	20.1	106.3	17.3	0.2	238.9	3.8	0.2
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh	433.9	77.9	19.0	1050.0	40.1	45.8	157.8	66.2	30.4	290.4	50.3	29.8
Level of Service (LOS)	F	F	B	F	D	D	F	E	C	F	D	C
Approach Delay, s/veh / LOS	140.1		F	310.8		F	89.0		F	143.5		F
Intersection Delay, s/veh / LOS	192.4						F					

Source: JICA Study Team

LOS Rank: The definition is as follows. The minimum standard LOS in urban areas is ranked at D and recomended over D rank.

A: Delay time is less than 10 sec, B: Delay time is 10–20 sec, C: Delay time is 20–35 sec, D: Delay time is 35–55 sec, E: Delay time is 55–80 sec, F: Delay time over 80 sec

Figure 3.65 Analysis Method of Intersection LOS (HCM Form)

2) Result of LOS

The LOS defined by HC was calculated for the five major intersections before (existing) and after (grade separation) intersection improvement (see Table 3.21). The current level of service at the intersections shows the lowest rank of F, indicating a situation of traffic congestion at the intersections. On the other hand, in case the intersections are upgraded to grade separation, the delay time at each except for Intersection No. 17 will be reduced by more than 100 seconds (the LOS will be changed to a rank higher than F). It turns out that the grade separation of major intersections has a significant time-saving effect.

Table 3.21 LOS of Major Intersection before and after Improvement (Reduction of Delay Time)

No.	Intersection	Inflow Traffic Volume (veh/day)	Before Improvement		After Improvement		Reduction of Delay Time (sec)
			Delay Time (sec)	LOS	Delay Time (sec)	LOS	
1	East Intersection	88,149	192.4	F	69.5	E	122.9
2	Sapporo Intersection	94,134	160.9	F	58.7	E	102.2
3	No. 17 Intersection	59,736	183.4	F	132.2	F	51.2
4	West Intersection	96,427	149.0	F	22.6	C	126.4
5	Bayanburd Intersection	80,688	185.3	F	34.8	D	150.5

Source: JICA Study Team

3.5 Environmental and social issues

3.5.1 Impacts on Project Implementation due to Non-Disclosure

The EIA law requires that, at the screening stage, the predictive assessment of social impacts shall focus on the local residents expected to be affected.

- Infringement of land occupation and property rights
- Existence of social impacts on local residents
- Existence of the impact on urban area
- Presence of resettlement are conducted

Projects with conditions that apply to the DEIA are cases with large negative impacts affecting health and the environment or cases in which impacts cannot be predicted. It will require further detailed study as the project develops and uses large amounts of natural resources.

In the case of large or mega infrastructure projects, most are required DEIA and the following items need to be considered in detail at the DEIA implementation stage.

(1) Baseline data and standard regarding the environment of the project implementation area.

(2) Estimations and findings of studies conducted to identify the potential as well as major impacts of a project.

(3) Recommendations for mitigation and elimination of potential and major impacts of a project.

(4) Recommendations for alternative methods and technologies that may potentially reduce the pollution level expected from the proposed project and for environmentally considered methods and technologies.

(5) Risk assessment of impacts on human health and the environment of the proposed project.

(6) Objectives, scope, and indicators of the Environmental Management Plan.

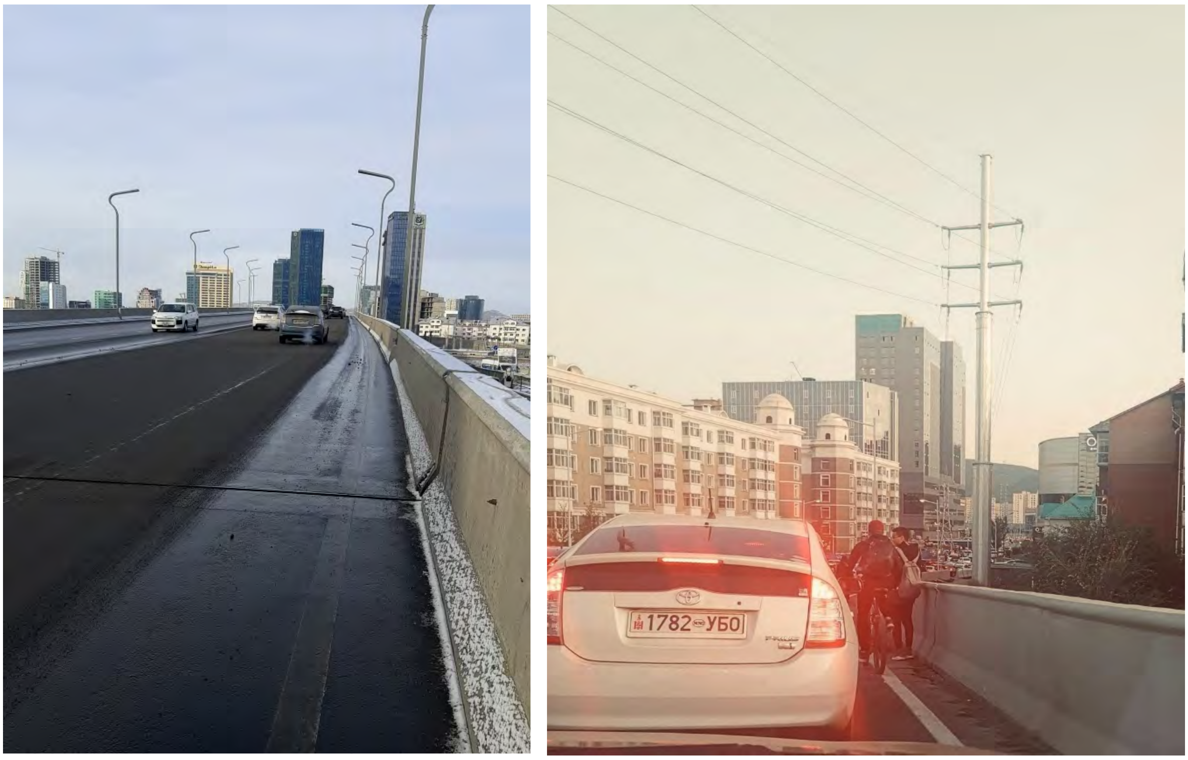
(7) Notes of consultations made with local authorities and communities likely to be affected by the proposed project.

(8) Other issues pertaining to the cultural stratum and nature of the project.

From the above, the EIA law requires a city and soum briefing and consultation by the council at the screening stage and submitting a resolution. In the DEIA stage, the project implementer and professional organization that conducted the assessment shall jointly present the DEIA report to the residents affected by the project (Article 10.5).

However, discussions and submissions of resolutions are conducted in the city councils, but clarifications and information disclosure have not been carried out to the general public and affected residents. Only information on the project title, location, and implementation period will be disclosed, not information on the impact on citizens' lives and risk assessment.

A recent example is the Olympic flyover built with Chinese grant aid in the fall of 2019. Only its image was released to the public, and the project was launched without sufficient explanation and without collecting opinions from residents. As a result, after completing its construction, the access road to the center of the neighborhood was blocked, forcing the residents to take a long detour to commute to work or school. The lack of sidewalks has also caused problems, such as pedestrians walking across the roadway, not providing adequate safety.



Source: JICA Study Team

Figure 3.66 Olympic Flyover

3.5.2 Impacts on Project Implementation due to Lack of Explanation by Residents Regarding land Acquisition

Lack of explanation regarding land acquisition and dialogue opportunities and failure to follow the process of consensus-building cause conflicts with residents. However, there are many cases in which projects started before the conduct and approval of their EIA. There were lawsuits due to complaints about land expropriation or dissatisfaction with the amount of compensation.

Public participation in providing information and gathering opinions must be required, even repeated explanations regarding land acquisition to the public during the project planning stage until reaching a consensus. However, in many infrastructure projects, information is not often sufficiently disclosed because it is assumed that doing so at an early stage may confuse land sales, compensation claims, etc., making eventual information disclosure difficult.

As mentioned, information disclosure of public projects is essential for public administration to fulfill its accountability, and consensus-building with residents can only be achieved with sufficient information disclosure.

3.5.3 Lack of Consideration for Vulnerable Road Users

There are various definitions of "vulnerable road users" in car society of urban area, but for this study, it is assumed that it includes nonowners of vehicles, such as pedestrians and those that rely on public transportation and commute by bicycle. In UB City, there is a lack of consideration for the waiting time of bus users, the transit environment, and the safety of pedestrians and commuters on trains. Due to the shortage and inconvenience of the existing public transportation bus, it is necessary to improve the service, diversify routes, and increase the number of buses.

According to the results of the questionnaire survey conducted by UB City, 68% responded that getting on the bus is sometimes difficult because it is always full, 64% found the bus services inconvenient (filthy, cold in winter, hot in summer, frequent emergency braking, etc.), 54% has difficulty waiting for the bus during winter, 50% responded that waiting for a bus takes too long, 49% found taking the bus with children is inconvenient, 48% said there are many pickpockets, 44% said there are drunks and west pickers, 33% found bus stops too far or none are nearby, 33% said there is no available bus route for them, 32% found bus routes are only duplicated, and 10% have other reasons.

On the other hand, 70% of pedestrians found sidewalks are difficult to walk on when these are flooded during summer rains, 68% found sidewalks are often damaged and inadequate, 65% responded sidewalks are slippery and snow removal is inadequate, 65% responded sidewalks are quite dusty and dirty, 62% said pedestrians get puddled, another 62% responded it is unsafe for people with children, 60% found the roads are noisy, 60% responded that being involved in an accident is a high risk, 58% found riding bicycles on sidewalks is dangerous, 56% found sidewalks have many fences, posts, and holes, 50% found sidewalks cold to walk on during winter, and 7% responded with “others.”

Looking at the responses of those commuting to work or school by bicycle or motorcycle, 84% said there are hardly dedicated lanes for bicycles, 67% found many bicycle lanes are cut-off in some places, 67% responded it is dangerous to ride on car roads and prone to accidents, 64% responded there is no bicycle parking, 61% answered that sidewalks are narrow and road curbs are too high, 56% responded there are many fences, posts, and potholes that make it difficult to bike, 56% responded that roads and sidewalks are flooded during summer, 54% said it is slippery during winter, 53% said bicycles are often stolen, 53% responded that riding along the road causes water accumulation, 52% said there is no bicycle registration system, and 5% responded with “others.”

The risk of traffic accidents has been increasing from the widening the width of roads as a mitigation measure for traffic congestion that narrows sidewalks forcing people to walk on the road and parking lots. Steps, holes, and fences also make it difficult for wheelchairs and baby carriages to pass and for pedestrians. The timing of pedestrian signals at crosswalks is short, such as the green light for pedestrians on Peace, and consideration for the elderly and physically challenged is lacking. Many traffic accidents occur at crosswalks without traffic lights, often involving children. Most bus stops are not adequately maintained, and only a few are covered.

Source: JICA Study Team

Figure 3.68 Bumpy Sidewalk with Many Telegraph Poles

Source：gogo.mn

Figure 3.69 Passengers Waiting for Bus

In the field of road transport, mitigation measures for traffic congestion have become an important issue, and as a result of prioritizing road widening, road repair, and construction, there is a lack of consideration for vulnerable road users. In the future, shifting from a car-centered society to a people-centered society will be necessary to develop convenient and safe transportation systems and create a road environment with universal design.

3.6 Natural Conditions

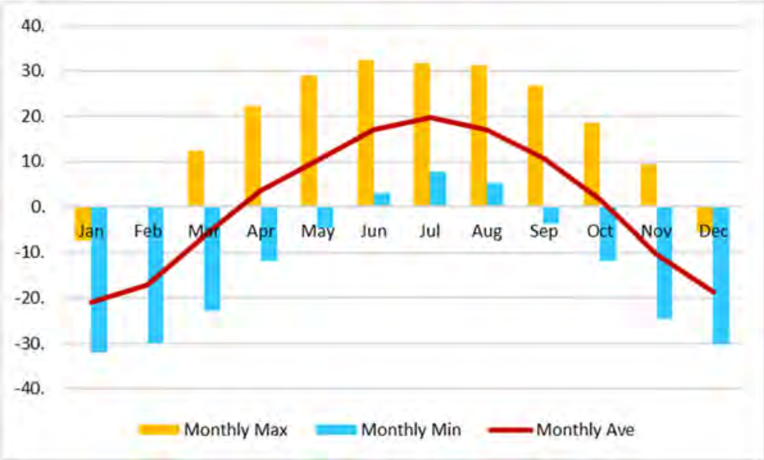
3.6.1 Natural Conditions of UB City

(1) Climate

Natural conditions, such as temperature, humidity, precipitation, wind speed, topographical and geological features, of UB City are shown below.

1) Temperature

The climate classification of Mongolia belongs to a typical continental subarctic or steppe climate. Four seasons occur throughout the year, divided into short dry summer (June to August), cold winter (November to March), and severe changes in temperature of spring and autumn. The average temperature over the past 10 years in UB City is 0.5℃. The average temperature from October to June is about 0℃ or below (minimum temperature is -37.3℃), followed by hot summer that ranges from 30℃ to 40℃ (Figure 3.70). (maximum temperature is 38.3℃) from May to September.

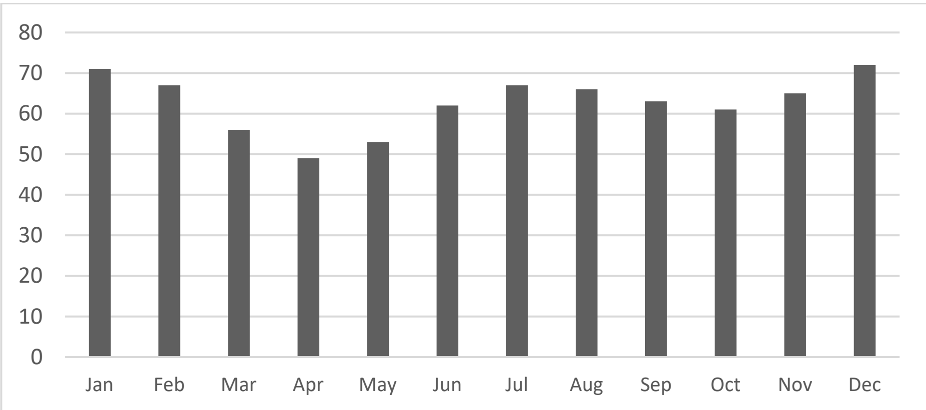


Source: National Statistics Office of Mongolia

Figure 3.70 Temperature Range of UB (2011–2020)

2) Humidity

The average annual relative humidity of UB City is from 63–64%. The humidity ranges from 71% to 75% in December–January to 47–53% in May, the lowest in the year.

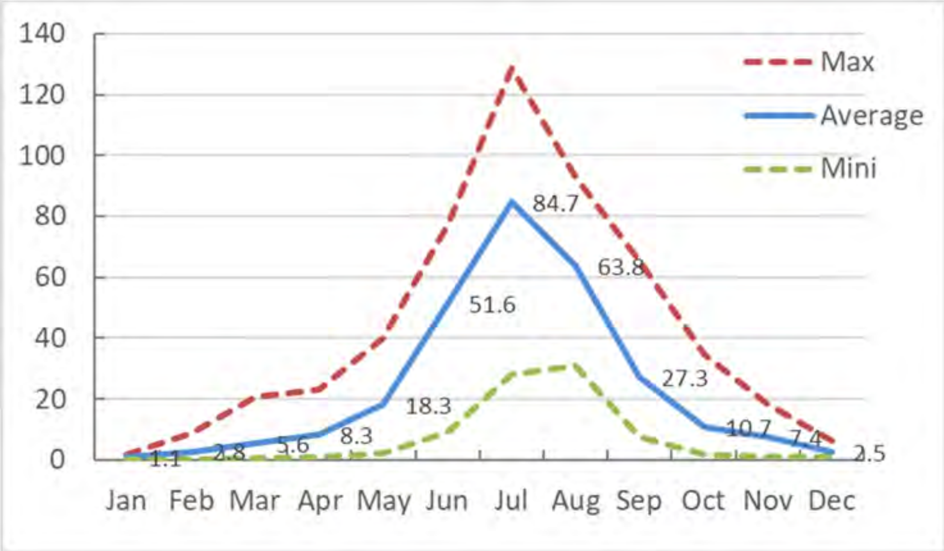


Source: Tuul River Expressway Feasibility Study Report

Figure 3.71 Average relative humidity of UB City, by Month (Ulaanbaatar Station)

3) Amount of precipitation

In UB City, more than 90% of annual rainfall is usually from April to October, and winter rainfall with snow is less than 10%. The average annual rainfall for the past 10 years (2011–2020) is 284 mm. The monthly rainfall is usually in July (average of 84.7 mm/month) (Figure 3.72).

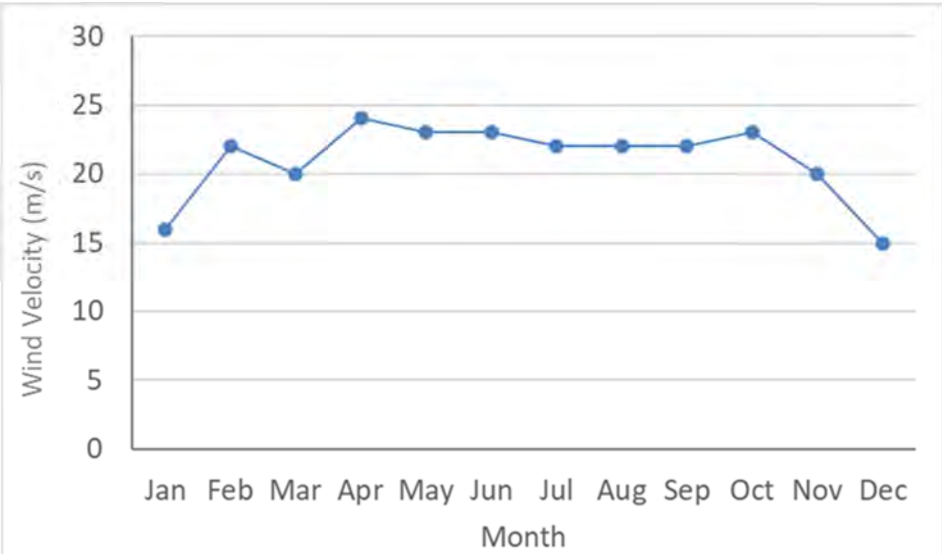


Source: The Natural Disaster Database of the Ministry of Environment and Transport (MET) and National Statistics Office of Mongolia

Figure 3.72 Monthly Precipitation (2011–2020)

4) Wind Velocity

UB City has about 100 calm days (wind speed less than 3 m/s) a year, and the average annual wind velocity is 4–6m/s, mostly from the northeast. The maximum wind velocity for the last 10 years (2011 to 2020) is V=24m/s (April 2014), and the value of V=20m/s has been recorded throughout the year. On the other hand, the wind velocity tends to decrease during the harsh winter months of December to January, and harmful substances emitted from vehicles, air pollutants, and coal fuel of ger areas tend to stay in UB City, making air pollution more serious (Figure 3.73).

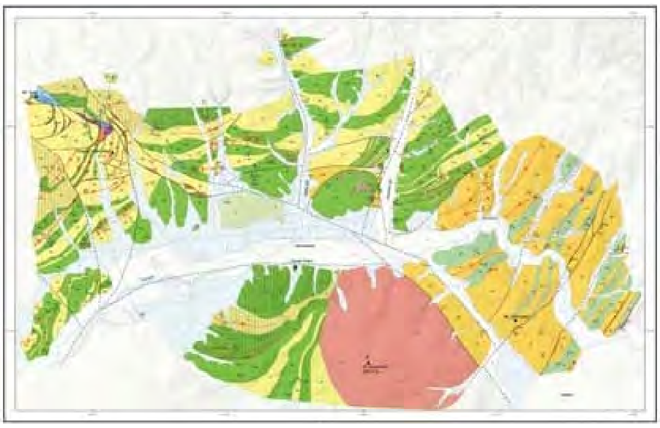


Source: National Statistics Office of Mongolia

Figure 3.73 Monthly Maximum Wind Speed in UB City (2011–2020)

(2) Topographic and Geological Features

The UB City stretches in the east-west direction, which is about 5 km north-south and about 30 km east-west, with an altitude of 1,300 m approximately. On the southern part of the city, the Tuul River runs from east to west along the foot of Bogdkhan Mountain Protected Area, and there is a series of mountains and hills on the northern part of the city. The Selbe River (of which downstream is called as Dundgol River) flows into the Tuul River from the south slope in the northern part of the city. Topographic and map information (scale 1/500) of UB City is owned by Agency for Land Administration and Management, Geodesy, and Cartography and is available for a fee. As for geological features of UB City and its surroundings consists of sandstone and shale of the Carboniferous period in the Paleozoic era and the Cretaceous period in the Mesozoic era and, in particular, granite of the Jurassic period in the Mesozoic era is distributed on the south mountains (Figure 3.74).

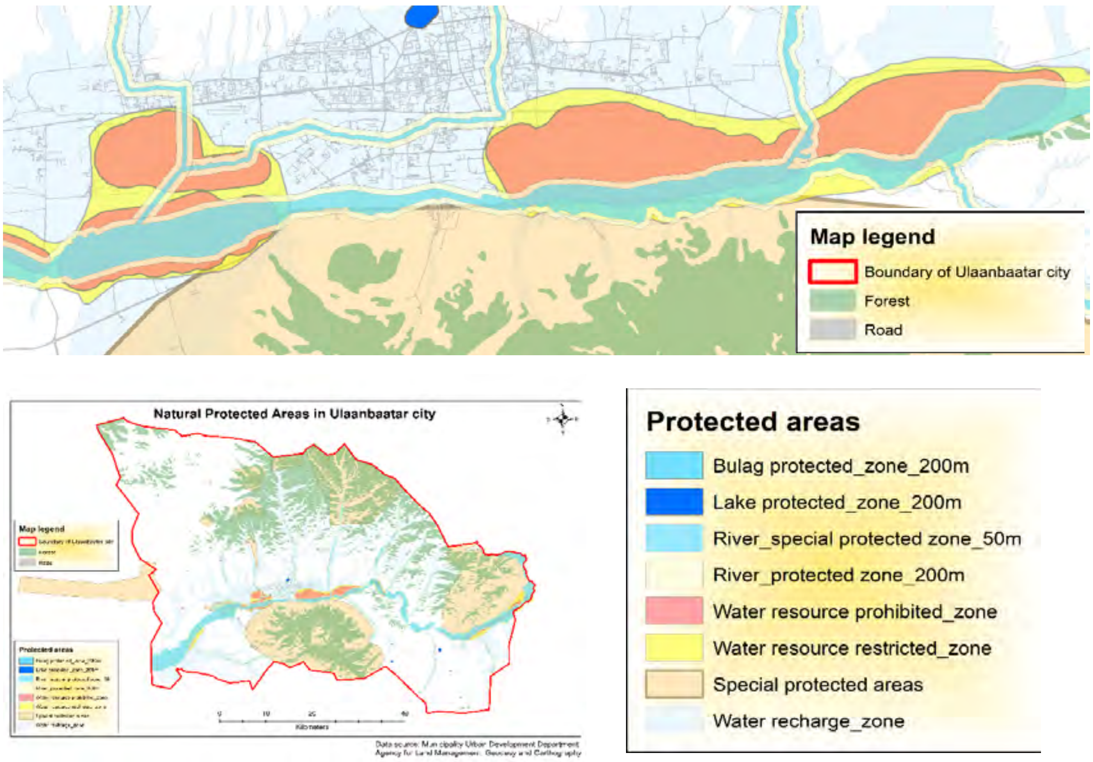


Source: Tectonics Group, Graduate School of Nagoya University

Figure 3.74 Geological map of Ulaanbaatar area

(3) Water Source Protection Areas

Environment protection areas of UB City include the Bogdkhan Mountain National Park and Terelj National Park, as well as Forest Protection areas (Forest Law (revised in 2012)) and Water Source Protection Areas (Water Law (revised in 2012)).



Source: Urban Planning and Development Department of UB City

図 3.75 Environment protection areas map of UB City

The establishment of water sources and other areas as well as implementable activities within those areas are determined by regulations issued by the decree of the Minister of Environment and Green Development and the Minister of Construction and Urban Development (A-230/127, 5 June 2015). In water protection zones, such as protected areas and special protection zone located 50–100 m from the riverfront, the construction of buildings, agricultural, and manufacturing activities are prohibited. However, infrastructure development, such as flood embankments, roads and bridges, and water supply, can be implemented as public projects after conducting an environmental impact assessment. Detailed information on water protection zones is given in the table below.

Table 3.22 Requirements for water source protection zone and sanitary protection zone

Zone	Target area	Prohibited activities	Remarks
Water source special protection zone	・ Upstream of the river ・50 m from river/spring front ・100 m from the shore of lakes and flow control ponds. As for river pond, the zone is the same area as the width of the special protection zone ・100 m from water source front in the urban area, 50 m from flood embankment ・Water source prohibited zone ・30 m from flood facilities and embankments	・Development of residential areas ・Construction and use of water source facilities ・Water purification facilities which use surface water as a water resource ・Coast development project ・Development of public park and sports facilities, tree planting activities ・Livestock grazing ・ Borehole drilling and monitoring activities	・ Special protection zone is not established in areas with infrastructure and lifelines, such as the construction of mega-project facilities as public works, flood embankment, adjustment dams, reservoirs, and other facilities, as well as roads and bridges, waterworks, transmission lines, and heating pipes.
Water source protection zone	・200 m from the water source front ・500 m from the water source front in the capital city as well as aimag center	・Tree planting ・Construction and use of buildings not connected to the sewage network, or without sewage treatment facilities ・ Storage and use of petroleum, chemicals, radioactive materials, fertilizers, etc. ・Construction of gas stations and car wash ・Dumping of waste and contaminants, and installation of waste storage ・ Livestock washing activities and development of agro-processing plants ・ Installation and use of sewerage systems and toilets which do not meet standards	
Sanitary limitation zone for water supply	・Sanitary zone for water supply is established near the central water supply source, water supply kiosk ・5 m from the central water supply pipe and facilities ・200 m from other water sources in urban areas	・ Excavation of surface soil, afforestation, extraction of sand and gravel ・Leaving unused groundwater pipes ・Runoff of untreated wastewater and dumping of waste ・ Soil excavation that affects groundwater ・Development of wells for purposes other than survey and drinking water ・Development of wells in areas with central water supply facilities and water	Measures to be taken at the sanitary zone: ・Prevention of rainwater inflow etc. ・Connection of related facilities to the central sewerage system. If the connection is difficult, sewage pipes and toilets which meet the standards should be installed outside of the

Zone	Target area	Prohibited activities	Remarks
		pipes ・Use of fertilizers ・Storage and use of petroleum, chemicals, and radioactive materials ・Maintenance of the gas station and car washing activities ・Processing and preservation of livestock products ・Construction of houses, factories, and service buildings ・Ownership and use of land	sanitary zone ・Widening and repair of related facilities should be carried out based on the design confirmed by the sanitary audit organization. ・Sanitary zone should be fenced, and security guards should be permanently posted. ・Keep sanitary zones clean. ・Additional measures should be taken depending on the hydrogeological conditions.
Sanitary prohibited zone for water supply	・Setting up sanitary zones to prevent water source pollution. ・100 m from the central water supply source ・50 m from other sources of water in urban areas	・The prohibited activities are the same as a sanitary limitation zone for water supply. Other prohibited issues: ・No outsiders allowed ・Leaving cars and trucks unattended ・Activities such as livestock grazing and vegetable cultivation	
Groundwater recharge zone	・To be established based on the hydrogeological survey	・Production of radioactive and chemically hazardous materials and all activities that utilize them	

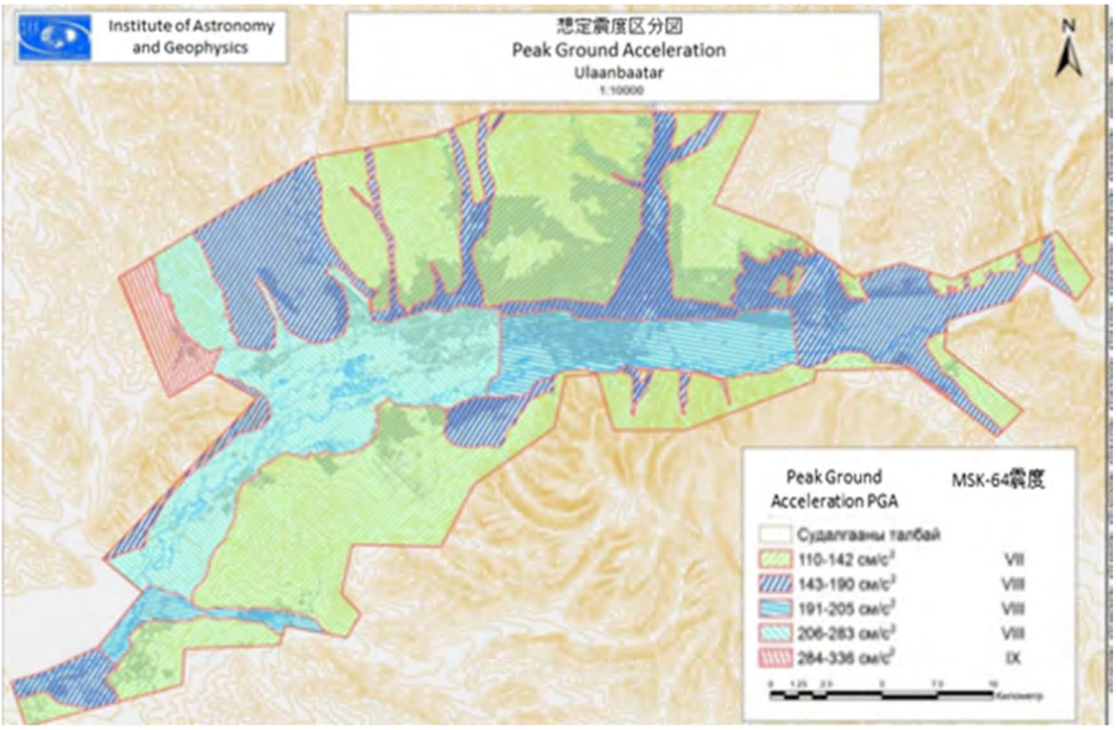
Source: A-230/127 decree (June 5, 2015) by the Minister of Environment, Green Development, Tourism and Minister of Construction and Urban Development

(4) Natural Disasters

1) Earthquake

Large earthquakes of the M8 scale have occurred four times since 1905, mainly in the western region of Mongolia. In 2020–2021, tremors from the earthquakes that occurred in Khuvsgul and Dundgovi were observed and felt in UB City. In recent years, Emeelt active faults (western part of UB City, 35 km length, earthquake scale is M6.5-7.1), Gunjiin active faults (southwest of UB City, 20 km length, earthquake scale is M6.7), and Khustai active faults (southwest of UB, 35 km length, earthquake scale is M7.8) were identified near UB City. In 2019, Nagoya University, Mongolian National University, and University of Science and Technology jointly discovered a 50-km long Ulaanbaatar fault that runs along the UB City from southeast to northwest that has been active 35,000 years ago and said to be capable of causing M7.1 class earthquakes, which is still being investigated (Earthquake Hazard of Ulaanbaatar, Suzuki, et al., 2020).

In 2015, the seismic intensity distribution map of UB City was updated by the Ministry of Construction and Urban Development (MCUD) (Figure 3.76), and the expected seismic ground motion in the city area is predicted to be MSK intensity of 7–9 (200 gal or more/reproduction period of 475 years).



Source: Ministry of Construction and Urban Development (MCUD)

Figure 3.76 UB City seismic intensity distribution map

Recently, the number of earthquake occurrences in UB City has been increasing. Approximately 200 observations were made in 2005, but the number quadrupled in 2012 and tenfold in 2013. In 2021, 221 occurrences were observed.

According to the Project for Strengthening the Capacity of Seismic Disaster Risk Management in Ulaanbaatar City, Mongolia (2013), if a strong earthquake of M7.1 scale occurs in UB City, 48% of apartments and buildings in urban areas could collapse and result in 7,500 deaths, 81% of buildings in the Ger area could result to 38,060 deaths, about 7,600 buildings could catch fire, and the estimated total length of damages in water and sewerage systems is 259 km.

2) Flood

According to the Flood Risk Assessment (Flood Risk Assessment and Management Improvement Strategy, World Bank, 2015), 35 floods occurred in the period of about 100 years (1915 to 2013) around the UB City, and 60% occurred from 2000–2010. It is predicted that 26,784 people from 6696 households could be affected by a flood caused by a 100-year probability of rainfall.

Flood risk along the Tuul and Selbe River area, as well as in the Ger area expanding to the northern slope of UB City (Figure 3.77), is considered to be particularly high.

Flood discharge due to the 100-year probability of rainfall along the Tuul River is predicted to be 746 m^3/s upstream, 1,877 m^3/s near the Selbe and Dund River in UB City, 2,093 m^3/s near the Northern Zaisan, and 2,307 m^3/s near the Bukheg-Turgen River on the western side of Ulaanbaatar. The highest water level and the maximum speed of floods due to the 100-year probability rainfall are estimated to be 5.59 m and 3.07m/s, respectively, which would inundate 43,080 ha city area or 10% of the whole city area (Flood Risk Assessment and Management Improvement Strategy, WB, 2015).

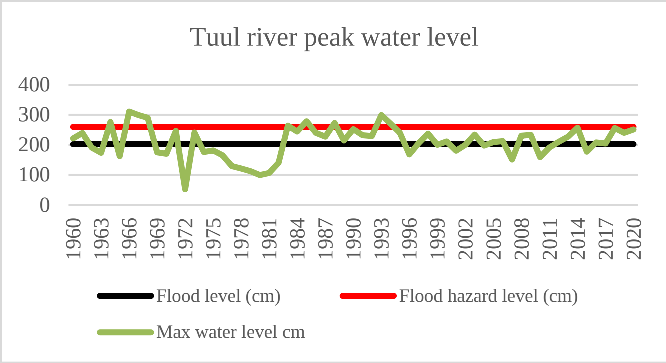
Source: UB City Geodesy and Water Facility Agency

Figure 3.77 UB City Flood hazard map

The biggest flood that occurred in UB City within the past 100 years was the 1966 flood. Due to the heavy rainfall that began on 10 July 1966, floods from the upstream of the Tuul River flowed into UB City on 12 July 1966, resulting in damage over a wide area of the city, mainly along the Tuul River. The flood destroyed the Uliastai bridge on the Tuul River, which swept away a bus full of passengers running on it and washed away houses around the Tuul and Dund Rivers, resulting in 1,302 deaths (https://medee.mn/ 2015).

Source:https:olloo.mn/ 2018

Figure 3.78 Flood Occurred in UB City, July 1966



Source: Natural Agency Meteorology and Environmental Monitoring

Figure 3.79 Highest Water Levels in Tuul River, 1960–2020

The Tuul-Ulaanbaatar monitoring station, which observes the water level of the Tuul River, has observed the annual water level (daily average) for the last 60 years. It reached the highest level in 1966.

In recent years, flood damage has become more frequent in UB City due to torrential rains and several days of rainfall. The heavy rains from 9 to 11 June 2021 caused damages to roads and pedestrian bridges and flooding of underpasses and underground buildings, mainly around the Selbe and Tuul River. Under such circumstances, it is indispensable to improve flood control facilities and manage to live in areas with high flood risk. 3,227 households live in high flood risk areas in UB city, 1,825 locations have inappropriate land ownership, and 60 locations unauthorized modification of flood facilities or building violations.

Source: JICA Study Team

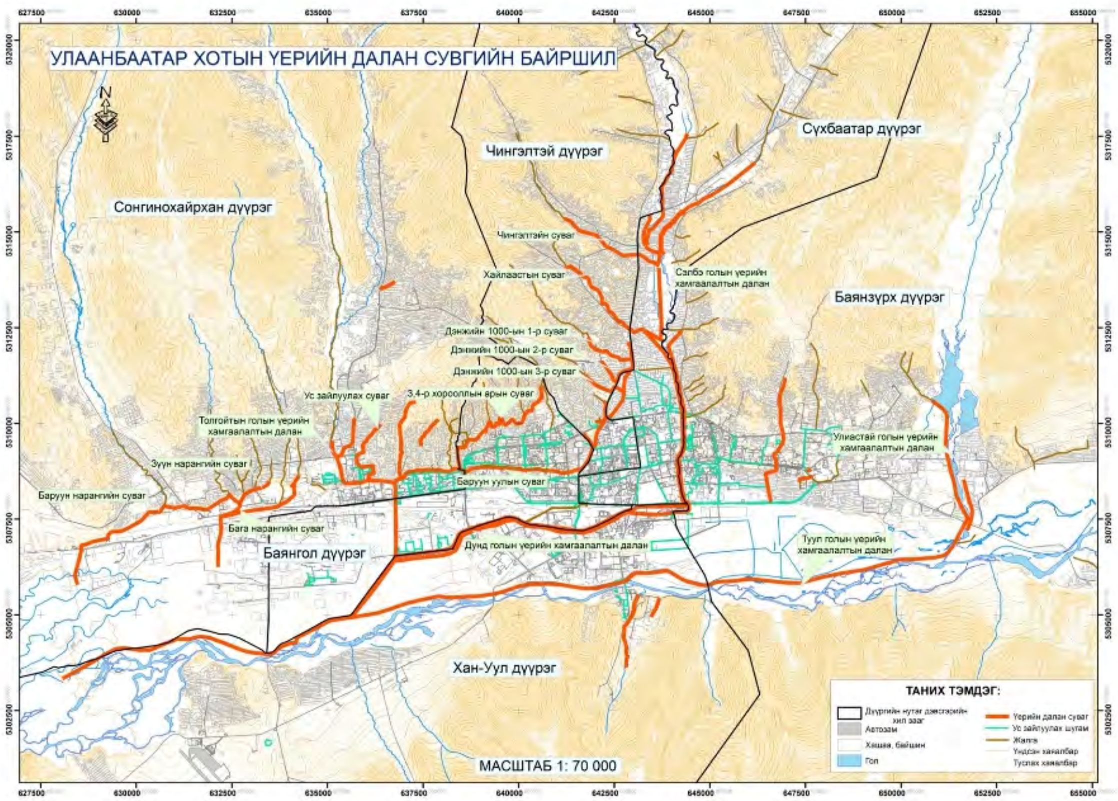
Near the Peace Bridge

Source: https://gogo.mn/r/v5l0l

Bayanmongol underpass

Figure 3.80 Flooding occured in June 2021

UB City has 148 km of flood control facilities (including 33 km of levees and flood channels), of which about 100 km (equivalent to 67%) was constructed in 1966–1987 and 48 km (33%) was between 1987 and 2020. More than half of them are aging. It is estimated that 136 km of new levee facilities will be constructed in addition to repairing the aging levees.



Source: UB City Geodesy and Water Facility Agency

Figure 3.81 Location map of flood levee facilities in UB City

(5) Air Pollution

Mongolia (46.6 μg/m^3) is ranked fourth after Bangladesh, Pakistan, and India in the country ranking of PM 2.5 concentration, and third after Delhi in India and Dhaka in Bangladesh in the capital ranking[22]. The UB City measures air pollutants (PM 10, PM 2.5, CO, SO_2, NO_2, and O_3) at 16 measuring stations and informed by agaar.mn. Ranges in air pollutants show that they are relatively low from April to October and tend to exceed the standard values from November to March, with the highest levels in December and January. The average daily maximum value of PM 2.5 in winter is 687 μg/m3, which is 27 times higher than the WHO guideline (25 μg/m^3). The average winter PM 2.5 is as high as 100-149 μg/m^3 between 2015 and 2019.

Figure 3.82 Levels of Winter Average and WHO Guidelines in PM 2.5 (2015–2019)

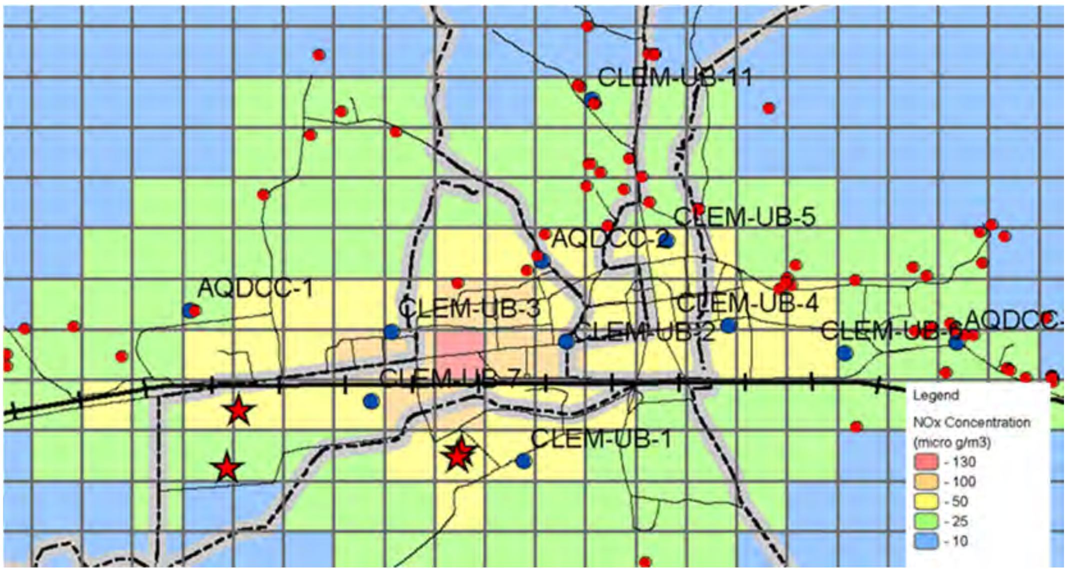
The main source of air pollution (as of 2016) is Ger district stoves (80%), followed by vehicles (10%). The increase rate of vehicles in recent years is 6.4–7.9% (2015–2019), of which 3% is used for 1–6 years, 16% for 7–9 years, and 77 % for 10 years or more[23], and the proportion of new vehicles is considerably smaller.

Due to the use of older vehicles, the growth of the urban population, and the increase in the number

[22] 2020 Global Air Quality Report (https://www.iqair.com/world-air-quality-report))
[23] Mongolian Statistic Information Service, http://www.1212.mn.

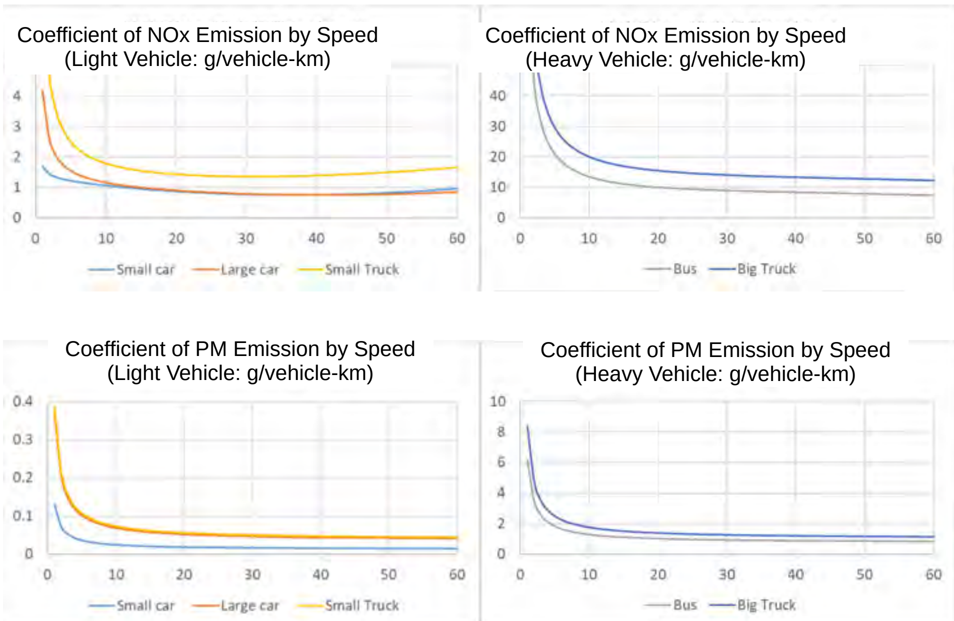
of vehicles, the exhaust gas problem continues to worsen. According to the results of exhaust gas concentration simulations conducted in 2016, Phase 2 of the Capacity Development Project for Air Pollution Control in UB City, emissions of harmful substances like NO_x and PM10 have been increasing because of the effects of slowdown caused by traffic congestion, resulting in significantly exceeding the acceptable environmental standards along the roadside. Health effects to residents along roadsides have also become a serious issue. Soil pollution caused by lead derived from exhaust gas and wastewater from gas stations and automobile maintenance factories is also considered a problem.

Emissions will increase rapidly if the travel speed falls below 10 km/h when stopping or departing at intersections, during traffic jams, etc. Therefore, raising the travel speed while alleviating traffic congestion can be expected to reduce the emission of air pollutants.



Source: Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 2

Figure 3.83 Concentration from Vehichle Emission Sources (NO_x)



Source: Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 2 (JICA; 2013–2017)

Figure 3.84 Coefficient of No_x and PM10 Emissions by Speed

(6) Noise problem

A detailed survey of noise damage in UB has not been conducted, and according to UBRD, the allowable noise range in urban areas is 60 decibels during the day and 45 decibels or less at night. But, in UB City, 80 to 90 decibels noise is generated due to automobiles, horns, construction machinery, etc. According to the survey of working conditions of traffic police officers in 2015, the average noise was 76.3 decibels. Due to the increase in the number of cars and poor manners of car drivers (such as honking the horn frequently), noise has a large impact on the daily lives of the citizens but is not a serious concern.

3.6.2 Policy on the natural environment of UB City Issues on the natural environment related to infrastructure development

Based on the above natural environmental conditions, it is necessary to plan while considering the following points regarding road infrastructure development in UB City.

(i) Since civil engineering work (outdoor work) is difficult in the midwinter, it is necessary to make a plan that can shorten the outdoor work as much as possible.

(ii) To giving consideration to the track system that can run stably in extremely cold regions, it is necessary to devise ways to comfortably operate public transportation, including buses, in cold environments.

(iii) When planning bridge structures, etc., it is necessary to introduce the latest seismic intensity knowledge and design with sufficient seismic capacity.

(iv) When constructing roads, bridges, etc. at the water source along the Tuul River, it is necessary to adopt a construction method that minimizes groundwater pollution. Especially when constructing bridge foundations, it is necessary to select a construction method that does not allow harmful substances to penetrate into groundwater.

(v) When planning a transportation infrastructure in the floodplain of the Tuul River, it is important to make a flood forecast by referring to past flood damage, etc., and to secure a sufficient water flow section.

4 Future Transport and Demand Forecast in UB City

Chapter 4 describes the future socio-economic indicators and transportation demand forecast of UB City. Based on this, the issues of urban transportation development discussed in Chapter 3 are rearranged, and the future transportation development policy is organized.

4.1 Socio-Economic Trends

4.1.1 Population and Urban Development Trends

UB City has been expanding in the past 20 years, especially in the northern and western ger areas. Since 2010, the Yarrmag area has been developed along with the expansion of the ger areas, especially in the west. The following figure shows the development of urbanization in UB City since 2000.

Source: JICA Study Team based on satellite images.

Figure 4.1 Urbanization in UB City

Looking at the city population, the annual growth rate is 1.6 times from 2000 to 2010 and 1.3 times from 2010 to 2020. The districts with higher growth rates than the entire UB City are Bayanzurkh, Khan-Uul, and Songinokhairkhan. Bayanzurkh and Khan-Uul districts, in particular, have experienced rapid growth from 2000 to 2010 and from 2010 to 2020, respectively, with a growth rate of 1.8 times (see (3) 4) of Chapter 3.1.3).

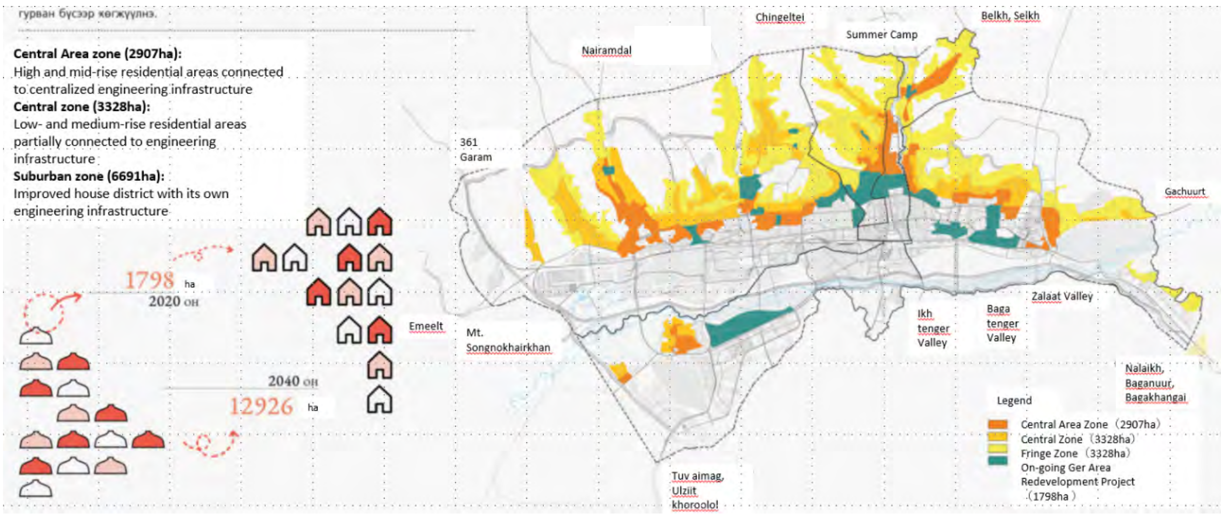
Table 4.1 Population of UB City by District

	Population			Increase Rate	
	2000	2010	2020	2010/2000	2020/2010
UB Total	749,427	1,161,785	1,499,140	155%	129%.
Khan Uul	70,442	112,055	195,927	159%	175%.
Baganuur	20,318	26,905	29,342	132%	109%
Bayanzurkh	144,712	265,997	367,679	184%	138%
Nalaikh	23,207	31,458	38,690	136%	123%
Sukhbaatar	92,224	136,917	144,616	148%	106%
Bayangol	137,507	185,104	231,517	135%	125%
Bagakhangai	3,486	3,647	4,463	105%	122%
Chingeltei	104,203	147,438	151,203	141%	103%
Songinokhairkhan	153,328	252,264	335,703	165%	133%
	Percentage in UB City				
UB Total	100.0	100.0	100.0		
Khan Uul	9.4	9.6	13.1		
Baganuur	2.7%	2.3%	2.0		
Bayanzurkh	19.3	22.9	24.5		
Nalaikh	3.1%	2.7%.	2.6		
Sukhbaatar	12.3	11.8	9.6		
Bayangol	18.3	15.9	15.4		
Bagakhangai	0.5	0.3	0.3		
Chingeltei	13.9	12.7%	10.1%		
Songinokhairkhan	20.5%	21.7	22.4		

Source: National Statistics Office (www.1212.mn)

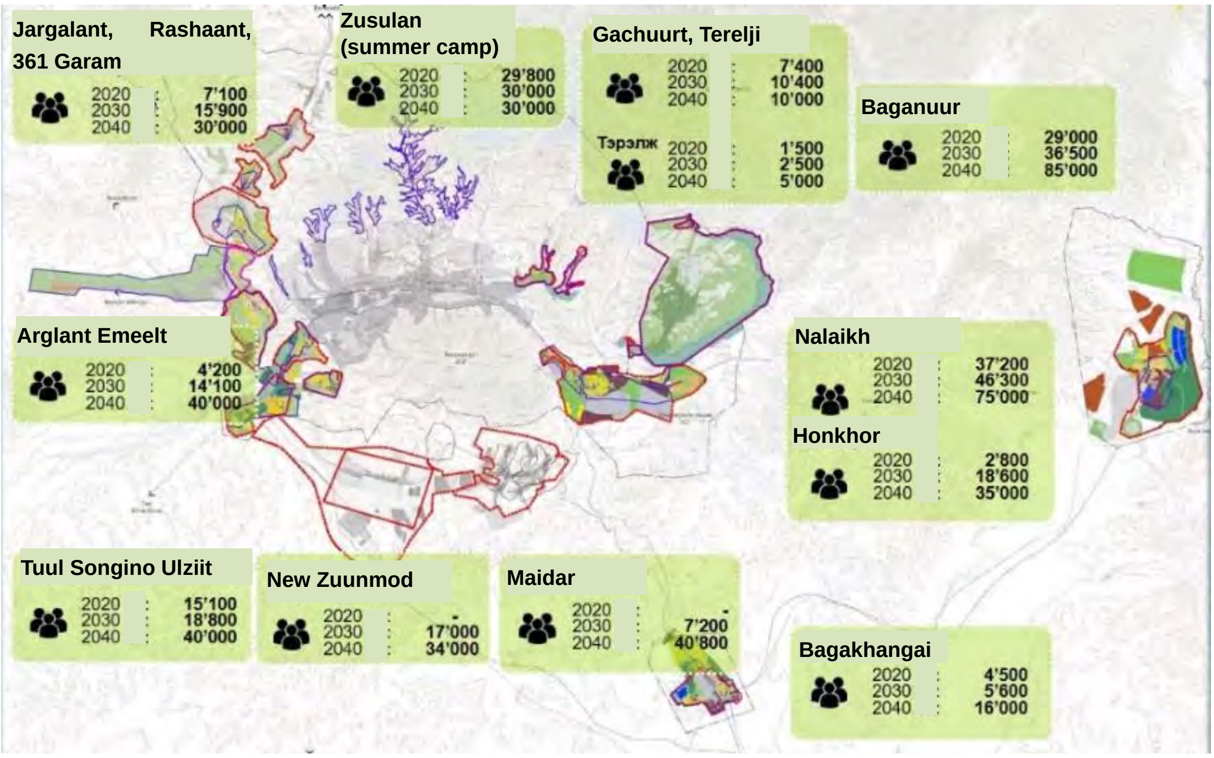
4.1.2 Development Scenarios in the Year 2040

As mentioned in Chapter 2, the development of UB City is to promote the construction of a multi-nuclear city through the development of sub-centers and the redevelopment of ger areas based on the MP2040. Likewise, it is to diversify industry and population by relocating urban functions to satellite cities and other areas outside the central six districts of UB. In the central six districts, the ger areas are planned to be converted into apartments mainly in the sub-center, along with the continuation of the Yarmag area development (see Figure 4.2). Based on Figure 4.3, satellite city development is expected to house about 440,000 people by 2040.



Source: JICA Study Team. Translation of draft MP2040.

Figure 4.2 Development Policy of the Ger Areas



Source: UPRI

Figure 4.3 Population Dispersal to Satellite Cities

4.1.3 Population Estimates in MP2040

The estimated population of UB City in 2040 based on MP2040 is 2,014,200 (excluding the total population of 74,800 of New Zuunmod and Maidar, which belong to Tuv aimag with 2,089,000 of the metropolitan area population). This is 134% of the resident population of 1,499,140[24] people in 2020.

Comparing the population estimates of 3,253,283 published by the National Statistics Office (NSO) in 2017 and the population estimates between 2021 and 2045 based on the 2015 population, the resident population of 2020 is almost in line with the estimated 99% of 3,279,404 people. On the other hand, the population of 1,499,140 of UB City is slightly lower at about 95% of the NSO estimate of 1,581,666 (48% of the national estimate). In 2040, the estimated population of 2,014,200 of MP2040 is 80% of the NSO's estimated population of 2,510,517 (56% of the national figure). It can be read that the city's population growth is expected to be suppressed in 2040 due to the implementation of policies.

[24] Resident population is the number of Mongolian citizens, foreigners, and people without nationality living in Mongolia for more than 6 months.

Table 4.2 Comparison of Future Population Estimates

	Mongolia		UB City	
	2020	**2040**	**2020**	**2040**
NSO Statistics (Actual)	3,253,283 (99% of NSO estimate)	–	1,499,140 (46% of the nation) (95% of NSO estimate)	–
MP2040 Assumed Population	–	–	–	2,014,200* (80% of NSO estimate)
National Statistics Office (NSO) Population estimates for 2021-2045	3,279,404	4,495,018	1,581,666 (48% of the nation)	2,510,517 (56% of the nation)

Note: Total population of New Zuunmod and Maidar in Tuv aimag (74,800 people) is excluded from the total population of the metropolitan area (2,089,000 people) in MP2040.

Source: JICA Study Team based on draft MP2040, renewed 2015–2045 population projection (National Statistics Office, 2017), www. 1212.mn

4.1.4 Organizing Economic Indicators

The GDP per capita of UB City has increased by 1844% in the last 20 years, from 884,900MNT in 2000 to 16,314,100MNT in 2020. The GDP per capita of UB City in 2020 was 1.4 times of GDP of Mongolia (11,612,900 MNT), but the ratio has shrunk since 2000. The following table summarizes the GDP per capita trend of UB City and Mongolia from 2000.

Table 4.3 Trends in GDP per Capita

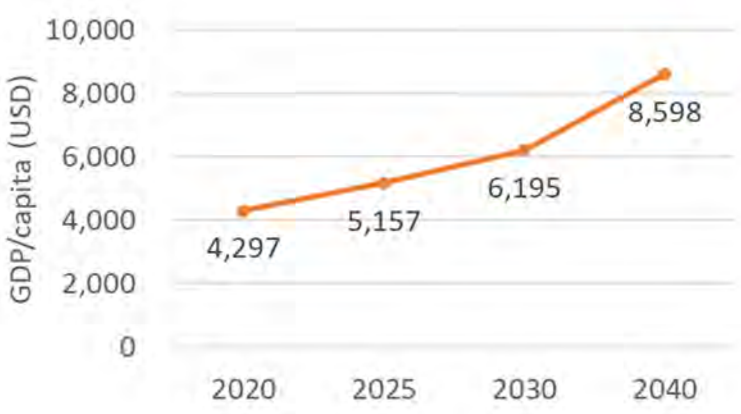
(Unit: 1,000 MNT)

Aimag	2000	2005	2010	2015	2020
Total	522.2	1,223.0	3,697.6	7,724.1	11,612.9
UB City	884.9	1,852.4	5,398.5	11,055.8	16,314.1

Source: 1212.mn

On the other hand, the GDP per capita of Mongolia is expected to double from USD 4,297 in 2000 to USD 8,598 in 2040.

	2020	2025	2030	2040
GDP/capita (USD)	4,297	5,157	6,195	8,598
percent	100%	120%	144%	200%



Source: USDA, Economic Research Service U.S. Department of Agriculture.

Figure 4.4 Forecast of GDP per Capita

4.1.5 Population Estimates Used in This Study

In order to estimate the population for transportation demand estimation, based on the policies and trends of urban development indicated in the previous sections, the following three development scenarios by 2040 are proposed: (i) Do Nothing Case, (ii) Subcenter Development Case, and (iii) Satellite City Development Case (see Table 4.4). Table 4.5 shows the results of the population estimates.

Table 4.4 Assumed Population Case

Expansion case	Assumptions
Do Nothing Case	The Do Nothing case in this study reflects a situation in which the population trend continues as it always has been. In other words, it is the case that assumes that the concentration of population will continue in the central part of Ulaanbaatar, where it is increasing while the population in rural areas and suburbs will continue declining since residence and development are in the outer reaches of the city. In UB City, as shown in the previous section, there are efforts to alleviate various urban problems by dispersing the population through a satellite urban development plan. But the plan cannot be implemented in the short-term, considering the cases in other countries, as it is necessary to create conditions for labor, living, infrastructure development, and industrial activities within the development area. This is a case that considers the fact that the project can be carried out, but the trend will not change to focus the population on the central part of UB City.
Sub-center Development Case	This case assumes that sub-center development successfully distributes the population as indicated in MP2040, but the population will not be dispersed to satellite cities.
Satellite City Development Case	This case assumes that sub-centers and satellite cities development is successfully implemented as indicated in MP2040 and that the population will disperse into satellite cities.

Source: JICA Study Team

Table 4.5 Night Time Population in Each Case

(000)	Past Trends		Do Nothing Case			Sub-center Concentration Case				Satellite City Development Case			
	2010	2020	2025	2030	2040	2025	2030	2035	2040	2025	2030	2035	2040
Khan Uul	112	196	252	309	358	251	306	337	351	256	293	300	312
Baganuur	27	29	30	30	31	30	30	31	31	33	36	69	85
Bayanzurkh	266	368	419	470	541	419	471	504	537	414	467	482	491
Nalaikh	31	39	42	45	48	41	43	45	46	44	49	64	80
Sukhbaatar	137	145	159	173	193	158	171	179	188	167	182	193	204
Bayangol	185	232	240	249	257	240	248	252	255	251	269	269	267
Bagakhangai	4	4	5	5	5	5	5	5	5	5	6	11	16
Chingeltei	147	151	159	166	173	160	169	177	185	152	153	150	146
Songinokhairkhan	252	336	378	420	484	380	424	457	490	357	388	402	414
UB City	1,162	1,499	1,683	1,867	2,090	1,683	1,867	1,987	2,090	1,683	1,867	1,987	2,090
Satellite cities (Tuv)	–	–	–	–	–	–	–	–	–	4	24	47	75
Khan Uul (%)	9.6	13.1	15.0	16.5	17.1	14.9	16.4	17.0	16.8	15.2	15.7	15.1	14.9
Baganuur (%)	2.3	2.0	1.8	1.6	1.5	1.8	1.6	1.5	1.5	2.0	2.0	3.5	4.1
Bayanzurkh (%)	22.9	24.5	24.9	25.2	25.9	24.9	25.2	25.4	25.7	24.6	25.0	24.2	23.5
Nalaikh (%)	2.7	2.6	2.5%	2.4	2.3	2.4	2.3	2.3	2.2	2.6	2.6	3.2	3.8
Sukhbaatar (%)	11.8	9.6	9.4	9.3	9.2	9.4	9.1	9.0	9.0	9.9	9.8	9.7	9.8
Bayangol (%)	15.9	15.4	14.3	13.3	12.3	14.2	13.3	12.7	12.2	14.9	14.4	13.5	12.8
Bagakhangai (%)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.6	0.8

(000)	Past Trends		Do Nothing Case			Sub-center Concentration Case				Satellite City Development Case			
	2010	2020	2025	2030	2040	2025	2030	2035	2040	2025	2030	2035	2040
Chingeltei (%)	12.7	10.1.	9.4	8.9	8.3	9.5	9.0	8.9	8.9	9.0	8.2	7.5	7.0
Songinokhairkhan (%)	21.7	22.4	22.4	22.5	23.1	22.6	22.7	23.0	23.5	21.2	20.8	20.3	19.8
UB City (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.8	98.7	97.6	96.4
Satellite cities (Tuv) (%)	–	–	–	–	–	–	–	–	–	0.2	1.3	2.4	3.6

Source: JICA Study Team

4.2 Traffic Demand Forecast

4.2.1 Necessity of Understanding Project Impacts and Forecasting the Demand

As described in Section 2.1, many comprehensive plans, including drastic plans, were suggested but not prioritized with the exception for a few, and the objectives or analytical results are not well defined. As a result, it has been tend to adopt and implement projects with relatively low costs, and dependent on higher-level decision making. In order to address this issue, National Traffic Congestion Management Committee was established in 2021, and also a forum was held to discuss projects at the National Committee with ministers from the central government. It is very important to prioritize and identify important projects to coordinate among the local government organizations since the establishment of the Ministry of Economic Development in January 2022 will increase the number of decision makers.

On the other hand, in UB City at present, there are several sections where the ratio of traffic volume to traffic capacity exceeds 3.0. Traffic congestion is estimated to become more serious in the future. If the project is implemented under these conditions, traffic can easily be detoured and focused on a new project. There are two aspects to consider. It will enable high-speed travel (a positive impact on the project) and increase access traffic around the new infrastructural development (which will generate new congestion). Therefore, it is necessary to analyze the effects of the project by considering both positive and negative impacts of the implementation and new congestion caused by increased access traffic to the rapid transportation infrastructure. If the implementation produces negative effects and worsens traffic congestion in particular areas yet the total benefit is positive, the project could still be recommended.

In order to calculate, understand, and compare these impacts, the demand forecasts to estimate future situation is the one of the methodology at this stage. By calculating the benefits obtained from these estimates and using them as effects, and comparing them among projects, it is possible to estimate project priorities and project synergies.

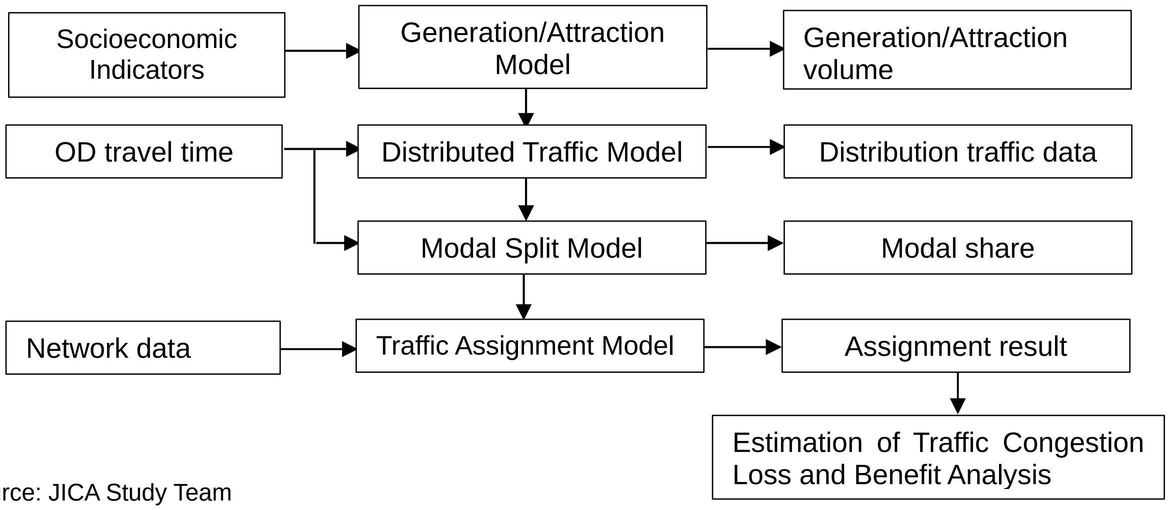
In this study, benefits, including reduction of time loss (opportunity loss), driving cost, and environmental cost, were estimated. The number of estimated benefits was almost the same level as the loss caused by traffic congestion. This makes it possible to analyze the level of reduction in traffic congestion caused by project implementation.

4.2.2 Demand Forecast Results

(1) Demand Forecast Method

In this study, the most common demand forecasting method, four-step modeling, was applied. The four-step modeling method is a traffic demand forecasting method consisting of four steps: (i) trip generation/attraction, (ii) distribution, (iii) modal split, and (iv) traffic assignment.

During this study, a huge number of people infected with COVID-19 increased in UB City, and traffic count surveys, including cordon line surveys, screen line surveys, and occupancy surveys, would not provide a reasonable volume. Existing traffic count surveys conducted in 2019 were used for the traffic count estimation model and verification of the result.



Source: JICA Study Team

Figure 4.5 Four-Step Estimation Method

1) Generation/Attraction Model

The generation/ attraction model estimates traffic volume by purpose based on the nighttime and daytime populations of socioeconomic indicators by Traffic Analysis Zone (TAZ) (Khooroo unit in this study). It is obtained by the method of least squares, and the equation and parameter explanatory variables are shown in Table 4.6. According to the table, each socioeconomic indicator is a parameter that determines how much trips increase with an additional one person, and the higher the coefficient, the greater the number of trips generated or attracted. In order to reduce the concentration of people in the city center, it is necessary to make the level of “to home” and other areas the same, and it is essential to develop not only housing in the suburbs but also to a well-functioning commercial district at the same time.

$$GA \quad = \alpha_1 \ \cdot Workers + \alpha_2 \ \cdot \mathrm{Students} + \alpha_3 \ \cdot \mathrm{Population} + \mathrm{Const}$$

Here.

GA_i^k Objective k, the amount of traffic generated or concentrated in zone i

$\alpha_1\ \alpha_2\ \alpha_3$: parameters of objective k

$Const$ Objective k, traffic generated in zone i

Table 4.6 Generation/Attraction Model Parameters

Trip Purpose	Generation			Attraction		
	Variables	Coefficient	t-value	Variables	Coefficient	t-value
To Home	Workers α_1	4.0712	23.0376	Population α_3	1.3710	16.5891
	Students α_2	0.4320	2.2568			
	Constant	47.1499		Constant	338	
	R	0.9404		R	0.8366	
To Work	Workers α_1	0.3864	6.8639	Workers α_1	2.1927	53.0193
	Constant	3425.6268		Constant	-1056	
	R	0.5342		R	0.9796	
To School	Students α_2	0.1662	3.8672	Students α_2	1.1991	59.7123
	Constant	2095		Constant	-282	
	R	0.3354		R	0.9839	
Business	Workers α_1	0.1964	12.8610	Workers α_1	0.3609	12.8610

Trip Purpose	Generation			Attraction		
	Variables	Coefficient	t-value	Variables	Coefficient	t-value
	Constant	-31		Constant	-31	
	R	0.6237		R	0.7640	
Private	Workers α_1	0.8877	8.6000	Workers α_1	2.8685	14.3844
	Students α_2	0.4734	4.2347	Students α_2	-0.1603	-0.7424
	Constant	4136.0871		Constant	679.7917	
	R	0.7952		R	0.8454	

Source: JICAStudy Team

2) Traffic Distribution Model

The traffic distribution model is a method to estimate traffic distribution according to travel time based on parameters estimated using traffic surveys and existing models. The traffic distribution was estimated for each trip purpose using parameters in Table 4.7. The larger the nighttime population in a zone is, or the larger the travel time between OD is, or the larger the “to home” trip is, the smaller OD traffic volume within or outside zones becomes.

$$\text{Intra OD traffic : } T_{ii}^{\mathrm{intra,k}} = \alpha_{\mathrm{k}} \cdot \mathrm{G_i^k} \cdot \beta_{\mathrm{k}} \cdot \mathrm{A_i^k} \cdot \delta\varepsilon_{\mathrm{k}} \cdot \mathrm{density_i}$$

$$\text{Inter OD traffic : } T_{ij}^{\mathrm{inter,k}} = \frac{\alpha_{\mathrm{k}} \cdot \mathrm{G_i^k} \cdot \beta_{\mathrm{k}} \cdot \mathrm{A_j^k}}{\gamma_{\mathrm{k}} \cdot \mathrm{D_{ij}}}$$

Here.

$T_{ii}^{intra,k}$:Objective k, intra traffic volume in zone i

$T_{ij}^{inter,k}$:Objective k, inter traffic volume in and out of zone i

$\alpha_{\mathrm{k}}\ \beta_{\mathrm{k}}\ \gamma_{\mathrm{k}}\ \delta_{\mathrm{k}}$:Parameters of objective k

G_i^k :Objective k, traffic generated in zone i

A_i^k :Objective k, traffic generated in zone i

$density_i$:Population density at night in zone i

D_{ij} :ODij travel time (hr)

Table 4.7 Traffic distribution model parameters

Trip Purpose	Variables	Intra (i=j)		Variables	Inter	
		Coefficient	t-value		Coefficient	t-value
To Home	Generation	0.6278	9.5585	Generation	0.7197	39.1888
	Attraction	0.3127	1.7951	Attraction	0.4466	13.4689
	PopDensity	0.1135	2.3626	Distance(km)	0.4054	19.1021
	Constant	0.6589		Constant	0.0006	
	R	0.6877		R	0.5016	
To Work	Generation	-0.0784	-0.4379	Generation	0.4321	12.3470
	Attraction	0.8148	14.4237	Attraction	0.5550	29.3624
	PopDensity	0.1816	2.7008	Distance(km)	0.2566	10.3308
	Constant	2.2156		Constant	0.0070	
	R	0.8193		R	0.4704	
To School	Generation	0.6101	4.4216	Generation	0.3376	6.6024
	Attraction	0.7652	12.8412	Attraction	0.5781	23.1037
	PopDensity	0.2517	4.4415	Distance(km)	0.3921	12.3871
	Constant	0.0400		Constant	0.0110	
	R	0.8316		R	0.4516	
Business	Generation	0.2532	1.8768	Generation	0.4308	8.7402

Trip Purpose	Variables	Intra (i=j)		Variables	Inter	
		Coefficient	t-value		Coefficient	t-value
	Attraction	0.5420	6.0469	Attraction	0.4681	13.5589
	PopDensity	0.3269	2.8524	Distance(km)	0.0510	1.1563
	Constant	0.7000		Constant	0.0660	
	R	0.5694		R	0.4293	
Private	Generation	-0.0441	-0.2473	Generation	0.4635	16.6691
	Attraction	0.8403	9.7128	Attraction	0.6330	30.7068
	PopDensity	0.0721	1.4799	Distance(km)	0.2939	14.6558
	Constant	2.4465		Constant	0.0017	
	R	0.7595		R	0.4601	

Source: JICA Study Team

3) Modal Split Model

The modal split model calculates the transportation mode between ODs based on the traffic survey results, using the following equation and parameters in Table 4.8. The longer the inter-OD distance and greater cost in terms of fare and travel time are, the smaller the share of either private or public transportation tends to be.

$$P_{\mathrm{ij}}^{\mathrm{m}} = \frac{\exp(V_{Pri})}{\exp(V_{Pri}) + \exp(V_{pub})}$$

$$V_{pri}^{ij} = \alpha_{pri} \cdot GC_{ij}^{pri}$$

$$V_{pri}^{ij} = \alpha_{pub} \cdot GC_{ij}^{pub} + \beta$$

P_{ij}^{m} : Proportion of OD ij, means m (=1: public transport, =2: private car, =3: pedestrian)

V_{Pri} :The utility value of means m and ODij

V_{pub} :The utility value of means m and ODij

$\alpha_{pri}\alpha_{pub}\beta$: Parameter

GC_{ij}^{pri} : generalized cost of private cars, OD ij

GC_{ij}^{pub} : generalized cost of public transport, OD ij

Table 4.8 Transportation Mode Sharing Model Parameters

Means of Transportation	Parameters	constant (e.g., in science)
private automobile	-5.228.E-05	-
public transportation	-1.579.E-04	3.876.E-01

Source: JICA Study Team

The generalized cost is calculated by the parameters and OD distance in Table 4.9.

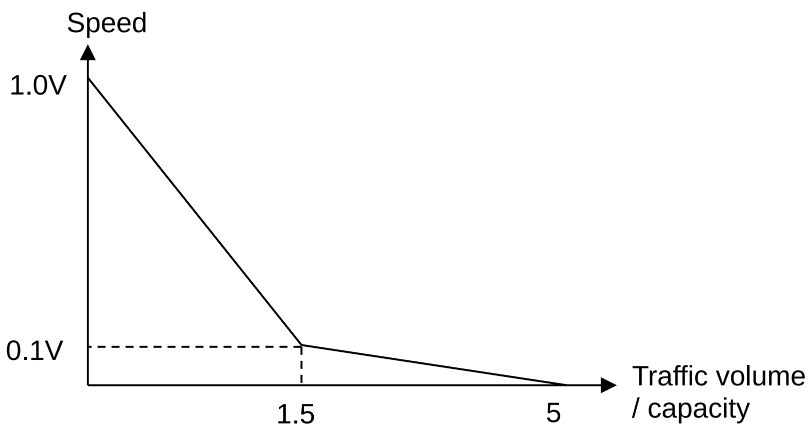
Table 4.9 Generalized cost calculation parameters

	Generalized cost (Tg)	
	Intercept (the point where a graph crosses one of the Cartesian coordinate axes)	Distance (km)
private automobile	586	395
public transportation	568	114

Source: JICA Study Team

4) Traffic Assignment Model

The traffic assignment model uses the incremental assignment method, which allocates OD traffic volume several times on the shortest route. In accordance with the allocated traffic volume, travel speed is calculated using a traffic volume-speed function, as shown in Figure 4.6. The traffic capacity was calculated from the basic traffic capacity about the HCM, considering UBRD2030, and the network conditions.



Source: JICA Study Team

Figure 4.6 Traffic Volume - Speed Diagram

Table 4.10 Fare Setting (current price)

	fare
Bus	500Tg
Urban railway	400Tg+100Tg/km
Electric bus	300Tg

Source: JICA Study team

5) Calculation of Benefits

The benefits are calculated by getting the difference in traffic volume before and after the project, as shown below.

Benefit of project = $TC_{without} - TC_{with}$

The traffic congestion cost TC is calculated by the following equation.

TC (*Traffic* Congestion Cost) =

Time Cost *TTC* + Driving Cost *VOC* + Environmental Cost *EV*

$$TTC = \sum_{m=\mathrm{Vtype}} \sum_{l=\mathrm{Link}} Q_l^m \cdot T_l^m \cdot \alpha$$

Here,
Q: Traffic volume of vehicle types on road links (vehicles/day)
T: Travel timeon road link (minutes)
α: Vehicle time cost (Tg/vehicle/minute) (see table below).

$$VOC = \sum_{m=\mathrm{Vtype}} \sum_{l=\mathrm{Link}} Q_l^m \cdot T_l^m \cdot \beta$$

Here,
Q: Traffic volume of vehicle types on road links (vehicles/day)
T: Travel distance (km) on road link
β: Running Cost (Tg/vehicle/km) (see table below).

EV =

$$\left\{\sum_{l=\mathrm{Link}} Q_l^{Public} \cdot T_l^{Public} \cdot C_{Nox}^{Public} \sum_{l=Link} Q_l^{private} \cdot T_l^{private} \cdot C_{Nox}^{private}\right\} \cdot U_{Nox} +$$
$$\left\{\sum_{l=\mathrm{Link}} Q_l^{Public} \cdot T_l^{Public} \cdot C_{CO2}^{Public} + \sum_{l=\mathrm{Link}} Q_l^{private} \cdot T_l^{private} \cdot C_{CO2}^{private}\right\} \cdot U_{CO2}$$

Here.

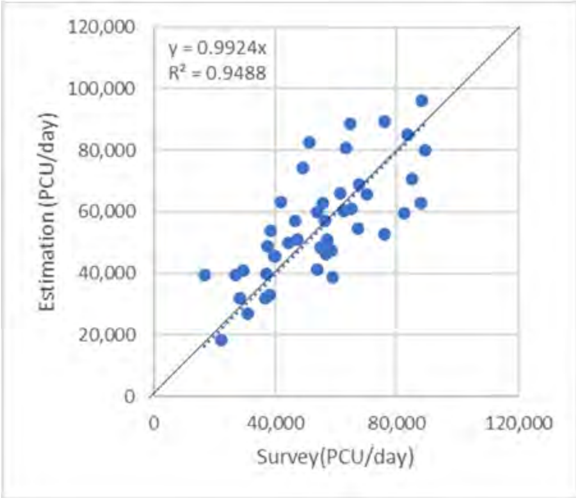
Q:	: Traffic volume of vehicle types on road links (vehicles/day)
T:	: Travel time on *road* link *l* (minutes)
$C_{nox/Private}$, $C_{nox/Public:}$	: Nox emission intensity by speed (Nox/km) in the right figure
$C_{CO2/Private}$, $C_{CO2/Public}$	: CO_2 emission intensity by speed (Nox/km) in the figure on the right
U_{CO2}	: CO_2 monetary equivalent (Tg/t) (see table below)
U_{Nox}	: No_x monetary equivalent (Tg/t) (see table below).

Table 4.11 Basic Unit for Benefit Calculation

Transport cost	Value
Time Value cost (Tg/min)	119.3
Running Cost (Tg/km)	98.1
CO_2 (Tg/t)	757,500
NO_x (Tg/t)	25,732,500

Source: Congestion Loss Calculation Data based UB City Investment and Development Planning Committee on Congestion Management.

Figure 4.7 shows the result of the current traffic volume. The coefficient of R square is above the value of 0.9, meaning the model has enough accuracy to check macroscopic traffic volume, compared with the traffic survey conducted in 2019.



Source: JICA Study Team

Figure 4.7 Calibration Rate in 2019

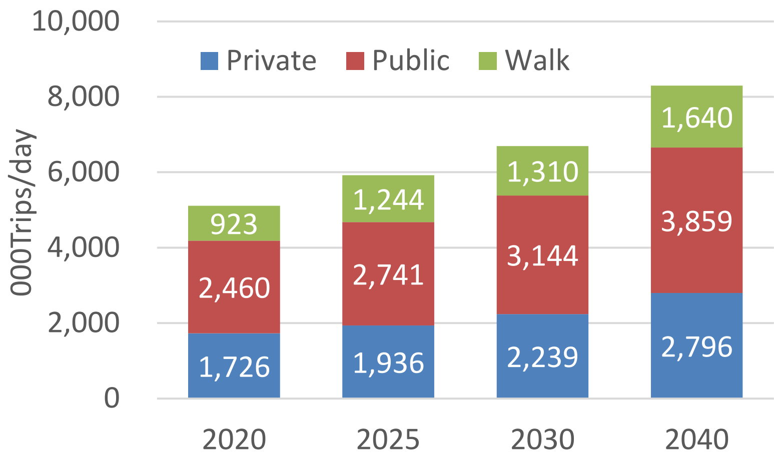
(2) Future Estimates

The number of trips in the future traffic estimates increased by 16% in 2025, 31% in 2030, and 62% in 2040, when 2020 was at 100%. In the future, an increase in the number of students, workers, and population concentration in UB City will be expected. The transportation sharing ratio, on average, will not change drastically in the future.

Table 4.12 Future Traffic Volume Estimates

	2020	2025	2030	2040
Population (000)	1,499	1,683	1,867	2,090
000 trips/day	5,109	5,920	6,692	8,295
trips (2020: 100%)	100%	116%	131%	162%
Trip rate	3.41	3.52	3.58	3.97

Source: JICA Study Team

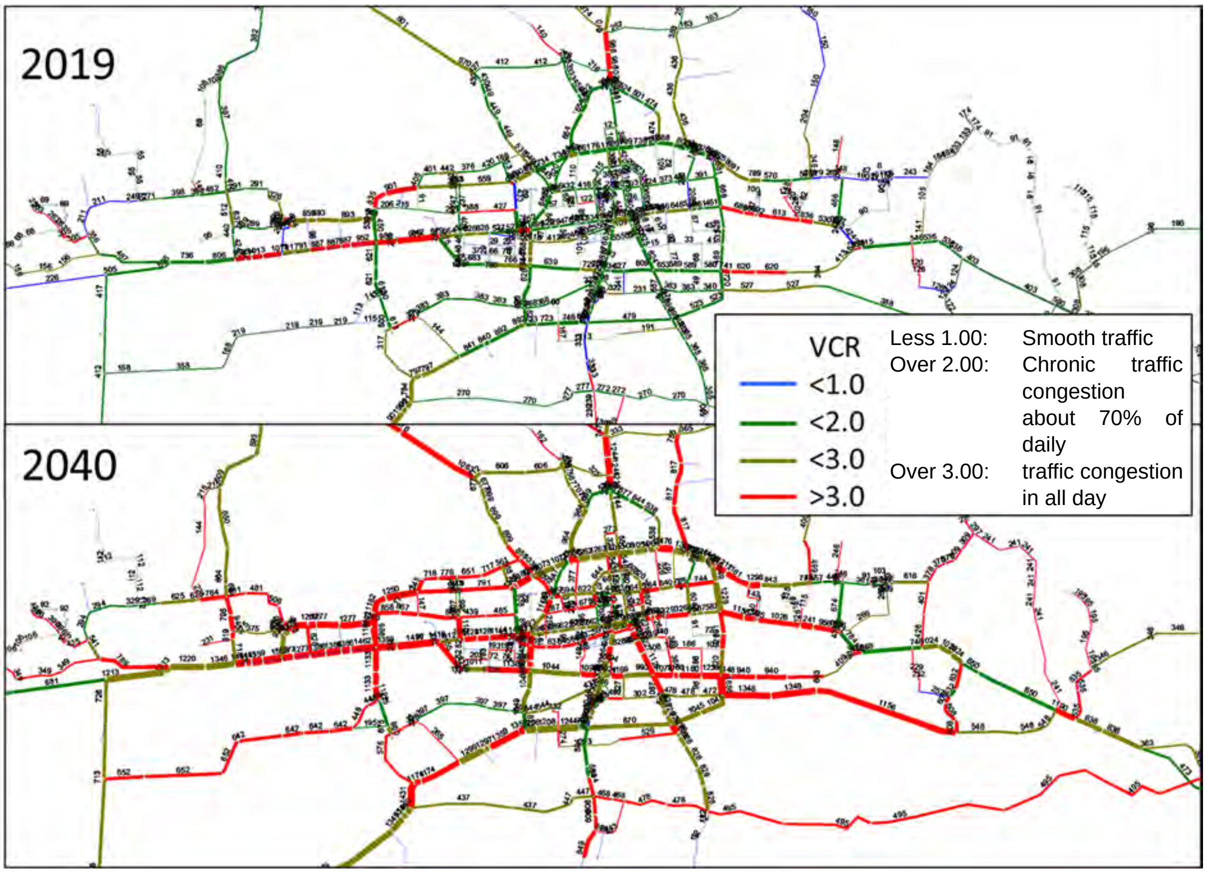


Source: JICA Study Team

Figure 4.8 Results of Future Traffic Volume Estimation

(3) Do Nothing case in 2040

The demand forecast results for years 2019 and 2040 in Do Nothing case are shown in Figure 4.9. The colors show the congestion level (VCR=traffic volume/traffic capacity). The figure shows that in 2019, congestion occurs all day mainly on Peace Avenue in red, or there are green sections between congestion levels from 1 to 2, where congestion continues for several hours a day. On the other hand, in 2040 and Do Nothing case, there are many red sections where the VCR is 3.0 or above, the traffic situation indicates a situation where the congestion occurs all day long. Therefore, in the future, it will be essential to have drastic easing traffic congestion projects, not only a short-term project focusing on traffic congestion in the near future.



Source: JICA Study Team

Figure 4.9 Demand Forecast Results in 2019 and 2040

4.3 Future Urban Transportation Development in UB City

4.3.1 Issues in the Future

As described in Chapter 3, traffic congestion has been getting increasingly serious in current UB City, which causes many problems. In particular, the number of cars owned is growing at an annual rate of 9.5%, but road maintenance is still progressing at a rate of 1.5%. Based on the estimation, UB City will face traffic congestion all day long in 2040 if transport plans are not implemented. On the other hand, even if traffic congestion measures are implemented, it will be difficult to solve the current serious traffic congestion, and although the implementation of the project will have a great effect, the effect may seem to be canceled out by the increasing future traffic volume.

The Mongolian government, UB City, and other international donors previously suggested several plans and comprehensive master plans for congestion countermeasures, but almost all projects were not implemented. For that reason, many urgent necessary projects to drastically improve the traffic situation have yet to be implemented, but only the small-scale projects with little effect have been implemented. Thus, the issue is how to implement the large project to ease congestion.

When countermeasure projects for traffic congestion are planned, if large-scale development is proposed, the progress might be delayed the same as before, and planning for large-scale projects also need much time to consider.

As described above, there are many issues necessary to be resolved for UB City, but the study focuses on the prioritized transportation projects because all projects have time and financial constraints. Therefore, the high priority issues are identified, and countermeasures are suggested. In this section, the priority issues are (i) traffic concentration, (ii) Increasing traffic congestion loss, (iii) Issues in terms of management and technology, and (iv) land constraints, financial resource constraints, and increasing traffic demand, are described below.

(1) Traffic Concentration

Traffic congestion has been getting more and more serious in UB City, particularly on Peace Avenue where the number of traffic volume or volume capacity is 3.3. Above 3 means the road is heavy all day and drastic measures are required. In addition, the Chinggis Road running through the north–south of the center of UB, shows 2.2 of a traffic volume/traffic capacity that needs to be addressed. In recent years, the development of the new city of Yarmag and the development of residential buildings in the suburbs have increased the traffic passing through the Chinggis Road, also, the lack of bridges crossing the Tuul river has intensified the concentration of traffic.

In the future, these conditions will worse if the expansion of suburbs ger, development of bedroom towns, concentration of the daytime population to city center as well as inadequate dispersion of the daytime population in sub-city center continue.

For the traffic concentration, the development of new roads can disperate concentrated traffic. New network of roads is desirable to efficiently ease the congestion by utilizing existing road capacity and cause smooth traffic even though access traffic around the facility is increased in the future.

In general, modal shift by mass transit is effective to ease traffic congestion. Currently, the existing public transportation in UB City is buses (buses, minibusses, trolleybuses), which requires improvements to encourage a modal shift from private to public transportation. In addition, improvements in the local railway system can be expected to significantly contribute to modal shift since road congestion does not affect the railway system.

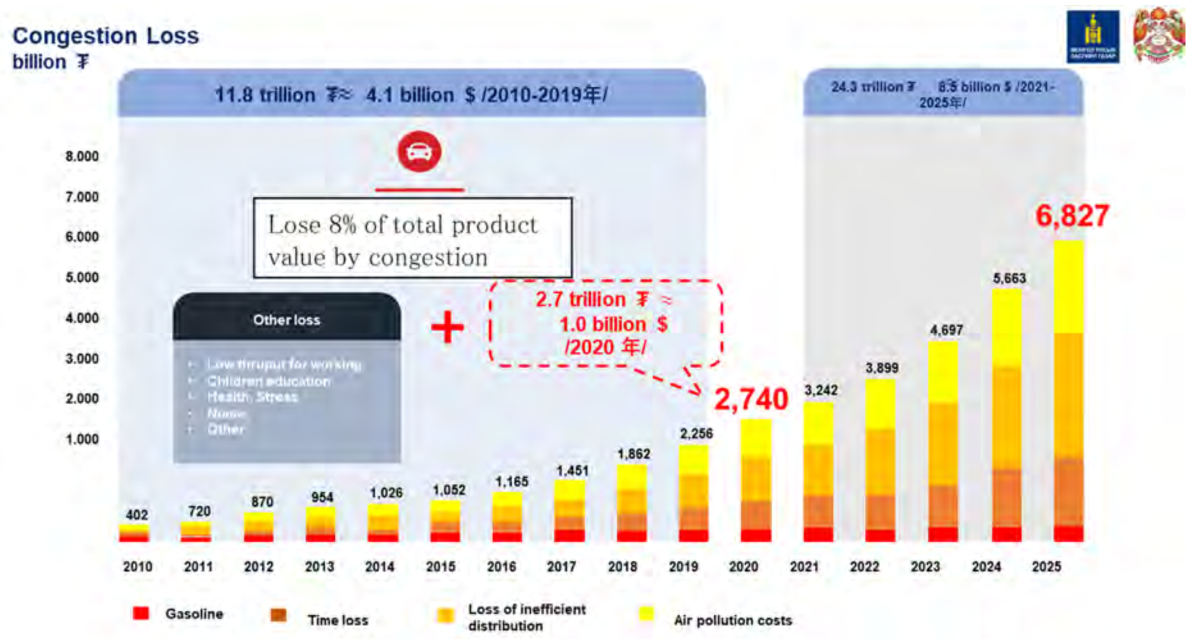
However, developments or updates focusing on one side between the public transport and private traffic will not largely contribute to ease of traffic congestion. Because the level of future congestion is often very high, more than three, cars are likely to detour to reach their destinations faster. Therefore, when the infrastructure is developed in this situation, the traffic will use new infrastructure which causes new traffic congestion. For example, if an interchange is built at the intersection of major roads, new congestion will occur from that point. For this, a basic policy is to plan the infrastructure considering the impact of the combination of the projects including both public transportatioin and road developments. In addition, public transportation development should focus on not only the railway development but also bus transportation facility development and bus service improvement. Because, as decribed in 3.2.2, the use of buses continously is necessary after railway development, the bus service should be improved as a terminal transportation, and if the railway development is delayed, bus transportation services become to be more important.

(2) Increased Traffic Congestion Losses

In UB City, the increase in losses from traffic congestion is a concern. The loss was calculated by UB City, and the calculation is composed of time cost (opportunity loss), vehicle operating cost, and environmental cost. Considering such generalized costs as policy outcomes has the advantage of clarifying and standardizing issues on a government policy that public and private organizations and citizens should discuss, which advances the discussion level by one more step.

According to UB City records, traffic congestion losses were as much as 270 million Tg/day in 2019, subject to double to 750 million Tg/day by 2025. In reality, life patterns may change, and the loss may be different from the estimate. However, based on this assumption, for example, the current travel time of 30 to 60 minutes will become 83 to 166 minutes by 2040. This means that the labor productivity, quality of life, and quality of learning are significantly impaired, which in turn will collapse the citizens' lives. If UB City, having a population that is half of Mongolia, does not have the unifying power, problems in various fields, such as industry, livelihood, academics, consumption, employment, and the environment, may occur, and the country's strength could be reduced.

Based on the above viewpoint, the most important issue is reducing traffic congestion loss to ensure sustainable development in the long future.



Source: The plan of the Investment and Development Planning Committee for Traffic Congestion Management in UB City, 19 May 2021

Figure 4.10 Congestion Loss (UB city)

(3) Management and technical issues

As mentioned in Chapter 3, UB City lacks adequate parking lot operation, public transportation planning and management, traffic policing, intersection geometry design, maintenance, and traffic operation. Since these management and technical issues require specialized knowledge, it is difficult for the public to point out the issues. Given the past background of Mongolia, the resolution of these issues tends to be delayed. For UB City to truly grow, the city must have the ability to clarify issues in terms of management and technology with the perspective of outside experts and solve these issues autonomously by strengthening its capacity to achieve sustainable development. The major issues listed in Table 4.13 were identified in terms of management and technical aspects.

Table 4.13 Management and Technical Issues

Issue	Description
Parking lot management	The capacity of parking lots in the city center is low, and traffic congestion caused by vehicles waiting to enter the parking lots on the roads at the entrances and exits is causing road blockages, which in turn is causing new traffic congestion.
Geometric Design	There are intersections where the number of lanes decreases before and after passing

Issue	Description
Technology	through an intersection, creating a bottleneck at the intersection, which intensifies the traffic congestion.
Traffic control and traffic monitoring	Traffic is monitored, but the transition of monitoring traffic to changing signal timing is not smooth. Due to manual traffic control, the control system is not efficient.
traffic control	Traffic enforcement regulatory power is low, and there is not much enforcement power for high-income earners. Enforcement is needed mainly in bus lanes, parking at bus stops, and illegal parking.
Traffic Manners	There is a lack of legal compliance among drivers as a whole, and rough driving, obstructing traffic of other vehicles on narrow roads, and illegal parking are rampant.
Public transportation planning	There is a tendency for bus routes to become longer and longer, resulting in less frequent service. Few routes reach the Ger area. User monitoring is insufficient and not reflected in the plan. There is no perspective on the use of transportation nodes and public transport-oriented development, resulting in low service rates.
Public Transportation Management	Bus cards do not work, and many passengers ride without paying. Subsidies are increasing, which may lead to operational failure in the future. The gap between the fare level and the track plan will be high.
Urban drainage facility planning, maintenance and management technology	Inadequate flood prevention provision through urban drainage planning and maintenance capacity. In many cases, the damage caused by floods is prolonged. In addition, there is insufficient maintenance and management technology to maintain the function of transportation facilities.

Source: JICA Study Team

(4) Land Constraints, Financial Resource Constraints, and Increasing Transportation Demand

In UB City, the rapid economic growth that began around 2005 led to a growth in private sector activities and a development of mid- to high-rise buildings. The currency crisis which begun in 2014 put a temporary hold to this growth but residential buildings are now sprouting up in the southwestern suburbs of UB City, as seen from the city center, and this area has been drawn attention as a future transportation problem area.

On the contrary, in the center of the city, outdated facilities are being redeveloped, but there is a tendency of selling off public land to the private sector. Hence, public land is becoming scarce. There are also many sites for universities and vocational schools, and even with proposals to relocate these sites, the current progress is slow. The sale of public land reduces the potential for effective use of public land, especially in the city center, in terms of the development of public transportation facilities and large-scale public transportation facilities, and the potential for integrated development of multi-modal facilities and TOD-related public transportation facilities. The difficulty of developing a public transportation system that does not get caught up in traffic congestion tends to result in a city with slower growth. Currently, the lands sold to the private sector usually have mid- to high-rise buildings, and it is almost impossible to buy those back. It takes about half a century to acquire those lands, but by then, those lands become obsolete. On the other hand, in new residential development areas in the suburbs, land constraints are not yet as severe that the main highways are relatively wide. Some sections of the current highways in the Yarmag area, however, are already congested. At the stage of developing a public transportation system, there is a slight shortage of land for low-cost development. Currently, not enough land is available for low-cost public transportation system development.

The comprehensive plans with financial support proposed in Chapter 2 have not been implemented, and many plans have not yet received a budget. In particular, when UB City proposes a plan, the National Assembly still has to approve the budget, which takes time. It is also likely approval will not be granted. In addition, there are cases where the government has secured financial resources for a project, but the project is implemented without sufficient research and analysis, and it has to be suspended or its contract canceled midway.

Despite the land and financial constraints described, the number of cars in the country is increasing by 9.5% per year, as shown in Chapter 3, and traffic congestion is worsening due to the overwhelming lack of infrastructure development.

4.3.2 Urban Transport Development Policy

In order to solve the major issues presented in the previous section, i.e., (i) traffic concentration, (ii) increase in traffic congestion loss, (iii) issues in terms of management and technology, and (iv) land constraints, financial resources, and increasing traffic demand, managing traffic congestion through efficient infrastructure investment, an evaluation method that considers the balance between the amount of investment and the amount of effect, and traffic congestion loss is essential. This requires evaluation methods; therefore, the following perspectives are necessary for urban transportation development.

(1) Traffic Decentralization, Public Transportation Conversion

As mentioned, this requires road improvement projects that enable traffic decentralization and a shift to public transportation. It is also important to strengthen the road network by resolving issues, such as missing links and intersection bottlenecks as mentioned in Chapter 3, improve bus services, fundamentally improve public transportation such as railways, and strengthen traffic management.

(2) Monitoring and Evaluation of Traffic Congestion Loss

Evaluating the effect of the project by considering the time cost, driving cost, and environmental cost, such as the calculation of traffic congestion loss by UB City, is recommended so the overall and average effect can be grasped with objective figures, rather than measuring the effect only by discussion. For this purpose, it is recommended to use evaluation tools (demand forecasting and cost-benefit analysis), as well as prioritize the evaluation with social and environmental considerations and implementation capacity.

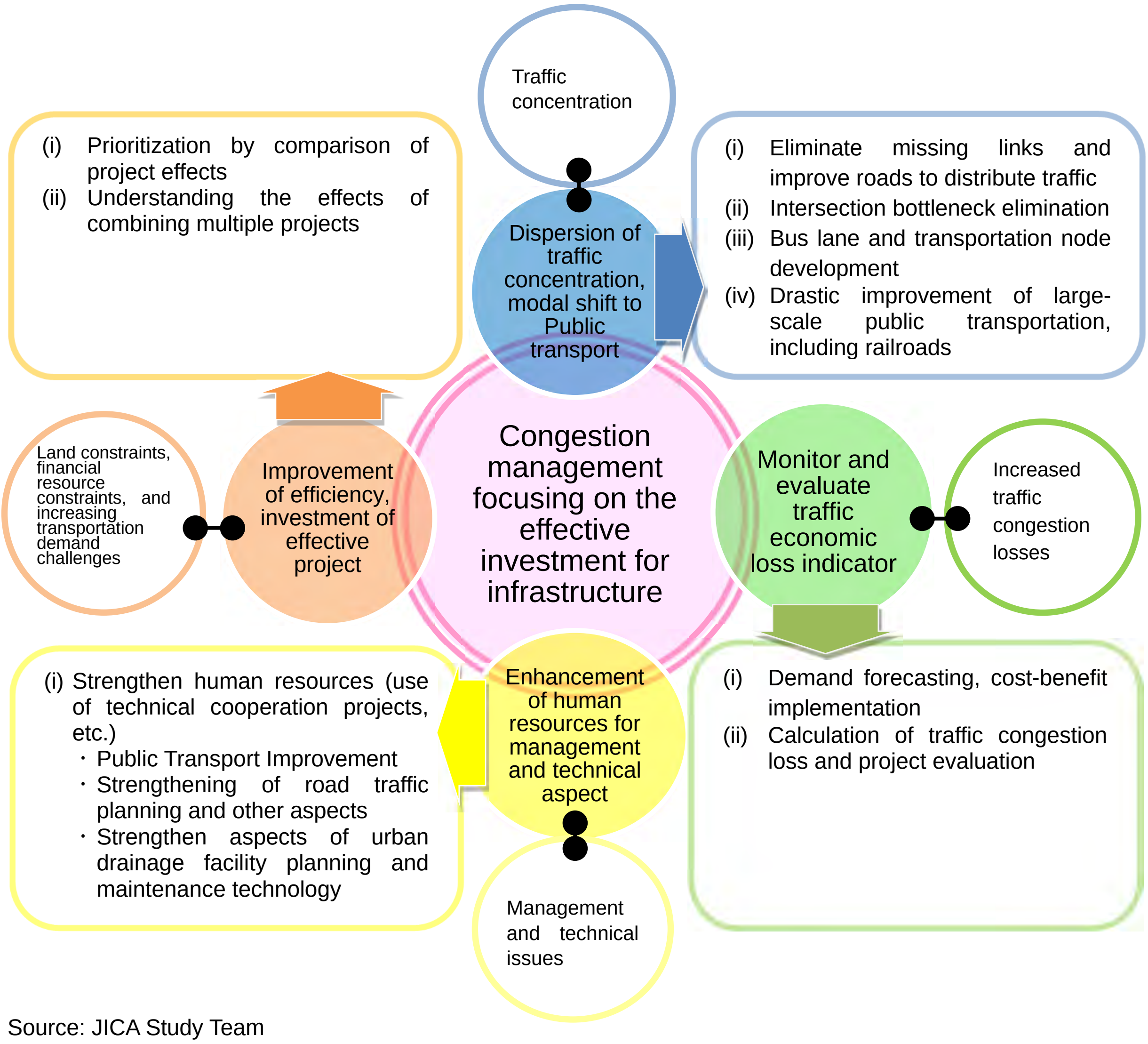
(3) Strengthen Human Resource Capacity in terms of Management and Technology

In addition, due to the management and technical challenges in the transportation sector, capacity building can be done simultaneously to increase the traffic capacity of intersections and existing roads, and to deter private traffic growth by improving bus services. This can be done through the use of JICA's technical cooperation projects.

(4) Improvement of efficiency, investment of effective project

In order to deal with constraints on financial resources and land and the increasing demand for transportation, it is necessary to improve the efficiency of projects and concentrate investment in highly-effective projects. If only a single project is considered for implementation, there is no prioritization in the area of effectiveness, and efficient infrastructure investment cannot be made. For this reason, prioritization through comparison of project effects is necessary. In addition, rather than using a single project evaluation, the combined effects of other projects should be taken into account in the calculation to concentrate investment in highly effective project groups.

By strengthening the above measures, it will be possible to reduce the amount of infrastructure development with the improvements of existing infrastructure and public transport services, while at the same time concentrating investment in new road and public transport infrastructure development that can be expected to have an effect of synergy, thereby steadily dispersing the concentration of road traffic and reducing the amount of traffic congestion related losses. It is possible to steadily disperse road traffic concentration and reduce traffic congestion losses.
The following Figure 4.11 is a concise representation of the urban transportation development policy.



Source: JICA Study Team

Figure 4.11 Urban Transport Development Policy

4.4 A Proposal for the Ideal Urban Transport System in UB City

In accordance with the urban transportation development policy outlined in the previous section, the following specific directions are outlined: (i) traffic dispersion and public transportation conversion, (ii) monitoring and evaluation of traffic congestion loss, (iii) enhancement of human resource capacity in terms of management and technology, and (iv) concentrated investment in highly effective projects. The following proposes the ideal form of urban transportation.

4.4.1 Traffic Dispersion and Public Transportation Conversion

(1) Eliminate Missing Links and Improve Roads for Decentralization

While the significant increase in traffic volume expected in the future, the traffic movement originating from the sub-center located in the South-Western part of UB City, the logistics and passengers movement due to the development around the new airport, and the expansion of industry and logistics in the western part of UB City are expected to have significant growth. Therefore, it is important to develop the secondary arterial roads to complement the existing primary arterial roads and distribute the traffic volume.

1) Traffic in the East–West direction

Peace Avenue and Chinggis Avenue cater to the East-West traffic in UB City, and these roads have already exceeded their traffic capacity. Therefore, it is necessary to develop a secondary arterial road to supplement the East-West axis to meet future traffic demand. This East-West direction movement is 290,000 vehicles/day (21,000 vehicles/day/lane) in the western part of UB City and 210,000 vehicles/day (12,000 vehicles/day/lane) in the eastern part of UB City. The traffic capacity shortage of existing roads is crucial particularly in the western part of UB City.

Table 4.14 Total Number of Vehicle Movements in the East-West Direction

	No. of Lanes		Year 2019 (Vehicle/Day)		Year 2030 (Vehicle /day)	
	W	E	Western of UBC	Eastern of UBC	Western of UBC	Eastern of UBC
Chinggis Ave.	6	-	90,100	-	99,700	-
Da Hupee Ave.	-	4	-	26,900	-	37,100
Power Plant Road	2	-	21,900	-	41,300	
Peace Ave.	6	6	88,700	61,300	107,100	67400
Ard Aysh Road	4		89,300	-	111,800	
Narny Road	-	4	-	62,000	-	69,100
Hunnu Street	-	2	-	52,700	-	81,400
Sky Resort Road	-	2	-	18,100	-	18,800
Total Traffic Volume	14	18	290,000 (1.000)	221,000 (1.000)	359,900 (1.241)	273,800 (1.238)
Traffic per lane			20,714	12,228	25,707	15,211

Source: JICA Study Team

2) Traffic in the North–South Direction

As for traffic in the North-South direction, the number of vehicles moving across the Tuul River is 118,500 vehicles/day (11,850 vehicles/day/lane), and the number of vehicles crossing the railway, which divides the area of UB City into North and South, is 383,200 vehicle/day (13,686 vehicles/day/lane), which exceeds the existing road lane capacity. Also, the lines crossing the railway have many safety issues, such as bridges with insufficient load-bearing capacity and crossing railways at grade, which requires radical improvement.

Table 4.15 Total Number of Vehicle Movements in the North-South Direction Across the Tuul River.

	No. of Lanes	2019 (Vehicle/day)	2030 (Vehicle/day)	Remarks
Sonsgolon Bridge	4	41,400	57,300	
Yarmag Bridge	6	78,400	103,600	
Zaisan Bridge	2	33,300	63,700	There is a plan to widen the lane.
Ikh Tenger Bridge	4	36,500	52,600	
Total	16	189,600 (1.000)	277,200 (1.462)	
Traffic volume per lane		11,850	17,325	

Source: JICA Study Team

Table 4.16 Total Number of Vehicle Movements on Bridges Crossing the Railway.

	No. of Lanes	2019 (Vehicle/day)	2030 (Vehicle/day)	Remarks
Sonsgolon-Tolgoit Plane Crossing	4	50,500	81,300	China Underpass Project
Gurvaljin Bridge	6	62,100	83,200	2012Yearly renovation
Narni Bridge	4	62,500	81,500	Japan free of charge
Peace Bridge	4	66,300	89,200	10T load regulation
Underpass aside of Peace Bridge	2	14,100	28,100	No passage for large vehicles
FO in front of Police Station	4	55,700	71,800	China loan
At grade railway crossing in front of Narantuul Zaha	4	72,000	73,300	China Underpass Project
Total	28	383,200 (1.000)	508,400 (1.327)	
1traffic volume per lane		13,686	18,157	

Source: JICA Study Team

In light of this situation, the UBMP 2040 and the UB Municipal Congestion Management Committee have already planned the development of new bypass road connecting the UB city in the East-West direction, connecting the missing links of existing arterial roads, and strengthening the North-South connectivity crossing the Tuul River and railway. It can be deemed that necessary concepts have been proposed towards a reasonable direction (see Figure 4.12). However, all of them have many issues related to land expropriation; therefore, early establishment of ROW and well-scheduled and steady land expropriation are necessary to realize these projects. Particularly, the East-West and North-South arterial roads in the southern part of Peace Avenue, which mainly consist of secondary arterial roads, have been gradually becoming difficult to acquire the land (ROW) for road construction due to the expansion of urban areas. Therefore it is important to prepare for and start construction of each project as early as possible.

Source: Prepared by JICA Study Team based on UBMP2040

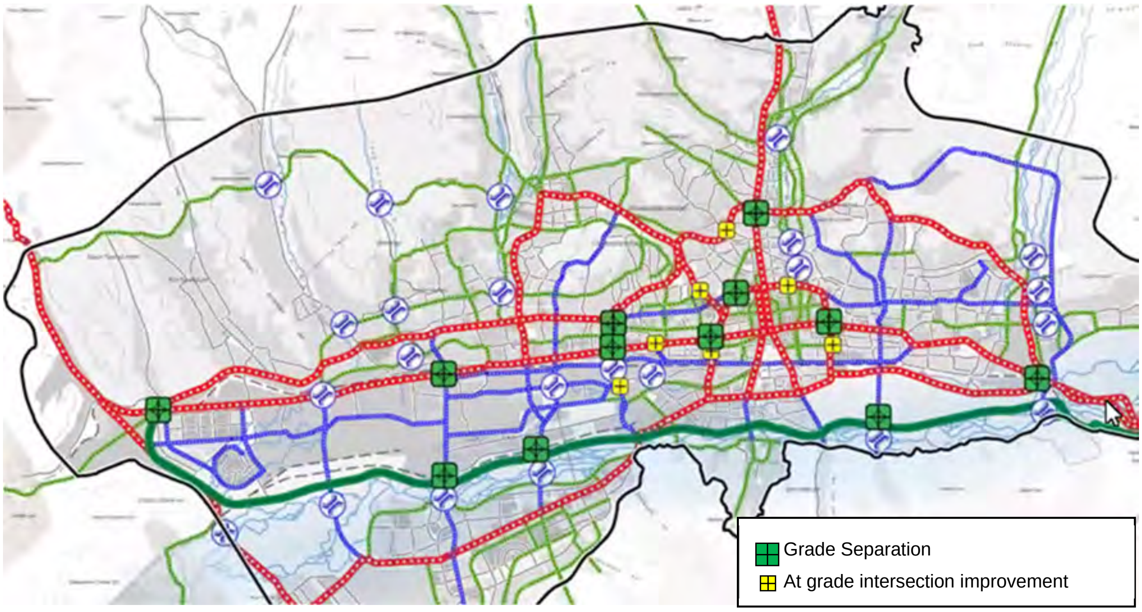
Figure 4.12 Arterial Roads in UB City Development Plan

(2) Elimination of Intersection Bottleneck

Many of the intersections in UB City have already exceeded their capacity for traffic control, resulting in extremely long waiting times for traffic signals. These conditions have spurred an increase in the amounts of harmful substances (NOx, SOx, etc.[25]) from vehicle emissions, leading to an increase in the concentration of air pollution near intersections. Although there are problems with signal control and traffic manners such as ignoring traffic signals, it is necessary to greatly enhance the low capacity of traffic control at intersections by means of grade-separation. In particular, it is recommended that intersections of primary arterial road and secondary arterial roads facing heavy traffic volumes should be improved by grade-separation sequentially, as the impact of eliminating the bottleneck along the arterial roads by grade-separation will be significant. The major intersections selected by MP2040 (seeFigure 4.12) have high traffic volumes and were estimated the lowest LOS (F) (see 3.4.3), so it is necessary to improve them on a priority basis through the grade separation.

On the other hand, at normal intersections other than arterial roads crossings, it is considered necessary to enhance capacity by the installation of dedicated left-turn lanes and appropriate signal control. The National Committee has proposed (see Figure 4.13) 7 priority intersections to be improved at grade, while the Committee of UB City has proposed 25 locations. Since grade separated intersection projects are expensive in terms of high construction costs as well as social cost due to traffic control during construction, and also have a significant impact on the landscape of urban area, it can be deemed that UB City's development policy to sequentially improving efficiency of at grade intersections is technically and economically reasonable.

[25] Toxic substances contained in vehicle exhaust: SOx: Sulfur oxide, NOx: Nitrogen oxide.



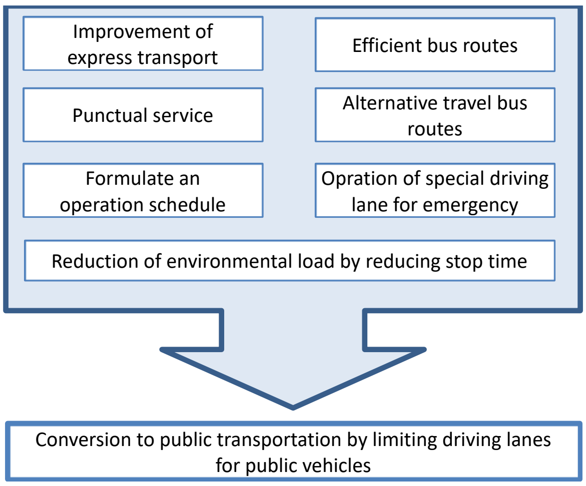
Source: UBMP2040

Figure 4.13 Priority Intersections to be improved

(3) Bus Priority or Exclusive Lanes and Traffic Node Development

1) Bus Priority / Exclusive Lane

Figure 4.14 shows the strength of a bus priority or exclusive lane. By introducing these lanes, it is expected to secure the express delivery and punctuality, which are the current issues in UB City. In addition, by implementing combination of policies for traffic demand management and promotion of the bus utlization, the use of private cars will be restrained and it will be possible to convert the private cars to public transportation.



Source: JICA Study Team

Figure 4.14 Benefits of Bus Priority and Exclusive Lanes

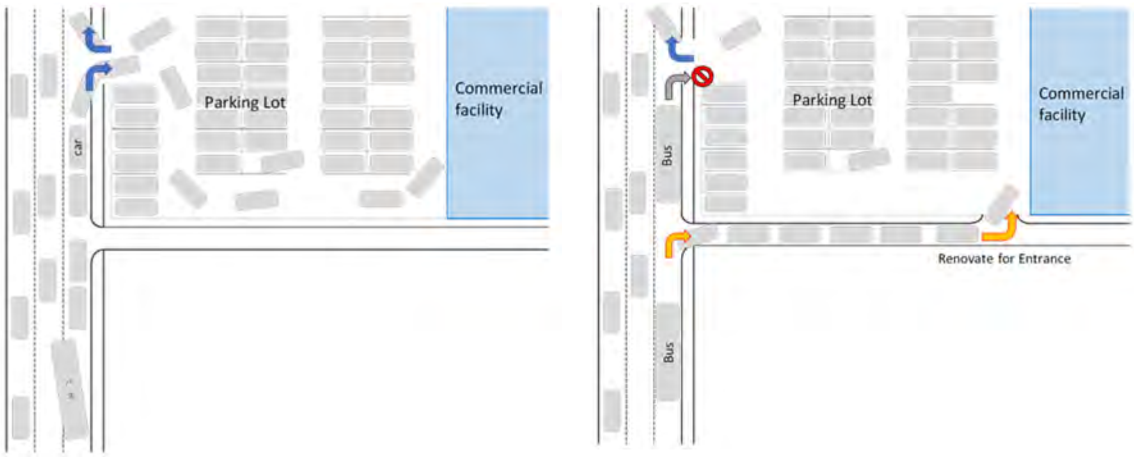
In UB City, there is currently a bus priority lane on part of Peace Avenue (this is referred to as a "priority lane" because Private cars that turn right can enter and drive). As for the road facilities, a solid white line is usually drawn between the bus priority lane and private car driving lane and reflective road studs are installed in some places. Surveillance cameras are also installed, although some parts are not functioning due to failures. In a situation where there is no traffic congestion, private cars are rarely used, but when there is, private car drivers entering and driving in the bus priority lane is commonly seen. As a result, express delivery is gone and arrival at the destination is delayed from the schedule, resulting in loss of punctuality, which also affects the passage of emergency vehicles, such as ambulances.

Promoting bus lanes in UB City to improve the speed and punctuality of bus operations is necessary, but without the understanding of private car drivers, no matter how much maintenance is done, it cannot play its original role. Therefore, it is important to restore the original functions of the bus lane by improving the driving environment in the existing bus lane on Peace Avenue as a preliminary step to the new bus lane development.

One is to strengthen police crackdowns on bus lanes. The police publicize the role and significance of bus lanes for private car users, raise awareness that public transportation is prioritized, and promote compliance with traffic rules. Through such actions, it may be possible to prevent private cars from unnecessarily entering the bus lane even when there is traffic congestion. In addition, some broken surveillance cameras should be fixed and maintained to strengthen the crackdown.

The other is to propose the redevelopment of parking lot entrances and exits in commercial facilities. Along Peace Avenue, there are many commercial facilities and many people come by private car, mostly on weekends. Therefore, the parking lot becomes saturated, and a line of private cars waiting to enter the facility go on the bus priority lane. Bus operations are obstructed, such as being forced to change lanes (to private vehicle lanes). As shown in Figure 4.15, it is necessary to request the cooperation of commercial companies and to construct a new entrance utilizing general roads, etc., from the conventional parking lot entrance and exit from the bus lane to reduce the number of vehicles on the lane.

Before maintenance After maintenance



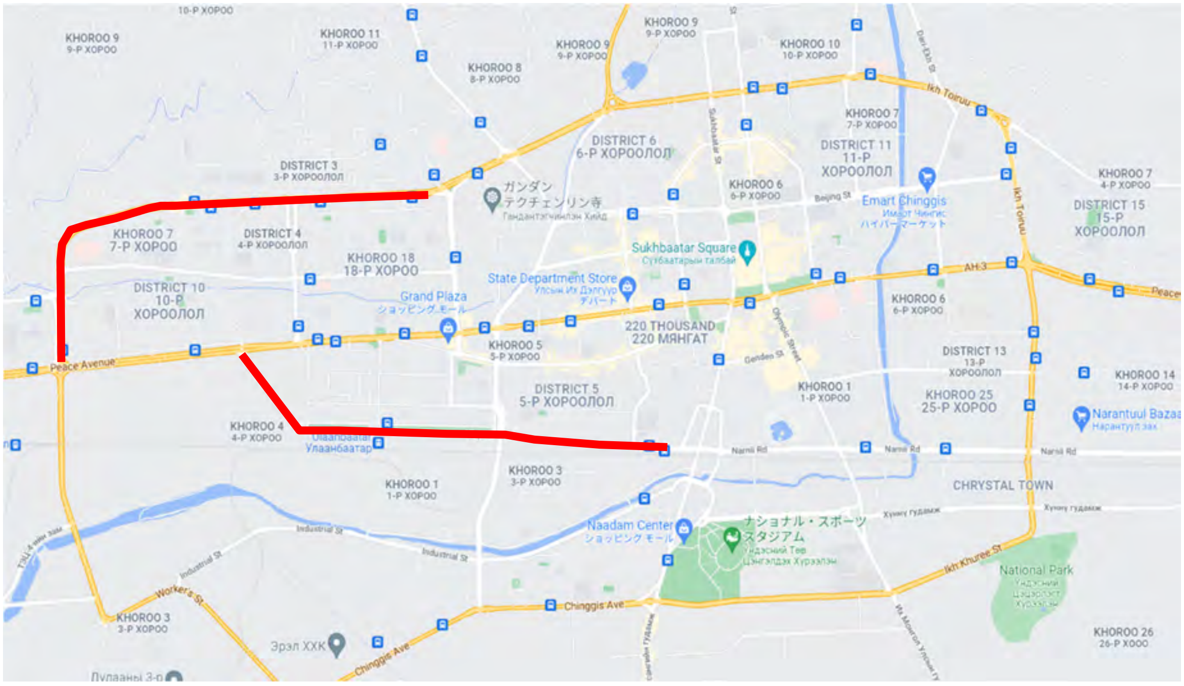
Source: JICA Study Team

Figure 4.15 Developing Parking Lot in Commercial Facility（Image）

It is suggested that new bus lanes will be constructed in two locations other than Peace Avenue after understanding UB City citizens, as shown in Figure 4.16.

・Bus lane utilizing the median strip in the western area of Ard Ayush Avenue.

・Bus lane utilizing green space (park) parallel to the road in the western area of Narnii Road.



Source: JICA Study Team

Figure 4.16 Area for Developing New Bus Lane（draft）

By developing the two bus lanes, three bus lanes will be developed on the west side of the center of UB City, including the existing bus priority lanes on Peace Avenue. Dispersion of the traffic volume on Peace Avenue is expected. At the same time, by redesigning the existing bus route network on the west side of UB City and developing a new bus route network plan, it will be possible to select multiple routes and improve convenience.

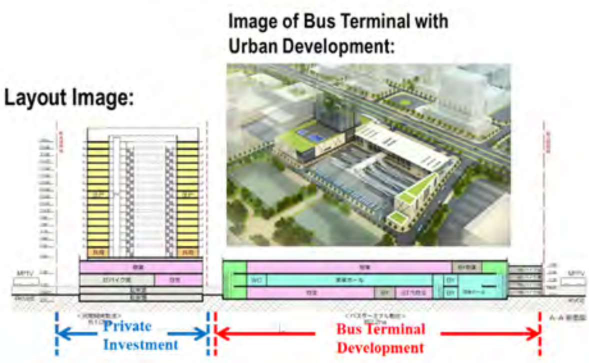
The median strip installed on Peace Avenue is not subject to the expansion of private car lanes and bus priority lanes. It is expected to be used as a construction yard for mass transit, such as the Metro, in the future and as a development site for transportation nodes in the station at the timing of the opening of the mass transit.

2) Development pf Bus Stops and Transportation Node

Bus lane improvements will lessen the concentration of bus routes on the west side of UB City, but the long queues, which is also one of the issues, will not be solved. Therefore, in UB City, it is very important to develop a transportation node that also has bus terminal function. By arranging the nodal points, it becomes possible to achieve the following objectives.

- Bus routes can be short-circuited when nodal points are improved. The delay time when caught in a traffic congestion can be minimized and the punctuality will be improved.

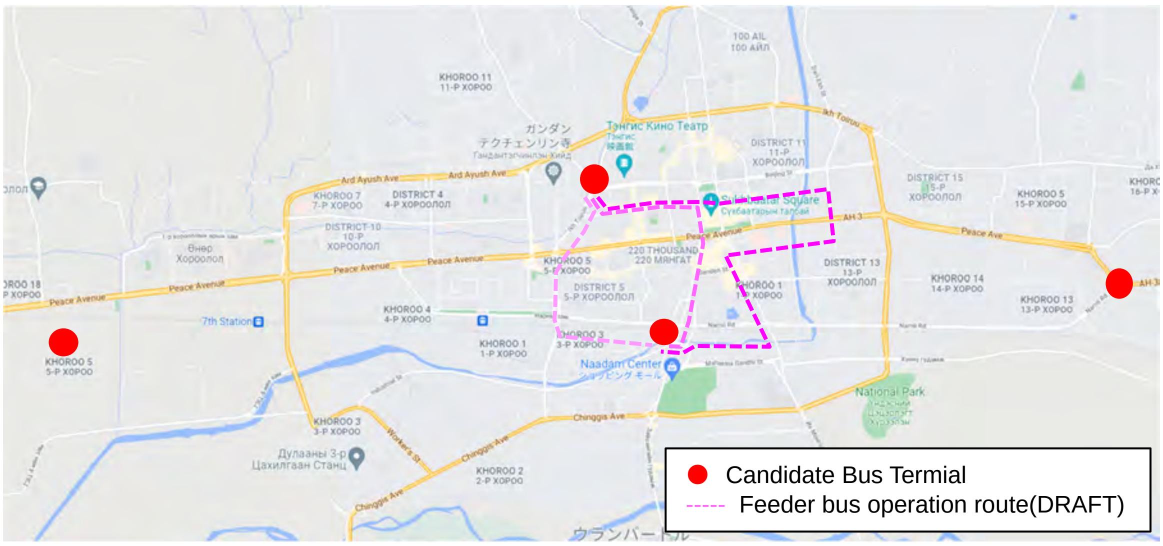
- It is necessary for UB City to promote the development of intercity bus terminals currently in two places in UB City and development of commercial facilities besides the bus terminals by the private companies as shown in Figure 4.17 as well as city route buses in orider to have a lively function of a town. The developemnt above will lead to curb the flow of people to the center of UB City, and as a result, it will contribute to alleviating traffic congestion in the city center.



Source: JICA Study Team

Figure 4.17 Image Figure of Developing Bus Terminal

The study team proposes to develop transportation nodes in each of the east, west, south, and north locations of the Sukhbaatar Square from the center, as shown in Figure 4.18. The purpose of maintaining the nodes in each direction is summarized as follows.



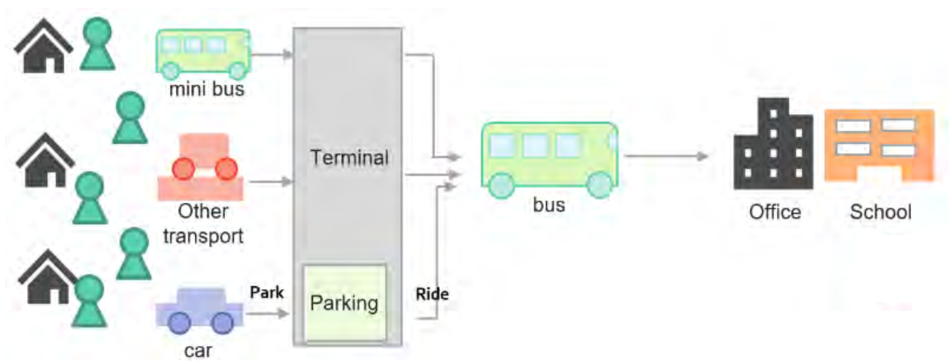
Source: JICA Study Team

Figure 4.18 Four Candidate Bus Terminal in UB City and Bus Route of Feeder Bus Operated in North-South Direction（draft）

- <u>Terminals in North and South</u>. The terminals will be established at the east end of each of the two bus lanes constructed on the west side of UB City. In order to curb the inflow of buses into the center of UB City, multiple feeder buses should be operated connecting the north–south bus terminals to access the city center. As a result, for buses that operate in the short-circuited central area, the frequency of the operation will increase and users will be able to select multiple routes for each destination, which increases convenience. As for the feeder buses, it will be possible to reduce the environmental burden by intensively using EV buses that have been recently introduced. Furthermore, from the user's point of view, it is expected there will be more concern on the "economic" barrier of having to pay fares two times when changing buses rather than the "physical" barrier. Therefore, when connecting between buses operating in the suburban area and the city center, it is important to introduce fare measures to reduce the financial burden, such as free fare for the feeder buses.

- Terminals in East and West. The new transportation node in the east and west will be established between the expanding ger district and the center in UB city, and a multimodal means of transportation other than buses and facilities that allow park-and-ride will be added. As shown in Figure 4.19, it will be possible to provide new mobile services such as mini-bus, ride-hailing service, bike-taxi, and bicycle sharing even in the ger area where it is difficult to provide existing bus services because road maintenance cannot keep up with the population growth. By using a route bus that operates frequently from the nodal point, it can be expected to have the effect of curbing the inflow of private cars into the city center.

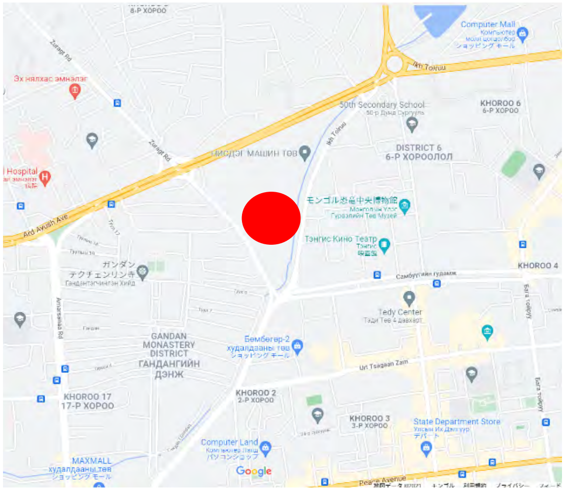
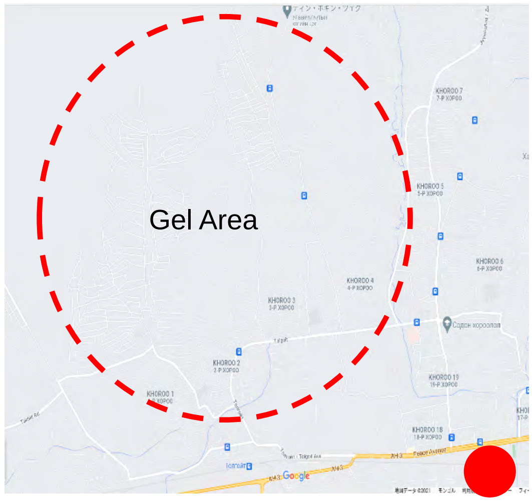
This study has not yet identified a specific terminal site to develop but has organized the issues as shown in Table 4.17 for each candidate site.

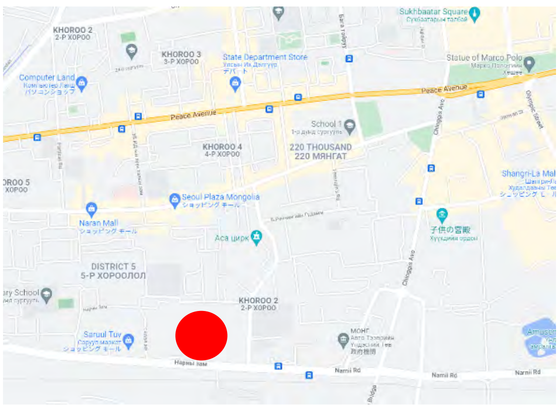
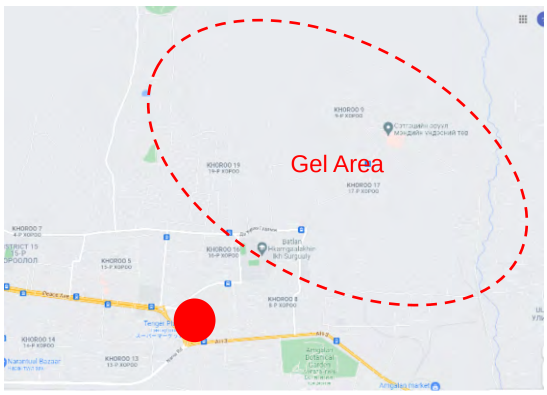


Source: JICA Study Team

Figure 4.19 Image of Transportation Node Connecting Ger Area and the City Center

Table 4.17 Candidate sites by terminal development direction and their issues

<table>
<tr><td colspan="2">【Overall issue】
・ Since the contents of development differ depending on the function to be installed, it cannot be shown unconditionally, but considering the cases in Japan, it is necessary to secure a 30,000 m² or more of land in one place.
・ Therefore, it is expected that it will be difficult to secure land, and as an example, it will be possible to promote the relocation of government agencies and universities to the suburbs to secure vacant land as a terminal.
・ If it is still difficult, consider developing a terminal adjacent to the sub-center and community center proposed in MP2040, which is currently being formulated.
【North-South Terminal】
・ Since it is necessary to increase the frequency of feeder bus operations, the establishment of a bus terminal is required in a place closer to the center of the city.</td></tr>
<tr><td>[North Terminal] Near Tasgan

Issue: May be used during religious events in the neighboring Gandantegchinlen-monastery. There are also historic sites.</td><td>West Terminal] Near the Dragon Bus Terminal


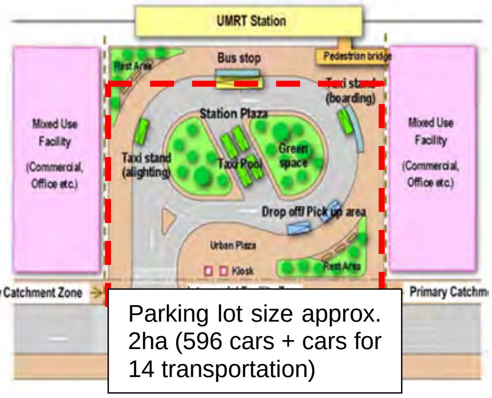
Issue: The south side of the bus terminal was previously a depot for private bus operators, but it was sold to a private car retailer company.</td></tr>
<tr><td>【South Terminal】Vacant land along Narnii Road near the Peace Bridge

Issue: Previously used as a depot for the bus operator, but in recent years it has been sold to a private company and there is information that it will be developed in the future. If terminal development is difficult, consider using the area in front of Ulaanbaatar Station.</td><td>【East Terminal】Near Bayanzurkh Bus Terminal (Tenger Plaza)


Issue: Since it is used as a intercity highway bus terminal and as a commercial facility, it needs to be redeveloped.</td></tr>
</table>

Source: JICA Study Team

3) Development of Transport Hubs

The bus terminal shown in section 2) is a facility mainly for bus transportation, but if railway is constructed in the future, a multimodal transportation node will be needed. The main roles of this transport hubs are to provide (i) transit facilities to railway, buses, taxies, etc.; (ii) social interaction; (iii) evacuation space and disaster prevention base; and (iv) public toilets and information boards. For example, transit facilities are bus stops, taxi berths, cab pools, car stops, transit information displays, operation information facilities, and transit waiting areas. Other faciliies are open spaces for the social interaction function and stockpile warehouses for the disaster prevention function.



Source: Research team based on JICA The Project for Improving Public Bus Service in Yangon

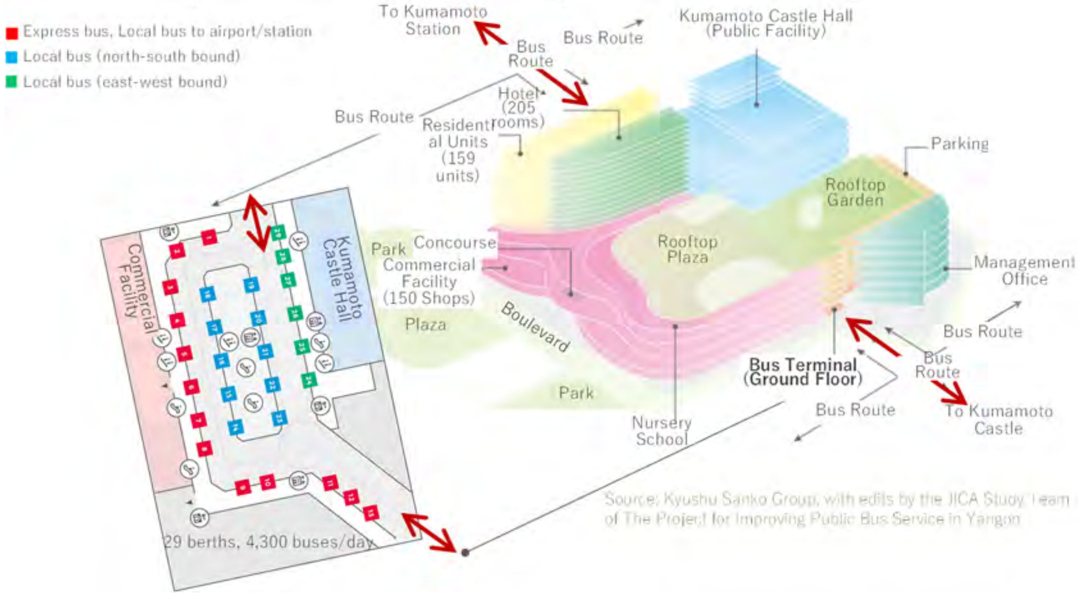
Figure 4.20 Transport Hubs (Station Plaza Type)

There are three types of transportation nodes: station square, bus terminal, and integrated ROW (see Table 4.18.) and the decision should be made following the required functions and available area.

Table 4.18 Types of Transport Hubs

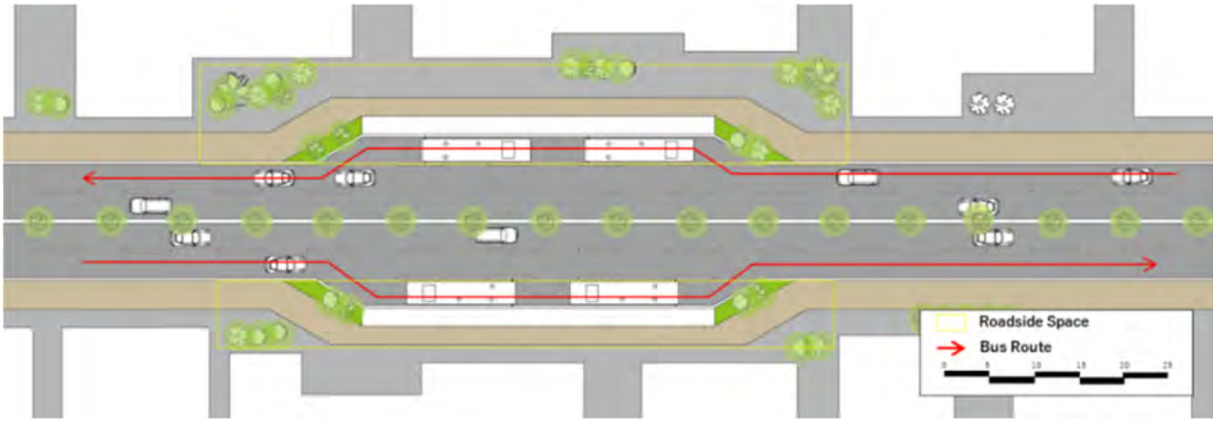
Type of IMF	Land Availability	Transfer Functions
Station Plaza Type	High	Multi-mode
Multi-story Type (Bus Terminal Type)	Moderate-Low	Multi-mode
Bus Interchange Type (Integrated Right-of-way (ROW) Type)	Low	Single (Bus only) to Multi-mode

Source: JICA Study Team of The Project for Improving Public Bus Service in Yangon



Source: JICA Study Team of The Project for Improving Public Bus Service in Yangon

Figure 4.21 Example of Multi-story Bus Terminal Type (Kumamoto Bus Terminal)



Source: JICA Study Team of The Project for Improving Public Bus Service in Yangon

Figure 4.22 Integrated ROW Type

Considering the location in UB City of where the transport hubs would be introduced, it might be possible at UB Station, as shown in the comparison below, since the space is almost the same, the possibility of the transport hub in Ulaanbaatar station would be higher than other.

Transport hub (within the red dotted line) approx. 1.7 ha

Source: Research team based on Google earth

Figure 4.23 Comparison between UB Station and Japanese Cases (Station Plaza Type, in front of Shin-Urayasu Station)

(4) Drastic Improvement of Large-scale Public Transportation, Including Railways

In order to promote modal shift from the private to public transport, developing mass public transit system is very important. In UB City, mass public transit system has many definitions, such as BRT, AGT, LRT, and MRT. This section describes the mass transit systems and their characteristics proposed by the study.

1) Selection of Mass Transit System

The following points are important when selecting mass transit system.

- Capacity of transportation, especially the number of passengers per hour per direction (PPHPD) in the peak hour
- Space for introduction. Limitation by minimum curve radius and maximum gradient of the system
- Climate conditions, especially cold temperature in UB City

Characteristics of each type of urban mass public transportation are shown in Table 4.19. LRT and MRT definitions are unclear, but this study defines the former as a railway system that has a small size rolling stock. Its width is between 2.5–2.8 m. LRT includes various systems, such as the tram type LRT, which can run on a small radius curve because the length of rolling stock is very short like Manila LRT; a normal railway style-LRT with a rolling stock that is bogie type and more than 15m long like Jakarta LRT; and the linear motor system LRT like Linear Metro. Each LRT type has different conditions (see Figure 4.24). “Metro,” which is called in UB City, does not have a clear definition, though it generally means “urban mass rapid transit system.” Though MRT or dedicated space LRT may be interpreted as “Metro”, MRT can be regaded as “Metro” considering how the UB municipal government likes to call LRT as a cheaper railway than “Metro.”

Table 4.19 Characteristics of Each Type of Urban Mass Public Transportation

	BRT	AGT, Mono Rail	Steel Wheel Railway		
			LRT (Tram Type)	LRT (Track on Dedicated Space)	MRT
Maximum capacity, thousand passengers/hour	3–10	10–20	5–15	6–20	40–50
Minimum Curve Radius, m	10	30–60	1–30	30–100	100
Maximum Gradient, %	9.0; Note1	6.0; Note1	6.0	3.5–6.0	3.5

Note: 1) Slipping in cold weather of UB city should be considered because of rubber tires. Though maximum gradient is limited under 4–5 % on the viaduct of roads, many traffic accidents happen because of slipping in the city. In the case of AGT and monorail, many people say that these are not suitable for cold weather conditions because their protection systems are designed on the condition with no slipping.
Source: Survey Team with reference to Page 141 of “Tram and City Development” by RACDA

Tram style LRT

Subway with Tram type Rolling Stock

Elevated Railway with Tram type Rolling Stock

LRT with Bogie type rolling stock (by Okubo)

LRT with Linea Metro

Photo by Survey Team (Except additional remark)

Figure 4.24 Various Type of LRT

A suitable system should be selected based on the necessary conditions of urban public transportation of UB City.

At first, a system with rubber tires, such as AGT and monorail, is not suitable for UB City because safety is not ensured for slipping under the cold weather conditions of UB City in winter.

On the assumption of a normal railway with steel wheels, the necessary capacity is expected to be 65,000–80,000 passengers/day/direction at the maximum section in 2040. Thus, if the peak hour concentration ratio is 13%, PPHPD (passengers per hour per direction) is 8,500–10,500 at peak hours, nearly the limit for BRT but suitable for steel wheel railways, as shown in Table 4.19.

In the case of 20 trains/hour in the peak time, 425–525 passengers take on each train. In the case of a tram car with a 30 m/car set and capacity of 150 passengers per car, it has three cars with an occupancy rate of 150%. In the case of a bogie car that is 18 m/car and 2.8 m cars, the capacity is 130 passengers per car. Therefore, both cases are necessary for three cars with an occupancy rate of 150%. In this situation, the 90-m tram train seems too long for shortened intersection length. In addition, bogie cars are cheaper than tram cars.

Based on the rough sketch of track alignment on the planned route, the minimum curve radius seems more than 100 m and the maximum gradient seems less than 3.5%. These specifications of bogie cars are enough. Considering the price of cars, the steel wheel railway with bogie cars is recommended as public mass transportation in UB City. The system should be decided after examination of the conditions of the route.

2) Review of JICA PPP F/S and Propose of Alternative Plan

2)-1 Problems of the Plan of UB Metro

The UB Metro plan proposed by the JICA PPP F/S implemented in 2012 is the first public mass transportation in UB City planned, which would run on the route with the biggest demand. But it could not start development in the past 10 years. The reason seems that the project cost of 150 billion yen was too costly for the Mongolian Government to decide on starting the project.

Therefore, reducing the initial costs using the following methods will help with the decision to start the project:

- to adopt an elevated structure as much as possible instead of underground, which is more expensive;
- to adopt cheaper structure than elevated structure; and
- to open partially. For this purpose, the depot should be located along the first opening section.

2)-2 To avoid underground structure

The following are the reasons why an underground structure is recommended for the middle section of UB Metro.

- Narrow width of Peace Avenue in the central area of UB city. It is essential to reduce the number of lanes of Peace Avenue if the elevated structure is constructed.
- Elevated structure will spoil the scenery in front of Sukhbaatar Square, a symbolic place for the locals.

For these reasons, it is difficult to construct a viaduct on Peace Avenue in the central area, as well as shorten the length of underground section because there is no space to enter into and exit from underground in the central area.

Considering these, the study team proposes an alternative plan. If the route goes on Narnii Road instead of Peace Avenue, which is in parallel of around 1 km away from the latter where most of the demand exists, it is possible to construct a viaduct because of enough road width. The route is shown in Figure 4.25.

Source: JICA Study Team

Figure 4.25 Alternative Route on Narnii Road

Though the results of demand forecast of the route on Narnii Road is fewer by 25% than on Peace Avenue, the demand is enough for railway to continue its operation and maintenance. This demand forecast is implemented in case of adding a short section of South–North Line from Narnii Road to the station near Sukhbaatar Square.

2)-3 To Adopt Cheaper Structure than Elevated Structure

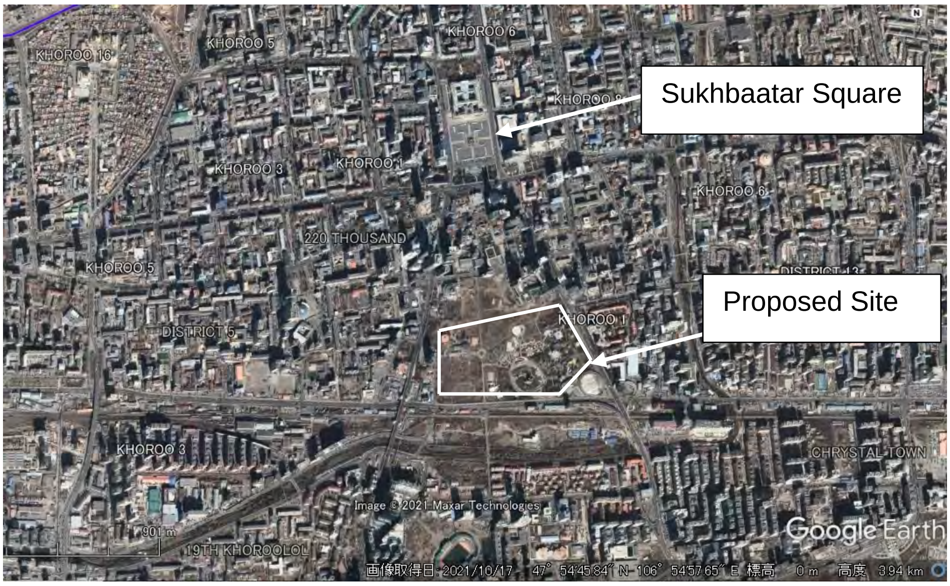
On the suburban area of UB City, Peace Avenue has enough width to construct not only the elevated structure but also tracks on the ground like for a tram. But in this case, railroad crossing or street running track will disturb traffic flow on the crossing road, and it will cause traffic jams. Train speed will also become slow. Therefore, this alternation will not be adopted at present for it is not an ideal plan.

2)-4 Alternative Plan for Opening Partially

The partial opening should be implemented on the section where some demand is expected. The big demand for East–West Line goes between suburban area and central area. For this reason, it seems better to partially open the section between the stations in the central area and where a big demand is expected, such as eastern and western bus terminals.

For the realization of this plan, the depot should be along the first opening section. But the proposed sites for the depot are only in the suburban area; therefore, a partial opening was difficult on the plan of JICA PPP F/S.

In this study, the study team examined a new depot site. They discovered that the space as the National Amusement Park could be used freely because the owner is UB City. The site is shown in Figrue 4.26.



Source: JICA Study Team

Figure 4.26 Proposed site for the depot

If the depot is either on the ground or basement floors at this site and the space on the roof of the depot is for the public park, the depot can be in the central area of UB City. The cost of roofing the depot is more expensive than the cost of a normal depot, but there are some examples of this in the center of the city where it is difficult to occupy a big space, such as Oshima depot on Tokyo Shinjuku Line and Kitami depot on Odakyu Main Line, as shown in Figure 4.27. All depot areas should have roofing because of the cold temperature during winter. Therefore, the difference in costs between a normal depot and a depot with a public park is not so large.

Source: Odakyu

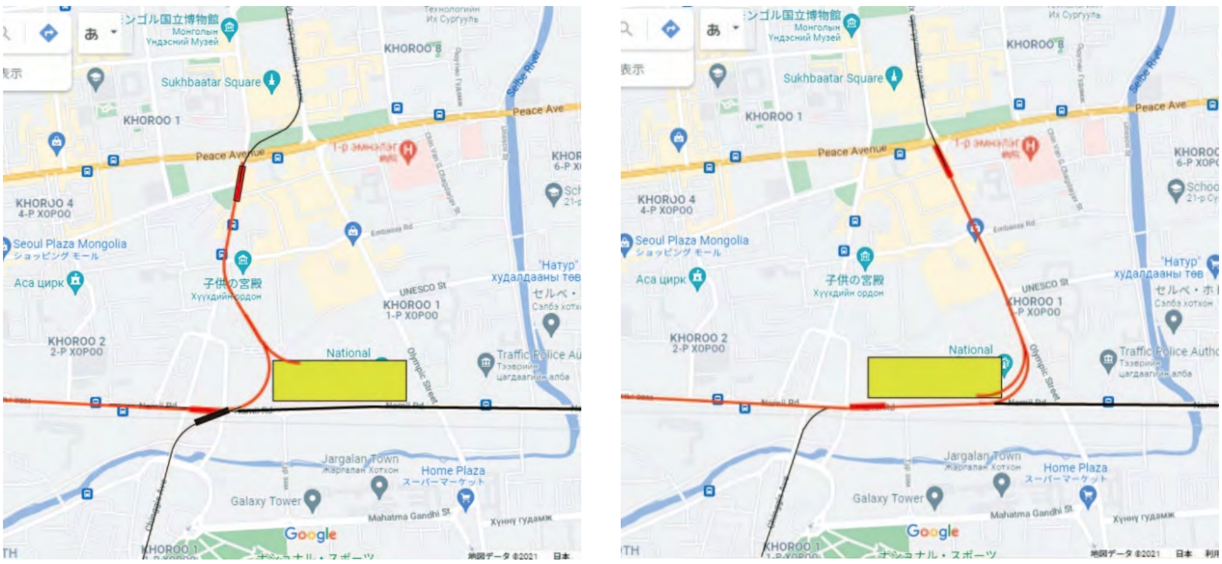
Figure 4.27 Kitami Depot on Odakyu Main Line, Where a Stabling Yard Has a Roof Used as a Public Park

If the depot can be at this site, the railway can be constructed in any direction (the East–West or North–South Lines from the central area of UB City) and adequate length can be developed according to the budget as partial opening. The UB municipal government plans to start discussions about this possibility.

In addition, setting the same specifications between West-East and North-South Lines and implementing rolling stock maintenance, at least heavy maintenance, at only one depot is efficient. Therefore, the depot should have enough space for both lines, and the connecting line between the two should be constructed. This study recommends constructing the route on Narnii Road with connecting line to one station near Sukhbaatar Square on the North-South Line at the first phase for the convenience of passengers. In this case, two routes are recommended, as shown in Figure 4.28.

In both plans, two lines are separated into two levels: East-West Line is the upper level and the North–South Line is the lower level. In Plan 2, tracks become two layers, and the station has two stories. The North-South Line goes underground to the station near Sukhbaatar Square. The connecting line between the two is installed and trains run between East-West Line and the station near Sukhbaatar Square directly at the first phase. In the second phase, trains run through East-West Line, and the shuttle train between the two stations is operated on North-South Line.

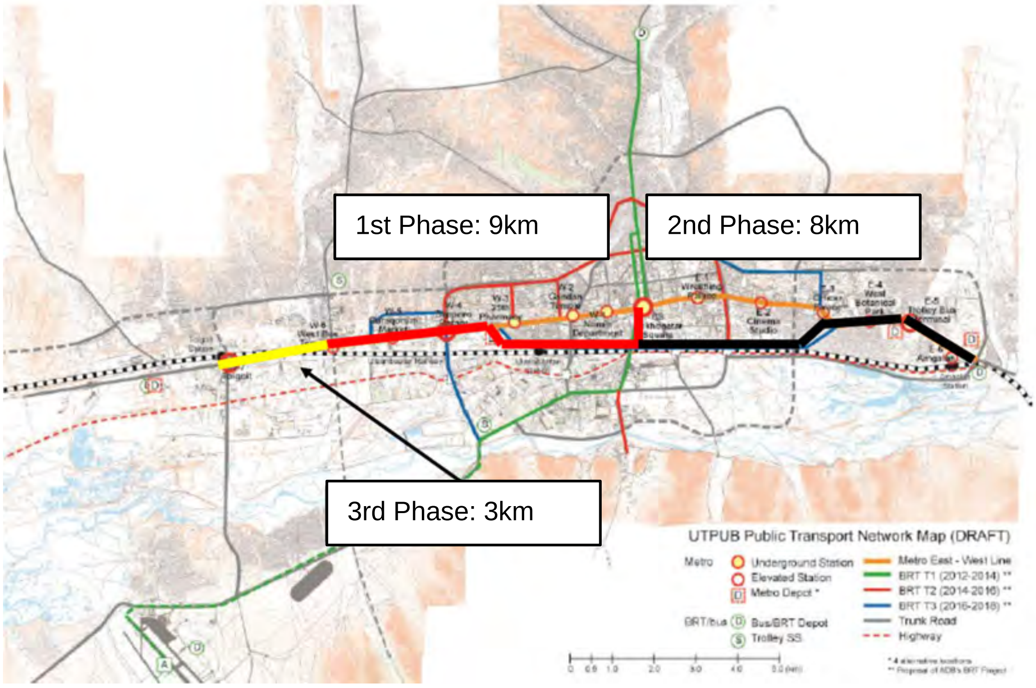
(Plan 1) (Plan 2)



Note: Red Line: East-West Line 1st Stage, Black Bold Line: East-West Line 2nd Stage, Black Fine Line: North-South Line
Source: JICA Study Team

Figure 4.28 Plans of layouts of the depot, the connecting line and stations

The study team proposes to divide the construction of East–West Line into three stages, as shown in Figure 4.29, on the assumption these can be realized.



Source: JICA Study Team

Figure 4.29 Divided Stage of Construction of East–West Line

If the construction is in three phases, the cost of the first phase is USD 850 mil, the second phase is USD 600 mil, and the third phase is USD 200 mil. These are calculated with the same conditions as JICA PPP F/S implemented in 2012. the total is USD 1,762 mil in OP-1 of the table of the project cost. Also, an additional cost for the full opening of the North-South Line is USD 1,000 mil.

If the construction phase is divided into parts, the total will be higher than the original cost because of several bidding processes, duplicate installation of facilities, replacement of facilities at each stage, long period of construction, etc.

3) Comparison between Original Plan, Alternative Plan and Plan of UB City, and Feasibility of Each Plan

Presently, some routes are proposed, one of which is the original East–West Line route along Peace Avenue. In the UBMP 2040, the North–South Line through the central area of UB city and the West–East Line along Ard Ayush Avenue are proposed. From the UB municipal office, the West Side Route and East Side Route in the central area of the North–South Line are proposed.

This study calculated the demand of each route to decide which should be first constructed. Six routes shown in Figure 4.30 were compared after adjusting each route to the same operating distance to equally compare. Table 4.20 shows the result.

As a result, the lines in order of larger demand are East–West Line along Peace Avenue, East–West Line along Narnii Road, East–West Line along Ard Ayush Avenue, North–South Route through the central area, East Side Route of North–South Route, and West Side Route of North–South Line.

Figure 4.30 Six Routes to Compare

Table 4.20 The Results of Demand Forecast on Each Route

Alternative	Year	No. of Ridership (000/day)	Project Length (km)	Average Sectional Vol. (000pax/km/2w)	Fare Revenue (bil.Tg/year)	Transport Benefit (bil Tg./year)			
						Total	TTC	VOC	Environment
East–West Line (Narnii Ave.)	2040	322	18.0	119.9	102	444.8	338.0	25.3	81.5
East–West Line (Peace Ave.)	2040	459	18.0	148.2	131	456.2	347.7	25.7	82.8
North–South Line	2040	243	17.6	94.7	79	427.7	339.6	21.6	66.5
UB City Alignment East–West	2040	132	19.8	35.0	35	330.4	283.3	8.3	38.8
UB City Alignment North–South (West)	2040	168	16.7	58.5	48	236.5	225.4	0.0	11.0
UB City Alignment North–South (East)	2040	261	20.8	63.1	67	225.7	209.8	3.1	12.7

Source: JICA Study Team

Each route of the East-West Line has appropriate demand for serving the function of the railway. On the other hand, each route of the North-South Line has small demand, especially in the end part of the route. Therefore, it will serve as a function of railway only near the central area of UB city in 2040.

For the assessment of the possibility for operations, the fare revenue was forecast.

It will be decided in the future which route will be constructed first in consideration of these results. The important point is that they should not start construction if fare revenue cannot cover O&M costs even if all construction cost is paid by taxes. The operation cannot continue without any subsidies from tax.

O&M cost of the urban railway of around 20-km in length is generally about MNT 80-100 billion per year. If this is set as the borderline, they can only continue the operations of East-West Line along Peace Avenue, East-West Line along Narnii Road, and North-South Line through the central area.

It is necessary to study the following considerations for developing a structural plan that can continue operation sustainably.

- The operation organization should be established, and they should continuously earn the costs for O&M for sustainable operation. If the Mongolian Government or UB municipal government builds the infrastructures and/or facilities as public property, they should decide how to reimburse the construction cost, how to rent to the operation organization with or without a fee, and who is responsible for daily maintenance and long term-replacement. According to the decision, they should establish a system that the operation organization can pay the mandatory expense continuously.

- Generally ,the number of passengers and fare revenue increases gradually in railway operation. Therefore, if the operation organization pays the O&M cost, it might operate at a loss during the early stage after opening and the balance becomes profitable gradually. For avoiding bankruptcy of the operation organization, it should have the capability to endure the debt burden at the peak period.

From now on, the UB municipal office should decide not only a construction plan with a route plan but also an operational structural plan in which the operation organization can endure the debt burden and can operate continuously. For this purpose, they should consider the balance between the expected fare revenue and subsidy and support by the government from the stage when they decide the route. They should also select the route with enough revenue to continue operations as a response to the concern that a high share of taxes will be necessary to continue operations after opening.

4.4.2 Strengthen Human Resource Capacity in terms of Management and Technology

In this section, the necessity for human resource capacity in terms of management and technology is described from the perspective of (i) Public transportation, (ii) enhancement of road transport plan, and (iii) the possibility of necessity.

(1) Aspects of public transportation improvement

1) Strengthen the management system of bus operation and planning entities

Among UB City bus operators, the study team inspected the public bus corporation. They were able to confirm that the management of labor (attendance) of drivers and the use of surveillance cameras in the buses are being properly implemented. However, private bus companies do not have surveillance cameras. It is impossible to check the driving status of the drivers or customer service. Therefore, it is considered impossible to check if the drivers make unreasonable lane changes that could cause accidents or if they talk or operate their mobile phones while on duty. It is believed that bus companies can provide safety and security from the viewpoint of preventing crimes such as pickpocketing as well as encouraging drivers to change their behavior by equipping all UB buses with surveillance cameras.

In addition, it is necessary to establish an organizational structure besides a server and promote human resource development in UB City to collect and store data on the usage of IC cards (smart cards) used for fare payment and GPS for location information. Capacity building of departments in UB City responsible for formulation plans should be promoted.

The perspective of public transport-oriented development (TOD) becomes more important in mitigating traffic congestion when it comes to developing nodal points, as explained in Section 4.4.1(3), and railway systems. By reinforcing the contents as a public transport-oriented urban development through technical cooperation, the convenience of public transport can be further improved.

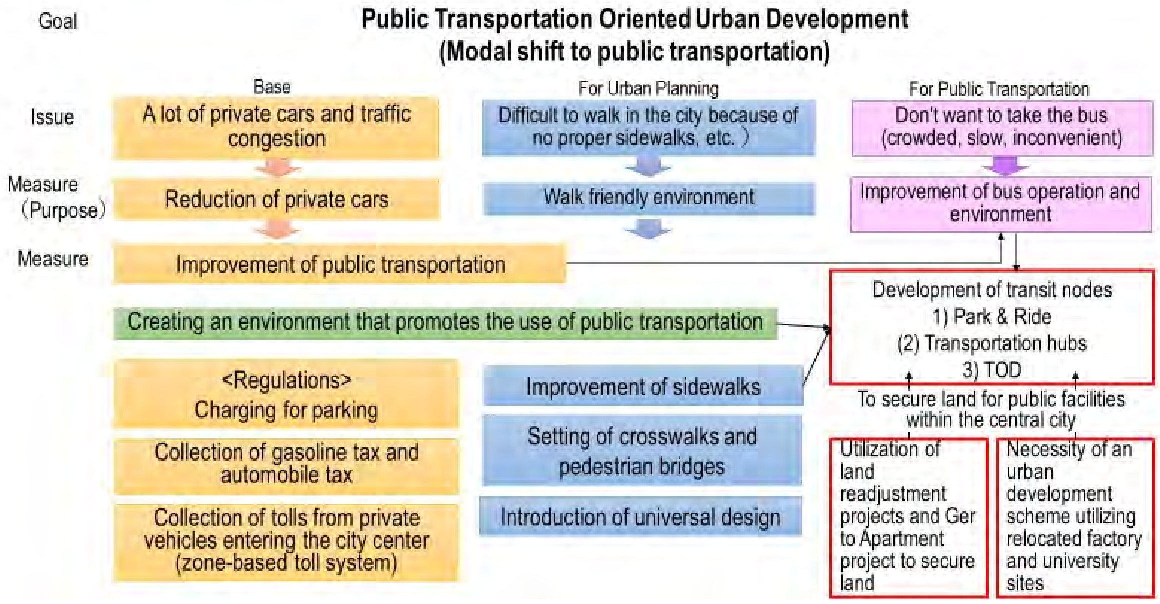
2) Public Transportation Centered Urban Development (Modal Shift to Public Transportation)

Alleviating traffic congestion in UB City requires improving the environment for public transportation that it becomes easy to shift from private to public transportation. In order to achieve this, it is necessary to create an environment allowing people to walk around the city with peace of mind, to improve the operation and environment of public transportation, and to create an environment that promotes the use of public transportation.

The following three approaches are considered to create an environment that promotes the use of public transportation: (i) Park & Ride, which serves as a base for transferring from private cars to public transportation, (ii) the development of transport hubs that serve as transfer points between buses, or between buses and railway, and (iii) the introduction of TOD, which is an urban development that does not overly rely on automobiles but public transportation (see following sections).

Lands are needed for the development of the above three facilities, but a lack of large areas is a challenge in the central six districts of UB City. Dealing with this issue necessitates incorporating the above facilities into the urban redevelopment schemes based on the Urban Redevelopment Law and developing a new mechanism for the effective use of the land generated by the planned relocation of urban functions (see also section 4.4.4(3)).

Additionally, as a mechanism to encourage the use of public transportation, regulating the use of private cars is essential, as well as establishing preferential measures when using public transportation.



Source: JICA Study Team

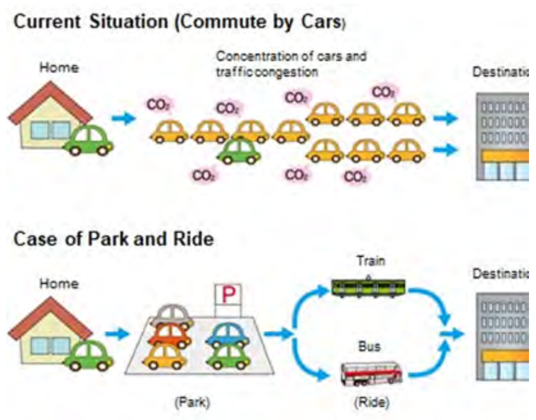
Figure 4.31 Public Transportation-centered Urban Development

2)-1 Park & Ride

Park & Ride is a system allowing people to park their cars in parking lots near bus stops or train stations in the suburbs and transferring to buses or trains, thereby reducing the concentration of cars in the city center (Figure 4.32 andFigure 4.34).

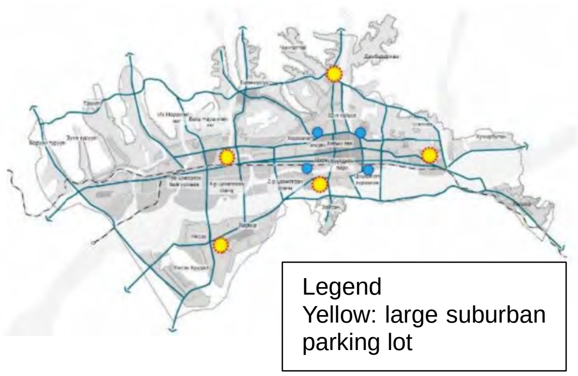
UB City also plans a Park & Ride and considers large-scale parking lots in five locations in the suburbs for those who use public transportation to get to the center (Encircled in Figure 4.33).

There is a possibility to develop one in Yarmag to integrate into private development.



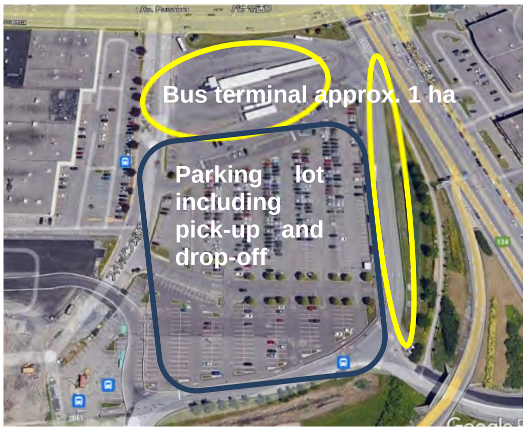
Source: jaef.or.jp/6-traffi-cation/img/TC_37_t.pdf

Figure 4.32 Park & Ride



Source: UB City

Figure 4.33 Large-scale Parking Lot Plan



Source: JICA Study Team based on Google earth (Montreal, Canada)

Figure 4.34 Case Study of Park & Ride

2)-2 TOD

TOD（Transport Oriented Development）aims to create a city where people can walk comfortably around stations through urban development that combines real estate development (commercial facilities, office buildings, and residences), public facilities (parks and government offices), and public transportation (buses around transport hubs). In Japan, Europe, the United States, and other countries, this concept has been introduced at railway stations where public transportation, high-density residential areas, proximity to public facilities, commercial and business functions, and high-quality pedestrian networks are arranged around it. In Japan, this development has been practiced for a long time, especially at railway stations along railway lines. It is a development that works for both the city and railway, improving the profitability of urban railway and creating compact urban areas. Specifically, the benefits are as follows.

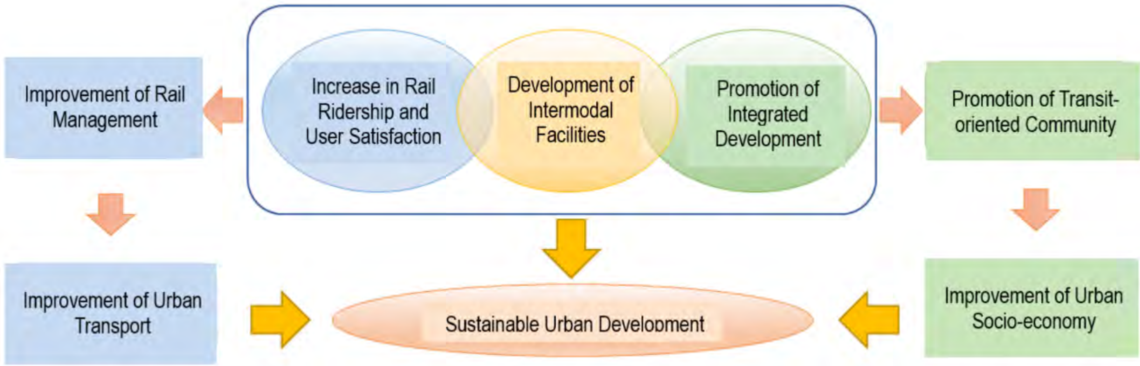
- Promote increasing the number of passengers and convenience of transportation for citizens by integrating the public transportation system, consisting of railway and buses, and improving the convenience of transfers.
- Promote socio-economic development of districts by developing various public service facilities and commercial and business facilities around the station to enhance the convenience for public transport users.

In light of the future railway development in UB City, it is a good time to start considering the introduction of TOD.

2)-3 Reorganization of the Public Transportation Network and the Need for TOD

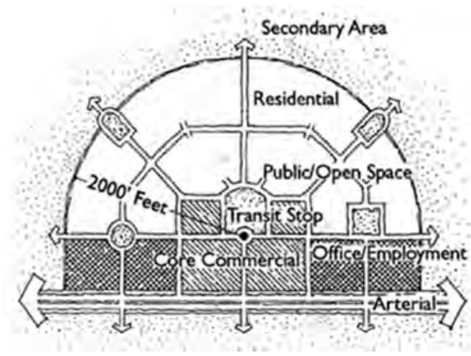
With the construction of the railway, citizens will have a reliable means of transportation. In order to make its effect larger, in conjunction with the railway development, the following should be developed: (i) reorganization of the bus route network and the railway as the core; (ii) development of last mile transport mode, such as taxis and other means of transportation to ensure end-to-end transportation; (iii) development of transit hubs to facilitate connections between these modes of transportation and the railway, and (iv) development of Park & Ride to facilitate connections from private cars to the railway.

Moreover, to develop a city with high public transport mobility, TOD-centered stations are required. The advantages of TOD are shown in Figure 4.35.



Source: JICA, Dhaka Urban Transport Development Project (TOD) Preparatory Survey Report, Bangladesh.

Figure 4.35 Advantages of TOD



Source: Peter Calthorpe, The Next American Metropolis,1993

Figure 4.36 TOD Image

As proposed in the "Study on Implementation of Ulaanbaatar City Urban Transportation Project in Mongolia" conducted by JICA from 2011 to 2013, TOD is the development of facilities and pedestrian space that will promote the use of railways, such as transportation hubs and commercial facilities, within a 100-radius near the station. It also has the development of various facilities, such as bus services and residential and public facilities within a 10- to 15-minute walking distance from the station (about 500 m to 1000 m) (see Figure 4.36 and Figure 4.37). The development around the station will be promoted by enhancing bus services and developing various facilities. The expected effects of urban development integrated with railways are as follows.[26]

- **Environmental improvement:** Reduce traffic congestion and improve air pollution by reducing automobile traffic.
- **Economic revitalization:** Renew urban functions and revitalize economic activities along Peace Avenue.
- **Real estate market formation:** Form new real estate market through the construction of new commercial, business buildings, and apartments in the vicinity of the stations.
- **Job creation:** Create new jobs in redevelopment projects around the station and commercial facilities
- **Increase in tax revenue:** Increase government tax revenue, such as real estate related load value tax (VAT), land related tax, business sales tax, and income tax, due to rising land and real estate prices and economic activities along the railway line.

[26] Partially modified based on the Ulaanbaatar City Construction Preparation Survey.

Source: JICA Study Team based on Google Earth

Figure 4.37 Example of TOD in Japan (Shin-Urayasu Station Area)

(2) Strengthening of Road Drainage Facility and Maintenance Management Function

Inadequate road planning and design, inappropriate roadside use, and lack of road drainage functions are also some of the major factors hampering the traffic flow. In order to improve this situation, it is necessary to improve road traffic capacity for the most effective use of the limited ROW by eliminating parking spaces, etc. along arterial roads, securing median strips, securing/extending dedicated left-turn lanes; securing bus-priority lanes, and providing stormwater drainage system.

(3) Strengthening of Road Traffic Planning and Other Aspects

In the UB City, there is a significant lack of district roads (living roads) connecting between the main roads and populated area, and many of the district roads in the Khoroo's (an autonomous district in UB of about 400~500m square) in the residential and commercial area, have been used as parking spaces and have not played a role to serve as connecting road for passing traffic coming in from the main roads. The lack of continuity of the district roads is one of the main reasons for the lack of traffic flow capacity of UB City. It is highly recommended to promote the land restructuring in Khoroo, securing the accessibility of the roads, and improving their connectivity to the main road in UB City to reduce traffic congestion on arterial roads.

In addition, it has been observed that the existing major arterial roads are below capacity compared to the basic traffic capacity due to various factors such as inadequate ROW, lack of median separation, lack of dedicated left-turn lanes, insufficient roadway width as an arterial road, illegal parking on the shoulder, etc. Therefore it is necessary to enhance the capacity of UB City in terms of traffic planning, geometric design of intersections, and traffic control in the city districts and major arterial roads to facilitate the existing traffic.

Main Roads and Living Roads in Sendai City, Japan

Main Roads and District Roads in the center of UB City

Source: JICA Study Team

Figure 4.38 Differences of Living Road Connectivity between Japan and the Mongolia

4.4.3 Concentrated Investment in Highly Effective Priority Projects

Although comprehensive plans for UB City have been developed by various government agencies, cities, and donors, it is difficult to implement projects when there are financial and land constraints and to implement easy solutions for complicated traffic behavior (due to severe traffic congestion). This situation makes it difficult to implement a comprehensive plan in the same way as in the past, and at the same time, increases the possibility that projects will be implemented without adequate evaluation, causing low investment efficiency and misplaced investment priorities.

In order to solve these problems, it is important to decide which should be prioritized for project implementation, not just from a one-sided perspective of what should be done. In other words, it would be more efficient to evaluate projects not only based on their effectiveness and investment efficiency, but also the acquisition of land, human resources of the implementing organization, and technical capabilities of the organization, and to adopt projects after prioritizing them. For this to happen, it is necessary to analyze the effectiveness of each project, analyze whether the combination of projects is effective based on complex traffic behavior, and select the infrastructure that is truly necessary for the UB City.

4.4.4 Other Development that Needs to be Coordinated with Urban Policy

UB City currently has a large demand for new urban development, mainly in the new city of Yarmag, and the rebuilding of mid- and high-rise buildings in some ger areas. Therefore, serious traffic congestion is occurring in various aspects, such as ingress and egress traffic, traffic within district roads, parking lots, and access traffic to facilities. Thus, it is necessary to introduce a pre-development traffic impact assessment. In addition, although public transportation service enhancement, including for buses, and future planned large-scale public transportation is proposed, it is also necessary to alleviate traffic concentration. It would be more efficient to conduct public transportation-centered urban planning, and by improving the efficiency related to development, it can efficiently contribute to the alleviation of traffic congestion.

Some related proposals and recommendations how to incorporate them into various cooperative projects and their use in revising the legal system of UB City are described below.

(1) Proposal to introduce traffic impact assessment

In Japan, the United States, Australia, the United Kingdom, and many other countries, traffic impact assessments are conducted prior to the implementation of major development projects. The purpose of traffic impact assessment is to evaluate the various traffic impacts, including traffic congestion, resulting from large-scale development, and to take measures in advance to mitigate the impacts. What is particularly important in the implementation of traffic impact assessment is that the developer bears the cost. As mentioned in the analysis of the issues arising from the urban structure in 3.5 (1) in Chapter 3, the impact of large-scale development on traffic in the surrounding area is significant, so it is time for Mongolia to introduce a traffic impact assessment.

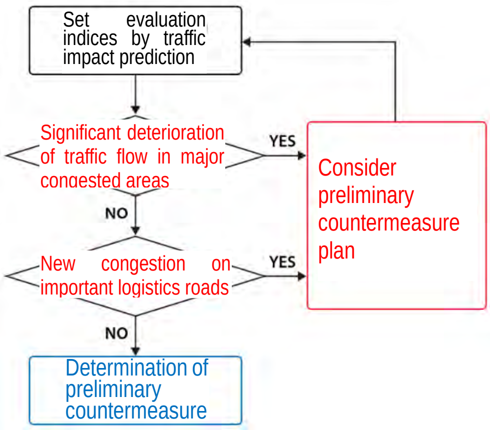
Target Facilities	Projection Items
1. Automobile Traffic Facilities • Arterial Roads • District Roads • Station Plaza, Transportation Plaza • Parking Lots, Bycycle Parking • Cargo Handling Facilities • Taxi Poor	1. Automobile Traffic Projection • Vehicle Traffic Volume on Roads in and outside the area (single-street sections and intersections) • Parking Demand Volume • Cargo Handing Demand Volume • Taxi Demand Volume
2. Pedestrian Traffic Facilities • Pedestrian Path • Pedestrian Facilities	2. Pedestrian Traffic Projection • Pedestrian Traffic Volume on Sidewalks • Pedestrian Traffic Volume at Pedestrian Facilities
3. Public Transportation Facilities • Railway Facilities • Bus Facilities	3. Public Transportation Projection • Railway Transportation Volume • Bus Transportation Volume

Source: www.mlit.go.jp/common/001042950.pdf

Figure 4.39 Facilities to be Studied

In Japan, there are several rules on traffic impact assessment depending on the situation. For example, the "Manual for Transportation Planning Related to Large-Scale Development" defines the target facilities as (i) commercial development with a total floor area of 10,000 m^2 or more, (ii) business development with a total floor area of 20,000 m^2 or more, and (iii) other uses (special uses other than the above such as residential, hotels, event facilities, etc.) and mixed-use development, or a scale that is expected to generate the same level of traffic as (i) and (ii). Taking into consideration the characteristics of the development area, scale and use of development, the status of public transportation facilities around the development area, and other factors, the impacts of development on the transportation facilities and the amount of demand for the facilities will be forecast for the transportation facilities. Based on the forecast, the proposed related transportation plan is evaluated and the most appropriate plan is formulated. The “Technical Operation Manual for Conducting Traffic Assessments on Important Logistics Roads” is another traffic assessment that includes the planning stage before facilities are developed and additional measures after the facilities are developed in order to reduce congestion caused by land use around roads and to ensure safety, as part of the functional enhancement and support for priority places for road transportation networks designated as important logistics roads, which are important for logistics, to ensure stable transportation regardless of normal or disaster conditions.

The target facilities are retail stores (including processing and repair businesses but excluding restaurants) with a total floor area of more than 1,000 m^2 and facilities with a total floor area of more than 20,000m^2 (excluding apartment buildings).



Source: www.mlit.go.jp/road/sisaku/butsuryu/pdf/manual.pdf

Figure 4.40 Flow of Impact Assessment by Facility Location

	Soft Measures	Hard Measures
Measures on the premises	• Assignment of traffic control personnel • Introduction of a parking guidance system	• Secure the required number of parking spaces • Select of an efficient parking configuration • Secure a waiting space for incoming vehicles • Adjust the number and location of entrance and exit • Dispersion of parking lots • Separation of traffic lines from pedestrians • Secure bicycle parking spaces • Development of cargo handling facilities
Measures on surrounding roads	• Set up an appropriate guide route to the parking lot • Settings up Guide display • Guidance on avoiding the time of traffic jams • Promote the use of public transportation	• Installation of additional lanes • Intersection improvement • road widening • linear improvement

Source: www.mlit.go.jp/road/sisaku/butsuryu/pdf/manual.pdf

Figure 4.41 Preliminary Measures

(2) Utilization of redevelopment projects such as land readjustment projects and ger area to apartment conversion projects

In UB City, securing a large land for the development of transport-related facilities is hard. JICA conducted the project to support the formulation of redevelopment mechanism and legal framework from phase 1 in 2010-2013 and phase 2 in 2015-2018, and based on it, the project to covert ger area to apartment area and old apartment reconstruction projects have been conducted in UB. For ADB projects, the ger area is also being redeveloped. The purpose of these projects is to secure land for public facilities construction. Therefore, it is necessary to include the development of transportation hubs in the urban projects in the ger area and especially in the integrated sub-center development.

On the other hand, in the ger area, the distances between the bus stop and each house are so far that residents who use public transportation have to walk long distances. In order to carry out urban development based on the urban structure map (see Figure 2.5) in MP2040, it is very important to develop transportation hubs, especially in the sub-centers, in combination with feeder development, as this will improve the convenience for residents in the ger area and promote the use of public transportation.

In addition, redevelopment under the Redevelopment Law can secure lands for road development and social service facilities in the neighbourhood. Especially in areas where ger areas are being replaced by apartment buildings, it is important to use the law to properly plan the area and implement the project according to the plan to develop the required facilities for enhancement of residents' access to public transportation, rather than leaving it to individual private developers.

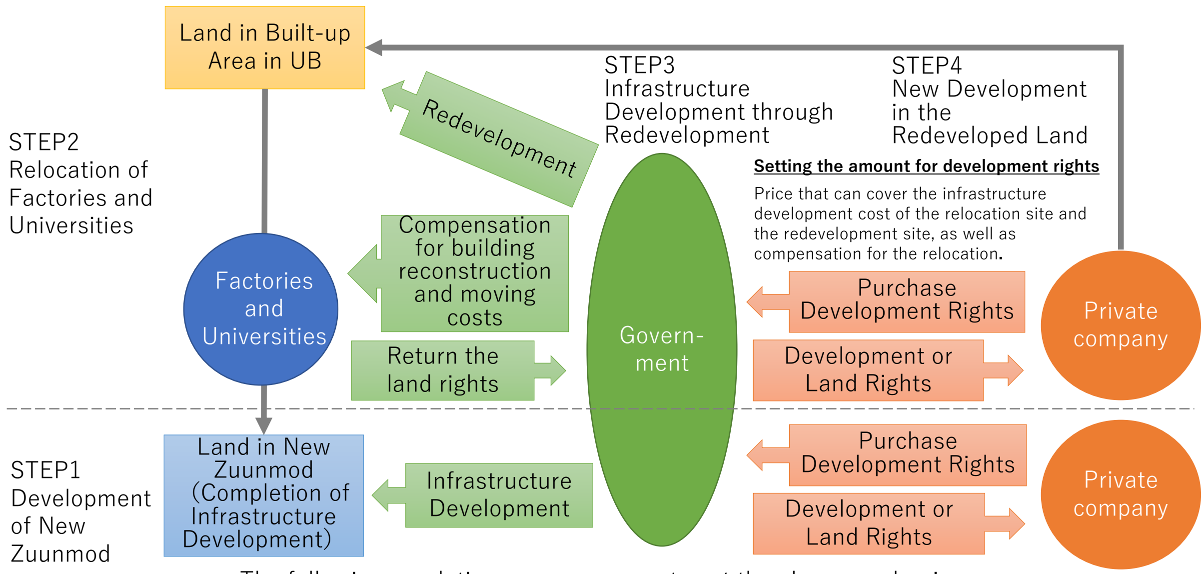
(3) Necessity of an Urban Development Scheme Utilizing Relocated Factory and University Sites to Secure Land for Public Facilities within the Central City Area

Government policies, like the MP2040, include relocating urban functions such as universities and factories, of the UB City through the development of satellite cities. It is very important for UB City, which have limited land and financial resources for urban development, to effectively utilize prime sites in the city center by relocating facilities to generate land and funds for development.

Establishing a law regarding this is urgent and necessary.

As shown in Figure 4.42, for the facility to be relocated to a new location with improved infrastructure (for example, a satellite city such as New Zuunmod), the government must give the rights of new land and pay compensation for the relocation (building reconstruction and moving costs), while the private sector returns the land rights to the city to the government. The government will then develop infrastructure, including social service facilities like transportation hubs at the site, and sell the development or land rights of the developable land to the private sector. Since these former sites are in prime locations of the city and very expensive in private transactions, it is essential to apply market prices to sell the sites to private companies by the price that covers costs necessary for the government to develop infrastructure at the relocated site and the former site and pay compensation for the relocation.

Along with the establishment of the above mechanism, in order to encourage relocation to the suburbs, it is necessary to regulate industries in the city center.



The following regulations are necessary to set the above mechanisms.

- Regulation of the location of factories in the city center
- Regulation of land occupancy and use rights for companies to set government's land price to sell land by applying the market price

Source: JICA Study Team

Figure 4.42 Urban Development Scheme Using the Redevelopment Site

5 Review of Proposed Cooperative Programs

In this chapter, in line with the development policies listed in Chapter 4, a long list of cooperative programs will be prepared based on transportation projects that are proposed by the UB City Congestion Management Committee and the UBMP 2040, as well as important projects in this study.

A shortlist of necessary development projects for UB City will also be created with consideration of the results of the demand forecast, reduction of congestion losses, and evaluation of the project. For clarification purposes, a combination of shortlisted projects will be also presented.

5.1 Short-, Medium-, and Long-term Outlook for the Cooperation Program

Based on the development policies in Sections 4.1 to 4.5, the following areas on development were selected for the target projects, which can contribute to the improvement of transportation: "development related to traffic concentration, traffic dispersal, and public transportation conversion (development of arterial roads for traffic dispersal, elimination of missing links, elimination of traffic bottlenecks, and development of a drastic public transportation system)," and "capacity building, management, and technology improvement by technical assistance." Each targeted project is assigned to either development effort and categorized into expressway/primary, mass transit, bus transportation, secondary road, intersection, technical assistance, and traffic management, as shown in Table 5.1. The development year is divided into 2025, 2030, and 2040.

The target projects are proposed by both the UB City Congestion Management Committee and the UBMP 2040 (July 2021 edition) and projects proposed by the study team based on the results of field surveys. The target projects are not much different from those considered in the past but are considered significant by the Mongolian side and urgent by the UB City Congestion Management Committee. Summary sheets of each project are shown in the Appendix.

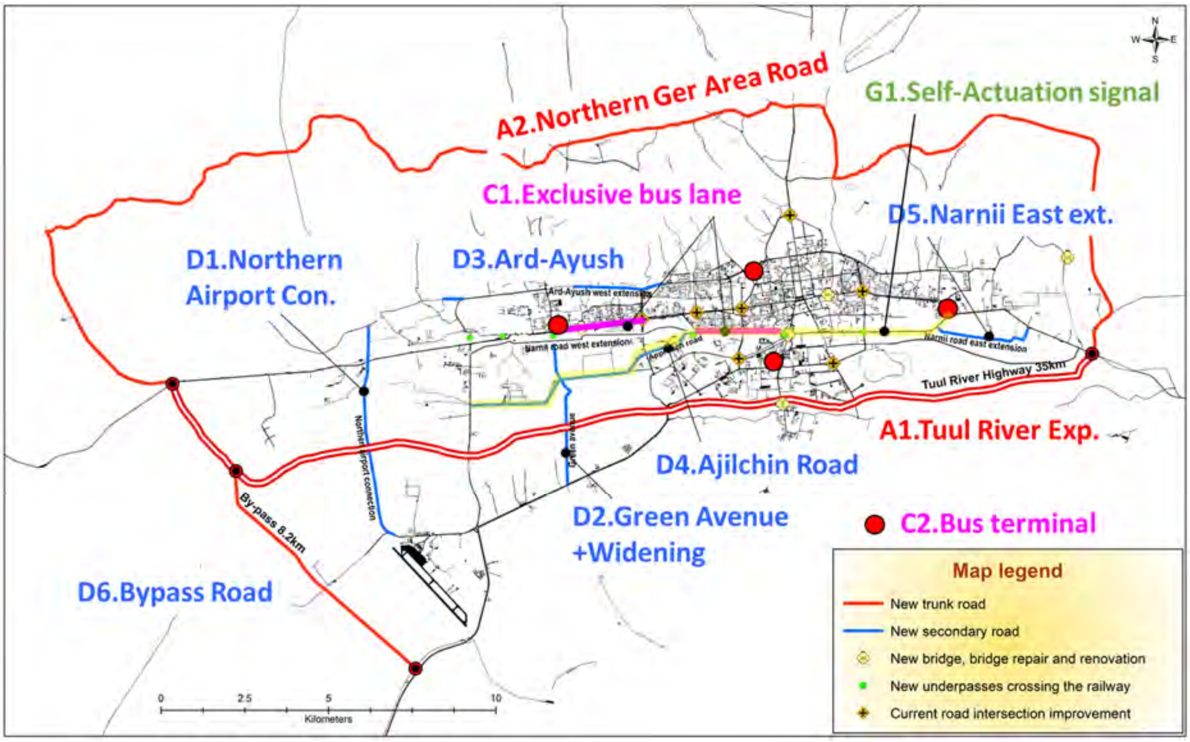
Table 5.1 List of Targeted Projects

(1) Main road improvement for traffic dispersion, and elimination of missing links	**A.**	**Expressway/Primary**	**2025**	**2030**	**2040**
	A1	Tuul River Expressway+bypass			●
	A2	Northern Ger Area Road		●	●
(2) Drastic improvement of public transportation system	**B.**	**Mass Transit**	**2025**	**2030**	**2040**
	B1	East–West line (Narnii ave)			●
	B2	East–West line (Peace ave)			●
	B3	North South line			●
	B4	UB City alignment East-West			●
	B5	UB City alignment North–South (West side)			●
	B6	UB City alignment North–South (East side)			●
	C.	**Bus transportation**	**2025**	**2030**	**2040**
	C1	Exclusive Bus lane		●	●
	C2	Advancing Bus Terminal	●	●	●
(1) Main road improvement for traffic dispersion, and elimination of missing links	**D.**	**Secondary Road**	**2025**	**2030**	**2040**
	D1	Northern airport connection		●	●
	D2	Green Avenue (N-S+E-W) Project		●	●
	D3	Ard- Ayush west extension		●	●
	D4	Ajilchin Flyover Project		●	●
	D5	Narnii Road East Extension		●	●
	D6	Bypass road		●	●
(3) Eliminate transportation bottlenecks	**E.**	**Grade Separation Intersection**	**2025**	**2030**	**2040**
	E1	East side Intersection Grade Separation Project	●	●	●
	E2	Sapporo Intersection Grade Separation Project	●	●	●

	E3	No. 17 Intersection	●	●	●
	E4	West side Intersection	●	●	●
	E5	Bayanburd Intersection Grade Separation Project	●	●	●
Development of skills and improvement of management and technology by technical professionals	**F.**	**Technical Assistance**	**2025**	**2030**	**2040**
	F1	Public Transport Improvement Program		●	●
	F2	Road Traffic Improvement Technology Enhancement Project		●	●
	F3	Improvement of planning and maintenance techniques for urban drainage facilities		●	●
(3) Eliminate transportation bottlenecks	**G.**	**Traffic management**	**2025**	**2030**	**2040**
	G1.	Self-Actuated Signal Project	●	●	●

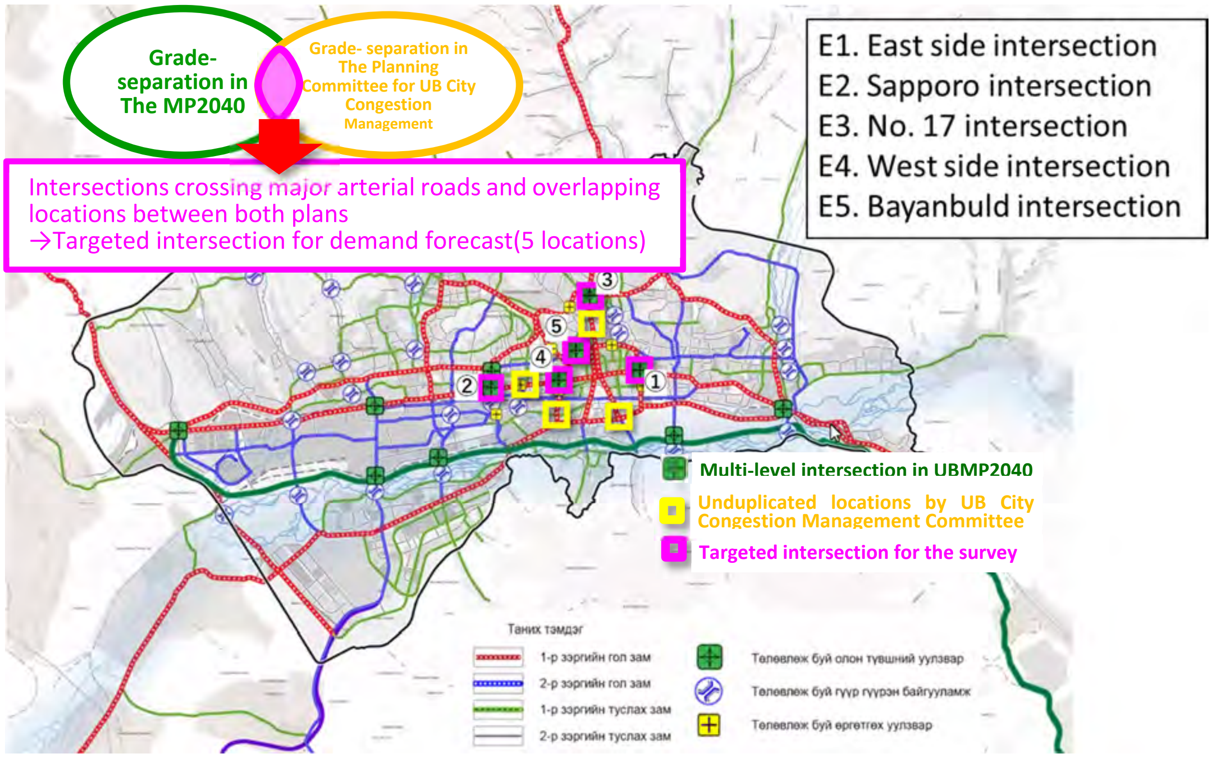
Source: JICA Study Team

In addition, the projects shown in Section 5.1.1 were evaluated from a "monitoring of traffic congestion loss and evaluation indexing" viewpoint, as described in the previous chapter. For the "project efficiency improvement and concentrated investment in highly effective projects," as also described, the effects of combining shortlisted projects were evaluated and the prioritized is presented in Section 5.4.



Source: JICA Study Team

Figure 5.1 Highways, Trunk and Secondary Road, Bus Network, and Traffic Management Projects



Source: JICA survey team based on UBRD2030.

Figure5.2　Intersection Leveling Project

Source: JICA Study team

Figure5.3　Track-based Transportation Infrastructure Development Route

5.1.1　Selection of Short-listed (proposed) Projects

For the project shortlisting, the indicators itemized in Table 5.2 were used to evaluate the projects.

Table 5.2　Project Evaluation Indicator

Evaluation Indicator	Description
Development effectiveness (five grade evaluation)	This study conducted a qualitative evaluation of the effects of development, focusing on traffic volume and travel time, and scored them on a five-point scale.
Investment effectiveness (five grade evaluation)	The annual benefit is determined by calculating the difference between the pre- and post-congestion costs based on the increase and decrease of the congestion loss costs, mainly by the demand forecast.

Evaluation Indicator	**Description**
	The investment efficiency has five score levels determined by calculating the approximate Economic Internal Rate of Return (EIRR) from these costs.
Technologies that can be utilized (five grade evaluation)	The difficulty of construction and structure and the possibility of using Japanese technology were scored on a five-point scale.
Capacity of implementing agencies (five grade evaluation)	On a scale of 1 to 5, how much knowledge and experience does the implementing agency have in implementing the project?
Environmental and social considerations (five grade evaluation)	The scoring was whether there were any difficulties in implementing the project in land expropriation on a 5-point scale.
Comprehensive evaluation	Sum of the above five grade indicators
Background Data for Evaluation Indicator	**Description**
Confirmed donor status	Describe any confirmed donors.
Estimated cost	Estimated costs for projects on which no F/S has been conducted may vary significantly.
benefit	It shows the pre- and post-event differential quantities consisting of TTC (time cost), vehicle operating cost (VOC), and costs of environment burden (CO_2, No_x). Based on their total value, the EIRR is calculated.
EIRR	The figure expresses the economic profitability or yield of the amount invested. When all the internal returns during the project period are converted to present value, it is considered worthwhile to invest if they exceed the total financing cost. This study evaluates the investment effectiveness based on this.

Source: JICA Study Team

The projects were evaluated based on the above indicators. Results are shown in Table 5.3. This study focuses on the short- and medium-term projects that can be implemented by 2030. As a result, D2. Green Avenue (N-S+E-W) Project, D4. Ajilchin Flyover Project, E2. Sapporo Intersection Grade Separation Project, E5. Bayanburd Intersection Grade Separation Project, and G1. Self-Actuated Signal Project were shortlisted (proposed projects).

Table 5.3 Evaluation Results of the Target Project List

Projects	Development effect	investment effect	application possible Technology	Implementing Organization Capacity of city	Environment society consideration	Total	Other Donner	Approx. cost (Mil.USD)	EIRR (%)	year	Benefit (Bil.Tg/Year)				Short list
											Total	TTC	VOC	ENV	
A. Development of highways and major arterial roads															
A1. Tuul River Expressway	5	4	3	2	2	16		902	19.7	'40	706.8	748.5	-27.3	-14.4	
A2. Northern Ger Area Road	3	4	1	3	2	13		141	18.5	'40	105.9	105.0	-7.3	8.2	
B. Urban railroad development															
East–West Line (Narnii Ave.)	5	5	3	3	3	19		P1:835,P2:566,P3:168	-	'40	444.8	338.0	25.3	81.5	
East–West Line (Peace Ave.)	5	5	4	3	3	20		1,362	-	'40	456.2	347.7	25.7	82.8	
B3. North–South line	4	4	4	3	3	18		995	-	'40	427.7	339.6	21.6	66.5	
B4.UB city alignment East–West	3	3	3	3	3	15		-	-	'40	330.4	283.3	8.3	38.8	
B5.UB city alignment North–South–West Side	3	2	3	3	3	14		-	-	'40	236.5	225.4	0.0	11.0	
B6.UB city alignment North–South East Side	3	3	3	3	3	15		-	-	'40	225.7	209.8	3.1	12.7	
C. Bus transportation improvement															
C1. Exclusive bus lane	4	4	3	3	2	16		11	-	'30	196.6	-84.9	70.9	196.6	
C2. Advancing bus terminal	4	3	3	3	2	15			-	'25	-	-	-	-	
D. Development of secondary arterial roads															
D1. Northern airport connection	3	1	3	4	4	15		92.2	-	'30	0.6	7.4	-5.4	0.6	
D2. Green Avenue (N-S+E-W) Project	**5**	**3**	**4**	**4**	**4**	**20**		**117**	**13.0**	**'30**	**31.4**	**31.0**	**-2.2**	**31.4**	✓
D3. Ard–Ayush west extension	3	5	1	3	2	14		23	33.2	'30	53.7	50.0	-1.1	53.7	
D4. Ajilchin Flyover Project	**5**	**5**	**5**	**4**	**4**	**23**		**89**	**23.9**	**'30**	**75.9**	**66.5**	**1.0**	**75.9**	✓
D5. Narnii Road East Extension	3	1	1	3	2	10	WB	21.6	-	'30	-6.2	-4.4	-2.4	-6.2	
E. Intersection improvement and maintenance															
E1. East side Intersection	4	3	4	4	3	17		33	12.5	'25	7.1	7.3	1.0	-1.2	
E2. Sapporo Intersection Grade Separation Project	**4**	**2**	**4**	**4**	**4**	**18**		**33**	**10.7**	**'25**	**40.6**	**28.3**	**2.1**	**10.2**	✓
E3. No. 17 Intersection	2	3	4	4	4	17		33	13.1	'25	11.2	8.0	0.6	2.7	
E4. West side Intersection	4	2	4	4	3	17		70	5.4	'25	5.2	9.4	-0.8	-3.4	
E5. Bayanburd Intersection Grade Separation Project	**5**	**4**	**4**	**4**	**4**	**21**		**33**	**15.0**	**'25**	**17.1**	**15.8**	**-0.1**	**1.3**	✓
F. Technical Cooperation Program															
F1. Improve public transportation	-	-	-	-	-	-	-	-	-	'30	1,131.8	828.8	61.6	241.5	
F2. Road Traffic Improvement Technology Enhancement Project	-	-	-	-	-	-	-	-	-	'30	724.8	611.5	4.1	109.2	
F3. Improvement of technology for planning and maintenance of urban drainage facilities	-	-	-	-	-	-	-	-	-	'30	-		-	-	
G. Traffic management and maintenance															
G1. Self-Actuated Signal Project	**4**	**5**	**5**	**4**	**5**	**23**	**-**	**11.4**	**-**	**'30**	**-**		**-**	**-**	✓

Source: JICA Study Team

The project location map for the selected projects is in Figure 5.4.

Source: JICA Study Team

Figure 5.4 Shortlisted (Proposed) Projects

5.2 Outline of the proposed project and site conditions

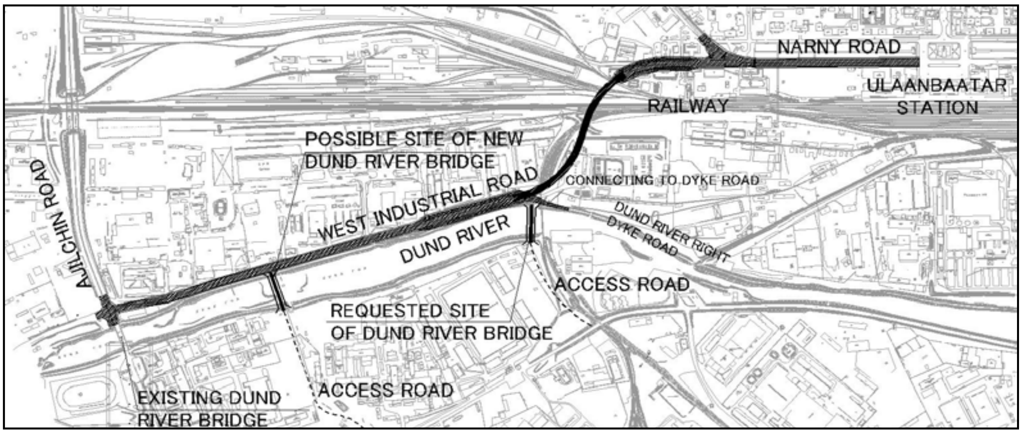
(1) Ajilchin Flyover Project

1) General

Based on the UBRD2030, this project will connect the missing link from Narnii Road to West Industrial Road, which has been disconnected by the UB Railway, and develop the East–West secondary arterial road parallel to Peace Avenue.
The traffic from Peace Avenue and Chinggis Avenue, which are the most congested roads in UB City, will be diverted to the new road that will mitigate the traffic congestion of both arterial roads. (Project Location: Bayangol District, Khan Uul District).

2) Project Site Condition

The project site is a 2.9-km road section that runs from the west end of Narnii Road to West Industrial Road across the UB railway. A preparatory survey, i.e., topographical survey, geological survey, underground investigation, preliminary design, as well as social and environmental survey were conducted under JICA in 2013 based on the assumption that the project would be implemented under the assistance of Yen Loan (STEP). The condition of the connecting road has not changed significantly since 2013. However, the Resettlement Action Plan (RAP) may need to be updated since some encroachment is observed after 2013 within the right-of-way (ROW).



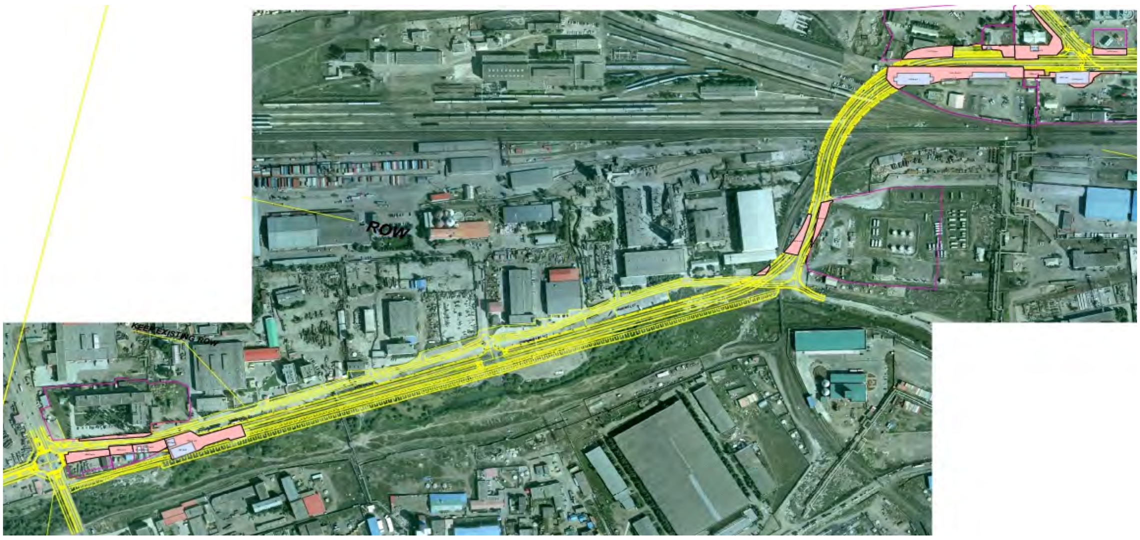
Source: "Report on Preparatory Survey for the Construction of Ajilchin Flyover Project in Ulaanbaatar City " (JICA, 2013)

Figure 5.5 Scope of the Project for the Construction of the Ajilchin Flyover

Source: JICA Study Team (as of August 2021)

Figure 5.6 Panoramic View of the Construction Site

According to the outcome of the environmental and social consideration survey conducted in the year 2013, it was confirmed that no resettlement would be expected. However, there will be land acquisition, and affected facilities shall be compensated.

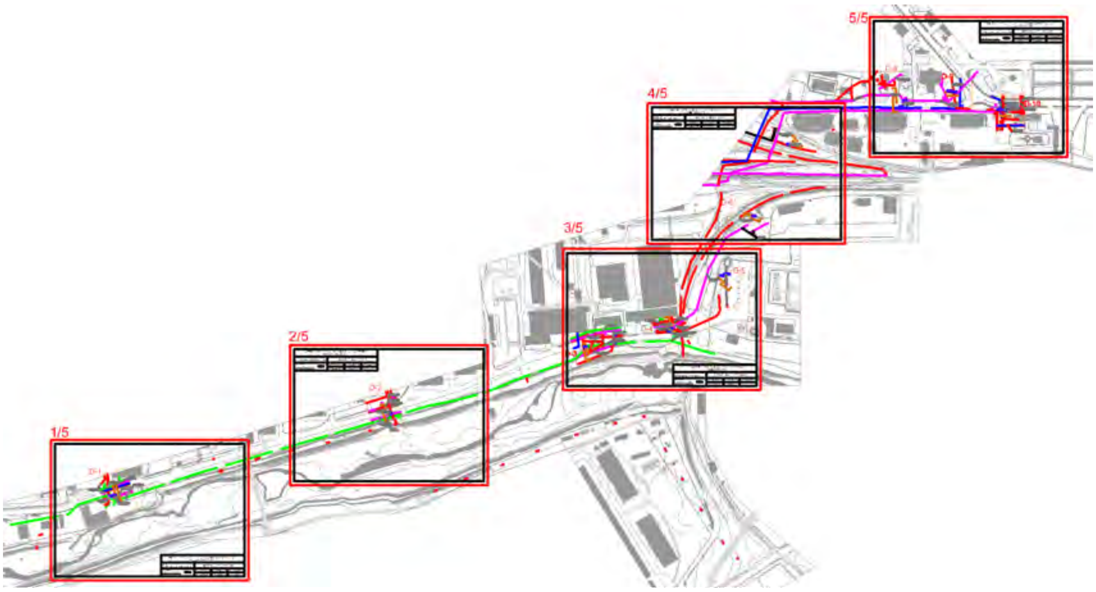


Source: "Report on Preparatory Survey for the Construction of Ajilchin Flyover Project In Ulaanbaatar City " (JICA, 2013)

Figure 5.7 ROW and Land Acquisition for the Project

3) Existing Utilities at the Project Site

During the preparatory survey of this project in 2013, a number of underground utilities such as heating pipe, water supply, sewerage pipe, power and communication cables including the power cables of the UB railway had been identified at the project site. In this regard, the relocation costs, works, and plans had also been outlined and prepared.



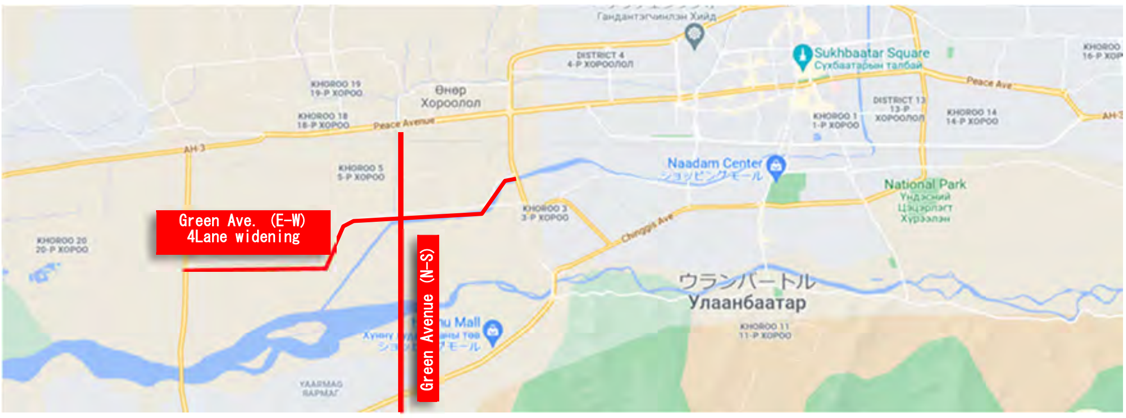
Source: "Report on Preparatory Survey for the Construction of Ajilchin Flyover Project in Ulaanbaatar City " (JICA, 2013)

Figure 5.8 Results of Underground Utility Survey

(2) Green Avenue (E-W+N-S) Project

1) General

The East–West Corridor will be formed together with Narnii Road and Ajilchin Flyover to divert the traffic volume concentrated on Peace Avenue and Chinggis Avenue by constructing a new 5-km road that will connect the currently developing subcenter of Yarmag District (southern part of UB City) to Peace Avenue in the north–south direction and widening the east–west road in front of the 4th thermal power plant to four lanes (location: Khan-Uul District, Bayangol District, Songinokhairkhan District).

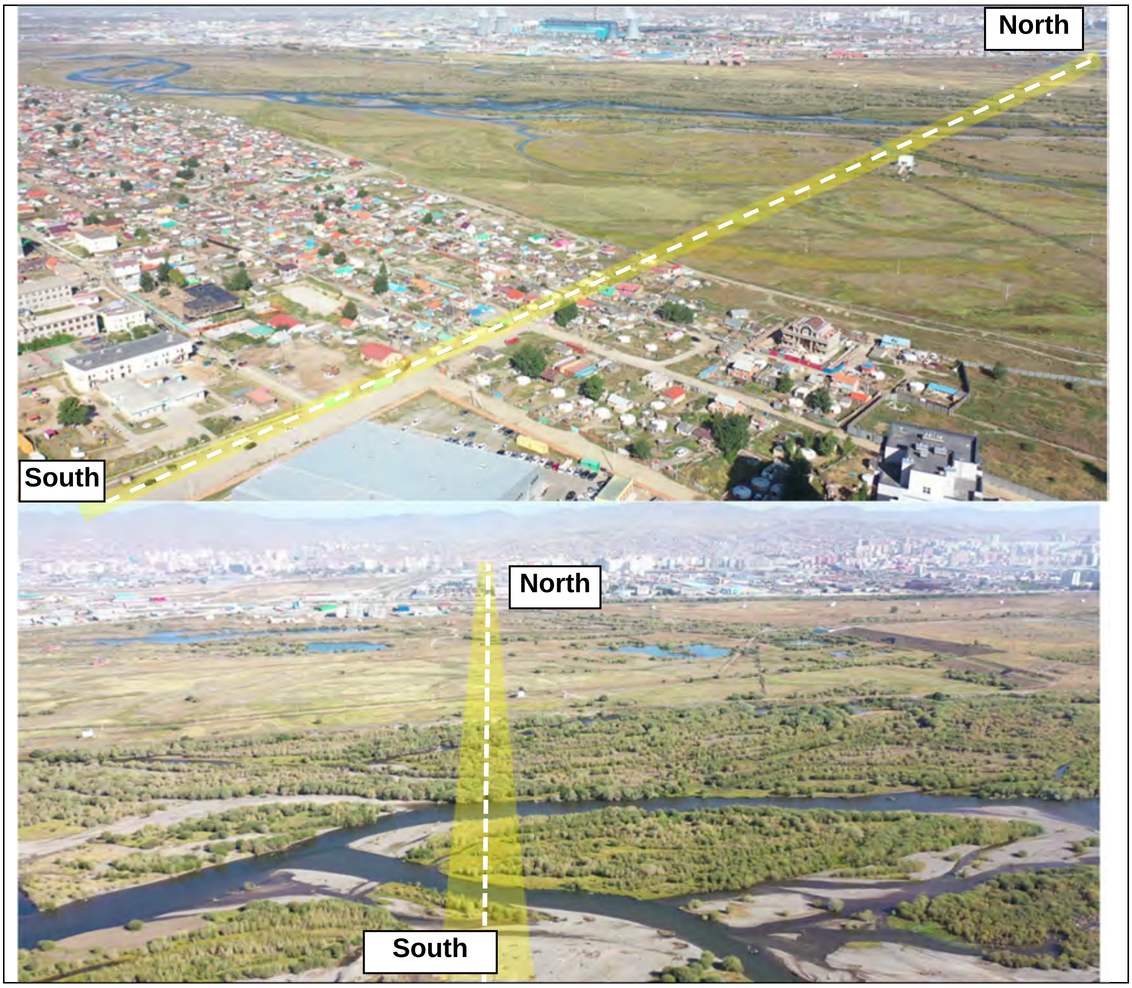


Source: Prepared by JICA Study Team based on Google Map

Figure 5.9 Location Map of Green Avenue (E-W+N-S) Project

2) Project Site Condition

The north–south line of the project site traverses at a designated environmental preservation area for water resources and also passes through the flood plain of the Tuul River, as explained in 3.6.1(3). The bridge extension must be carefully planned, taking into account the flood plain based on a 100-year return period, as introduced in Section 3.6.1.(4)2).



Source: JICA Study Team

Figure 5.10 Current Situation of Green Avenue (N-S: Tuul River Watershed)

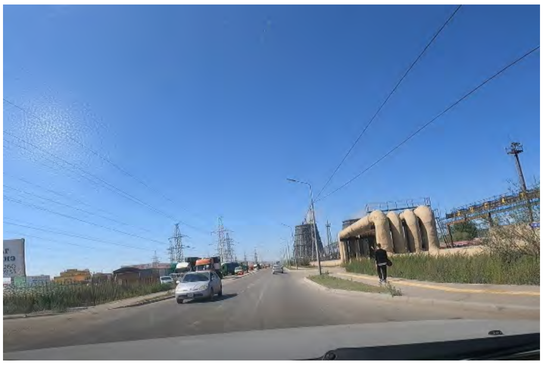
The railway crossing and junction of Peace Avenue will need to be in parallel to the drainage channel, which may result in the replacement of the channel if necessary. The junction of Peace Avenue is likely to require a grade-separated intersection to prevent congestion at the junction. There is a possibility that a large-scale viaduct will be required to fly over the railway and Peace Avenue.

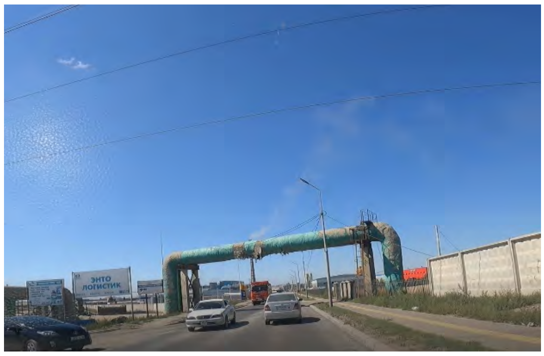
Source: JICA Study Team

Figure 5.11 Current Situation of Green Avenue (N-S: intersection of Railway and Peace Avenue)

The existing road in the East-West direction passing the front of the No. 4 thermal power plant is currently a two-lane road with the thermal power plant and factories at the roadside. Since the heating pipes from the power plant run parallel to the existing road, some will be affected and relocated to accommodate the widening of the existing road. In addition, it is necessary to consider the construction of sidewalks and drainage systems at the time of implementation since the road drainage system is not in place.

View of the existing 2 Lane Road





View of the hot water pipes extending from the No.4 thermal power plant.

Source: JICA Study Team

Figure 5.12 Current Condition of Green Avenue (E-W)

(3) Sapporo Intersection Grade-Separation Project

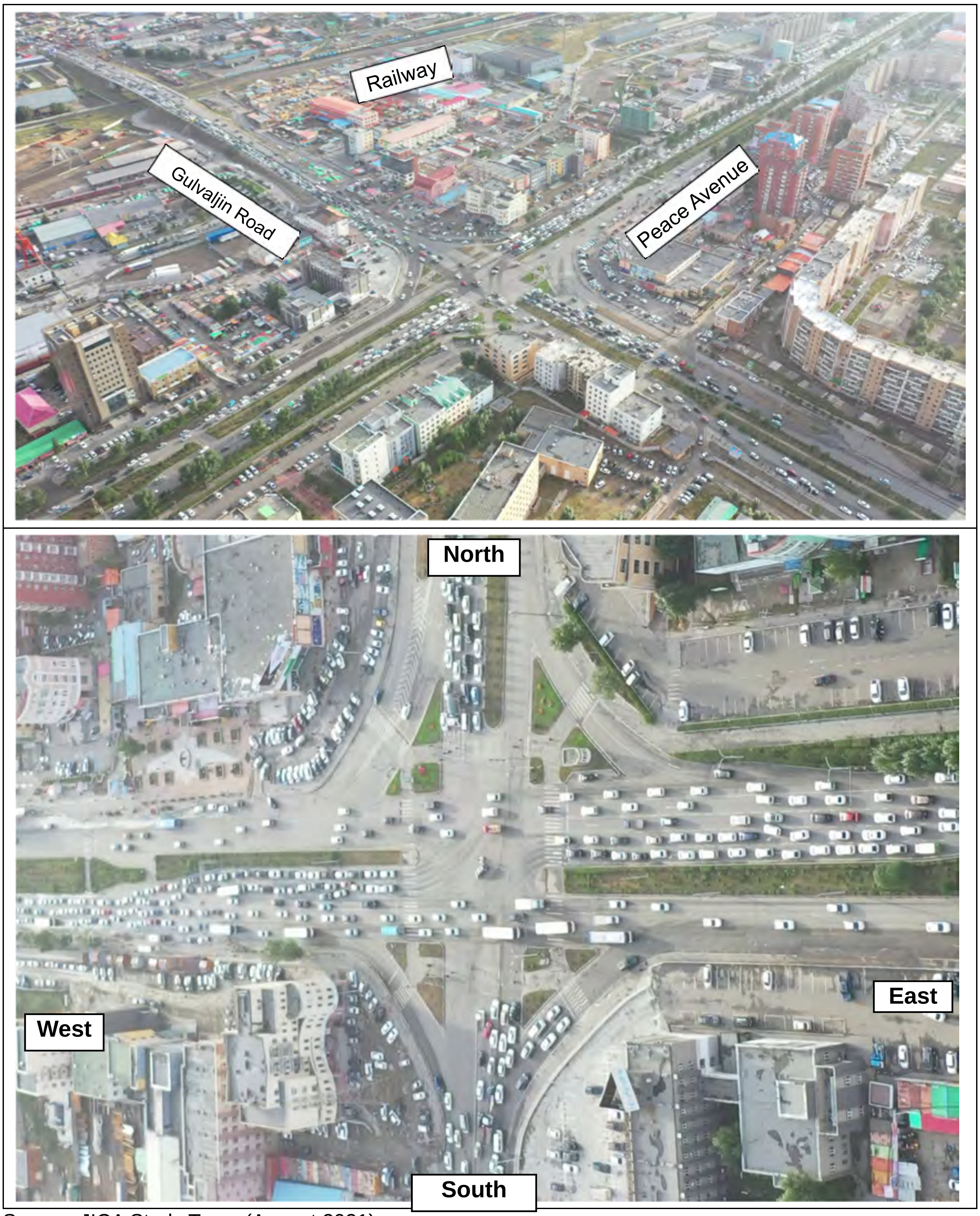
1) General

The Sapporo Intersection (at-grade intersection of Peace Avenue and Gulvarjin Road/Ard Ayush Road), which is one of the most congested intersections along Peace Avenue, will be improved by means of grade-separated intersection to eliminate the bottleneck in the intersection. The Sapporo Intersection was upgraded from a roundabout to a signalized 4-leg intersection under the Street Project conducted by the Ministry of Economic Development in 2015.

Source: Prepared by JICA Study Team based on Google Earth

Figure 5.13 Location Map of Sapporo Intersection Grade-Separation Project

2) Project Site Condition

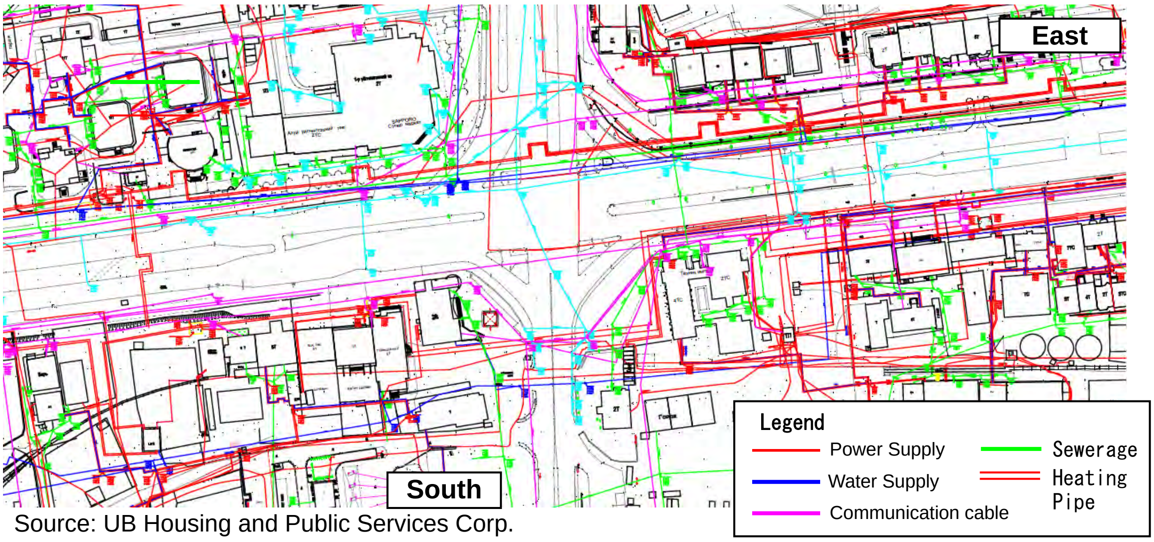


Source: JICA Study Team (August 2021)

Figure 5.14 Panoramic View of Sapporo Intersection.

3) Existing Utilities at the Project Site

Utilities such as heating pipes, water and sewerage pipes, power cables, communication cables and etc. have been observed at the underground of the construction site while power supplies (high-voltage cables), trolley bus overhead lines, etc. are the utilities visible above-ground. High-voltage power cables and pylons need to be carefully checked for the necessity of relocation when planning the grade separation (in case of fly-over) intersection. As for the overhead lines of trolley buses, it is necessary to confirm that they need to be relocated based on future plans of the trolley bus operation.



Source: UB Housing and Public Services Corp.

Figure 5.15 Underground Utilities at the Sapporo Intersection

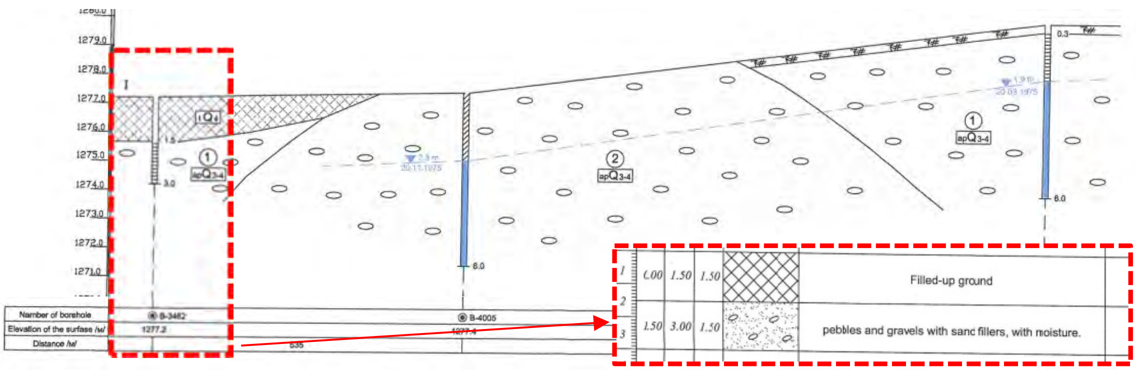
	
Pylon and high voltage lines extending in the North-South direction of the intersection	Trolley bus overhead line is extending in the direction of East-West of the intersection

Source: JICA Study Team (August 2021)

Figure 5.16 On-Ground Utilities at Sapporo Intersection

4) Geological Information

According to the existing geological survey data conducted in 2006, the ground surface depth of 1.0 m at the site is composed of filled-up material and soil is formed with relatively loose sandy soil of up to about GL-2.5m. The bearing layer of the foundation is expected to be deeper than GL-3m., but since there is no information about the standard penetration test, it is necessary to confirm in detail during the feasibility survey. The underground water level has been confirmed to be approximately 2.5 m below the existing ground level.



Source: Report on Engineering Geotechnical Investigation for The Basic Study on Urban Transmit Network at the City of Ulaanbaatar (2009).

Figure 5.17 Geological map near the Sapporo Intersection.

(4) Bayanburd Grade-Separation Intersection Project

1) General

The intersection of the secondary east–west arterial road (Tagusan Road) parallel to Peace Avenue plus the busy main ring road (Ikh Toiluu) will be improved by constructing grade-separated intersection to mitigate traffic congestion. The new grade-separation will contribute not only to elimination of the traffic bottleneck but also to improvement of traffic safety which is currently in hazardous condition due to existing roundabout.

Source: JICA Study Team based on Google Earth.

Figure 5.18 Bayanburd Intersection Location Map

2) Project Site Condition

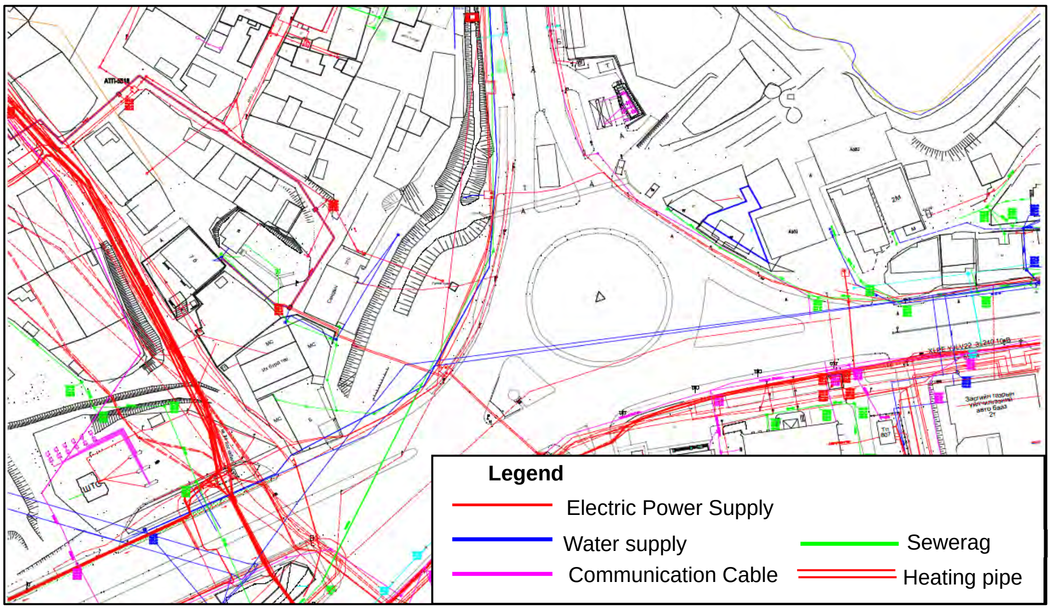
Located in one of the most heavily congested commercial areas, the roundabout intersection and signalized intersection are located adjacent to each other, which is one of the most hazardous intersections in terms of traffic safety. During construction, it will be important to provide detour routes to ensure the safety of existing traffic.

Source: JICA Study Team (August 2021)

Figure 5.19 Panoramic view of Bayanburd Intersection.

3) Existing Utilities at the Project Site

Underground utilities, including heating pipes, water and sewerage pipes, power cables, and communication cables, are observed at the project site. Only power (low-voltage) cables are seen on-ground along the sidewalks. Relatively, few utilities are expected to be relocated for this project.

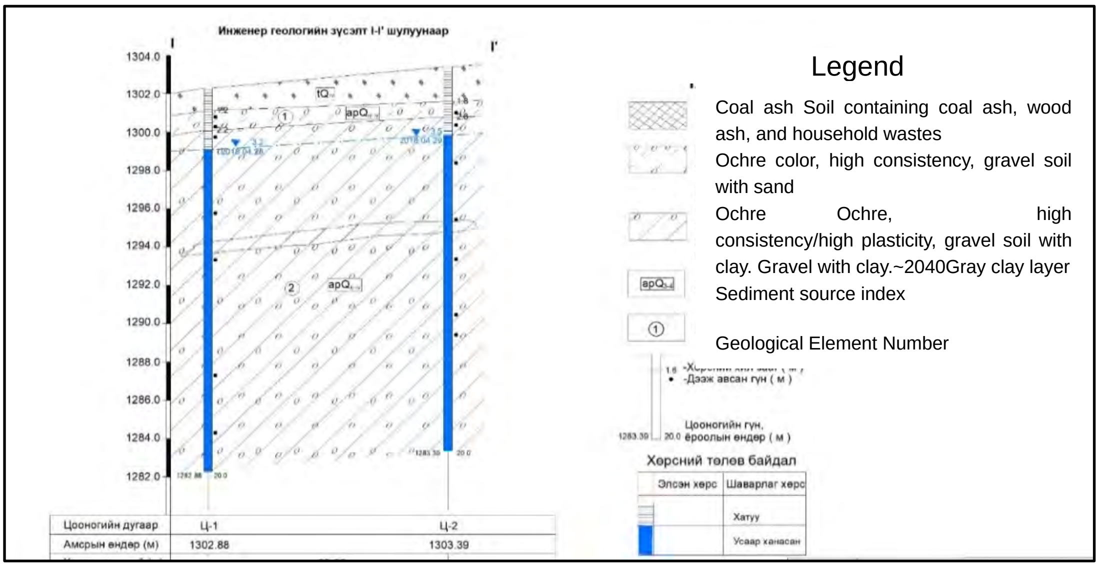


Source; UB Municipal Housing and Public Services Corp.

Figure 5.20 Underground Utilities at the Bayanburd Intersection

4) Geological information

According to the boring survey conducted during the construction of the neighboring building, the surface layer of approximately 1 m in sediment with low consistency and a slightly hard gravel layer intervenes up to a depth of 3 m. However, there is no information to confirm the strength of the stratum, such as standard penetration tests; therefore, it is necessary to conduct another boring investigation survey during the project implementation. Groundwater is generally confirmed at -3 m from ground level.



Source: SBD No. Geotechnical investigation report for 9Holu maintained apartment building.2018

Figure 5.21 Geological Map near the Bayanburd Intersection

5.2.2 Technical cooperation projects

Section 5.2.1 presented the infrastructure development projects. Organizations in UB City, as shown in Chapter 4, are lacking in coordination and knowledge and expertise in detailed technologies, making prior considerations impossible. Analysis and decision-making based on objective evidence, etc., are also lacking, which leads to worsening traffic congestion and reducing project effectiveness. Therefore, developing the capacity of technology and management through technical cooperation projects is important so efficient investments can be made in the end. In this section, three cooperation projects are presented: (i) Capacity Development for Public Transport Improvement, (ii) Capacity Development Project for Road Transport Improvement and Enhancement, and (iii) Capacity Development Project for Urban Drainage Planning and Management.

(1) Capacity Development Project for improvement of Public Transportation

It is necessary to review various aspects, such as strengthening the operation system of public transportation, improving the ability to implement traffic management measures, improvement of operation plans with many long routes and insufficient punctuality and frequency of operation, improvement of planning ability as well as improvement of operation service for the bus operations in UB city. Therefore, the technical assistance project “Ulaanbaatar City Public Transport Improvement Project” (tentative name) was proposed together with the development of bus lanes and bus terminals as shown in Table 5.4.

The WB also plans to implement a technical assistance project. Duplication must be prevented during implementation. Currently, although the items to implement in the technical assistance project have been raised, the specific activities and timing of implementation have not been decided.

＜The scale of the Project>

Assumed Input Man-Month (MM): Short-term experts: 60 MM

Target C/P Agency: UB City Urban Development Department, Traffic Planning and Coordination Engineering Department, Road Development Department, UB City traffic police, and Bus Company

Implementation Schedule: 36 months

Table 5.4 Overview of Technical Assistance Project（DRAFT）

Overall Goal:

Conversion from private to public transportation in UB City is enhanced.

Project Purpose:

The standard of bus service in UB City is improved.

Output Items:

Output 1: The management system for public transportation in UB City is strengthened.

Output 2: UB City's infrastructure for public transportation and capacity to implement traffic management measures is improved

Output 3: UB City's ability to study and plan for public transportation is improved

Output 4: Bus service in UB city is improved

Activities:

Activities related to Output 1

Activity 1-1	The financial status of UB city bus operators is improved.
Activity 1-2	Setting appropriate bus fares is considered.
Activity 1-3	The subsidies for public transportation in UB City are examined. (Procurement of financial resources that contribute to the self-sustaining development of public transportation projects)
Activity 1-4	Preferential policies for public transportation are considered.
Activity 1-5	The way bus operators are managed and operated will be improved.

Activities related to Output 2

Activity 2-1	Compliance and maintenance of bus lanes to ensure on-time public transportation is promoted.
Activity 2-2	Nodal points with terminal functions at four locations in the city are developed.
Activity 2-3	Development of bus stops that are easy to transfer to is promoted.
Activity 2-4	Traffic control and other measures to enforce traffic regulations such as illegal parking is enhanced.

Activities related to Output 3

Activity 3-1	An optimal public transportation network in UB City is proposed.
Activity 3-2	Data from IC cards and other devices to develop demand-based operation plans is used.
Activity 3-3	Inflow of people from the suburbs to the city center by using nodal points, setting up trunk and branch lines, etc., are controlled.
Activity 3-4	Monitoring of the established operation plan is conducted.

Activities related to Output 4

Activity 4-1	Education for bus operators (bus drivers) on safe driving in compliance with traffic laws is provided.
Activity 4-2	Public relations activities to promote the use of public transportation are conducted.
Activity 4-3	Bus services using ICT technology are examined.
Activity 4-4	Development of bus waiting facilities for cold weather is considered.

Source: JICA Study Team

(2) Capacity Development for Road Traffic Improvement in UB City

As detailed in 3.1.2, apart from insufficient road network, the cause traffic congestion in UB City is resulted from the lack of capacity in road planning and operation. Improvements are needed in many aspects, such as traffic signal control, lane operation, intersection planning, and behavior of road user. In addition, UB City has a policy to promote IT for the utilization of information and road traffic management based on the RFID system. The method to propose measures for traffic congestion based on such information will require well-trained human resources and organization.

Due to this, it is highly recommended to implement a technical cooperation project to mitigate the traffic congestion through such road planning, traffic management, behavioral manner seminar/training of road users and implementation of necessary traffic congestion measures from the aspects of road planning and traffic management.

＜The scale of the Project>

Assumed Input Man-Month (MM): Long-term experts: 36 MM; Short-term experts: 70 MM

Target C/P Agency : UB City Urban Development Department, Traffic Planning and Coordination Engineering Department, Road Development Department, Traffic Control Center (TCC)

Implementation Schedule: 36 months

Table 5.5 Outline of the Capacity Development for Road Traffic Improvement in UB City (Draft)

Overall Goal: To mitigate road traffic congestion in UB City.
Project Objective: The planning and management capacity of roads in UB City will be strengthened.
Output Items: Output 1: Issues related to road traffic congestion in UB City are identified. Output 2: Road planning capacity of UB City is enhanced. Output 3: Traffic management capacity of UB City is enhanced. Output 4: Manners of road users in UB City is improved.
Activities: **Activities related to Output 1** Activity 1-1 Investigate the role of the organization and division in charge for road planning, traffic management, policy making and etc. Activity 1-2 Identify Road traffic bottlenecks in UB city and specify priority issues. Activity 1-3 Identify traffic management issues in UB city and specify priority issues. Activity 1-4 Investigate the factors of traffic congestion caused by the manners of road users in UB city and specify priority issues. **Activities related to Output 2** Activity 2-1 Conduct technology transfer intersection planning Activity 2-2 Conduct technology transfer related to urban road maintenance technology Activity 2-3 Propose methods to increase road traffic capacity by optimizing the use of footway boundaries, shoulders, and stopping spaces. Activity 2-4 Introduce overseas examples to improve district roads of UB City. Activity 2-5 Develop guidelines for UB urban road planning. **Activities related to Activity 3** Activity 3-1 Identify issues and areas for improvement in traffic management facilities. Activity 3-2 Transfer technology on BIG data for the traffic obtained from RFID and other sources. Activity 3-3 Appropriate traffic signal optimization in UB city. Activity 3-4 Improve information dissemination to road users, such as traffic jam information.

Activities related to Output 4
Activity 4-1 Develop trends and statistics of vehicles violation of the law and formulate priority measures to improve traffic manners.
Activity 4-2 Introduce overseas examples of measures to strengthen control of vehicles violation.
Activity 4-3 Propose measures to strengthen cooperation between the traffic control center and the traffic police.
Activity 4-4 Conduct educational activities for citizens regarding the improvement of traffic manners.

Source: JICA Study Team

(3) Urban Drainage Planning and Management Technical Cooperation Project

As stated in Section 3.1.1(7), UB City has been suffering from floods annually. The flooding in UB City during the rainy season (June to August) is becoming more serious every year, and the flooded roads not only cause traffic congestion during the rainy season but also affect the lives of citizens. However, due to the lack of sufficient know-how and budget prioritization, the planning and construction of stormwater drainage facilities have not progressed sufficiently to support the development of the city. In order to improve the above situation, it is recommended to establish technical cooperation that will undertake the improvement of the stormwater drainage function in UB City, which will ultimately reduce the damages of the road caused by flood and reduce traffic stoppage during the rainy season.

＜The scale of the Project＞

Assumed Input Man-Month (MM): Short-term experts: 70 MM

Target C/P Agency: UB City, Geodesy and Water Facility Department (GWFD), Urban Development Department, Road Development Department

Implementation Schedule: 36 months

Table 5.6 Draft Project for Technical Cooperation on Urban Drainage Planning and Management

Overall Goal: Urban drainage in Ulaanbaatar is improved.
Project Objectives: Improving the management capacity of the GWFD for urban drainage projects in Ulaanbaatar
Outputs: Output 1: Capacity to develop plans for stormwater drainage facilities is strengthened. Output 2: Ability to manage stormwater drainage using GIS is improved. Output 3: Asset management for the management of stormwater drainage is introduced Output 4: Implementation capacity for the operation and maintenance of stormwater drainage facilities is strengthened Output 5: The internal training system of the GWFD is strengthened.
Activities: **Activities related to Output 1** Activity 1-1 Identify the current status of stormwater drainage measures currently being implemented by the GWFD. Activity 1-2 Based on the issues identified in 1-1, the GWFD will compile the methods and procedures to effectively and efficiently implement stormwater drainage measures in UB City in the future. Activity 1-3 Compile the details of the development of facilities necessary to implement the methods and procedures proposed in 1-2. Activity 1-4 Compile the organizational, institutional, and financial reforms necessary to implement the methods and procedures proposed in 1-2.

Activity 1-5	Prepare the implementation schedule based on priorities for the improvement of facilities and organizational, institutional, and financial reforms summarized in 1-3 and 1-4.
Activity 1-6	Prepare a basic plan for the development of storm water drainage facilities in UB City based on the contents of 1-1 to 1-5.
Activities related to Output 2	
Activity 2-1	Define the plan and operation method by using GIS.
Activity 2-2	Maintain inventory data and GIS database.
Activity 2-3	Provide training on GIS operations (OJT: on-the-job training).
Activity 2-4	Compile information of maintenance planning and facility information (manholes, catch basins, pump stations, population, drainage area, etc.) for each drainage management area.
Activity 2-5	Develop a drainage plan based on GIS and actual drainage conditions.
Activity 2-6	Create Standard Operating Procedures (SOPs) for GIS data entry and update.
Activity 2-7	Update GIS data as a matter of routine.
Activities related to Output 3	
Activity 3-1	Conduct a seminar on the introduction of asset management for executives of the GWFD.
Activity 3-2	Select a pilot parcel for asset management.
Activity 3-3	Evaluate the soundness of the drainage pipeline in the pilot area.
Activity 3-4	Plan renewal scenarios based on the results of the health assessment.
Activity 3-5	Conduct a risk assessment of drainage pipelines in the pilot area.
Activity 3-6	Based on the risk assessment, conduct a priority assessment using a risk matrix.
Activity 3-7	Develop an inspection and investigation plan for drainage pipeline facilities.
Activity 3-8	Develop an "Asset Management Basic Plan" to maintain and manage drainage facilities.
Activities related to Output 4	
Activity 4-1	Select a pilot area to improve stormwater drainage facilities.
Activity 4-2	Investigate the current status of the pilot area through review of existing drawings, etc., and field inspection.
Activity 4-3	Formulate a pilot project implementation plan (including the schedule) for the pilot area.
Activity 4-4	Establish a quantitative baseline for the pilot area.
Activity 4-5	Assist in the design of drainage facilities to improve conditions in the pilot area.
Activity 4-6	Implement stormwater drainage measures in the pilot area.
Activity 4-7	Monitor the status of stormwater drainage in the pilot area and prepare a project report.
Activity 4-8	Prepare a "Stormwater Drainage Facility Maintenance Manual" regarding the methods and equipment acquired through the pilot project, introduce it at a seminar, and share it within GWFD.
Activities related to Output 5	
Activity 5-1	Identify training needs for the GWFD.
Activity 5-2	Develop an overall training program (systematic map) required by the GWFD.
Activity 5-3	Create a training database (assume Excel) to be conducted by the GWFD.
Activity 5-4	Create an internal training supervision manual.
Activity 5-5	Conduct training on training supervision for staff in charge of internal training.
Activity 5-6	Develop a training plan (training modules) in coordination with the technical staff responsible for training in the Bureau of Surveying and Stormwater Facilities.
Activity 5-7	Prepare for the training in cooperation with the technical staff in charge of training in the GWFD, including the preparation of teaching materials and the study of methods for measuring the effectiveness of the training.
Activity 5-8	Conduct training of trainers (TOT).
Activity 5-9	Analyze the results of each training program and provide feedback for the next training plan.

Source: JICA Study Team

5.3 Issues on Implementation of the Project to be Addressed

5.3.1 Survey and Relocation Plan for Underground Utility

Many underground and overhead utilities need to be relocated during the Project. Currently, the following organizations will be subject to coordinate to make a necessary survey as well as a plan for relocation and to discuss time schedule of the relocation for smooth implementation of the Project.

Table5.7 Utility Administration Offices in UB City.

<table>
<tr><th>Type of Utility</th><th>Type of Utility Lines</th><th>Office to be Coordinated</th></tr>
<tr><td>Heating Pipe</td><td>Pipe, manhole</td><td>Ulaanbaatar Heating Distribution Network Company;
Housing and communal service authority in UB City</td></tr>
<tr><td>Water Supply</td><td>Pipe, manhole</td><td>The Water Supply and Sewerage Authority</td></tr>
<tr><td>Sewerage System</td><td>Pipe, manhole</td><td>The Water Supply and Sewerage Authority</td></tr>
<tr><td rowspan="2">Power Supply</td><td>High voltage power lines (overhead, underground), Pylon</td><td rowspan="2">Ulaanbaatar Electricity Distribution Network Company; Energy Authority</td></tr>
<tr><td>Low voltage: power lines (overhead, underground)</td></tr>
<tr><td>Communication Cable</td><td>Cable (overhead, underground), pit</td><td>ICT Network Company</td></tr>
<tr><td>CATV</td><td>Main cable, sub-cable, pit</td><td>ICT Network Company</td></tr>
<tr><td>Gas station</td><td>Tube, pit</td><td>Ministry of Mining and Heavy Industry</td></tr>
<tr><td>Drainage</td><td>Pipe, manhole</td><td>Water Facility Public Corporation</td></tr>
<tr><td rowspan="2">Railway</td><td>Railway track</td><td>Ulaanbaatar Railway (UBTZ)</td></tr>
<tr><td>Power cable, communication cable, etc.</td><td>UBTZ
Electric Power Department</td></tr>
<tr><td>Trolley Bus</td><td>Overhead line</td><td>UB City Metropolitan Passenger Transport Corporation Regional Property Office</td></tr>
</table>

Source: JICA Study Team

Relocation of utilities for any infrastructure project in Ulaanbaatar City is conducted in accordance with the following procedures after approval of the project implementation. The relocation work and its management are conducted under the responsibility of UB City. The relocation plan should be made at the same time of the Detailed Design of the Project, and the relocation work should be completed prior to start of the Construction Work.

- STEP-1 Engineering Facility Department in UB City asks administration offices of the objective utilities for specific design and cost estimate for required relocation.
- STEP-2 Each administration office of the utility orders specific design to the local consultant.
- STEP-3 Specific design and relocation costs prepared by the local consultant are submitted to UB City.
- STEP-4 UB City approves the budget for relocation.
- STEP-5 UB City orders the relocation work to a local contractor.

5.3.2 Land Acquisition

In case land acquisition is required for the construction of infrastructure, it is important to acquire the land to prevent delays in the implementation schedule. After completion of F/S of the project, prompt staking of the R.O.W. with the announcement of cut-off date based on Land Acquisition and Resettlement Action Plan to control further land use by new parties is important for smooth land acquisition for the Project. It is also important to periodically monitor the procedures of land acquisition undertaken by the Working Group composed of the chief of the municipality and Khoroo, Road Development Department, and Land Administration Department of UB City in collaboration with NGOs, to confirm its progress without any delay.

5.4 Comparison of Candidate Projects and Selected Priority Project

5.4.1 Comparison of Candidate Projects

While various projects have been proposed in UB City, many plans had to be stopped for reasons including financial resources. Therefore, the selection of priority projects is important to promote implementation by efficient and concentrated investments. When selecting among priority projects, it is also very important to understand how much the combination of projects will generate the effect (whether synergies will generate or new congestion will occur, etc.) because in long future, traffic congestion will be more serious.

In this study, it is possible to estimate the benefits of prioritizing projects by using the demand forecast results. The method can contribute to a more objective explanation. As mentioned in Section 4.1, there are many comprehensive plans proposed in UB City, but the objective evidence with extensive consideration is not shown in many cases. Therefore, this kind of analysis can provide a basis for project justification in future.

This section analyzed the combined effects of the short-listed projects and assessed the effects to select the priority projects. Table 5.8 shows the comparison of benefits between E5. Bayanburd Intersection Grade Separation Project and E2. Sapporo Intersection Grade Separation Project to be developed in 2025. It also shows the comparison of benefits between D2. Green Avenue (N-S+E-W) Project and D4. Ajilchin Flyover Project to be constructed by 2030 after developing E2 and E5.

As a result of comparing Estimation No. 1 and No. 2, E2. Sapporo Intersection Grade Separation Project generates greater benefits than E5. Bayanburd Intersection Grade Separation Project. Comparing D2. Green Avenue (N-S+E-W) Project and D4. Ajilchin Flyover Project, the benefits of D4 are higher than that of D2.

Table 5.8 Estimation Results for Effects of Multiple Projects

Estimation No.	Estimate Year	Total cost (mill. USD)	E5. Bayanburd Intersection Grade Separation Project	E2. Sapporo Intersection Grade Separation Project	D2. Green Avenue (N-S+E-W) Project	D4. Ajilchin Flyover Project	G1. Self-Actuated Signal Project	Benefit (Bil.Tg/Year)			
								Total	TTC	VOC	Environ-ment
1	2025	44.4		✓			✓	40.6	28.3	2.1	10.2
2	2025	44.4	✓				✓	17.1	15.8	-0.1	1.3
3	2030	160.4	✓	✓		✓	✓	146.4	139.6	-5.5	12.3
4	2030	194.4	✓	✓	✓		✓	117.5	107.6	-5.7	15.6
5	2030	277.4	✓	✓	✓	✓	✓	210.4	198.2	-8.5	20.7
6	2030	116.0		✓		✓	✓	129.3	123.8	-5.4	11.0

Source: JICA Study Team

Estimation No. 6 is a reference value obtained by the difference between No. 2 from No. 3 on the assumption that the benefits of No. 2 in 2025 will be of the same level as after 2030.

5.4.2 Synergy Effect of the Ajilchin Flyover Project and Green Avenue Project(E-W) Project

Among the priority projects, the Green Avenue (E-W) Project (D2) and the Ajilchin Flyover Project (D4) will form an East–West Corridor of secondary arterial road parallel to Peace Avenue, with a significant synergistic effect if both are constructed.

As shown in Table 5.8, No. 3 (Intersection + Ajilchin Flyover) and No. 4 (Intersection + Green Avenue(E-W)) have been estimated to generate a large benefit for individual cases, whereas No. 5 (development of Ajilchin Flyover and Green Avenue(E-W)) resulted in a maximum benefit (210.4B.Tg / Year) without any cancellation of each benefit and effect.

As a result, it can be concluded that the Ajilchin Flyover Project and the Green Avenue (E-W) Project have very high synergistic effects and will have significant impacts on mitigating traffic congestion in UB City. On the other hand, it has been confirmed that implementing each project independently has sufficient economic feasibility in terms of EIRR, as will be shown in section 6.1.7 in the succeeding chapter.

6 Proposals for Priority Projects supported by JICA

Based on the consultation with JICA for the candidate projects, additional information for the priority projects is provided as shown below.

6.1 Project for Improvement of Secondary Arterial Road and Congested Intersection

Among the projects shortlisted, through the discussion with JICA, the following were chosen as priority projects to be implemented under the JICA Yen Loan Project, which could be concurred with the Government of Mongolia: 1) Ajilchin Flyover Project, 2) Green Avenue (E-W) Project, 3) Sapporo Intersection Grade Separation Project, 4) Bayanburd Intersection Grade Separation Project, and 5) Self-Actuated Traffic Signal Project. The following provides an overview as well as specifics about each project.

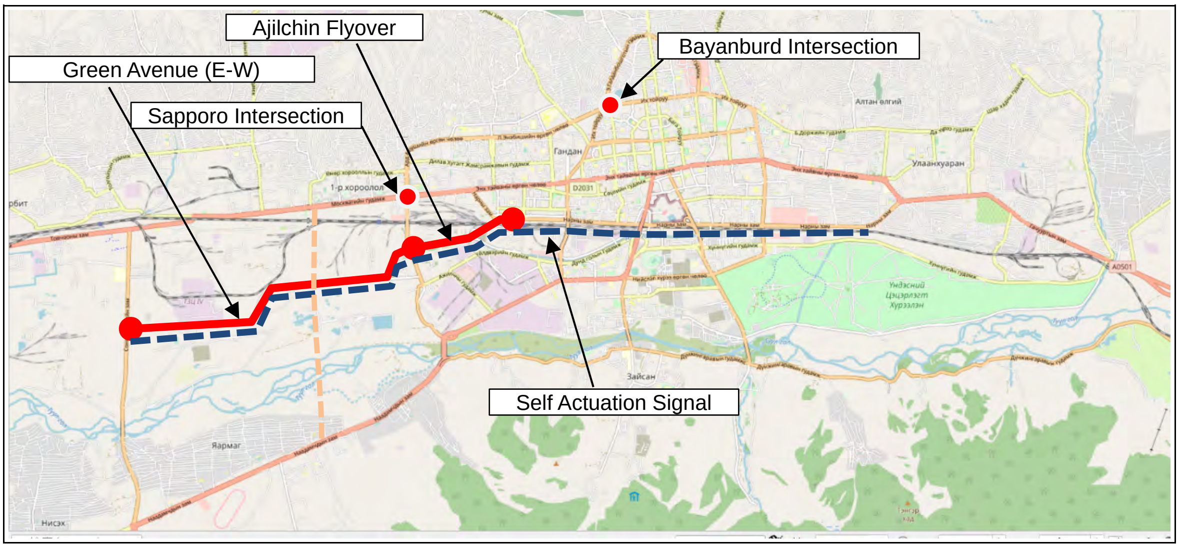
6.1.1 Project Overview

In accordance with the UBMP2040 and UBRD2030, these projects aim to develop the secondary arterial roads in the East-West direction parallel to Peace Avenue, alleviating and diverting traffic from the congested existing arterial road and improving bottleneck intersections. The main contents of the project are as follows.

Table 6.1Summary List of Priority Projects

Project Title	Project Overview	Number of Lanes	Remarks
(1) Ajilchin Flyover Project	Length of Improvement: 2.34 km Railway Overpass: 828 m East approach road: 514 m West approach road: 1000 m	4 lanes	
(2) Green Avenue (E-W) Project	Widening of existing roads: 6.00 km (2 to 4 lanes) Intersection maintenance: 3 locations	4 lanes	North–South line will be implemented by UB City, East-West widening is targeted
(3) Sapporo Grade Separation Intersection Project	Viaduct construction: 105 m Approach road: 230 m (115 m × 2)	4 lanes	
(4) Bayanburd Grade Separation Intersection Project	Viaduct construction: 110 m Approach road: 236 m (118 m × 2)	4 lanes	
(5) Self-Actuated Signal Control Project	The signals shall be installed along the Green Avenue (E-W Line) to the Ajilchin Flyover and Narnii Road (16 locations) to reduce congestion at the intersection bottlenecks in the East–West Corridor.	-	

Source: JICA Study Team



Source: JICA Study Team

Figure 6.1 Location Map of Priority Projects

6.1.2 Estimated Project Cost

(1) General

The project costs were estimated using April 2021 price data. The major unit prices of each material, etc. were calculated by applying the inflation factor to the cost estimated in the Preparatory survey for the construction of the Ajilchin flyover project in Ulaanbaatar City conducted in 2013 (see 6.1.2 (2)).
Soaring crude oil prices, rising global transportation costs as a result of the COVID19 pandemic, stagnation of cross-border transportation in China, and changes in market prices of steel products as a result of China's reduced crude steel production will pose a risk to increase project cost in the future. Therefore, a careful cost estimate is required during feasibility study toward project implementation.

Table 6.2 Estimated Project Cost

	Construction (M.USD)	Utility Relocation (M.USD)	Land Acquisition (M.USD)	Contingencies (M.USD)	Consultant Fee (M.USD)	Total (M.USD)
(1) Ajilchin Flyover Project	66.7	2.3	5.9	4.7	8.0	87.6
(2) Green Avenue (E-W) Project	9.0	2.0	5.9	0.6	1.1	18.6
(3) Sapporo Grade Separation Intersection Project	25	0.9	2.2	1.8	3.0	32.8
(4) Bayanburd Grade Separation Intersection Project	25	0.9	2.2	1.8	3.0	32.8
(5) Self Actuation Signal Control Project	9.6	0.0	0.0	0.7	1.2	11.4
Total	135.3	6.1	16.2	9.6	16.3	183.2

Note:
Utility Relocation Cost: referred from Preparatory Study for Ajilchin Flyover Construction Project (2013)
Land Acquisition Cost; referred from Preparatory Study for Ajilchin Flyover Construction Project (2013)
Price increase and reserve cost   Construction cost x 7%
Design/construction management fee   Construction cost x12%
1.0 USD = 110.21 JPY (as of April 2021)
1.0 JPY = 0.04206 MNT (as of April 2021)

(2) Price Escalation Factor from 2013

The amount in "Preparatory survey for the construction of Ajilchin flyover project in Ulaanbaatar City (2013)" is referred to in the estimated project cost. As a result of the local price survey, a price escalation rate of 12–42% is assumed against the cost estimated in 2013, as shown in Table 6.3.

Table 6.3 Price Escalation Rate (Base Cost 2013)

Area of Procurement	Cost Item	Esclation Rate	Share	Applicable Escalation Rate
Mongolia	Labor cost	1.55	34.80%	1.31
	Material Cost	1.13	35.60%	
	Machinery Cost	1.23	29.60%	
Japan	Steel Material	1.16		1.16
	General Construction Materials	1.12		1.12
	Transportation Cost	1.42		1.42
	Direct Labor Cost	1.31		1.31

Source: JICA Study Team

(3) Expected Measures for Cost Saving

The Ajilchin Flyover Project, Sapporo Grade Separation Intersection Project, and Bayanburd Grade Separation Intersection Project are all expected to construct a large-scale bridge that will entitle special construction on railway tracks and/or in congested intersections. As a result, maintaining safe and high-quality construction while also shortening the construction period with an effective cost-savings approach is critical, as presented below. It is necessary to check the local conditions and make a detailed cost estimate based on the most recent information at the time of project implementation. The following shows the possibility of a reduction of cost.

1) On-site Fabrication of Steel Girders

In UB City, a local steel fabrication company (UBKK) has been increasing its production capacity. As a result of the investigation, it is reasonable to expect that UBKK has the capability to fabricate I-shaped steel girders locally under the quality control of the Japanese fabricator, as long as they are simple shape girders. Therefore, it is reasonable to expect a significant reduction in the fabrication and transportation costs of the I-girder section through the on-site fabrication.

Source: JICA Study Team (August 2021)

Figure 6.2 Steel Member Fabrication Workshop in UBKK

2) Utilization of Precast PC Deck Slabs

In addition to steel products, the UBKK also fabricates concrete precast members and has a concrete production facility (including steam curing facilities for the winter season) in the workshop. As a result, there is a high possibility that precast PC Deck Slabs, which are highly durable and have been widely used in Japan, can be fabricated relatively at a lower cost than in Japan. During the project implementation, it is recommended to consider the possibility of cost-saving and shortening the construction period by using Precast PC Deck Slabs.

Source: JICA Study Team (August 2021)

Figure 6.3 Precast Concrete Workshop in UBKK.

(4) Maintenance and Operation Cost

This project will include the construction of a bridge, road pavement, traffic signals, and street lighting. Regular inspections of bridge structures will be performed every five years, and necessary repairs to concrete, painting and other facilities (expansion joint, drainage facilities, bearings bad, etc.) will be made. In the road area, it is expected that cracks in the pavement will be repaired on a regular basis based on the results of regular inspections, and that the pavement will be renewed or overlayed every 10 years. Assuming these maintenance practices, the project's average yearly maintenance cost is assumed to be 1% of the construction cost.

6.1.3 Project Schedule

The project implementation schedule shall be formulated based on the following assumptions. Although each project (1) to (5) has common contents except for the implementation schedule, in this study, the construction work under one (1) package program is assumed to be planned.

(1) JICA Preparatory Survey

A JICA Preparatory Survey shall be conducted before the implementation of the Project. The survey shall mainly consist of the following. It shall mainly consist of the geological and environmental surveys within 12 months, assuming it will start from April to avoid the coldest period. The conclusion of E/N and L/A can be accelerated if the appraisal is implemented in parallel with the preparatory survey.

- Natural condition survey (meteorology and hydrology survey)
- Site survey: topographic survey, geotechnical survey, underground utility survey, traffic count survey (as needed)
- Review of traffic demand forecast
- Basic engineering design
- Environmental and social consideration survey (EIA and Resettlement Action Plan)
- Construction planning
- Project cost estimate
- Formulation of project implementation schedule

Assuming that the JICA Preparatory Survey for this project begins in April to avoid interruptions and delays in field activities caused by the winter season, the total time will be 12 months to complete all activities, such as topographic survey, geological survey, and environmental survey, among others, as well as engineering design and cost estimate. It is also possible to expedite the process and conclusion of the exchange of notes (E/N) and loan agreement (L/A) by conducting the project appraisal concurrently with the JICA preparatory survey.

(2) Selection of Consultants

After concluding the L/A, the request for proposal (RFP) will be issued to the Consultants. The timeline for proposal preparation, bid evaluation, approval, contract negotiation, and signing of contract agreement will be conducted within six (6) months.

(3) Detailed Design

The selected Consultant must finalize the Definitive Plan within five (5) months after the start of work after reviewing the topography survey report and traffic volume data, and the final report based on the completion of Detailed Design shall be delivered after twelve (12) months from the commencement of work. The preparation of the bidding documents and the government approval process must also be included and considered during the twelve (12) month period.

(4) Land Acquisition and Relocation of Existing Utilities

Land acquisition shall start immediately after formulation of the Definitive Plan, and shall be completed in twelve (12) months, prior to the selection of the Contractor. The utility relocation is scheduled to commence after the Detailed Design under the supervision of the Utility Department of UB City, and the relocation work is scheduled to be completed within seven (7) months before starting of the winter season.

(5) Selection of the Contractor

The following procedures and duration are assumed for the Contractor selection. To reduce the time required for the bidding process, the Contractor's pre-qualification may begin after the Definitive Plan but before the Detailed Design is finalized.

[Pre-Qualification Screening (PQ)]

-PQ document preparation/approval	1.5 Months	
-PQ preparation period	1.5 Months	Total 5.0 Months (during Detailed Design)
-PQ evaluation/approval	2.0 Months	

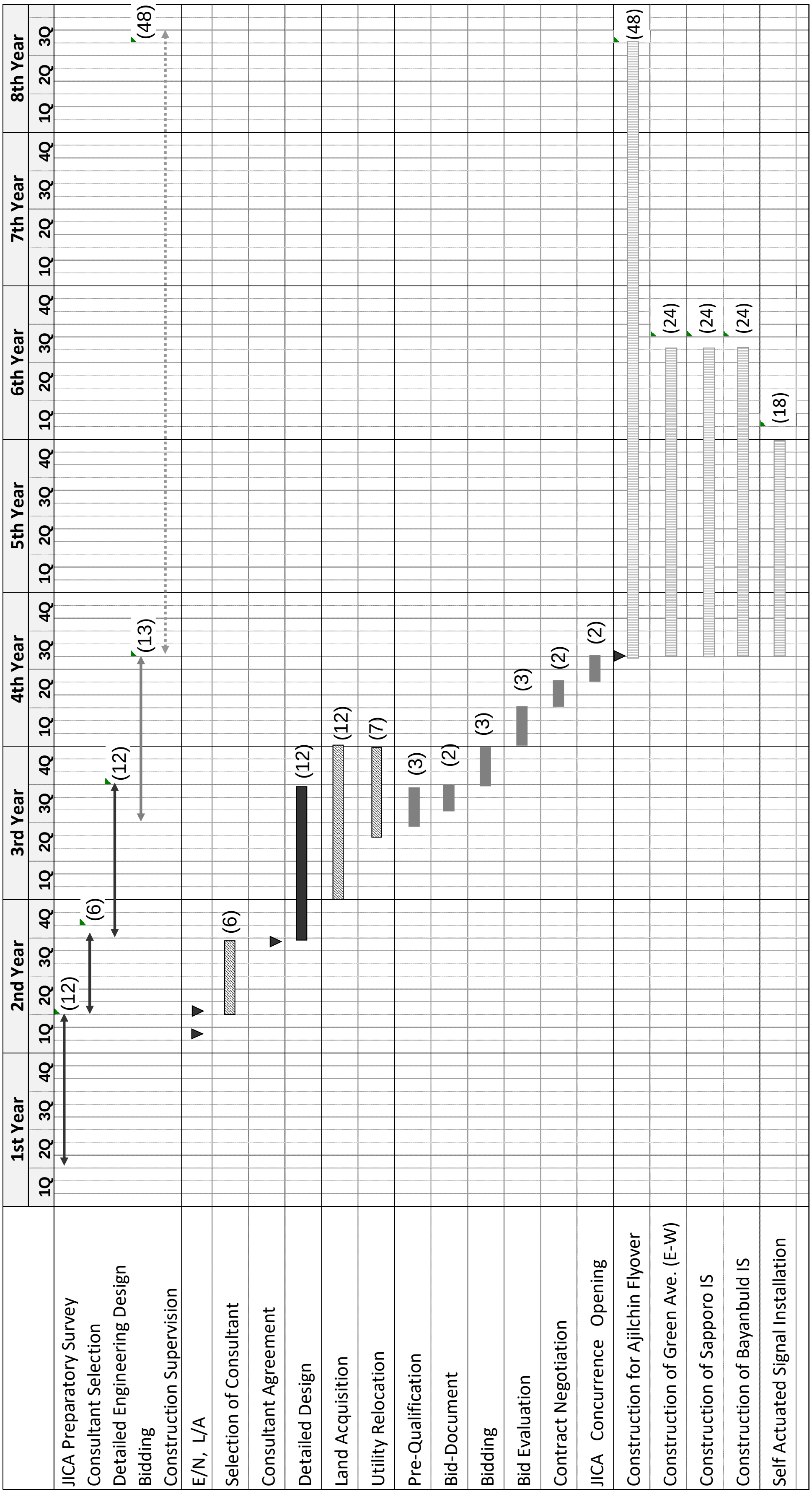
[Bidding]

-Bid Preparation period	3.0 Months	
-Bid Evaluation/Approval	3.0months	Total 10.0 Months
-Contract Negotiation/Approval	3.0 Months	
-L/C opening	1.0 Months	

The bidding document preparation and approval process shall be part of the Detailed Design.

(6) Construction Work

The construction period is estimated to be (1) 48-month for the Ajilchin Flyover Project, (2) 24 months for the Green Avenue (East-West Line), (3) 24 months for the Sapporo Grade Separation Intersection Project and (4) 24 months for the Bayanburd Intersection Grade Separation Project, and (5) 18 months for the Self Actuation Signal Control Project. However, depending on the contract's timing, it may be necessary to adjust construction period according to the construction plan because the schedule may be significantly affected by the winter season and depending on the season when the construction would be commenced.



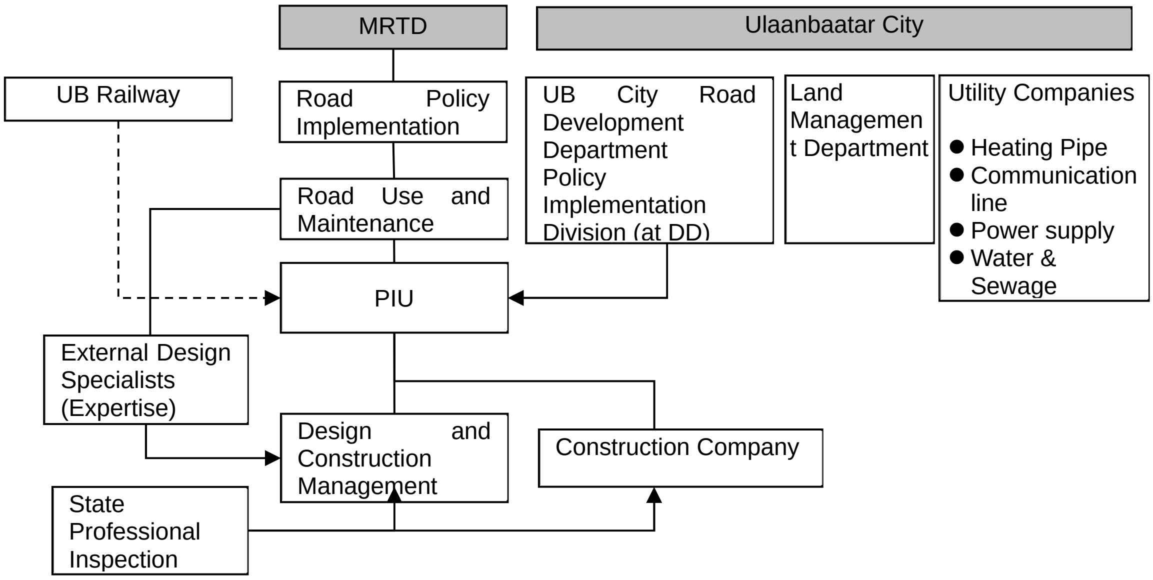
Source: JICA Study Team

Figure 6.4 Project Implementation Schedule

6.1.4 Implementation Organization Structure

According to the Mongolian Law on Coordination of Foreign Loans and Grant Aid (2003), the project implementation system of the Mongolia for foreign funded projects is required to organize the Project Implementation Unit (PIU) with implementing agency (UBC and/or MRTD) to manage the Project.

In the case of road projects in UB City, on the other hand, the role of the UB City as the implementing agency is critical in order to coordinate with adjacent road projects, relocation of underground utilities, and land acquisition. As a result, it is critical that the PIU shall be organized from the start of the Detailed Design and collaborate with the staff of the UB City Road Development Department as well as the staff who is in charge of the utility relocation and land acquisition. The Self Actuation Signal Project will be implemented concurrently with the road improvement works under the same organizational system.



Source: JICA Study Team

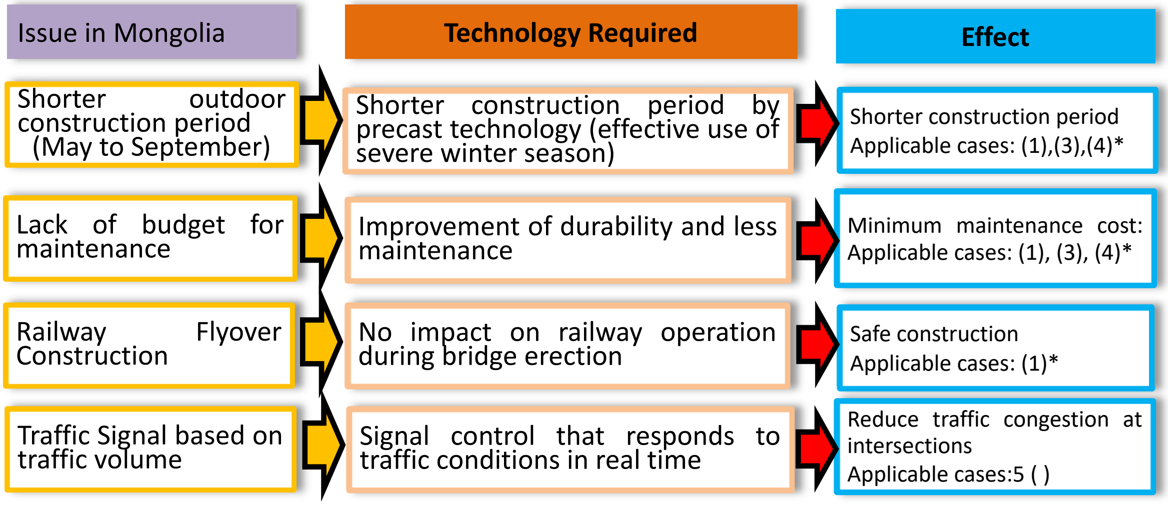
Figure 6.5 Project Implementation Structure

6.1.5 Operation and Maintenance Management System

During the construction of the Project, a Project Implementation Unit (PIU) comprised of the MRTD and/or UB City Road Development Department will be formed. After the completion of the Project, it will be transferred to UB City, and the UB City Road Development Department will be in charge of its maintenance and management. The UB Traffic Control Center (TCC) will be in charge of the maintenance and management of the traffic signal system.

6.1.6 Japanese Technologies expected to be utilized

The Japanese technologies that can effectively respond to Mongolia’s problems will be used. The following is a description of the issues associated with Mongolian road and bridge construction projects, as well as the corresponding Japanese technologies that may be applied to the Project.



Applicable projects; (1) Ajilchin Flyover Construction Project, (2) Green Avenue (E-W) Project, (3) Sapporo Intersection Project, (4) Bayanburd Intersection Project, (5) Self-Actuated Signal Project

Source: JICA Study Team

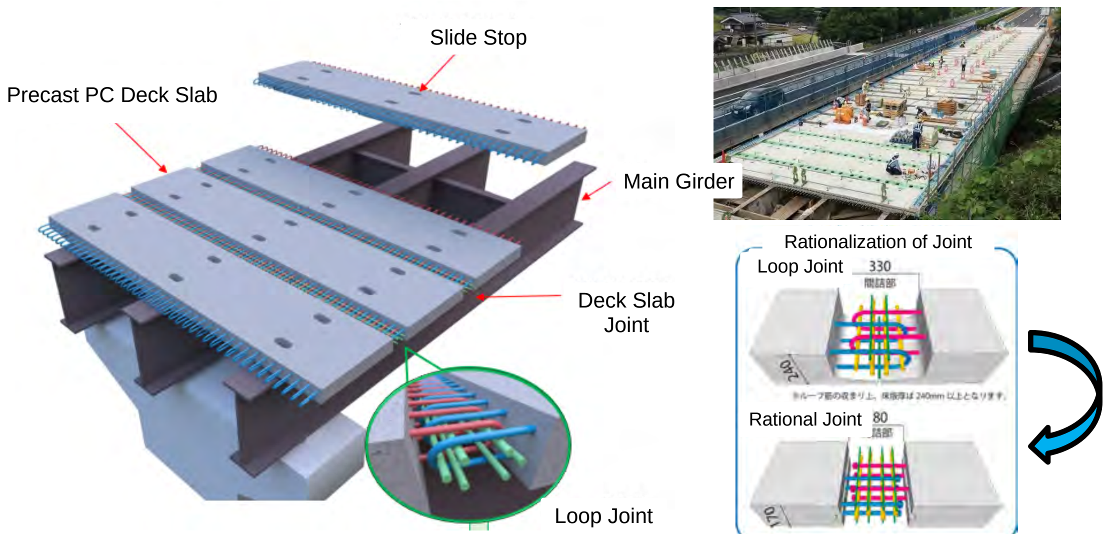
Figure 6.6 Japanese Technologies Required for the Project

(1) Shorter Construction Period by Precast Technology (effective use of severe winter season)

During the severe winter season (October to March), the average temperature in Mongolia is minus degrees even during the daytime, making outdoor construction work impossible. The effective use of precast materials that can be fabricated at the workshop will not only shorten athe construction period, but will also improve concrete quality control due to stable in-door condition.

1) Precast PC Deck Slab

Compared to cast-in-place RC deck slabs, this method has several advantages, including faster construction, consistent quality due to fabrication in the workshop, and lighter weight due to the high-strength of concrete. To improve on-site efficiency, the detail of the joints between precast slabs has been rationalized to allow for faster and more reliable connection. This technology can be fabricated in the UB city factories/workshop that produce concrete precast members, and it is highly possible that the deck slab construction speed can be accelerated up to five times by fabricating Precast PC deck slabs in the winter and installing them on-site in the summer.



Source: HP of FUJI PS Corporation

Figure 6.7 Precast PC Slab

2) Precast Concrete Barrier

The ordinal in-situ concrete barrier used for the elevated bridges requires skilled workers assembling reinforcing steel in a tight space, erecting wooden formwork at the elevated bridge deck, and carefully pouring concrete. This makes ensuring the quality of construction difficult. Furthermore, when work is required for a railway and roadway flyover, it will take time to complete the work in terms of safety measures. In Japan, the use of precast blocks are being promoted in view of the shortage of human resources for such work and to ensure quality. The use of precast concrete barriers has the potential to significantly reduce the construction periods as well.

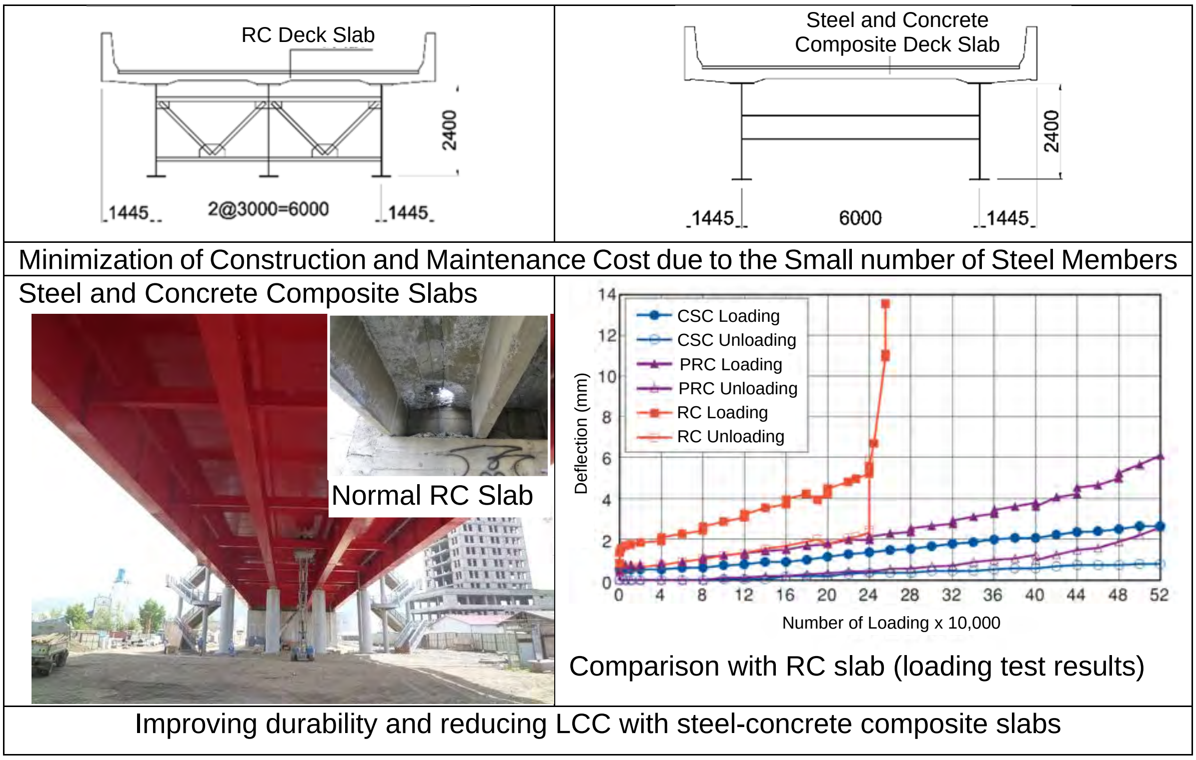
Source: Metropolitan Expressway Company Limited / Japan Hume Corporation HP

Figure 6.8 Precast Concrete Barrier

(2) High Durability and Small LCC

1) Small Number of Girders and Highly Durable Deck Slab

In steel bridges, which are commonly used in urban areas, the number of main girders can be reduced to simplify girder erection during the construction and maintenance after construction, and the number of sub-members can also be reduced, thereby reducing steel weight and making maintenance easier. Because the spacing between the main girders is wider than usual, this structure requires high-durability deck slabs such as Steel-Concrete Composite (SCS) Deck Slabs and/or PC Deck Slabs, among others, to increase the bridge's overall durability. It would be possible to optimize the life cycle cost (LCC) and reduce maintenance costs by using high durable deck slab structure and the Small number of Girders.

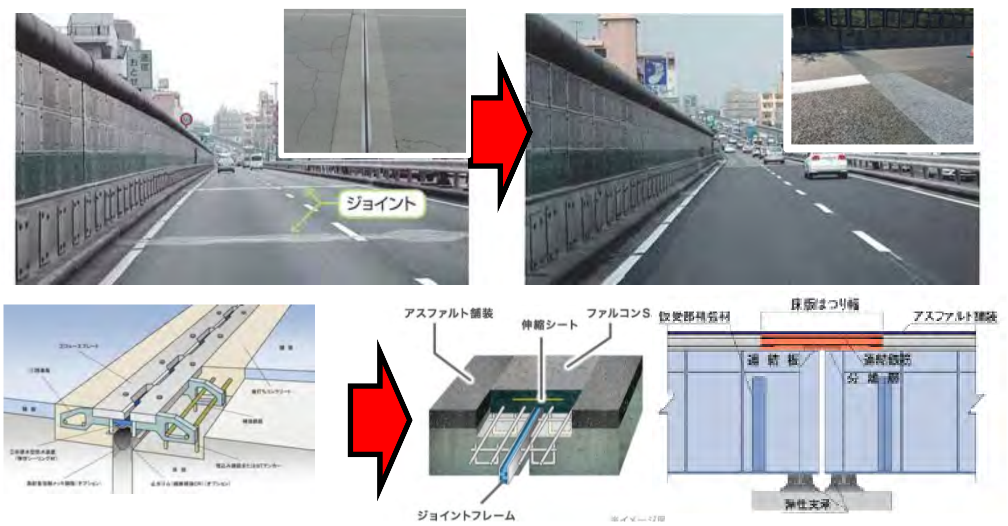


Source: JICA Study Team and website of the Japan Bridge Construction Association

Figure 6.9 Small-Number of Girder structure and High Durable Deck Slab

2) Non-Joint Technology for Bridge

This technology is being used on expressways in Japan to reduce the number of joints in existing bridges, to reduce noise and vibration, and to ensure smooth driving while also lowering joint maintenance costs. In some cases, Embedded Joints are installed, whereas, in others, RC slabs are connected directly, and the method is determined by the area and number of no-jointing, as well as economic efficiency. By using this method, UB City will be able to reduce the cost of bridge maintenance in the future.



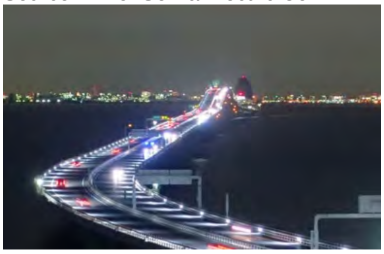
Source: JICA Study Team / Metropolitan Expressway Company / Heatlock Industry Co.Ltd.

Figure 6.10 No-joint technology for bridges.

3) Lower-Position Lighting

This technology, which has the following features, has been widely adopted in Japan in recent years for lighting on urban highways and bridges. Advanced light distribution control is required to ensure the same road surface uniformity as a standard pole lighting system while also reducing glare to drivers. It will contribute to reduce maintenance costs because they are simple to replace due to easy access.

Source: HP of Seiwa Electric Co.



Source: NEXCO East Japan HP

Figure 6.11 Example of the Lower -position Lighting

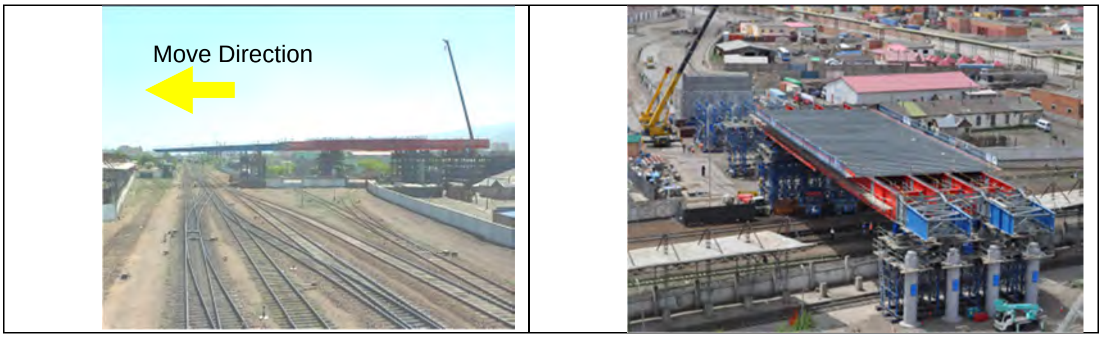
Table 6.4 Advantages of Low-Position Lighting

Item	Advantage
Maintenance	Compared to the pole lighting system, installation and maintenance can be performed without the use of elevated work vehicles.
Environmental	Reduce light leaking out of the road surface and light pollution to neighboring areas.
Delineation	It can be installed continuously on concrete barrier, and has a high visual guidance effect.

Source: JICA Study Team

(3) Bridge Erection Method on the Railway

The erection of bridge on the railway must be done in such a way that train operations are not hampered. Installing a bent (a column temporarily supports the girders), placing a girder on the bent, and connecting each girder is the general construction method. However, because there is no space to install the bent or place a crane over the railway, the launching method which assembles the girders in advance next to the railway and slides them over the railway must be used effectively. The launching method has generally used in locations where bents cannot be installed, such as on a railway or congested road. The girder stress however, inverts against ordinary time, and three-dimensional control is required for curved bridges during the girder launching, which will require advanced construction technology and experience.

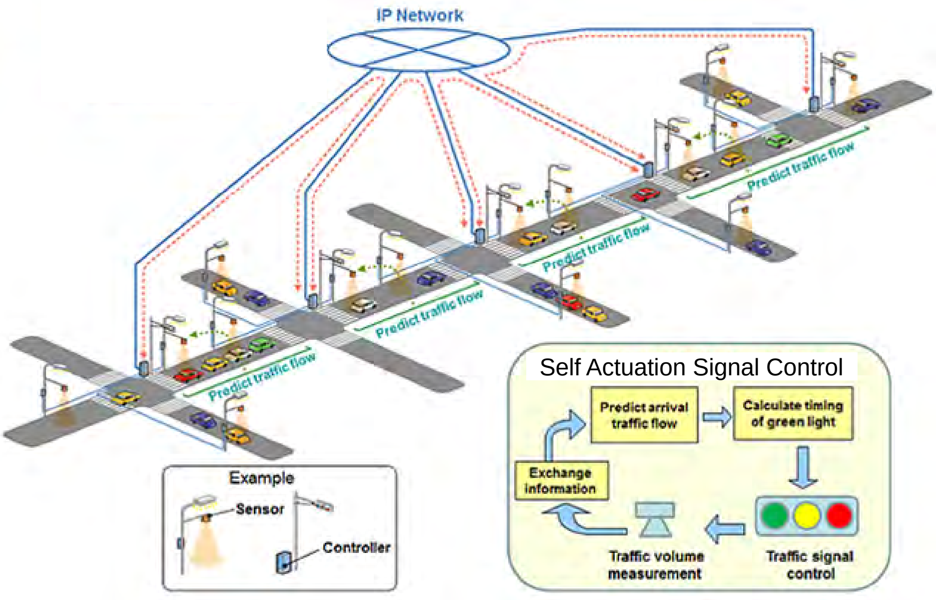


Source: JICA Study Team

Figure 6.12 Erection of the Girder by Launching Method (Example of Narny Bridge)

(4) Signal control that responds to traffic conditions in real time

If the establishment of centralization of the signal control system with the assistance of the WB does not proceed smoothly, it will be necessary to implement efficient signal control under the Project. In this case, Japanese developed Self-Actuation Traffic Signals, will be effective in improving current traffic control. In this signal control system, sensors automatically detect the number of incoming vehicles, and an autonomous processor automatically links adjacent signals without the need for central control as well as automatically analyzes the optimal signal control timing and green time.



Source: Kyosan Manufacturing Co.Ltd

Figure 6.13 Mechanism of Self Actuation Traffic Signal Control System

6.1.7 Expected Project Effects

(1) Economic Impact (EIRR)

This section conducts economic analysis for the four priority projects presented in 6.1.1: (1) the Ajilchin Flyover Project, (2) Green Avenue (E-W) Project, (3) Sappro Intersection Grade Separation Project, and (4) Bayanburd Intersection Grade Separation Project excluding the self-actuated signals. It also conducts a cost-benefit analysis by using the discounted cash flow method, a standard method of economic analysis.

The purpose of the economic analysis is to verify the effectiveness of each priority project from a national economic perspective and evaluate the economic feasibility of the project implementation. However, the analysis here is a simplified evaluation based on roughly estimated costs, and thus the result may differ from that of a feasibility study.

1) Methodology

The analysis is based on a comparison between benefits and costs when the project is implemented (with) and when it is not (without). In other words, the benefits are considered as the various positive effects on the national economy when the project is implemented, and the costs are considered as all the national economic expenditures required to implement the project. Naturally, it is impossible to measure all such benefits and costs, and only those that are technically available will be included. The following evaluation indicators are usually used to show the results of economic analysis.

- Economic Internal Rate of Return (EIRR)
- Net Present Value (NPV)
- Benefit-Cost Ratio (B/C)

The EIRR is a discount rate at that the present value of the total of annual net benefits from the project becomes zero, indicating the efficiency of the project for the national economy. The NPV is the sum of the annual net benefits discounted at the country's social discount rate, indicating the present value of the total social surplus generated by the project. The B/C is the ratio of the total present value of benefits to the total present value of project costs. It is an indicator of the economic efficiency of the project as well as the EIRR.

The project is economically feasible if the EIRR is higher than the social discount rate and the B/C is over one.

2) Assumptions

Assumptions are shown in Table 6.5. Since the social discount rate is not set by country, the study sets it at 10% based on figures from other projects (12%), the benchmark of World Bank at 10–12%, the benchmark of ADB at 9%, as well as the recent government bond yields (around 5%).

Table 6.5 Assumptions

Assumptions		Remarks
Start of Project	2023	
Start of Operation	(1) Ajilchin Flyover Project: 2030 (2) Green Avenue (E-W) Project: 2028 (3) Sappro Intersection Grade Separation Project: 2028 (4) Bayanburd Intersection Grade Separation Project: 2028	
Evaluation Period	30 years after the start of operation	
Maintenance Cost	1% of construction cost per year	
Exchange Rate	1.0 USD = 114.674 JPY 1.0 MNT = 0.04377 JPY 1.0 USD= 2619.9MNT	JICA's montly exchange rate (January 2022)
Social Discount Rate (SDR)	10%.	Set based on the figures of other projects, benchmarks of international organizations, yields on government bonds, etc.
Standard Conversion Factor (SCF)	0.89	Estimated by JICA study team

Source: JICA Study Team

3) Economic cost

The calculation for the economic cost excluded the contingency cost for price escalation from the estimated project cost in Table 6.6Table 6.6 and used the SCF in a simplified manner.

Table 6.6 Project Cost of Priority Projects in Economic Price

Unit: mill. USD

Project name	Construction costs	Utility relocation expenses	Land acquisition cost	Design/ Construction management fee	Total project cost
(1) Ajilchin Flyover Project	59.4	2.0	5.3	7.3	74
(2)Green Avenue East-West Line Project	8.0	1.8	5.3	1.0	16.1
(3)Sappro Intersection Improvement Project	22.3	0.8	2.0	2.7	27.8
(4) Bayanbuld Intersection Improvement Project	22.3	0.8	2.0	2.7	27.8

Source: Research Team

4) Economic benefit

The benefits of each project in their base year are shown in Table 6.7. The reduced vehicle operating cost (VOC) and travel time cost (TTC) and cost of environment burden (reduction of CO_2 and NOx) in the Ajilchin Flyover Project and Green Avenue (E-W) Project were considered benefits, and the benefits in 2030 were estimated. On the other hand, as for the two intersection improvement projects, as the next section (3) shows, the time lag between with the project and without the project was estimated as the benefits using the result of traffic volume survey at intersections by UB City Traffic Control Center in 2021 based on HCM.

Table 6.7 Benefits in base year

Unit: mill. USD

Project name	Benchmark Year	TTC	VOC	Environ-emnt	Total benefits
(1) Ajilchin Flyover Project	2030	25	0.4	3.2	28.6
(2) Green Avenue (E-W) Project	2030	13.9	-0.7	1.8	15.0
(3) Sappro Intersection Grade Separation Project	2021	2.7	-	-	2.7
(4) Bayanburd Intersection Grade Separation Project	2021	3.9	-	-.	3.9

Source: JICA Study Team

5) Economic Analysis Results

Based on the economic costs and benefits above, the EIRR, B/C, and NPV of each project were calculated. Table 6.8 to Table 6.11 shows the cash flow sheets for each project.

Results show that the EIRRs of all the projects are over 10%, concluding that all are economically feasible. The Green Avenue (E-W) Project marked the highest EIRR at 43%, followed by the Ajilchin Flyover at the rate of 23.4%. On the other hand, Ajilchin Flyover shows the largest NPV of USD 114 million, followed by Green Avenue East-West Line at USD 89 million.

Table 6.8 Cash Flow (Ajilchin Flyover Project)

Unit: mill. USD

Year	Cost			Benefit				Benefit-Cost
	Construction Cost	O&M	Subtotal	TTC	VOC	Environ-emnt	Subtotal	
2023	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2024	3.3	0.0	3.3	0.0	0.0	0.0	0.0	-3.3
2025	7.3	0.0	7.3	0.0	0.0	0.0	0.0	-7.3
2026	8.5	0.0	8.5	0.0	0.0	0.0	0.0	-8.5
2027	15.9	0.0	15.9	0.0	0.0	0.0	0.0	-15.9
2028	15.9	0.0	15.9	0.0	0.0	0.0	0.0	-15.9
2029	15.9	0.0	15.9	0.0	0.0	0.0	0.0	-15.9
2030	7.4	0.0	7.4	0.0	0.0	0.0	0.0	-7.4
2031	0.0	0.6	0.6	25.4	0.4	3.2	28.9	28.3
2032	0.0	0.6	0.6	25.9	0.4	3.2	29.6	29.0
2033	0.0	0.6	0.6	26.5	0.4	3.3	30.2	29.6
2034	0.0	0.6	0.6	27.1	0.4	3.4	30.9	30.3
2035	0.0	0.6	0.6	27.7	0.4	3.5	31.5	30.9
2036	0.0	0.6	0.6	28.3	0.4	3.5	32.2	31.6
2037	0.0	0.6	0.6	28.9	0.4	3.6	32.9	32.3
2038	0.0	0.6	0.6	29.5	0.4	3.7	33.6	33.0
2039	0.0	0.6	0.6	30.1	0.5	3.8	34.4	33.8
2040	0.0	0.6	0.6	30.8	0.5	3.8	35.1	34.5
2041	0.0	0.6	0.6	31.5	0.5	3.9	35.9	35.3
2042	0.0	0.6	0.6	32.1	0.5	4.0	36.6	36.0
2043	0.0	0.6	0.6	32.8	0.5	4.1	37.4	36.8
2044	0.0	0.6	0.6	33.6	0.5	4.2	38.2	37.7
2045	0.0	0.6	0.6	34.3	0.5	4.3	39.1	38.5
2046	0.0	0.6	0.6	35.0	0.5	4.4	39.9	39.3
2047	0.0	0.6	0.6	35.8	0.5	4.5	40.8	40.2
2048	0.0	0.6	0.6	36.6	0.5	4.6	41.7	41.1
2049	0.0	0.6	0.6	37.4	0.6	4.7	42.6	42.0
2050	0.0	0.6	0.6	38.2	0.6	4.8	43.5	42.9
2051	0.0	0.6	0.6	39.0	0.6	4.9	44.5	43.9
2052	0.0	0.6	0.6	39.8	0.6	5.0	45.4	44.8
2053	0.0	0.6	0.6	40.7	0.6	5.1	46.4	45.8
2054	0.0	0.6	0.6	41.6	0.6	5.2	47.4	46.8
2055	0.0	0.6	0.6	42.5	0.6	5.3	48.4	47.8
2056	0.0	0.6	0.6	43.4	0.7	5.4	49.5	48.9
2057	0.0	0.6	0.6	44.4	0.7	5.5	50.6	50.0
2058	0.0	0.6	0.6	45.3	0.7	5.7	51.7	51.1
2059	0.0	0.6	0.6	46.3	0.7	5.8	52.8	52.2
Total	74.2	16.6	90.8	964.1	14.5	120.3	1,098.9	1,008.1
NPV			51.7				165.6	113.9

Source: Research Team

Table 6.9 Cash Flow (Green Avenue (E-W) Project)

Unit: mill. USD

Year	Cost			Benefit				Benefit-Cost
	Construction Cost	OM	Subtotal	TTC	VOC	Environ-emnt	Subtotal	
2023	0.4	0.0	0.4	0.0	0.0		0.0	-0.4
2024	7.0	0.0	7.0	0.0	0.0		0.0	-7.0
2025	2.1	0.0	2.1	0.0	0.0		0.0	-2.1
2026	4.3	0.0	4.3	0.0	0.0		0.0	-4.3
2027	2.1	0.0	2.1	0.0	0.0		0.0	-2.1
2028	0.0	0.1	0.1	13.3	-0.7	1.7	14.3	14.2
2029	0.0	0.1	0.1	13.6	-0.7	1.8	14.6	14.6
2030	0.0	0.1	0.1	13.9	-0.7	1.8	15.0	14.9
2031	0.0	0.1	0.1	14.2	-0.7	1.8	15.3	15.2
2032	0.0	0.1	0.1	14.5	-0.8	1.9	15.7	15.6
2033	0.0	0.1	0.1	14.9	-0.8	1.9	16.0	15.9
2034	0.0	0.1	0.1	15.2	-0.8	2.0	16.3	16.3
2035	0.0	0.1	0.1	15.5	-0.8	2.0	16.7	16.6
2036	0.0	0.1	0.1	15.8	-0.8	2.0	17.1	17.0
2037	0.0	0.1	0.1	16.2	-0.8	2.1	17.4	17.4
2038	0.0	0.1	0.1	16.5	-0.9	2.1	17.8	17.7
2039	0.0	0.1	0.1	16.9	-0.9	2.2	18.2	18.1
2040	0.0	0.1	0.1	17.3	-0.9	2.2	18.6	18.5
2041	0.0	0.1	0.1	17.6	-0.9	2.3	19.0	18.9
2042	0.0	0.1	0.1	18.0	-0.9	2.3	19.4	19.3
2043	0.0	0.1	0.1	18.4	-1.0	2.4	19.8	19.8
2044	0.0	0.1	0.1	18.8	-1.0	2.4	20.3	20.2
2045	0.0	0.1	0.1	19.2	-1.0	2.5	20.7	20.6
2046	0.0	0.1	0.1	19.6	-1.0	2.5	21.2	21.1
2047	0.0	0.1	0.1	20.1	-1.0	2.6	21.6	21.5
2048	0.0	0.1	0.1	20.5	-1.1	2.6	22.1	22.0
2049	0.0	0.1	0.1	21.0	-1.1	2.7	22.6	22.5
2050	0.0	0.1	0.1	21.4	-1.1	2.8	23.0	23.0
2051	0.0	0.1	0.1	21.9	-1.1	2.8	23.5	23.5
2052	0.0	0.1	0.1	22.3	-1.2	2.9	24.1	24.0
2053	0.0	0.1	0.1	22.8	-1.2	2.9	24.6	24.5
2054	0.0	0.1	0.1	23.3	-1.2	3.0	25.1	25.0
2055	0.0	0.1	0.1	23.8	-1.2	3.1	25.7	25.6
2056	0.0	0.1	0.1	24.3	-1.3	3.1	26.2	26.1
2057	0.0	0.1	0.1	24.9	-1.3	3.2	26.8	26.7
Total	16.0	2.4	18.4	556.0	-28.9	71.6	598.7	580.3
NPV			12.5				101.5	88.9

Source: Research Team

Table6.10 Cash Flow (Sappro Intersection Grade Separation Project)

Unit: mill. USD

Year	Cost			Benefit			Benefit-Cost
	Construction Cost	OM	Subtotal	TTC	VOC	Subtotal	
2023	1.1	0.0	1.1	0.0	0.0	0.0	-1.1
2024	2.8	0.0	2.8	0.0	0.0	0.0	-2.8
2025	6.0	0.0	6.0	0.0	0.0	0.0	-6.0
2026	11.9	0.0	11.9	0.0	0.0	0.0	-11.9
2027	6.0	0.0	6.0	0.0	0.0	0.0	-6.0
2028	0.0	0.2	0.2	3.3	0.0	3.3	3.1
2029	0.0	0.2	0.2	3.4	0.0	3.4	3.2
2030	0.0	0.2	0.2	3.5	0.0	3.5	3.3
2031	0.0	0.2	0.2	3.6	0.0	3.6	3.3
2032	0.0	0.2	0.2	3.6	0.0	3.6	3.4
2033	0.0	0.2	0.2	3.7	0.0	3.7	3.5
2034	0.0	0.2	0.2	3.8	0.0	3.8	3.6
2035	0.0	0.2	0.2	3.9	0.0	3.9	3.7
2036	0.0	0.2	0.2	4.0	0.0	4.0	3.8
2037	0.0	0.2	0.2	4.1	0.0	4.1	3.8
2038	0.0	0.2	0.2	4.2	0.0	4.2	3.9
2039	0.0	0.2	0.2	4.2	0.0	4.2	4.0
2040	0.0	0.2	0.2	4.3	0.0	4.3	4.1
2041	0.0	0.2	0.2	4.4	0.0	4.4	4.2
2042	0.0	0.2	0.2	4.5	0.0	4.5	4.3
2043	0.0	0.2	0.2	4.6	0.0	4.6	4.4
2044	0.0	0.2	0.2	4.7	0.0	4.7	4.5
2045	0.0	0.2	0.2	4.8	0.0	4.8	4.6
2046	0.0	0.2	0.2	4.9	0.0	4.9	4.7
2047	0.0	0.2	0.2	5.0	0.0	5.0	4.8
2048	0.0	0.2	0.2	5.1	0.0	5.1	4.9
2049	0.0	0.2	0.2	5.3	0.0	5.3	5.0
2050	0.0	0.2	0.2	5.4	0.0	5.4	5.1
2051	0.0	0.2	0.2	5.5	0.0	5.5	5.3
2052	0.0	0.2	0.2	5.6	0.0	5.6	5.4
2053	0.0	0.2	0.2	5.7	0.0	5.7	5.5
2054	0.0	0.2	0.2	5.9	0.0	5.9	5.6
2055	0.0	0.2	0.2	6.0	0.0	6.0	5.8
2056	0.0	0.2	0.2	6.1	0.0	6.1	5.9
2057	0.0	0.2	0.2	6.2	0.0	6.2	6.0
Total	27.7	6.7	34.4	139.5	0.0	139.5	105.2
NPV			20.9			23.6	2.75

Source: Research Team

Table6.11 Cash Flow (Bayanburd Intersection Grade Separation Project)

Unit: mill. USD

Year	Cost			Benefit			Benefit-Cost
	Construction Cost	OM	Subtotal	TTC	VOC	Subtotal	
2023	1.1	0	1.1	0	0	0	-1.1
2024	2.8	0	2.8	0	0	0	-2.8
2025	6.0	0	6.0	0	0	0	-6.0
2026	11.9	0	11.9	0	0	0	-11.9
2027	6.0	0	6.2	0	0	0	-6.2
2028	0.0	0.2	0.2	4.7	0	4.7	4.5
2029	0.0	0.2	0.2	4.9	0	4.9	4.6
2030	0.0	0.2	0.2	5.0	0	5.0	4.8
2031	0.0	0.2	0.2	5.1	0	5.1	4.9
2032	0.0	0.2	0.2	5.2	0	5.2	5.0
2033	0.0	0.2	0.2	5.3	0	5.3	5.1
2034	0.0	0.2	0.2	5.4	0	5.4	5.2
2035	0.0	0.2	0.2	5.5	0	5.5	5.3
2036	0.0	0.2	0.2	5.7	0	5.7	5.4
2037	0.0	0.2	0.2	5.8	0	5.8	5.6
2038	0.0	0.2	0.2	5.9	0	5.9	5.7
2039	0.0	0.2	0.2	6.0	0	6.0	5.8
2040	0.0	0.2	0.2	6.2	0	6.2	5.9
2041	0.0	0.2	0.2	6.3	0	6.3	6.1
2042	0.0	0.2	0.2	6.4	0	6.4	6.2
2043	0.0	0.2	0.2	6.6	0	6.6	6.4
2044	0.0	0.2	0.2	6.7	0	6.7	6.5
2045	0.0	0.2	0.2	6.9	0	6.9	6.6
2046	0.0	0.2	0.2	7.0	0	7.0	6.8
2047	0.0	0.2	0.2	7.2	0	7.2	6.9
2048	0.0	0.2	0.2	7.3	0	7.3	7.1
2049	0.0	0.2	0.2	7.5	0	7.5	7.3
2050	0.0	0.2	0.2	7.6	0	7.6	7.4
2051	0.0	0.2	0.2	7.8	0	7.8	7.6
2052	0.0	0.2	0.2	8.0	0	8.0	7.8
2053	0.0	0.2	0.2	8.2	0	8.2	7.9
2054	0.0	0.2	0.2	8.3	0	8.3	8.1
2055	0.0	0.2	0.2	8.5	0	8.5	8.3
2056	0.0	0.2	0.2	8.7	0	8.7	8.5
2057	0.0	0.2	0.2	8.9	0	8.9	8.7
Total	27.7	6.9	34.6	198.5	0.0	198.5	163.9
NPV			21.0			33.6	12.6

Source: Research Team

Table 6.12 Results of Economic Analysis

	Project Cost (M.USD)	EIRR	B/C	NPV (Mill. USD)
(1) Ajilchin Flyover Project	87.6	23.4	3.2	114
(2) Green Avenue (E-W) Project	18.6	43.0	8.1	89
(3) Sappro Intersection Grade Separation Project	32.8	11.3	1.1	2.8
(4) Bayanburd Intersection Grade Separation Project	32.8	15.2	1.6	12.6

Source: JICA Study Team

(2) Mitigation of the Traffic Congestion at Surrounding Roads

A new road network is expected to be formed by constructing secondary arterial roads and connecting missing links, and traffic will be diverted from congested existing roads to newly constructed roads. The table depicts the expected change in traffic volume when both Ajilchin Flyover and Green Avenue are constructed. The following two improvements are expected to reduce traffic congestion on congested sections of Peace Avenue and Chinggis Avenue by more than 20%.

Table 6.13 Improvement Effect (2030)

Project Title	Item	Improvement Effect		
		Before (PCU/day)	After (PCU/day)	Reduction
Ajilchin Flyover Project	Traffic after Construction	–	64,300	–
	Reduction of Traffic at Peace Ave.	121,800	96,100	-22.1%
	Reduction of Traffic at Chinggis Ave.	103,600	98,200	-5.2%
Green Avenue (E-W+N-S) Project	N-S Direction Traffic	–	37,000～44,100	–
	E-W Direction Traffic	–	48,600～83,300	–
	Traffic on Peace Ave.	96,800	85,600	-11.6%
	Traffic on Chinggis Ave.	126,800	104,900	-26.8%
	Traffic on Sonsgolon IS	66,500	64,500	-3.0%
	Traffic on Gurvagin	82,700	75,600	-8.6%

Note：PCU: Passenger Car Unit
Source: JICA Study Team

(3) Reduction of the Stopped Delay at Intersections

As a result of the analysis based on HCM, the stopped delay at improved intersection by through grade separation is expected to be reduced by 102 to 151 sec/vehicle at each intersection, as introduced in Section 3.4.3(2). Although a slight increase in the average speed of the surrounding roads can be expected as a result of traffic redistribution by the improvement, the substantial benefit of the project will be evaluated based on the reduction of the stopped delay as a general practice for evaluating grade separation intersections.

Table 6.14 Improvement Effect by the Project (2025)

Project Title	Item to Evaluate	Improvement Effect
Sapporo Intersection Grade Separation Project	Flyover transit traffic volume (East-West Direction)	82,200 PCU/day (2025)
	Future projected traffic volume (north–south direction)	54,200 PCU/day (2025)
	Reduction of average stopped delay at intersections (/vehicle)	102 second/vehicle
Bayanburd Intersection Grade Separation Project	Flyover transit traffic volume (east–est direction)	55,000 PCU/day (2025)
	Future traffic volume (north–south direction)	67,900 PCU/day (2025)
	Reduction of average stopped delay at intersections (/vehicle)	151 second/vehicle

Source: JICA Study Team

6.1.8 Environmental and Social Considiration

The plan and design of the project need sufficient considerations for environmental and social acceptance. The expected environmental impacts by the project and draft-scoping plan were checked based on the Mongolian Law on EIA (May 2012) and JICA guidelines.

(1) Coverage for draft Scoping

The area for scoping includes the Green Avenue (E-W) Project (flyover at 0.2 km and bridge construction at 0.8 km), Ajilchin Flyover Project (2.7 km), Sapporo Intersection Grade Separation Project (flyover at 0.105 km and approach road at 0.115 km × 2), and Bayanburd Intersection Grade Separation Project (flyover at 0.11 km and approach road 0.118 km × 2). The Ajilchin Flyover Project was defined as category B in the “Preliminary Study for the Ajilchin Flyover Construction Project (2013)” by JICA.

Table 6.15 Draft Scoping in Environmental and Social Impacts

Impact	Evaluation		Explanation on Evaluation
	Before and during construction	Under operation	
Pollution			
Air	B-	C+	**Before and during construction**: Air pollution will temporarily worsen due to exhaust gas from construction machines and vehicles, fugitive dust, and traffic congestion. **Under operation**: Air pollution from automobile emission will be reduced due to reduction of traffic and increase in travel speed.
Water	B	C	**Before and during construction**: River water and groundwater pollution will temporarily worsen due to effluent water from construction and related facilities and excavation. **Under construction**: No serious impact is expected.
Soil	C-	C-	**Before and during construction:** Soil pollution will temporarily worsen due to exhaust gas and oil from construction machines, vehicles, fugitive dust, and traffic congestion. **Under construction**: No serious impact is expected.
Waste	B-	C	**Before and during construction**: Soil waste generation from construction waste. Suitable waste management, such as soil

Impact	Evaluation		Explanation on Evaluation
	Before and during construction	**Under operation**	
			outflows countermeasures, is necessary for soil dumping sites. **Under construction**: No serious impact is expected.
Noise ・ Vibration	B-	B-	**Before and during construction**: Noise from construction machines and vehicles is expected. **Under construction**: Some noise and vibrations are expected.
Subsidence	C-	D	**Before and during construction**: Subsidence by groundwater level change is not expected because fine sand and silt are few in the construction site. The general method does not cause ground subsidence; however, a soil survey is necessary for confirmation. **Under construction**: No pumping of groundwater that causes subsidence is requested, no large impact is expected.
Odor	D	D	**Before and during construction:** No work causing odor is expected. **Under construction**: No activity causing odor is expected.
Sediment	D	D	**Before and during construction**: No work affecting sediment is expected. **Under construction**: No activity affecting sediment is expected.
Nature Environment			
Protected Area	D	D	The project site is far from areas protected by the Law on Special Protected Areas, and there will be no impact.
Ecosystem	C-	C-	The surrounding area of the project site is urban and does not have rare species in the biota or ecosystem requiring special consideration. An ecosystem impact examination is necessary.
Hydrology	B	C-	Under the project sites, groundwater from the southern riverbed of Tuul River is expected. **Before and during construction**: Possible changes in groundwater level and water flow direction by water shielding in the Tuul river section and pumping and pouring during construction. It is reported that groundwater use is prohibited around the planned underground section. Verifying the information is necessary. **Under construction**: Hydrology might somehow be affected. Underwater hydrology change may affect the flow volume of the Tuul River. This needs assessment. Additionally, floodings from heavy rains every few years and the effects must be checked.
Topography and geology	D	D	**Before and during construction**: Topography of the project sites is gentle and most of the routes are planned as elevated, so any large embankment or excavation is not expected. **Under construction**: Changes in topography and geography is not expected.
Ground Freezing	D	D	**Before and during construction:** Groundwater may freeze from the ground surface to GL–3 to 4 meters. **Under construction:** Impact on ground freezing is not expected.
Climate change	B	C	**Before and during construction**: Temporary increase in GHG emissions because of fuel consumption by construction machines and vehicles. **Under construction**: Reduced GHG emissions from automobiles is expected from the decline in traffic and increase in travel speed.
Social Environment			

Impact	Evaluation		Explanation on Evaluation
	Before and during construction	Under operation	
Involuntary Resettlement and Acquisition	B-	D	**Before and during construction**: Regarding the Green Avenue (E-W) Project, land acquisition is necessary at the road near the 4th Power Plant, but involuntary resettlement is not. For the Ajilchin Flyover Project, land acquisition is easy because its site was split for construction in 2013, while involuntary resettlement is not necessary. Other grade separation intersection projects require land acquisition, but not involuntary resettlement due to the commercial area. **Under construction**: Involuntary resettlement is not expected during construction or operation.
Land Use	C-	C+	**Before and during construction**: Green Avenue passes through the Tuul river bed, green area would decrease. **Under construction**: Intensive land use and economic vitalization is expected by developments.
Public Health	C-	D	**Before and during construction**: Impact by construction of lodgings for workers is expected, but its impact is considered limited because construction period not long. **Under construction** : Negative impact to public health is not expected.
Risks by Infections	D	D	**Before and during construction**: There are risks of infections occurrence so on by inflow of workers, but its impact is considered limited because construction is short-term. Furthermore, it is expected to be manageable through education and training of workers if the management of inflowing workers follows the way of ongoing large-scale projects. **Under construction:** There is little possibility that the risk due to infectious diseases will change greatly.
Impact to road Traffic	B-	C++	**Before and during construction**: There is possibility of traffic congestion due to an increase in construction vehicles and land occupation. **Under construction**: Reduced traffic congestion and positive effects are expected.
Impact to Users of Public Transportation	B-	B+	**Before and during construction**: There is possibility of traffic congestion worsening due to an increase in construction vehicles and land occupation. **Under construction**: Many citizens are positively affected by the high likelihood that more cases will be able to move without getting stuck in traffic jams.
Division of Area	D	D	The dividing of the area does not occur due to the project.
Sunlight Obstruction	B-	B-	Sunshine obstruction at the northern side of the flyover and elevated section is likely.
Eletromagnetic Interference	C	C	No serious impact is expected.
Heritage	C-	D	**Before and during construction**: No heritage will be affected during construction. **Under construction**: There is no heritage that is affected.
Landscape	B-	B-	**Before and during construction**: There is no special landscape for consideration, but the landscape will be changed by the construction. **Under construction**: There is no special landscape for

Impact	Evaluation		Explanation on Evaluation
	Before and during construction	Under operation	
			consideration, but the elevated structure will change the landscape. Impacts on the proposed sites away from the central part of the city are limited.
Poor People, Ethnic Minorities and Indigenous People	D	D	**Before and during construction**: There is no special landscape for consideration, but the landscape will be changed by the construction. **Under construction**: There will be positive impacts, such as ease of commuting and access to work, social services, markets, etc. because the mobility of citizens will improve. Economic benefits will also improve.
Working Environment	B-	D	**Before and during construction**: Consideration of the working environment for construction workers is necessary. **Under construction**: No negative impacts expected.
Impact on Underground Utilities	D	D	**Before and during construction**: Damaging underground utilities by the boring survey and construction work is a possibility. Points for the boring survey will be carefully selected, and the boring survey will stop come wintertime when heating systems are on all the time. Therefore, the impact is considered extremely minimal. **Under construction**: No event which can damage the underground utilities is to be expected.
Local Economy Employment Opportunity and Means of Livelhood	B+	C-	**Before and during construction**: No impacts on employment opportunity is expected **During construction:** Employment opportunities for construction work will increase. **Under construction**: Not expected that new employment will be created.
Other Impacts on Daily Life	D	B+	**Before and during construction**: No other impact on daily life is expected. **Under construction**: Reduced traffic congestion will ease commuting and access to social services and marketplaces.
Others			
Accidents	B-	C-	**Before and during construction**: Accidents during construction work and operations of vehicles are expected. Capacity building in relation to daily inspection and maintenance is required by the start of operation in order to minimize accidents. **Under construction**: Traffic accident preventive measures are necessary.

Source: JICA Study Team

Notes: Evaluation Criteria

A-: Negative significant impact is supposed
B-: Negative impact is fair.
C-: Negative impact is slight.
D-: No impact or extremely minimal impact is supposed.

A+: Positive significant impact is supposed.
B+:Positive impact is fair
C+: Positive impact is slight.

6.2 Feedback from Mongolian side

Discussions were held with MRTD on 8 December 2021 and another with UB City on 10 December 2021 and 28 December 2021. It continued for the priority projects, as mentioned in Chapter 6.1. As a result, the Ajilchin Flyover Project, Green Avenue widening, and the Sappro and Bayanburd Intersection Grade Separation Projects were supported. As of the end of January 2022, the Japanese side continues discussions. JICA is discussing with UB City, MRTD, and the Ministry of Economic Development about the possibility of the F/S project.

The study team has suggested technical assistance projects, which are being discussed between the Japanese and Mongolian sides. The suggested assistance is (i) strengthening of transport planning and traffic management and (ii) strengthening of the road and bridge maintenance management. In the future, both Japan and Mongolia sides will continue discussions. Contents of the technical assistance are detailed below.

6.2.1 Capacity Development for Transport Planing and Traffic Management

This technical assistance project aims to ease the serious traffic congestion in Mongolia, scopes identifying necessary issues, and enhance improvement of planning formulation and traffic management capacity. In detail, it would implement the activities, such as identifying traffic issues, evaluating plans based on the demand forecast, improving or designing intersections, evaluating public transport and parking plans, and identifying traffic management.

<The scale of the Project>

Assumed Input Man-Month (MM): Short-term expert: 80 MM

Target C/P Agency: UB City Urban Development Department, Traffic Planning and Coordination Engineering Department, MRTD, TCC, UB City public transport service department, MRTD Railroads and Shipping Policy Implementation Coordination Bureau, UB City traffic police

Implementation Schedule: 36 months

Table 6.16 Capacity Development for Transport Planing and Traffic Management

Overall Goal: To mitigate road traffic congestion in UB City.
Project Purpose: Enhancement of Traffic planning and traffic management in UB City
Outputs: Output 1: Strengthen of identification of issues Output 2: Strengthen of traffic management
Activities: **【Activity for Output 1】** Activity 1-1 Document review and organizational analysis Activity 1-2 Identifying and addressing issues in the transportation network of the entire UB urban area Activity 1-3 Technical assistance for the development of intersection improvement plan Activity 1-4 Technical assistance for the development of urban road infrastructure plan Activity 1-5 Technical assistance for the development of public transportation plan Activity 1-6 Technical assistance for the development of parking facility plan **【Activity for Output 2】** Activity 2-1 Document review and organizational analysis Activity 2-2 Identification of traffic management issues Activity 2-3 Identification of traffic manner issues Activity 2-4 Identification and technical assistance for traffic management issues

Source: JICA Study Team

6.2.2 Capacity Development for Operation and Maintenance of Road and Bridge in Ulaanbaatar City

The capacity development is technical assistance for future maintenance and management of infrastructure development by Yen Loan and to maximize project effects. In addition, through the project activities, identifying issues in the construction quality management that causes damages in infrastructure and premature degradation can help minimize costs in the future for the road and bridge maintenance management and improve the initial quality of road and bridges in the construction.

<The scale of the Project>

Assumed Input Man-Month (MM): Short-term expert: 70 MM

Target C/P Agency: Road Develop Department of UB City (/Policy and Planning Department of MRTD)

Implementation Schedule: 36 months

Table 6.17 Capacity Development for Operation and Maintenance of Road and Bridge in Ulaanbaatar City

Overall Goal: Capacity Development for Operation and Maintenance of Road and Bridge in Ulaanbaatar City
Project Purpose: Maintenance Cycle of Road and Bridge in Ulaanbaatar City is developed.
Outputs: Output 1: The repair plan for priority bridges in UB City is developed. Output 2: The repair plan for priority roads in UB City is developed. Output 3: Pilot Project of repair work for road and bridge in UB City is implemented. Output 4: Issues on design and construction for road and bridge in UB City is identified and recognized.
Activities: **【Activity for Output 1】** 1-1. Conduct the baseline survey on bridge maintenance system in UB City 1-2. Propose sustainable bridge inspection procedure in UB City 1-3. Conduct bridge inspection based on bridge inspection procedure proposed by 1-2 for all bridges in UB City 1-4. Formulate a mid-term bridge maintenance plan and select the priority bridges to be repaired 1-5. Develop bridge repair plan for the priority bridges. **【Activity for Output 2】** 2-1. Conduct the baseline survey on road maintenance system in UB City 2-2. Propose sustainable road inspection procedure in UB City 2-3. Conduct road inspection based on road inspection procedures proposed by 2-2 for all arterial roads in UB City 2-4. Formulate a mid-term road maintenance plan and select the priority road to be repaired 2-5. Develop a road repair plan for the priority road **【Activity for Output 3】** 3-1. Implement a pilot project for repair of bridge based on the repair plan proposed in 1-5 3-2. Implement a pilot project for repair of road based on the repair plan proposed in 2-5 3-3. Compile overall achievement of the inspection, repair plan, and implementation of repair work for bridge and road, and introduce it to UB City government and MRTD 3-4. Make a recommendation on budgetary allocation for the maintenance of bridges and roads based on the pilot project **【Activity for Output 3】** 4-1. Summarize the issues on design and construction quality of bridge based on activities in Output 1. 4-2. Summarize the issues on design and construction quality of road based on activities in Output 2. 4-3. Make a recommendation for improvement of design and construction quality of road and bridge based on the Activity 4-1 and 4-2. 4-4. Share the experience and issues of the Project with the Mongolian Road Association and Mongolian University of Science and Technology through seminars, etc.

Source: JICA Study Team

7 Review of Japan's Assistance

In this study, projects that are urgent, necessary, and need to be implemented in a relatively short period are suggested because of the serious congestion in UB City. The city has many issues in which Japanese assistance can help. This chapter analyzes the direction of assistance based on the strengths of Japan, extracts the contents of measures to solve or ease the traffic problems from various perspectives, and then proposes future assistance policies by organizing and considering the use of Japanese technology based on these measures.

7.1 Orientation of the Assistance based on Japan's Strengths

The "Outline of a New Strategy for Overseas Development of Infrastructure (from July 2020)" by the Japanese government focuses on the enhancement of feasibility studies (F/S) and implementation projects, strengthening of consulting functions, use of technical assistance and grant aid, the improvement of the attractiveness of Yen Loans, public-private partnerships to enhance competitiveness, and the improvement of the infrastructure export environment in light of the spread of the new COVID-19. With the gradual recovery of macro-economic improvement, Mongolia is expected to utilize the technological know-how of Japan in the field of transportation and urban areas to solve traffic congestion caused by rapid population concentration.

There are two aspects to adopt the technological know-how from Japan: (i) one of the biggest strengths of Japan is its great deal of knowledge and experience unique to it, even if it is not a new technology, and (ii) Japanese new technology that can be utilized for developing infrastructure. From this point of view, future technical assistance can be divided into three categories:

A. in terms of utilizing both Japan's strengths of knowledge and experience and Japanese technology;

B. in terms of utilizing Japan's strengths of knowledge and experience, but utilizing technology which is being followed in countries other than Japan; and

C. in terms of getting assistance from other countries.

On the other hand, Table 7.1 summarizes the contents of assistance,[27] including Yen Loan projects and technical assistance, based on the results of the diagnosis of transportation issues.

Looking at the contents of the Yen Loan projects and technical assistance, many measures are related to road improvement to alleviate traffic congestion, which is in line with the current situation in UB City.

Firstly, the current practice in terms of planning is to propose several small-scale and localized plans without much forethought. Even comprehensive plans are often implemented as individual, small-scale projects. For example, while making plans or measures to alleviate current traffic congestion, the future impacts are not taken into consideration.

Particularly in the city center, the traffic situation has already turned into an unsolvable problem that cannot be simply addressed by infrastructural developments. As traffic volume increases in the future, traffic congestion will become even more serious due to the increase in the number of registered vehicles, the extension of cities, and the high concentration of the daytime population; hence, drastic measures are necessary. The more serious the traffic congestion becomes, the more technically difficult the countermeasures will be, such as the construction of intersections and multi-story structures with underground facilities. There will be more potential for assistance and assistance utilizing Japanese technology in the future; however, drastic and technically difficult measures tend to be expensive for the local government. Getting financial resources is also a big

[27] Possibility of assistance in a wide field is analyzed utilizing the JICA Project Study on Urban Transport Planning.

concern that should be considered.

In addition, serious traffic congestion is likely to be caused by measures that have a large traffic impact, such as continuous multilevel crossings, expressways, and arterial road development, which will induce automobile traffic from the surrounding areas and require new congestion measures. Therefore, it is necessary to mitigate the problem by the packaged project implementing multiple projects for the congestion by increasing access traffic and technical assistance in the operation of existing transportation systems such as urban expressway operation.

As for the current public transportation system, the bus is the main means of public transportation for half of the total population. It should continue to be the core means of transportation. For this reason, it is necessary to consider infrastructures like bus priority and dedicated lanes, advanced bus terminals that take Park & Ride facility (see Section 4.4.2 2)-1), and use traffic lights in the bus priority lane. Since the operational aspects of these are particularly important, the projects that can be incorporated as pilot projects in the technical assistance efforts can be considered.

There is potential for providing technical assistance, even in the area of bus operations and planning, such as cracking down on illegal parking near bus facilities, improving bus drivers' operational manners, and reorganizing bus routes. It is important to promote a modal shift through these efforts.

Additionally, looking at the status of past plans, although the local master plan also mentions drastic measures to combat traffic congestion through large-scale public transportation systems, the implementation of expensive track systems tends to be delayed or cancelled due to their high costs, change the development orientation, or long-time consideration. Low-cost, small-scale public transportation systems are often chosen even with the possibility of insufficient transportation capacity over a long period of time. Establishing a drastic public transportation network based on the premise of cost reduction through staged development would be better to raise the feasibility, as well as continue providing cooperative assistance for the improvement of the existing bus service ratio, which becomes more important with the delay of the railway project.

In the area of urban planning, as mentioned in Chapter 5, an urban development permit system based on traffic impact assessment, the improvement of transportation convenience through Park & Ride (see Section 4.4.2 2)-1)), transportation node development, TOD can be adopted. Redevelopment projects based on public transportation-oriented urban planning and relocation of factories and universities to the suburbs are also considered increasingly necessary in the future.

In terms of parking, there are many flat-packed parking lots, which are inexpensive, but it limits land availability for public transportation development. Also, due to its low capacity, on-street parking and road blockage by cars waiting for entry are occurring in residential areas. A city-wide parking management policy that includes changes in on-street parking fees and minimum parking spaces is needed, which is already being considered a PPP business mainly by the local government. In addition, there is a possibility to assist the private sector, such as introducing mandatory parking and garage certification systems, constructing multi-story parking garages, mandatory parking in the underground and rooftop areas of commercial facilities, and providing information on the availability of street parking.

Sidewalks and bicycle environments are not adequately maintained, and there are issues with barrier-free measures. Sidewalks are narrow in some places, with many steps and long distances between parking lots and destinations. Improvements are needed in pedestrian route planning based on public transportation systems, such as road space redistribution, underpasses between underground facilities, and pedestrian decks. Due to the cold climate, the development of passageway building-to-building connections combining underground streets and passageways with commercial facilities, parking lots, etc., are effective. With a complex structure, assistance in this aspect is a possibility.

In traffic management, infrastructure development and technical assistance are being promoted by WB, China, and South Korea donors support traffic management assistance. If the case that the technical assistance is not utilized or does not scope the necessary field, the Mongolian government should solve the problem by themselves. Introducing the highly technical infrastructure development of Japan in areas such as public traffic priority signals and provision of road traffic information to facilitate traffic, as well as assistance in the area of human resource development for traffic control and traffic management planning, is a possibility.

From a perspective of social and natural conditions, floods and earthquakes are need to be taken into account when planning. Considering such in planning makes expenses high, so it is necessary to compare them with the overall project evaluation and have thorough discussions and considerations.

Table 7.1 Prescriptions for urban transport problems and directions for Yen Loan projects and technical assistance

Measures for urban transportation problems			**Effective Perspectives on Priority Issues for Mongolia**	**Orientation of yen loan projects and technical assistance**
Category	**Section**	**Measurement**		
Land use/ urban structure		Compact city/ multipolar city structure, TOD	Effective for a rapid increase in vehicle registrations Effective against concentration in cities	Technical assistance for TOD promotion project
Infrastructure	Road infrastructure	Construction of highways and arterial roads	Effective for traffic dispersion	Construction of urban expressways and elevated roads
		The missing link is complete.	Effective for traffic dispersion	Road network improvement promotion project
		Hierarchical network construction		
		Improvement of collector roads and district roads	Effective for traffic dispersion	Road Network Improvement Promotion Project
		Strengthening of maintenance and management system (pavement improvement)	Effective in eliminating poor pavement and frozen road surfaces	Technical assistance to improve road management capacity Cold Region Road Pavement Strengthening Project
		Multilevel intersections at major intersections	Effective in reducing traffic congestion in urban areas	Intersection project
		Intersection shape improvement	Effective in reducing traffic congestion in urban areas	Bottleneck intersection countermeasure project
		Abolish roundabouts with high volume.		
		Improvement of pedestrian facilities	Effective for sidewalk network development	Road Space Reassignment Project Technical assistance and facility development for barrier-free facilities
		Construction and widening of bridges	Effective for traffic dispersion	Improvement of Tuul River Bridge
	Public Transportation Infrastructure	Urban railway development	Effective in improving public transportation services	Mass transit public transportation system construction project
		Reconstruction of the bus network	Concentration of bus routes, effective for lack of suburban routes	Public Transport Improvement Program BRT and express bus network development project
		Bus stop maintenance	Improved service rate	Public Transport Improvement Program
		Bus terminal maintenance	Effective in providing bus services in suburban areas	Transportation node improvement project
		Diversification and replacement of vehicles	Effective for improving bus service	Bus vehicle maintenance
		Modernization of bus services	Effective for improving bus service	Public Transport Improvement Program
		Bus - Minibus - Paratransit		
Traffic management	Road traffic management	Introduction of traffic signals	Effective for inefficient intersection control	Technical assistance for improving traffic management capacity Introduction of traffic signals Introduction of priority traffic system for public transport
		Improvement of signal control (right/left turn indication)		
		Area traffic control maintenance		
		Facilitation of traffic through traffic control	Effective for lack of driving manners	Technical assistance for improving traffic management capacity

Measures for urban transportation problems			Effective Perspectives on Priority Issues for Mongolia	Orientation of yen loan projects and technical assistance
Category	**Section**	**Measurement**		
		On-street and off-street parking lot maintenance	Effective for parking shortage	Introduction of parking management system
		Tighter control of illegal parking	Effective for parking shortage	Technical assistance for improving traffic management capacity
	Traffic demand management	Introduction of restrictions on private car use and ownership	Effective for rapid increase in private vehicle registrations	Introduction of parking management system
		Promotion of modal shift	Effective in reducing the use of private vehicles	Public Transport Improvement Program
		Public transport priority policy	Effective for improving bus service	Introduction of priority traffic signals for public transport Public Transport Improvement Program
		Transportation demand dispersion measures	Effective for road congestion and modal shift to public transportation	Introduction of road traffic information system Technical assistance for improving traffic management capacity
	Traffic Safety	Traffic safety education	Effective in improving traffic safety	Technical assistance for improving traffic safety capacity
		Improvement of traffic safety facilities	Effective in reducing the number of traffic accidents	
		Tighter enforcement of traffic violations	Effective for lack of driving manners	
Organization/System	Transportation planning and administration	Clarification of the division of roles among related organizations		
		Establishment of an urban transportation agency (coordinator)		
		Human resource development and capacity building	Public transport capacity building Effective in improving traffic management capacity	Public Transport Improvement Program Technical assistance for improving traffic management capacity
	Public transportation management and operation	Improve efficiency of management system (licensing, regulations)	Effective against over-concentration of bus routes and lack of suburban routes	Bus route realignment project Public Transport Improvement Program
		Ensure financial independence and eliminate subsidies.		Public Transport Improvement Program
		Modernization of the management system		
	Project implementation structure	Development of land acquisition methods		Technical assistance for TOD promotion project
		Development of PPP system		
		Human resource development and capacity building	Effective for thorough control of bus operations, adequate traffic policing, and improvement of project implementation capacity	Public Transport Improvement Program Technical assistance for improving traffic management capacity
	Lack of financial resources	Securing financial resources	Effective in controlling private traffic, improving public transportation services, and strengthening road pavement	Technical assistance for improving the financial capacity of transportation
		Development of specific financial resources for transportation	Effective in controlling private traffic, improving public transportation services, and strengthening road pavement	

Source: JICA Study Team

7.2 Study of the possibility of using Japanese technology

In this section, under the policy of Japanese assistance, the possibility of using Japanese technology, in terms of hardware and software, is shown.

7.2.1 Infrastructure Development

(1) Bus Transportation

In terms of bus transportation, many vehicles and hardware are made in Korea, and the applicability of these are currently assessed in the situation of UB City. Donors from other countries prioritized the utilization of Japanese technology even considering the costs. While there are advantages in using Japanese technology, the lack of experience in the use of outdoor systems is a concern, especially in the cold climate of Ulaanbaatar. On the other hand, there are areas for improvement in the know-how required for bus operations and ample room for Japanese management and operation technology to be utilized. For this reason, Japanese technical assistance in software use is considered highly feasible. Table 7.2 shows a summary of the expected project effects and their background.

Table 7.2 Expected Effects and their Background of the Implementation of the Enhancement of Bus Transportation Technical Assistance Project

	Project Effects	Background
1	Strengthened management system for public transportation in UB City	In 2020, UB City subsidies will account for 57% of operating costs and 15% of the UB City budget. To maintain healthy public transportation, UB City and operators need to improve their operations and reduce subsidies.
2	Improved capacity of UB City to develop infrastructure for public transportation and implement traffic management measures	In addition to the development of hardware, such as infrastructure, it is necessary to identify issues from the user's perspective and implement software such as usage methods at the same time.
3	Study on the improvement and review of operational plans for public transportation in UB City and improve the capacity for planning	Since bus operation plans that take into account the road environment, such as traffic congestion, have not been formulated, both UB City and bus operators must be able to formulate operation plans that ensure on-time performance.
4	Improved bus service in UB City	It is necessary to foster safe driving manners for bus drivers to comply with traffic laws. In addition, it is necessary to examine bus-related services that are currently not being provided to citizens and encourage them to switch to public transportation.

Source: JICA Study Team

(2) Urban railway development

As for urban railway development, Japanese technology can be utilized.

Table 7.3 Potential for Utilization of Japanese Technology

Item	Utilization of Japanese Technology
Public works	Shield tunneling, tunnel construction using the open-cut method with minimal disruption to road traffic, steel pipe columns (construction of elevated bridges with minimal disruption to road traffic)
Orbit	Rails (Japanese rails have been exported to the Mongolian Railways)
Vehicles	Such as trains, but there are difficulties for manufacturers in terms of cold-weather specifications and transportation to Mongolia)
Power supply system	Power-efficient substation systems
Operation security system	Entire operation and safety system, including signals, ATP, ATO, and command systems
AFC	Entire AFC system, including contactless systems

Source: JICA Study Team

Since no urban railways are currently in Mongolia (except the national railway), it is necessary to strengthen its capacity from the perspectives of design, pre-opening capacity building necessary for railway system operation, and railway operations. Assuming the Yen Loan, in addition to covering the design through F/S and Detail Design, it is conceivable to cover the pre-opening capacity building and railway operations by implementing a technical assistance project before and after the start of railway operations.

(3) Bridge Construction Technology

Bridge construction in UB City is facing durability issues as it needs to cope with the harsh natural environment, improve quality control, shorten the construction period, and technologies to reduce maintenance costs. In addition, the multi-story intersection project proposed in this study is the first for a major road in UB City, and it will be constructed with many restrictions, such as ensuring traffic safety during construction and reducing traffic congestion caused by construction. It is important to introduce bridge construction technology that ensures quality, durability, workability, and safety by utilizing steel bridge technology, precast members, and rapid construction technology to realize construction in a cold climate as in UB City. Details of Japanese technology that can be used are explained in Chapter 6.

(4) AI-based signal control system

The Traffic control center (TCC), which manages the traffic signals in UB City, is unable to adequately manage the current signals due to the lack of human resources and budget. For this reason, the traffic management system to be developed in the future by WB must be based on the actual capacity and budget of UB City. The autonomous signal control system is expected to function effectively in the current TCC since it can automatically set the optimal signal manifestation within a certain range, thus reducing the management burden.

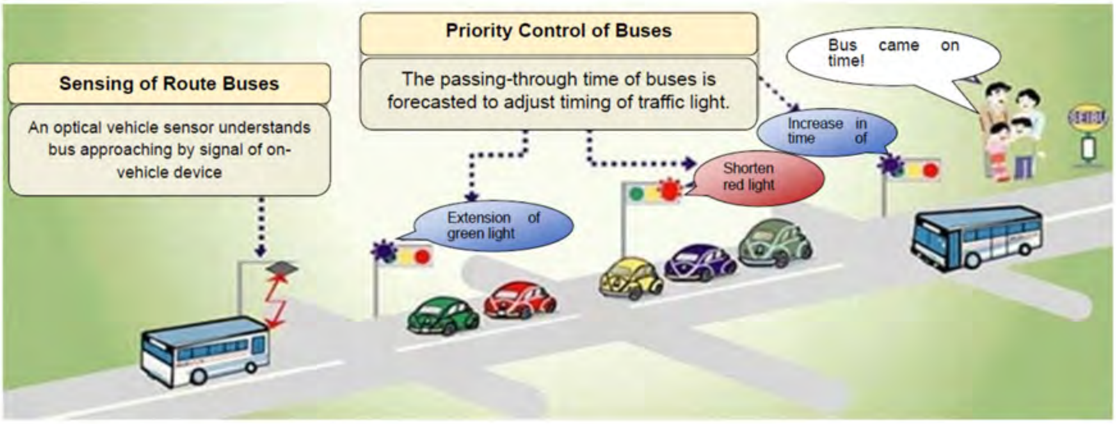
(5) Improving bus transportation convenience by introducing new technologies

From the perspective of buses operating in UB City, the apparatus for fare payments using IC cards, bus location services using GPS navigation apps, and in-vehicle surveillance cameras are installed in some vehicles. It’s the same technology as with Japanese bus operators.

・Implementation of PTPS: At intersections in the center of UB City, the police do the traffic control in addition to the traffic signals. This is not the only problem with the signal control but the driving behavior of drivers as well because many private cars enter intersections even when already congested. Therefore, to ensure that private car drivers comply with the rules when the road ahead of the intersection is congested, introducing PTPS can be considered at the bus lane or in the center of the city.

PTPS aims to extend the green light and shorten the red light by creating communications between the optical vehicle detector of the ground equipment and the dedicated device mounted on the bus.

It controls the signal according to the traffic conditions and does not always pass the bus at the green light.



Source: https://www.seibubus.co.jp/company/ptps/

Figure 7.1 Public Transport Priority System

・<u>Introducing MaaS</u>: Although route buses are the main public transportation in UB City, road maintenance is not progressing in the suburban ger area where the population is increasing and where it is difficult to operate new bus routes. On the other hand, the demand for the enhancement of bus services as a means of daily transportation is increasing. It will be possible to optimize the movement of residents by combining multiple means of transportation, such as buses, minibuses, taxis, ride-hailing such as Uber, motorcycles, bicycle sharing, etc., starting from the transport node such as the newly constructed terminal. From the point of view of a user, this method should start disseminating information common to bus transportation regarding the selection of optimal transportation methods based on factors, such as required travel time and lower fares. In the future, securing seamless transportation will be possible by introducing MaaS, such as linking fare payments, and it is expected to shift from private to public transportation by improving public transportation services.

Figure 7.2 shows the promotional level of MaaS. Level 0 is the case where each traffic mode corresponds individually. Level 1 is a state in which it is possible to centrally search for operation plans and fare information in different traffic modes. Level 2 is a state in which searching information that combines different traffic modes is provided in one trip, and reservations and payments can be made accordingly. In Level 3, all transportation modes are packaged, a subscription-type fee structure is introduced, etc.

Source: Game Change for All Industries Beyond the MaaS Mobility Revolution (Yosuke Hidaka, Kazuhiko Makimura, Gakuichi Inoue, Kazo Inoue)

Figure 7.2 Definition of MaaS Levels

Considering the various measures in UB City, the current MaaS level is 0 because it is possible to grasp the bus position information in real-time by introducing the IC card and GPS. However, to promote MaaS to a higher level, the stakeholders, such as operators of each transportation mode and relevant authorities, must coordinate, yet it is not easy. There are issues on the coordination with the operation and organization of the MaaS platform of the performer and consolidation of cashless settlement coordination even in Japan because the private company aims to expand market share and maximize its profit.

Regarding standardization of common technical and implementation specifications by the government, the coordination of the private and public to establish the management organization (with opinion from the government) is necessary.

7.2.2 Strengthening the management system of the management and planning (Technical assistance)

(1) Public transportation

Bus routes and their frequencies are currently formulated by UB City, and bus operations are based on the contracts with UB City. One challenge in human resource development for bus transportation in UB City is to improve the ability to formulate operation plans, which are formulated by UB City Public Transportation Service Department. The department does not review the entire bus routes, although bus routes change temporarily, such as the construction works around the year-end and New Year holidays or the new school period. Possible causes for this are the insufficient human resources to review the operation plan of the entire UB City bus routes and no system to utilize the IC Card (smart card) used for fare payment and GPS for location information despite the availability. In the future, UB City will need to re-develop its bus route network in stages with the development of mass transit. For this purpose, establishing human resources capable of creating operation plans based on data is urgent. Therefore, for flexible operation planning in UB City, assistance for operators is suggested as part of the training in Japan for operation planners in UB City. Table 7.4 shows the counterpart that needs strengthening and the details of strengthening the management system for the bus operation and planning entities.

Table 7.4 Details of Strengthening the Management System for Bus Operating and Planning Entities

	Counterpart	Challenges and countermeasures
1	UB City Public Transportation Service Department	The department does not have a server to manage IC card data information. Since information from UB Smart Card cannot be obtained, an efficient bus route cannot be utilized. Accordingly, it is not possible to confirm whether appropriate service schedules, including frequency of service, can be provided for the citizens, so it is necessary to formulate service proposals based on the appropriate information.
2	UB City Department of Road Traffic Planning and Engineering	There is information that a review of routes will be conducted in assistance with universities. However, since it will be necessary to review again when the new transportation nodes and bus lanes are installed, a new timetable will be formulated based on the review.
3	MRTD	As subsidies to bus operators account for a large percentage of the UB City budget, it is necessary to consider setting appropriate fares in providing sustainable public transportation.
4	Traffic Police	Monitoring and enforcement of private vehicles in bus lanes and enforcement of illegal parking at bus stops have not been properly implemented. Ensuring punctual bus services will require strict enforcement of the law. In addition, since it has been observed that some bus drivers use their mobile phones while driving and turn left from the straight lane, thorough traffic safety guidance should be provided to raise awareness among drivers responsible for human lives on the road. Furthermore, the traffic regulations necessary for bus operations based on the idea of prioritizing public transportation should be reviewed.
5	Bus operator	Information necessary for safe, comfortable, and on-time operations, such as the driving environment, is not always reflected in the operation plan formulated by UB City. It is necessary to understand the actual conditions of the routes from the bus operators so the information can be reflected when formulating new operation plans. In addition, education on compliance with traffic laws and safe driving should be provided to drivers.
6	UB City Smart Card Company	Data from IC cards and cameras installed in cars should be provided to UB City regularly to provide flexibility in terms of operation and operation.

Source: JICA Study Team

(2) Aspects of transport planning

Japan has long experience in intersection improvement, and this ingenuity is reflected in the geometric design and design procedures. The problems in different intersections vary, and so do the countermeasures. Solving the problems is difficult with a single set of rules, but by making uniform causes and quality of countermeasures for the developing countries, the intersections could become easy to manage. In Ulaanbaatar, traffic congestion is severe that it is difficult to consider measures that will lead to solutions. But providing technical assistance (in know-how and introducing new technologies) in basic areas of improvement, such as reducing lanes before and after intersections, the lack of right and left-turn lanes, and vehicles waiting for entry can improve the situation. Medium-and long-term initiatives, such as introducing technologies for easier maintenance and improving road users' driving manners, can also be included in the technical assistance.

On the other hand, when planning the situation at a macro-level (such as developing a master plan), there are aspects where planning and implementation are determined through negotiations with each donor. There are many cases where this is not done enough. In addition, since there are various alternatives to a single project and no evaluation of each alternative or combination of alternatives, there are instances when the evaluation is insufficient to determine the essentiality of the project. In order to implement projects more efficiently in Ulaanbaatar, where there are no financial resources, it is necessary to follow a series of processes such as the one described in this study. It should become important to build an organizational structure for project selection and evaluation in the future and strengthen the capacity of engineers in terms of demand forecasting and evaluation.

(3) Aspects of road drainage technology and road management

Japan is a disaster-prone mountainous country, and various measures have been taken against the disasters. An example is flood control, which involves road drainage technology, water supply and sewage technology, and disaster countermeasures. In recent years, with the advancement of sensor technology, it has become possible to extend the service life of aging roads, bridges, and transportation facilities by verifying their condition, planning and implementing maintenance based on life cycle assessment, and so on. Through these technical collaborations, it will be possible to cultivate the ability to keep infrastructure functions intact.

7.2.3 Applicability of other new technologies

In recent years, proposals for transportation strategies using new technologies, such as ICT, DX technology, and new mobility strategies, have been made in developed countries. Mongolia seems to be following and discussing the feasibility of such strategies. Key words "flying cars," "ultra-compact mobility," and "automated driving" were often mentioned in interviews conducted for this study. Although many of the projects under consideration in this survey involve infrastructure development, and the necessity of such projects is sometimes questioned, there are still many issues in implementing these new technologies, as shown below. Since technological innovation may eliminate the obstacles in introducing these technologies, it is necessary to continue to monitor the applicability and technological trends in order to alleviate traffic congestion in Ulaanbaatar.

(1) Flying car

In Japan, flying cars are suggested to be suitable for the needs of the flying cab market, which is expected to be available by demand with the development of (example) Toyota's eVTOL (electric Vertical Take-Off and Landing) in 2024.[28] Other automakers are also working on the development of eVTOL. However, Audi, for example, announced stopping the eVTOL plan in 2019. They broadcasted some issues such as the difficulty of obtaining approval in consideration of cost, takeoff and landing space, and crash risk.[29] During research, issues of air traffic control, ground infrastructure, and noise have been cited as hurdles to the social implementation of the concept.[30] If the assumed specifications of eVTOL are several ten millions yen per vehicle, 1–9 person capacity, and 200 km/h speed, the cost is about 100-400 yen per km. It is reported that the use will be limited to port areas and suburbs as takeoff and landing sites, and legislation cannot be secured in UB City. Hence, even if Ulaanbaatar considers widespread use of the system, it might only be for emergency medical treatment, transportation between major bases, inter-city travel, and operation in rural areas because of the above issues. Therefore, it must be said that the possibility of the system being widely used by citizens and solving traffic congestion in UB City in 2040 is still low.

(2) Ultra-Compact Mobility

Ultra-compact mobility is a compact car with a capacity of one or two persons, which is slightly smaller than the current standard car. It is also an electric vehicle expected to be a means of transportation for individuals to move freely in the future.[31] In Mongolia, is highly likely that enclosed ultra-compact mobility vehicles will become popular because of the winter season, while other, lighter personal mobility vehicles will be difficult to expand due to their limitation for summer use only. Assuming the use of ultra-compact mobility that the size is a bit large and sealed vehicle, the road space of ultra-compact mobility vehicles will not be as compact as that of conventional vehicles, and the passenger capacity will be less. Transportation efficiency cannot be expected to be very high, and it is highly possible that traffic congestion may not be alleviated due to further increase in demand. However, since it is effective from an environmental standpoint, there is a possibility that its use in Ulaanbaatar will increase in the long run.

[28] "What is "Joby," a flying cab in which Toyota is investing 40 billion yen? It will be launched in 2024!", https://diamond.jp/articles/-/278434.
[29] "Audi: "Realizing a flying car has proven difficult. It's more a matter of wondering why they thought it would be possible." https://intensive911.com/?p=185412
[30] Necessity and Concept of Takeoff and Landing Site Layout Planning for eVTOL, Fujiwara, Manabe, Murayama, Japan Society for Urban Planning, 2020.
[31] According to the definition by the Study Group on Measures to Utilize Automated Driving Technology in Urban Transport, Urban Affairs Bureau, Ministry of Land, Infrastructure, Transport and Tourism in Japan.

(3) Automated driving

Automated driving is a function that allows the driver to move around without using the steering wheel, gas pedal, or brakes, but if advancing the technology further is possible, vehicle-to-vehicle communication then the connected and automated vehicle (CAV) or platoon driving will become possible.[32] It is said that when communicating information at intersections and between vehicles, it will be possible to introduce a system allowing traffic to pass without traffic lights and causing accidents, increasing capacity by up to 138%.[33] Increasing the existing traffic capacity by 138% is possible, which in turn will very much ease traffic congestion. But in Mongolia, where traffic is expected to increase further in the future, the benefits of automated driving will not be felt due to severe traffic congestion. The number of automatic vehicles is also expected to increase. Additionally, the costs of installing automated vehicles and systems to improve the efficiency of traffic signal entry will be expensive and unlikely to solve traffic congestion by 2040 (although possible in the long-term future). A large-scale public transportation system away from traffic congestion will be more beneficial.

Based on the above, introducing these new technologies by 2040 will not easily and directly solve traffic congestion and there are still uncertainties such as institutional aspects, necessary infrastructure development, prices, and social acceptability and it is not easy to make a plan based on these at present. It is important to consider both aspects of congestion easing based on infrastructure development, such as this study, and new technology development considering costs, acceptability, and new infrastructure development.

7.3 Recommendations for future assistance policy

The strengths of Japan and the possibility of utilizing Japanese technology described in the previous section are shown in Table 7.5, categorized as possible future assistance policies: assistance that takes advantage of Japan's strengths and the potential to utilize Japanese technology, assistance in which Japan's strengths can be utilized showing in Section 7.2 (but not so high in terms of enforcement technology), and measures that are difficult for a Japan cooperation effort. Combining the potential for utilization of Japanese technologies, the measures in the first and second categories in Table 7.5 are considered to have a high potential for future assistance policies. It is recommended to examine their business potential as in this study. As mentioned above, the trends vary significantly depending on the innovation technology, so the trends should continue to be monitored before considering the assistance policy.

[32] Platoon driving makes it possible for vehicles to accelerate and brake at once, allowing driving at a shorter distance between vehicles and passing intersections through any direction.
[33] Optimal Traffic Control at Smart Intersections: Automated Network Fundamental Diagram, December 2019, Transportation Research Part B.

Table 7.5 Possible Future Assistance Policies of JICA

Category	Measure	Supplement
(A) In terms of utilizing Japan's strengths in knowledge and experience and Japanese technology	Introduction of priority traffic signals for public transport	Introduce signals that allow public transportation to take priority, helping to reduce congestion.
	Mass transit public transportation system construction project	Conduct a railway F/S and study for implementation. Since the study requires time, it should be implemented as soon as possible.
	Technical assistance for improving traffic management capacity	Implement systematic and technical capacity building for traffic bottleneck detection, countermeasures, and signals.
	Transportation node improvement project	Improve transportation nodes and public transportation terminals to make it more convenient to transfer between existing buses and railways.
	Technical assistance for improving public transport management capacity	As presented in 5.2.2.
	Introduction of traffic signals	As shown in Chapter 6, introduce autonomous traffic signals.
	Construction of urban expressways and elevated roads	Construction of road highways and continuous multilevel intersections, while taking into consideration the environment, to promote traffic congestion through detours.
	Introduction of road traffic information system	By introducing a traffic information system, we aim to achieve more efficient transportation by comparing parking lot fullness, congestion, and public transportation.
	BRT and express bus network development project	The introduction of an express bus system will provide an inexpensive public transportation system, especially in areas that are not congested.
	Technical assistance for TOD promotion project	Emphasis will be placed on bus and rail travel through the construction of pedestrian and bicycle paths, transit facilities, and residential, work, and commercial facilities.
	Bus route realignment project	Reorganize existing bus and post-railway bus routes to establish an efficient bus network.
	Technical assistance and facility development for barrier-free facilities	Barrier-free facilities will be built so that people of all ages, both men and women, and the unfit can get around.
	Bottleneck intersection countermeasure project	Identify bottleneck intersections, causes of congestion, and countermeasures.
	Technical assistance for improving traffic safety capacity	Traffic safety aspects and traffic facilitation aspects of traffic policing, safety facility installation, bicycle-pedestrian route planning, and pedestrian/vehicle separation will be studied to improve traffic safety capacity.
	Railway operation assistance services	The goal is to achieve accident-free and sound railway management through technical assistance in railway operation and management.
	Technical assistance for improving the financial capacity of transportation (public transportation)	Examine operation plans and facility plans for the operation of public transportation, and improve services to increase usage from a private sector perspective.
(B) in terms of utilizing Japan's strengths in knowledge and experience, but utilizing technology which is being followed in countries other than Japan	Road network improvement promotion project	The project aims to alleviate traffic congestion by providing technical assistance in planning the development of roads in the district, traffic management, traffic impact assessment for large-scale facility development and redevelopment projects, and road network planning.
	Road network improvement promotion project	The aim is to reduce traffic congestion through the development of bypasses, high-standard roads, and continuous multilevel intersections for the purpose of traffic dispersion.
	Intersection project	Development of multilevel intersections at intersections with heavy traffic concentration.
	Improvement of Tuul River Bridge	The Tuul River crossing bridge will be improved to reduce congestion by dispersing traffic.
	Suburban relocation of industry and universities	Relocate traffic concentration points to the suburbs to reduce congestion.
(C) In terms of getting assistance from other countries.	Bus vehicle maintenance	Purchase bus vehicles to increase the frequency of service.
	Road space redistribution project	Re-examine the utilization of road space and make effective use of it.
	Technical assistance to improve road management capacity	Reinforcement of pavements, especially in gel areas, and against pavement damage due to unexpected overload
	Cold region road pavement strengthening project	
	Introduction of a parking management system	The goal is to reduce congestion by improving parking facilities and promoting measures such as switching to public transportation by collecting parking fees.

Source: JICA Study Team

Appendix

Appendix 1 Project summary

Data Collection Study on Transportation Infrastructure Development in Ulaanbaatar, Mongolia

Final Report

March 2022

Japan International Cooperation Agency (JICA)

Almec Corporation

CTI Engineering International Co., Ltd.

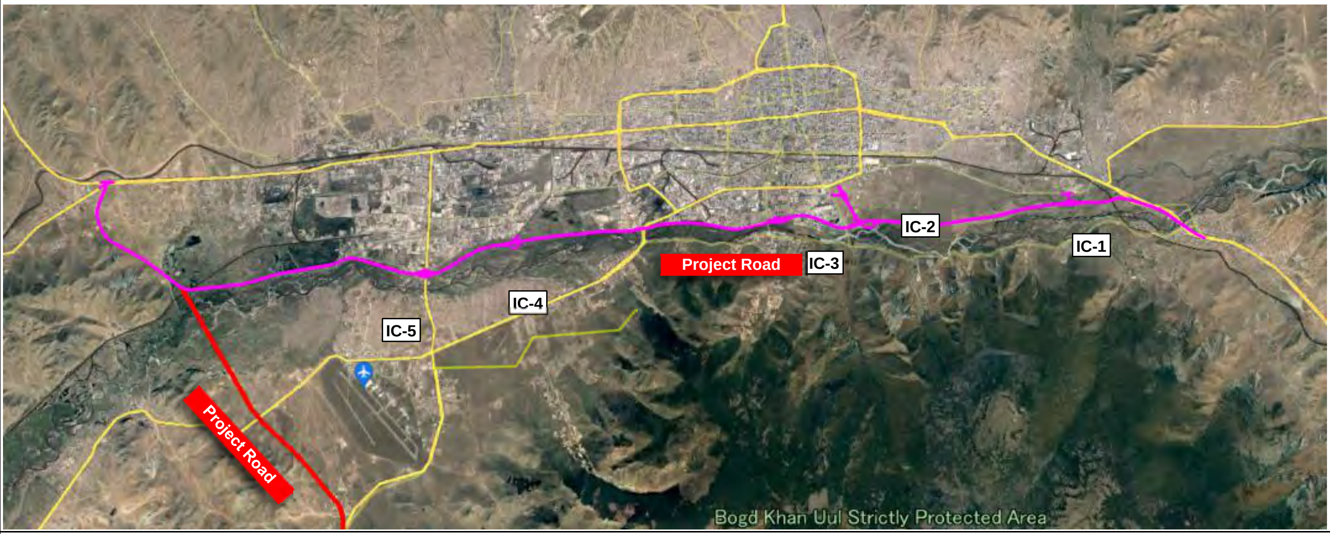
Project Overview/ Evaluation: 1

Project category: A. Expressway/Primary

Project ID: A1	**Project Name**: Tuul River Expressway & Bypass

Location (Name, Khoroo, etc.):

Location Map:



Project Outline: New expressway to bypass at the south part of UB City is developed. A new airport link from the west edge of the Tuul River Expressway will be constructed simultaneously to support the traffic from newly developed airport town as needed.

Road Length : 35 km (Tuul River Expressway with 6 Lanes) F/S in 2015 proposed 4 lanes
: 8 km (Western Airport Bypass with 4 Lanes)
Number of I.C. : 5 locations
Bridge : 13 locations (Tuul River Expressway)
: 1 location (Western Airport Bypass at 3000 m)
Underpass : 2 locations
Project Cost : 902 mil. USD

Development impact: Expected Traffic Volume (2040): Western Section: 130,600 PCU/day Eastern Section:151,100 PCU/day Traffic Volume at Peace Ave.: Eastern Section : 91,300 PCU/day→ 82,600 PCU/day (-10%) Western Section: 154,700PCU/day→137,000 PCU/day (-18%) Traffic Volume at Chinggis Ave.: Eastern Section: 105,800PCU/day→ 83,600PCU/day (-21%) Western Section: 97,600PCU/day→ 77,900PCU/day (-20%)	**Rate (5: High effect)** 1 2 3 4 ⑤
Investment effect: EIRR =19.7%	**Rate (5: High effect)** 1 2 3 ④ 5
Japanese technical features: The following technologies will be possible to apply for the project. ・No joint system for the bridge structure ・Minimization of construction period by using the pre-cast members	**Rate (5: Technical feature)** 1 2 ③ 4 5
The capacity of Implementation agencies: ・Knowhow for the operation and maintenance of the expressway needs to be enhanced. ・Involvement of the private sector would be required to bear huge amount of construction cost.	**Rate (5: Enough capacity)** 1 ② 3 4 5

Feasibility from environmental impact aspect: Close communication with the Tuul River Committee would be required due to the construction in a preservation area in the Tuul River Basin. In addition, land acquisition along the proposed road alignment is very difficult due to rapid development at Khan-Uul District, which will require a drastic review of road alignment. The same issue at the western edge of the expressway is becoming apparent.		**Rate (5: High feasibility)** 1 ② 3 4 5

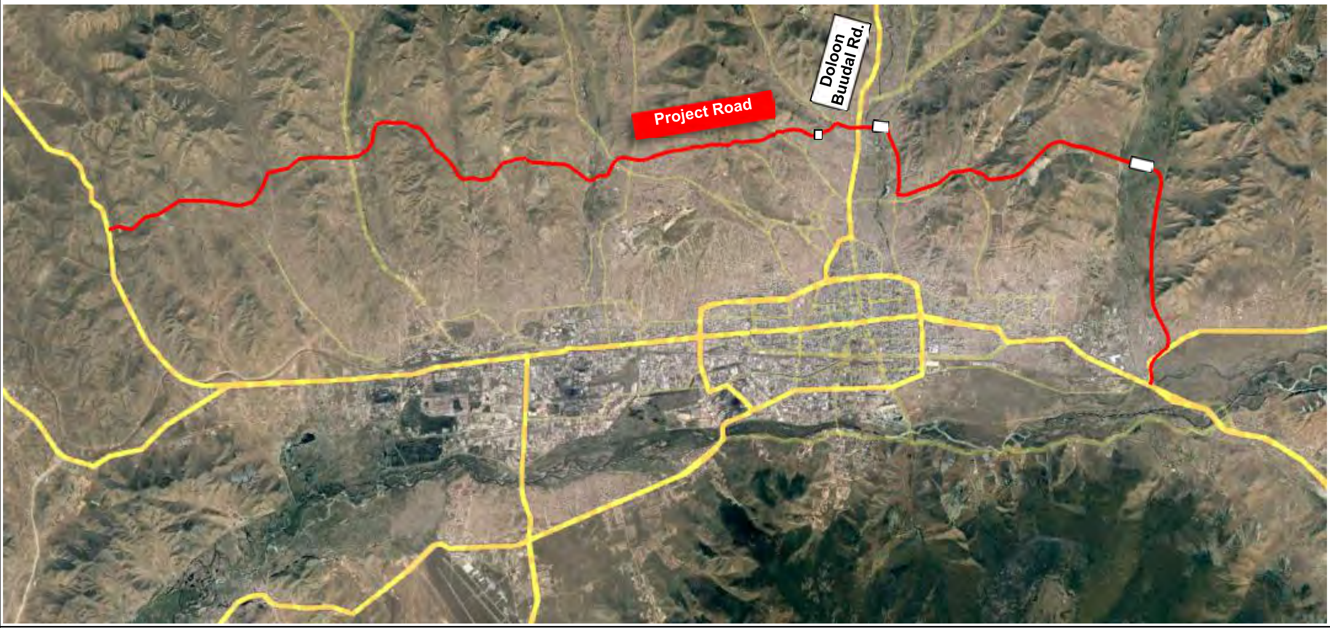
Project Overview/ Evaluation: 2

Project category: A. Expressway/Primary

Project ID: A2	**Project Name**: Northern Ger Area Road

Location (Name, Khoroo, etc.):

Location Map:



Project Outline : Four-lane arterial road passing through the northern ger area in UB City would be developed by connecting the missing link and widening the existing road.

Road Length : 51 km (4 lanes)

Bridge Locations : 3 locations

Project Cost : 141 mil. USD

Development impact: Expected Traffic Volume : 24,700–39,600 PCU/day (2040) Ard Ayush Rd. : Western section 61,700 PCU/day→55,000 PCU/day(-10.9%) : Eastern section 110,700 PCU/day→97,309 PCU/day(-12.1%) Peace Ave. : Western section 97,900 PCU/day→ 92,100 PCU/day(-5.9%) : Eastern section 66,400 PCU/day→ 61,300 PCU/day(-7.7%)	**Rate (5: High effect)**: 1 2 ③ 4 5
Investment effect: EIRR =18.5%	**Rate (5: High effect)**: 1 2 3 ④ 5
Japanese technical features: N/A	**Rate (5: Technical feature)**: ① 2 3 4 5
The capacity of Implementation agencies: ・ Local contractor can construct due to fewer difficulties in terms of construction technology. ・ It will take time for the land acquisition and stakeholder meetings.	**Rate (5: Enough capacity)**: 1 2 ③ 4 5
Feasibility from environmental impact aspect: ・ It will be highly possible to delay the implementation of the project due to the large scale of land acquisition and resettlement along the extent of the project road. ・ Arterial road construction may cause division of the community in the ger area to be concerned. 	**Rate (5: High feasibility)**: 1 ② 3 4 5

Project Overview/Evaluation: 3

Project category: B. Public Transportation	
Project ID: B1-B5	**Project Name**: Study for Railway Master Plan in UB City and Feasibility Study of Priority Project
Location (Name, Khoroo, etc.): East–West Line along Peace Ave., East–West Line along Narmi Road, North–South Line, North–South Circle Line, etc.	

Location Map:

Planned Initial Project Cost: 6 mil. USD	**Study Contents**: Studying the railway projects of each line, including East–West Line along Peace Ave., East–West Line along Narmi Road, North–South Line, and North–South Circle Line, by estimating the effects comparing between alternative plans, undertaking sensitive and economic and financial analysis to select the preceding project, and implementing its F/S to proceed to the next design stage.
Finding: Not yet	
Implementation agency: UB Municipal Office **Operation Agency:** UB Municipal Office	
Schedule: 2022–2024	

Development impact: The railway project is focused on as the drastic program for the UB municipal office and UB City citizens to change from private to public transportation. The HIS survey in the city showed that 60% agreed for the introduction of a railway. Many studies have already shown that the project would give many profits.	**Rate (5: High effect)** 1 2 3 4 ⑤
Investment effect: VOCs of major roads in UB City have already reached from 2.0 to 3.0. The railway project is extremely effective though expensive since large-scale road projects cannot be implemented because of the difficulty in land acquisition. The East–West Line along Narnii Road Phase 1 is 835 mil. USD, Phase 2 is 566 mil. USD, Phase 3: 168 mil. USD. The East-West Line along Peace Ave. is 1,362 mil. USD, the North–South Line (additional to East–West Line) is 995 mil. USD, and the other routes have no costs indicated yet.	**Rate (5: High effect)** 1 2 3 4 ⑤
Japanese technical features: Urban railway system including rolling stock, rail, signaling and AFC will be useful as Japanese excellent technology. Also, Japanese construction technology for viaducts and tunnels will be useful to get over the difficulties of designing and construction in limited space.	**Rate (5: Technical feature)** 1 2 3 ④ 5
The capacity of Implementation agencies: It should be considered that they have no experience of urban railway projects even in condition that project cost is very expensive though they do not have enough budget It will be essential for them to get supports for coordination between stake holders, training for skills of O&M, partnership with private sectors, etc.	**Rate (5: Enough capacity)** 1 2 ③ 4 5
Feasibility from environmental impact aspect: Some land acquisitions for the depot, sub-stations and curve sections will be necessary. But that impact will be small by designing facilities in ROW of roads as possible.	**Rate (5: High feasibility)** 1 2 ③ 4 5

Project Overview/Evaluation: 4

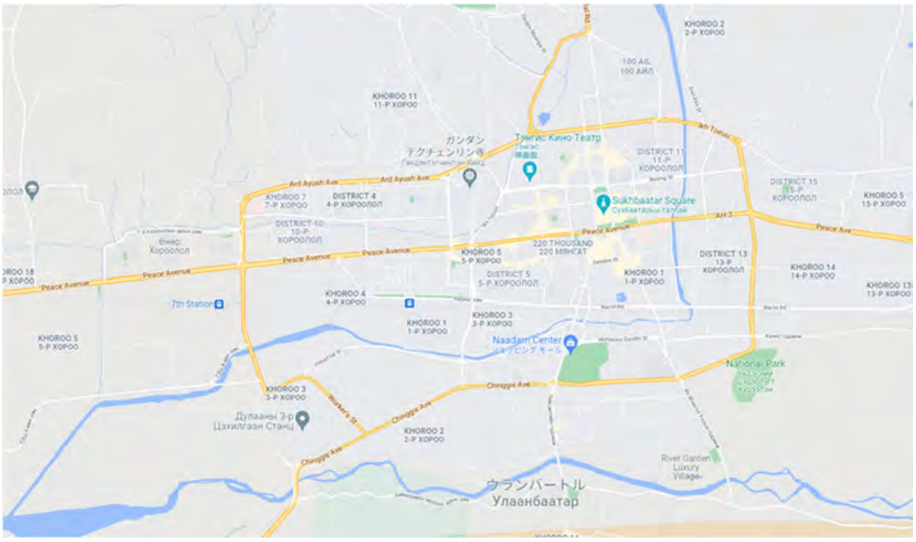
Project Category: C. Bus Transportation

Project ID: C1

Project Name: Maintenance of Bus Exclusive Lane in UB City (Public Transport Corridor Enhancement Project Sector Loan)

Location (Name, Khoroo, etc.): **Part of Ard Ayush Ave. and Part of Narnii Road in UB City**

Location Map:



Cooperation with technical assistance project and assumption of mutually impacts :

Promoting the use of public transportation by operating buses in exclusive bus lanes, curbing the influx of private vehicles into the city center, and reducing environmental impact.

Finding: ODA by Japanese Government

Implementation agency: UB City

Schedule: （From the case in Yangon city）

F/S	6 month
Detail Design	12 month
Construction	24 month
Total	42 month（3 years 6 month）

Project objective, overview:

By introducing an exclusive bus lane in UB City and improving the punctuality and speed of service, it aims to shift the use of buses from private cars and increase the use of buses, thereby building a sustainable bus operation system and improving service to users.

Development impact: As it will contribute to the reduction of road congestion on Peace Avenue, the development effect is expected to be significant.	**Rate (5:High effect)** : 1 2 3 ④ 5
Investment effect: The effect of investment is expected to be significant as the functionalization of exclusive bus lanes will improve the speed and punctuality of bus. Project cost (approximate): 11 mil. USD	**Rate (5: High effect)** : 1 2 3 ④ 5
Japanese technical features: Existing technology on the Mongolian side can be used for this purpose. However, guidance on operational technology will be needed.	**Rate (5: Technical feature)** : 1 2 ③ 4 5
The capacity of Implementation agencies: Although it is considered possible for UB City to handle this project, it would decrease the area of green space, and there may be protests by neighboring residents. It is desirable to implement this project in conjunction with the Project for Public Transportation in the city of Ulaanbaatar described in Evaluation Form 16.	**Rate (5: Enough capacity)** : 1 2 ③ 4 5
Feasibility from environmental impact aspect: In some areas, although the construction of bus lanes will require the conversion of green areas into roads, the impact is expected to be limited and contribute to reducing the environmental impact by reducing traffic congestion and vehicle exhaust emissions.	**Rate (5: High feasibility)** : 1 ② 3 4 5

Project Overview/ Evaluation: 5

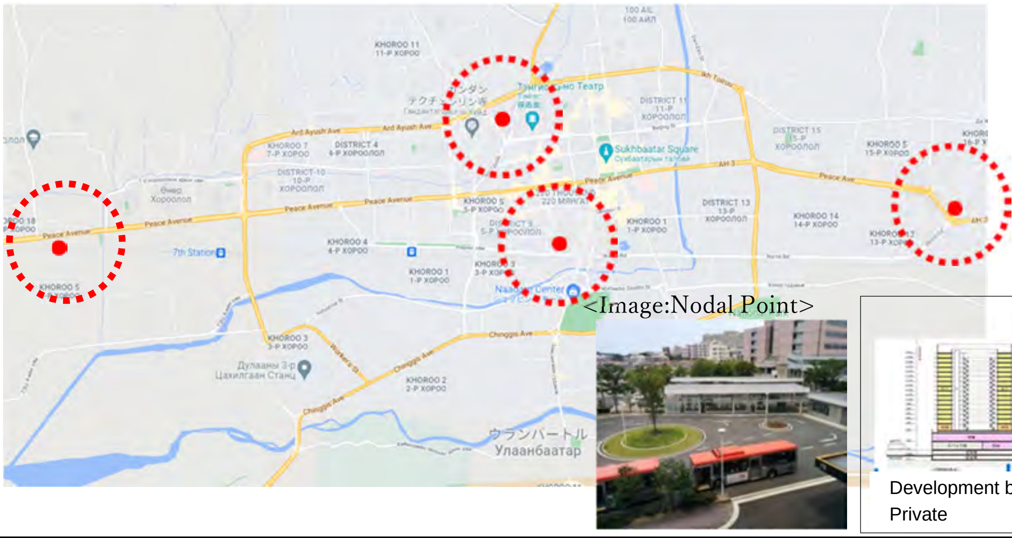
Project category: C. Bus Transportation

Project ID: C2

Project Name: Upgrading Project of Bus Terminal in UB city (Public Transport Corridor Enhancement Project Sector Loan)

Location (Name, Khoroo, etc.): 4 sites in the city

Location Map:



<Image:Nodal Point>

Development by Private

Development of Bus terminal

Cooperation with technical assistance project and assumption of mutually impacts :

Among the proposals in the technical cooperation project, “2-2. Promote bus stops that can easily transfer,” “3-1. Propose optimal public transportation network in UB city,” “3-3. Establish nodes, trunk lines and branch lines,” and so on, are assumed to be measures that will contribute to reducing the influx of people from the suburbs to the city center.

Finding: ODA by Japanese Government

Implementation agency: UB City

Schedule: (From the case in Yangon City)

F/S	6 months
Detail Design	12 months
Construction	24 months
Total	42 months（3 years and 6 months）

Project objective, overview:

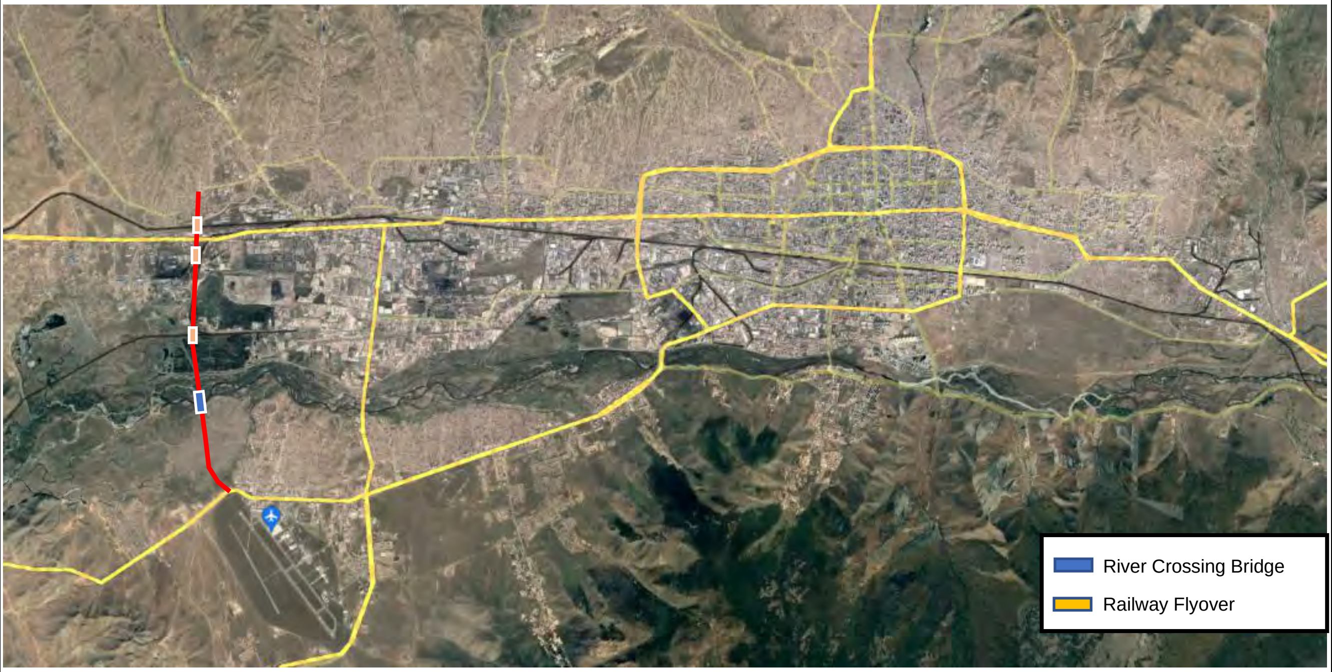
Two intercity bus terminals in UB City and two bus terminals near the city center will be developed as bus nodal points. The bus routes will be restructured to improve punctuality and accommodate the future introduction of mass transit. In addition, the bus terminal will maintain commercial facilities, etc., which will help to reduce the flow of people to the city center.

Development impact: The area will be developed as a place where people can easily congregate by building commercial facilities together with bus nodes.	**Rate (5: High effect)** 1 2 3 ④ 5
Investment effect: The effect of investment is highly expected due to the improvement of bus operations and ensuring punctuality. In addition, the development of commercial facilities will contribute to shortening the payback period. Project cost (approximate): To be determined	**Rate (5: High effect)** 1 2 ③ 4 5
Japanese technical features: It is necessary to utilize Japanese technology in the bus terminal layout method. Cooperation with local private developers will be needed for building and operating commercial facilities, but for the bus terminal concept, Japanese technical support is expected to be necessary.	**Rate (5: Technical feature)** 1 2 ③ 4 5
The capacity of Implementation agencies: In particular, coordination among stakeholders is required, and capacity is limited in this respect. It is desirable to implement this project together with the Project for Public Transportation in the city of Ulaanbaatar described in Evaluation Form 16.	**Rate (5: Enough capacity)** 1 2 ③ 4 5
Feasibility from the environmental impact aspect: It does not significantly change the environment. Environmental and social considerations can be addressed by considering the introduction of some green space along with the development.	**Rate (5: High feasibility)** 1 ② 3 4 5

Project Overview/ Evaluation: 6

Project category: D. Secondary Road	
Project ID: D1	**Project Name**: Northern Airport Link Road
Location (Name, Khoroo, etc.): See the following map	

Location Map:



Project Outline: North-South link road from the old airport to Tovchoo Road through Tuul River crossing would be constructed to divert the existing traffic of Chinggis Ave. and Sonsgolon Road.

Road Length	: 6.3 km (4-lane)
Bridge (River Crossing)	: 1 location (L = 250m)
Railway Flyover	: 3 Location
Project Cost	: 92.2 mil. USD

Development impact: Connecting the shortest distance to support the traffic between the new subcenter of the western part of UB City and Yarmag area as well as a new airport city. It will reduce the traffic congestion at Chinggis Ave. and Sonsgolon Rd. Expected Traffic Volume : 53,900 PCU/day (2030) Sonsgolon Rd. : 71,200 PCU/day → 40,000 PCU/day (-43.8%) Chinggis Ave. : 113,700 PCU/day →106,700 PCU/day (- 6.2%)	**Rate (5: High effect)** 1 2 ③ 4 5
Investment effect: EIRR =0 %	**Rate (5: High effect)** ① 2 3 4 5
Japanese technical features: ・ Minimization of construction period by using precast members. ・ Minimization of maintenance cost of a bridge by the non-joint technology ・ Minimization of maintenance cost and delineation by using the low-position lighting	**Rate (5: Technical feature)** 1 2 ③ 4 5
The capacity of Implementation agencies: ・ Close discussion and coordination with UB Railway for flyover would be required. ・ Continuous capacity development would be required for future maintenance for road facility including drainages.	**Rate (5: Enough capacity)** 1 2 3 ④ 5
Feasibility from environmental impact aspect: ・ Early implementation of F/S to ensure ROW would be highly recommended before land acquisition and resettlement becomes difficult.	**Rate (5: High feasibility)** 1 2 3 ④ 5

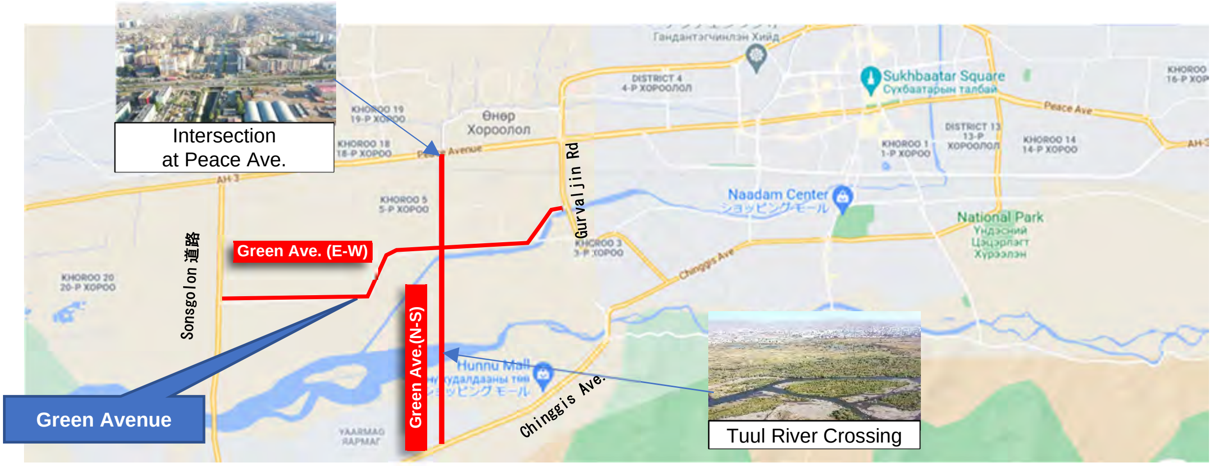
Project Overview/ Evaluation: 7

Project category: D. Secondary Road

Project ID: D2	**Project Name**: Green Avenue Project (N-S + E-W)

Location (Name, Khoroo, etc.): Khan-Uul District, Bayangol District, Songinokhairkhan District

Location Map:



Project Outline: New road connecting Yarmag Sub-center located in the southern part of UB City and Peace Ave. in the shortest distance (5 km long) will be constructed.

Tuul River Crossing Bridge	: L = 800 m
Railway Flyover	: L = 200 m
At-grade Intersection	: 3 locations (Peace Ave, Power Plant Road, Chinggis Ave)
New Road Construction	: 4.0 km / Green Avenue (N-S)
Widening of Existing Road	: 6.0 km / Power Plant Road (Green Avenue (E-W))
Project Cost	: 117 mil. USD

Development impact: Expected Traffic Volume : Green Ave. (N-S): 37,000～44,100 PCU/day (2030) : Green Ave. (E-W): 48,600～83,300 PCU/day (2030) Impact to Existing Road Traffic Peace Ave. : 96,800 PCU/day→ 85,600 PCU/day (-11.6%) Chinggis Ave. : 126,800 PCU/day→104,900 PCU/day (-26.8%) Sonsgolon Rd. : 66,500 PCU/day→ 64,500 PCU/day (-3.0%) Gurvalgin Rd. : 82,700 PCU/day→ 75,600 PCU/day (-8.6%)	**Rate (5: High effect)** 1 2 3 4 ⑤
Investment effect: EIRR=13.0%	**Rate (5: High effect)** 1 2 ③ 4 5
Japanese technical features: ・Minimization of construction period by the precast members ・Minimization of maintenance cost of the bridge by a Non-Joint Technology ・Prevention of contamination of underground water by using the rotary penetration steel pile ・Minimization of maintenance cost and delineation by using the Low-Position Lighting ・Self-Actuation Control Signal at intersections	**Rate (5: Technical feature)** 1 2 3 ④ 5
The capacity of Implementation agencies: Resettlement would be required at the south part of Green Ave. (N-S) which would not hamper the implementation of the project. Close coordination with UB Railway is important for the design and construction of railway crossings.	**Rate (5: Enough capacity)** 1 2 3 ④ 5
Feasibility from environmental impact aspect: Sufficient environmental protection measures would be required to ensure the quality of underground water in the water resource preservation area. Land acquisition will be required at Power Plant Road (Green Ave (E-W)) to widen the existing road while the possibility to delay the project implementation is small due to less resettlement.	**Rate (5: High feasibility)** 1 2 3 ④ 5

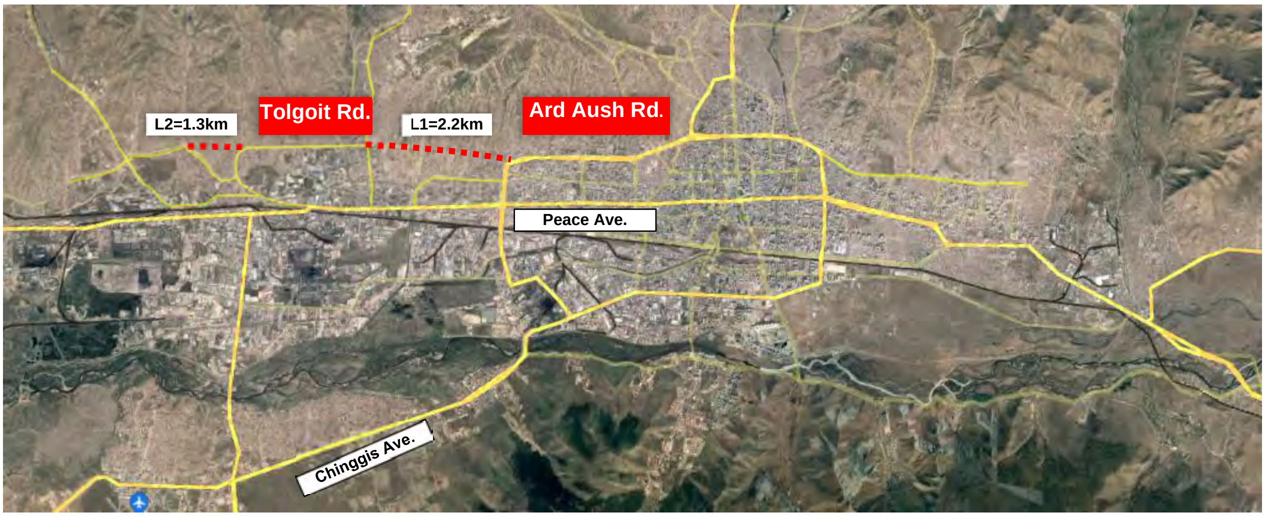
Project Overview/Evaluation: 8

Project category: D. Secondary Road

Project ID: D3 | **Project Name**: Ard Aysh Road Missing Link Connection

Location (Name, Khoroo, etc.): See the following map

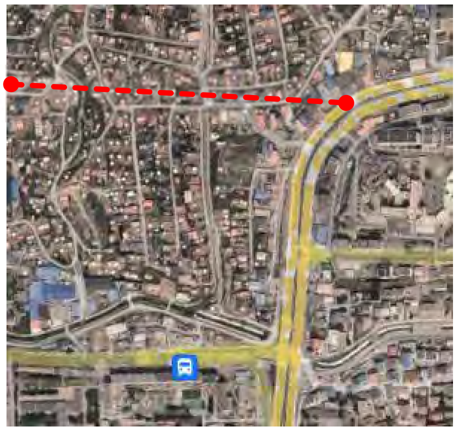
Location Map:



Project Outline: New East-West Corridor would be formed in parallel with Peace Ave by connecting the existing missing link between Ard Ayush Rd and Tolgoit Rd.

Road Length : 3.5 km (4 lanes)
Bridge Location : 0
Project Cost : 22.9 mil. USD

Development impact: Expected Traffic Volume: 80,900 PCU (2030) Impact on Traffic Volume of Peace Ave.: 102,599 PCU/day→ 87,800 PCU/day (-14.3%)	**Rate (5: High effect)** 1 2 ③ 4 5
Investment effect: EIRR = 33.2%	**Rate (5: High effect)** 1 2 3 4 ⑤
Japanese technical features: ・No Japanese technology is required.	**Rate (5: Technical feature)** ① 2 3 4 5
The capacity of Implementation agencies: ・ Continuous capacity development would be required for future maintenance for road facility including drainages.	**Rate (5: Enough capacity)** 1 2 ③ 4 5
Feasibility from environmental impact aspect: ・ It will be highly possible to delay in implementation of the project due to the large scale of land acquisition and resettlement along the project road passing through congested ger areas.	**Rate (5: High feasibility)** 1 ② 3 4 5



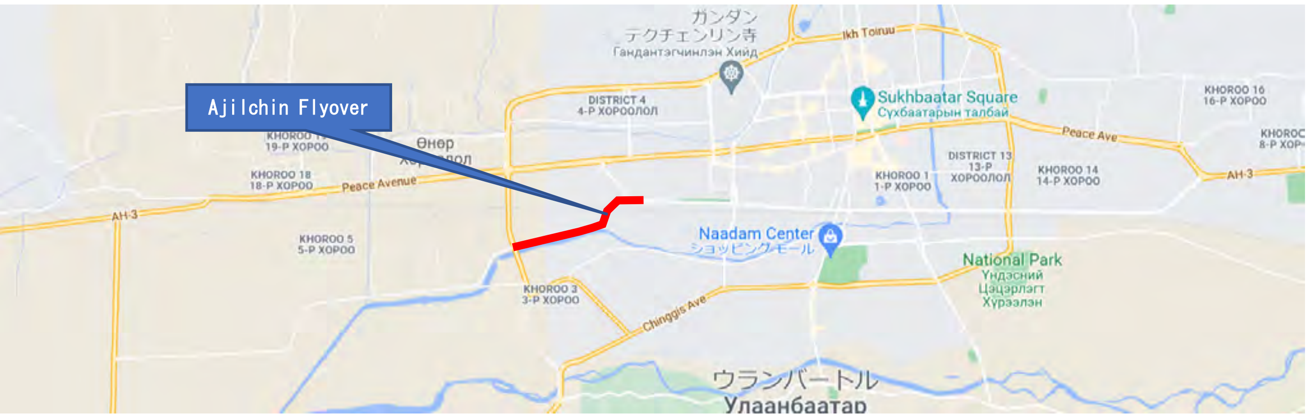
Project Overview/ Evaluation: 9

Project category: D. Secondary Road

Project ID: D4	**Project Name**: Ajilchin Flyover Project

Location (Name, Khoroo, etc.): Bayangol District, Khan Uul District

Location Map :



Project Outline: Missing link between Narnii Road and West Industrial Road divided by railway would be connected by the flyover and its approach road that is 2.7 km in total length.

Railway Flyover and viaduct	: L = 828 m (4-Lane with on-off ramp)
East Approach Road	: L = 515 m, Service Road L = 1210 m/ West Approach Road: L = 1000 m
Dund River Dike	: L = 915 m
West Industrial Road Improvement	: L = 1370 m
Project Cost	: 89 mil. USD

Development impact: Expected Traffic Volume : 64,300 PCU/day (2030) Peace Ave. : 121,800 PCU/day→ 96,100 PCU/day (-22.1%) Chinggis Ave. : 103,600 PCU/day→ 98,200 PCU/day (-5.2%) Travel Time from Yarmag Sub-Center to UB Railway Station will be reduced by 16 minutes.	**Rate (5: High effect)** 1 2 3 4 ⑤
Investment effect: EIRR = 23.9%	**Rate (5: High effect)** 1 2 3 4 ⑤
Japanese technical features: ・Minimization of L.C.C. by the small number of girders and highly durable deck slab ・Construction of pile foundation near railway track with rotary penetration steel pile ・Least effect to railway operation by launching method for girder erection. ・Self-actuated signal control	**Rate (5: Technical feature)** 1 2 3 4 ⑤
The capacity of Implementation agencies: Close communication among concerned agencies for utility relocation and construction in the railway area (experienced during Narni Bridge Construction).	**Rate (5: Enough capacity)** 1 2 3 ④ 5
Feasibility from environmental impact aspect: No resettlement would be required. The cut-off based on ROW was announced in 2013, and in the same year, the EIA was approved, which may be updated.	**Rate (5: High feasibility)** 1 2 3 ④ 5

Project Overview/Evaluation: 10

Project category: D. Secondary Road

Project ID: D5 | **Project Name**: Narni Road East Extension

Location (Name, Khoroo, etc.):

Location Map:

Project Outline: Traffic congestion of east part of Peace Ave. will be mitigated by extending Narni Rd. to the eastern side to shift the intersection with Peace Ave.

Road Length : 4.0 km (4-Lane)
Bridge Location : 0 Location
Project Const : 21.6 mil. USD

Development impact: Expected Traffic Volume : 48,400 PCU/day (2030) Traffic Volume at Peace Ave. : 69,700PCU/day→56,400PCU/day (-19.1%)	**Rate (5: High effect)**: 1 2 ③ 4 5
Investment effect: EIRR =--% (Minus Benefit)	**Rate (5: High effect)**: ① 2 3 4 5
Japanese technical features: N/A	**Rate (5: Technical feature)**: ① 2 3 4 5
The capacity of Implementation agencies: ・ Continuous capacity development would be required for future maintenance for road facility including drainages. ・ Land acquisition and stakeholder meetings need to be arranged by the UB City Government.	**Rate (5: Enough capacity)**: 1 2 ③ 4 5
Feasibility from environmental impact aspect: ・ It will be highly possible to delay implementation of the project due to the large scale of land acquisition and resettlement along the extent of the project road.  Photo of Project Site	**Rate (5: High feasibility)**: 1 ② 3 4 5

Project overview/ evaluation：11

Project category: E. Intersection Improvement

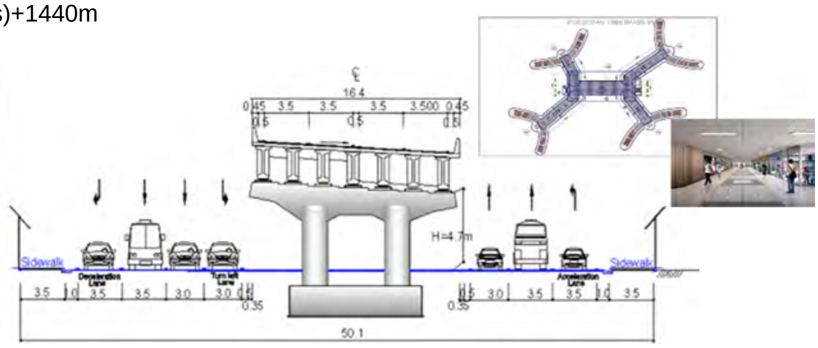
Project ID: E1 | **Project Name**: East Side Intersection Grade Separation Project

Location (Name, Khoroo. etc.): Bayanzurkh District

Location Map:

Project Outline:
Intersection of the Peace Ave and the Ikh Toiruu would be grade-separated by flyover. It was originally designed together with pedestrian underpass in 2008 and scheduled to be implemented in 2012 under finance of the Development Bank of Mongolia. However, it was suspended and no longer scheduled for implementation.

Flyover and Approach Road :135 m (4-Lanes)+1440m
Project Cost : 33 M. USD



Development impact: Mitigation of traffic congestion at Peace Ave. and Ikh Toiruu, and reduction of travel time at intersection. Traffic Volume (FO:E-W) : 44,700 PCU/day (2025) Traffic Volume (N-S) : 66,100 PCU/day (2025) Reduction of Average Stopped Delay :123 s/veh	**Rate (5: High effect)**: 1 2 3 ④ 5
Investment effect: EIRR =12.5 %	**Rate (5: High effect)**: 1 2 ③ 4 5
Japanese technical features: ･Rapid Construction by Steel Girders in Urban Area. ･Minimization of construction period by using the Precast Members. ･Self-Actuation Signal Control	**Rate (5: Technical feature)**: 1 2 3 ④ 5
The capacity of Implementation agencies: ･ Important to coordinate with future plan of Public Transportation Plan (BRT and/or LRT) ･ Continuous capacity development would be required for future maintenance for road facility including drainages.	**Rate (5: Enough capacity)**: 1 2 3 ④ 5
Feasibility from environmental impact aspect: ･ Land acquisition along service road at the intersection have been done at the time of detailed design, however, the plan needs to be reviewed since high-rise building have been already constructed at the same area. ･ Land scape needs to be concerned in the development of populated area.	**Rate (5: High feasibility)**: 1 2 ③ 4 5

Project overview/ evaluation：12

Project category: E. Intersection Improvement

Project ID: E2	**Project Name**: Sapporo Intersection Grade Separation Project

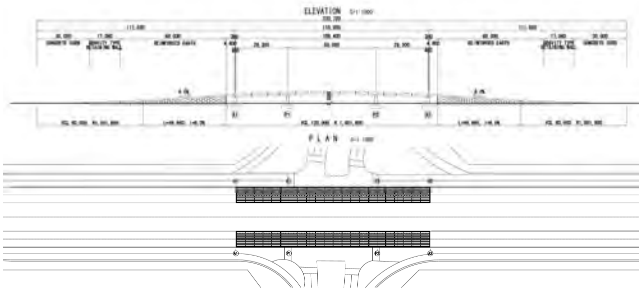
Location (Name, Khoroo, etc.): Bayangol District, No.5, 12, 20 Khoroo

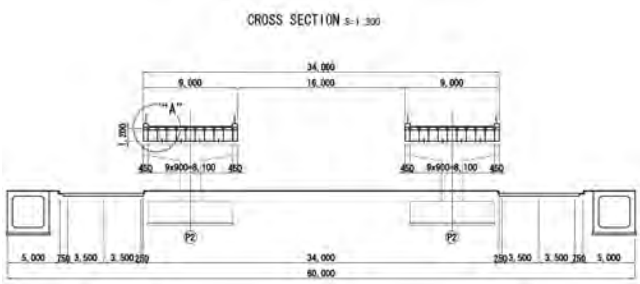
Location Map:

Project Outline: Grade separation by flyover would be constructed at the intersection of Peace Ave. and Gurvaljin Road/Ard Ayush Road. The roundabout intersection at the same location was improved to signalized intersection under the Street Project financed by the Ministry of Economic Development in 2015.

Flyover : L = 110m ＋ Approach Road: 118 m x 2 (4-lane)

Project Cost : 33 mil. USD





Development impact: Mitigation of traffic congestion at Peace Ave. and Gurvaljin Road/Ard Ayush Rd., and reduction of travel time at the intersection. Expected Traffic Volume (F.O. E-W) : 82,200 PCU/day (2025) Expected Traffic Volume (N-S) : 54,200 PCU/day (2025) Reduction of Average Stopped Delay : 102 sec/veh.	**Rate (5: High effect)** : 1 2 3 ④ 5
Investment effect: EIRR = 10.7%	**Rate (5: High effect)** : 1 ② 3 4 5
Japanese technical features: ･Rapid Construction by Steel Girders in Urban Area. ･Minimization of construction period by using the Precast Members. ･Self-Actuation Signal Control	**Rate (5: Technical feature)** : 1 2 3 ④ 5
The capacity of Implementation agencies: ･Important to coordinate for the future Public Transportation Plan (BRT and/or LRT) ･Continuous capacity development would be required for future maintenance for road facility including drainages. ･Cost and scale of utility relocation work will be relatively larger.	**Rate (5: Enough capacity)** : 1 2 3 ④ 5
Feasibility from environmental impact aspect: ･ Small scale land acquisition for the service road would be required, which is not a critical issue for implementation. No resettlement is expected.	**Rate (5: High feasibility)** : 1 2 3 ④ 5

Project overview/ evaluation：13

Project category:　E. Intersection Improvement

Project ID: E3　　**Project Name**:　No.17 Intersection Grade Separation Project

Location (Name, Khoroo, etc.): See the following map.

Location Map:

Project Outline:

Grade separation by flyover would be constructed at the intersection of Chingeltei Ave. (north–south direction) and Khailaast Road (east–west direction), which will be a part of the Northern Ger Area Connection Road in the future. The F/S has not yet been conducted.

Flyover	: 4-Lane × L = 70m
Approach Road	: 4-Lane × 140 m × 2
Intersection Improvement	: 1 location
Project Cost	: 33 mil. USD

Development impact: Reduction of stopped delay at the intersection of Chingeltei Ave. and Khailaast Road Expected Traffic Volume (F.O.: N-S) : 60,300 PCU/day (2025) Expected Traffic Volume (E-W) : 29,100 PCU/day (2025) Reduction of Average Stopped Delay : 51 sec/veh	**Rate (5: High effect)**: 1 ② 3 4 5
Investment effect: EIRR = 13.1%	**Rate (5: High effect)**: 1 2 ③ 4 5
Japanese technical features: ・Rapid Construction by Steel Girders in Urban Area. ・Minimization of construction period by using the Precast Members. ・Self-Actuation Signal Control	**Rate (5: Technical feature)**: 1 2 3 ④ 5
The capacity of Implementation agencies: ・Continuous capacity development would be required for future maintenance for road facility including drainages. ・Cost and scale of utility relocation work will be not critical.	**Rate (5: Enough capacity)**: 1 2 3 ④ 5
Feasibility from environmental impact aspect: ・ Small scale land acquisition for the service road would be required, which is not a critical issue for implementation. Less resettlement is expected.	**Rate (5: High feasibility)**: 1 2 3 ④ 5

Project overview/ evaluation：14

Project category: E. Intersection Improvement	
Project ID: E4	**Project Name**: West Cross Intersection Grade Separation Project
Location (Name, Khoroo. etc.): West Cross Intersection	

Location Map:

Project Outline: Grade separation by flyover would be constructed at the intersection of Peace Ave. and Ikh toiruu. D/S was conducted in 2008, and the Contractor was selected in 2013 to be implemented under a soft loan financed by China. The Project has been suspended, and no implementation schedule proposed.

Flyover including Ramps : L = 1,212.3 m
Approach Road : L = 2.1 km
Project Cost : 70 mil. USD

Development impact: Mitigation of traffic congestion of the Peace Ave. and the Ikh toiruu. Reduction of stopped delay at the intersection of the Peace Ave. and Ikh toiruu. Expected Traffic Volume (F.O.: N-S) : 51,300 PCU/day (2025) Expected Traffic Volume (E-W) : 62,100 PCU/day (2025) Reduction of Average Stopped Delay : 126 sec/veh.	**Rate (5: High effect)**: 1 2 3 ④ 5
Investment effect: EIRR =5.4%	**Rate (5: High effect)**: 1 ② 3 4 5
Japanese technical features: ･Rapid Construction by Steel Girders in Urban Area. ･Minimization of construction period by using the Precast Members. ･Self-Actuation Signal Control	**Rate (5: Technical feature)**: 1 2 3 ④ 5
The capacity of Implementation agencies: ･ Important to coordinate with the future plan Public Transportation Plan (BRT and/or LRT) ･ Continuous capacity development would be required for future maintenance for road facility including drainages.	**Rate (5: Enough capacity)**: 1 2 3 ④ 5
Feasibility from environmental impact aspect: ･Land acquisition along service road would be required. ･Landscape needs to be concerned in the development of the populated area.	**Rate (5:High feasibility)**: 1 2 ③ 4 5

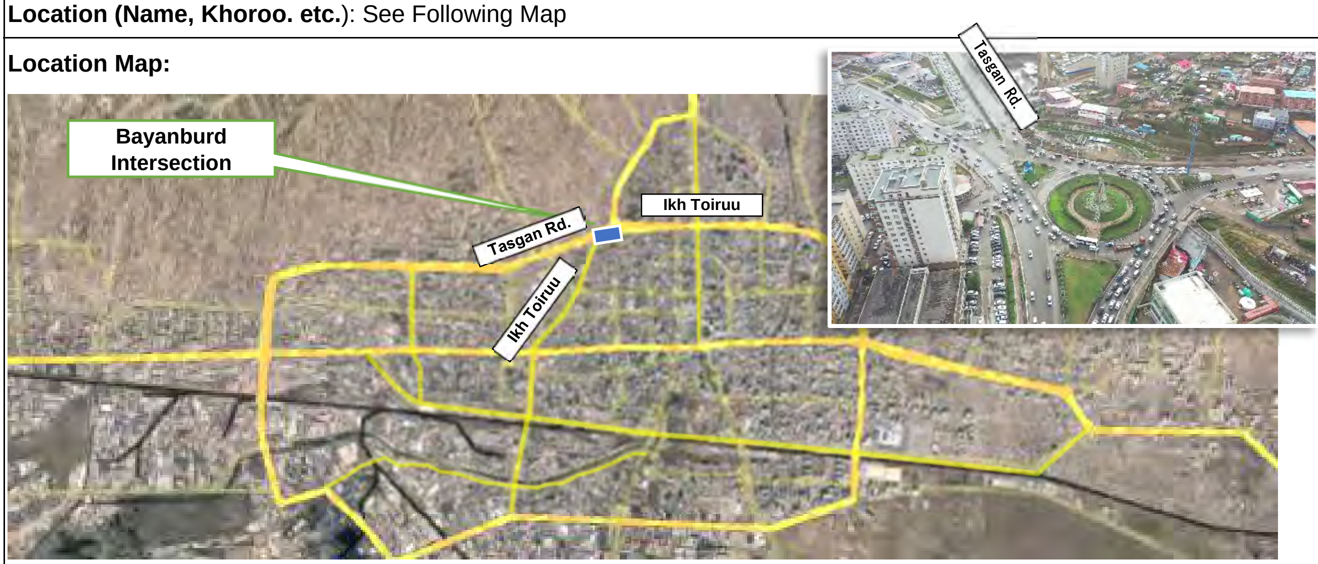
Project overview/ evaluation : 15

Project category: E. Intersection Improvement

Project ID: E5	**Project Name**: Bayanburd Intersection Grade Separation Project

Location (Name, Khoroo. etc.): See Following Map

Location Map:



Project Outline:

Grade separation would be constructed to improve the existing roundabout intersection of Ikh Toiruu and Tasgan Road. No F/S has been conducted yet.

Flyover	: 4-lane × l = 105 m
Approach Road (MSE Wall)	: 4-lane × 115 m × 2
Traffic Signal Improvement	: 1 location
Project Cost	: 33 mil. USD

Note: Right side perspective is prepared by the UB City Government based on the assumption that an underpass is constructed; however, the Flyover will be appropriate considering relocation of underground utilities and traffic control during the construction.

Development impact: Mitigation of traffic congestion of the Ikh Toiruu and Peace Ave. and Tasgan Rd. Reduction of stopped delay at the Bayanburd Intersection. Expected Traffic Volume (F.O.: E-W) : 55,000 PCU/day (2025) Expected Traffic Volume (N-S) : 67,900 PCU/day (2025) Reduction of Average Stopped Delay : 151 sec/veh.	**Rate (5: High effect)**: 1 2 3 4 ⑤
Investment effect: EIRR =15.0 %	**Rate (5: High effect)**: 1 2 3 ④ 5
Japanese technical features: ・ Rapid construction by steel girders in urban areas ・ Minimization of construction period by using the precast members. ・ Self-actuated signal control.	**Rate (5: Technical feature)**: 1 2 3 ④ 5
The capacity of Implementation agencies: ・ Continuous capacity development would be required for future maintenance for road facilities, including drainages. ・ However, there are many underground utilities. It is possible to relocate within the road premises.	**Rate (5: Enough capacity)**: 1 2 3 ④ 5
Feasibility from environmental impact aspect: ・ Because of sufficient width of ROW for road construction, less land acquisition and less resettlement are required, which will cause less possibility of delay in the implementation schedule of the Project.	**Rate (5: High feasibility)**: 1 2 3 ④ 5

Project overview/ evaluation：16

Project category: F. Others（Soft Measures）

Project ID: F1	**Project Name**: Project for improvement of Public Transportation in Ulaanbaatar City

Location (Name, Khoroo. etc.): Citywide in Ulaanbaatar

OVERALL GOAL: Conversion from private transportation to public transportation in Ulaanbaatar will be enhanced.

Project Purpose: The level of bus service in Ulaanbaatar will be improved.

Outputs:

1. The management system for public transportation in UB City will be strengthened. UB City subsidies will account for 57% of the operating costs and 15% of the UB City budget in FY2020. In order to maintain healthy public transportation, UB City and operators need to improve their operations and reduce subsidies.
2. UB City's infrastructure for public transportation and capacity to implement traffic management measures will be improved. In addition to the development of hardware such as infrastructure, it is necessary to identify issues from the user's perspective and implement software such as usage methods at the same time.
3. UB City's ability to study and plan for public transportation will be improved. Since bus operation plans that take into account the road environment, such as traffic congestion, have not been formulated, it is necessary to enable both UB City and bus operators to formulate operation plans that ensure punctuality.
4. Bus service in UB city will be improved. It is necessary to foster safe driving manners in compliance with traffic laws not only for bus drivers but also for private car drivers. In addition, it is necessary to consider the provision of bus-related services that are not currently available and encourage people to switch to public transportation.

Activities:

Activities related to Output 1

- Activity 1-1. The financial situation of UB City bus operators will be improved.
- Activity 1-2. Setting appropriate bus fares will be considered.
- Activity 1-3. The subsidies for public transportation in UB City will be examined. (Procurement of financial resources that contribute to the self-sustaining development of public transportation projects)
- Activity 1-4. Preferential policies for public transportation will be considered.
- Activity 1-5. The way bus operators are managed and operated will be improved.

Activities related to Output 2

- Activity 2-1. Compliance and maintenance of bus lanes to ensure on-time public transportation will be promoted.
- Activity 2-2. Nodal points with terminal functions at four locations in the city will be developed.
- Activity 2-3. The development of bus stops that are easy to transfer to will be promoted.
- Activity 2-4. Traffic control and other measures to enforce traffic regulations, such as illegal parking, will be enhanced.

Activities related to Output 3

- Activity 3-1. An optimal public transportation network in UB City will be proposed.
- Activity 3-2. Data from IC cards and other devices to develop demand-based operation plans will be used.
- Activity 3-3. The inflow of people from the suburbs to the city center by using nodal points, setting up trunk and branch lines, etc., will be controlled.
- Activity 3-4. Monitoring of the established operation plan will be conducted.

Activities related to Output 4

- Activity 4-1. Education to bus operators (bus drivers) on safe driving in compliance with traffic laws will be provided.
- Activity 4-2. Public relations activities to promote the use of public transportation will be conducted.
- Activity 4-3. Bus services using ICT technology will be examined.
- Activity 4-4. Installing bus waiting facilities for cold weather will be considered.

Inputs (MM): 60 MM

C/P:

① Department of Transportation Service in UB City. They do not have a server to manage IC card data information and have not been able to grasp the actual usage status of each bus route because data or information from UB Smart Card Company is not available. As a result, it is not possible to confirm whether appropriate operation services and bus schedules, such as operation frequency, are provided to the citizens.

② UB Department of Road Traffic Planning and Engineering in UB City. It is informed that they are working with universities and other organizations to review the length of routes that operate in long distances, but since it will be

necessary to review them again when new nodes and bus lanes are introduced, new timetable will be developed based on the data used in the current route review. ③ MRTD. As subsidies to bus operators account for a large percentage of the UB City budget, it is necessary to consider setting appropriate fares in providing sustainable public transportation. ④ Police. Monitoring and enforcement of private vehicles in bus lanes and enforcement of illegal parking at bus stops have not been implemented well. In order to ensure the punctuality of bus services, it is necessary to strictly enforce the law. In addition, since it has been observed that some bus drivers use mobile phones while driving and turn left from the straight lane, thorough traffic safety education should be provided to raise awareness among drivers who are responsible for human lives. Furthermore, reviewing the traffic regulations necessary for bus operations based on the idea of prioritizing public transportation will be reviewed. ⑤ Bus Operator. The information necessary for a safe, comfortable, and good driving environment for punctuality, is not always reflected in the operation plan formulated by UB City. It is necessary to understand the actual conditions of the routes from the bus operators so that the information can be reflected in the formulation of new operation plans. In addition, education on compliance with traffic laws and safe driving should be provided to drivers. ⑥ UB Smart Card Company. The IC card data and information from the surveillance camera installed in the buses should be provided to UB City regularly to provide flexibility in terms of operation.
Implementation Schedule: FY2023–FY2026

Project overview/ evaluation：17

Project category: F. Technical Assistance	
Project ID: F2	**Project Name**: To mitigate road traffic congestion in UB City.
Location (Name, Khoroo, etc.): UB City	
Overall Goal: To mitigate road traffic congestion in UB City	
Project Purpose: The planning and management capacity of roads in UB City will be strengthened.	
Outputs: Output 1: Issues related to road traffic congestion in UB City are identified. Output 2: Road planning capacity of UB City is enhanced. Output 3: Traffic management capacity of UB City is enhanced. Output 4: Manners of road users in UB City is improved.	
Activities: **【Activity for Output 1】** Activity 1-1 Investigate the role of the organization and division in charge for road planning, traffic management, policy making and etc. Activity 1-2 Identify Road traffic bottlenecks in UB city and specify priority issues. Activity 1-3 Identify traffic management issues in UB city and specify priority issues. Activity 1-4 Investigate the factors of traffic congestion caused by the manners of road users in UB city and specify priority issues. **【Activity for Output 2】** Activity 2-1 Conduct technology transfer intersection planning Activity 2-2 Conduct technology transfer related to urban road maintenance technology Activity 2-3 Propose methods to increase road traffic capacity by optimizing the use of footway boundaries, shoulders, and stopping spaces. Activity 2-4 Introduce overseas examples to improve district roads of UB City. Activity 2-5 Develop guidelines for UB urban road planning. **【Activity for Output 3】** Activity 3-1 Identify issues and areas for improvement in traffic management facilities. Activity 3-2 Transfer technology on BIG data for the traffic obtained from RFID and other sources. Activity 3-3 Appropriate traffic signal optimization in UB City. Activity 3-4 Improve information dissemination to road users, such as traffic jam information. **【Activity for Output 4】** Activity 4-1 Develop trends and statistics of vehicles violation of the law and formulate priority measures to improve traffic manners. Activity 4-2 Introduce overseas examples of measures to strengthen control of vehicles violation. Activity 4-3 Propose measures to strengthen cooperation between the traffic control center and the traffic police. Activity 4-4 Conduct educational activities for citizens regarding the improvement of traffic manners.	
Inputs(MM): Long Term Expert: 36 MM / Short Term Expert: 70 MM	
C/P: UB City Urban Development Department, Traffic Planning and Coordination Engineering Department, Road Development Department, Traffic Control Center (TCC), UB City Traffic Police.	
Implementation Schedule: 2023–2026	

Project Overview/Evaluation: 17B

Project category: F. Technical Assistance

Project ID: F2B	**Project Name**: Enhancement of Urban development improvement project in UB City

Location (Name, Khoroo, etc.): UB City

Overall Goal: To mitigate road traffic congestion in UB City.

Project Purpose:

Enhancement of traffic planning and traffic management in UB City

Outputs:

Output 1: Issues related to road traffic congestion in UB City are identified.

Output 2: Traffic planning capacity of UB City is enhanced.

Output 3: Traffic management capacity of UB City is enhanced.

Output 4: Manners of road users in UB City is improved.

Activities:

【Activity for Output 1】

Activity 1-1 Investigate the role of the organization and division in charge for road planning, traffic management, policy making and etc.

Activity 1-2 Identify Road traffic bottlenecks in UB City and specify priority issues.

Activity 1-3 Identify traffic management issues in UB City and specify priority issues.

Activity 1-4 Investigate the factors of traffic congestion caused by the manners of road users in UB city and specify priority issues.

【Activity for Output 2】

Activity 2-1 Technical assistance for Road planning formulation

Activity 2-1-1 Conduct technology transfer intersection planning

Activity 2-1-2 Conduct technology transfer related to urban road maintenance technology

Activity 2-1-3 Propose methods to increase road traffic capacity by optimizing the use of footway boundaries, shoulders, and stopping spaces.

Activity 2-1-4 Introduce overseas examples to improve district roads of UB City.

Activity 2-1-5 Develop guidelines for UB urban road planning.

Activity 2-2 Technical assistance for Public transportation (Railway and Bus) formulation

Activity 2-2-1 Technical assistance for public transport (Railway system and construction)

Activity 2-2-2 Technical assistance for public transport planning formulation (Alignment, planning evaluation etc.)

Activity 2-2-3 Technical assistance for public transport operation planning (Forecast the financial aspect, operation methodologies, formation agency

Activity 2-2-4 Technical assistance for the Planning formulation of multi modal facility planning (station square, parking facility)

【Activity for Output 3】

Activity 3-1 Identify issues and areas for improvement in traffic management facilities.

Activity 3-2 Transfer technology on BIG data for the traffic obtained from RFID and other sources.

Activity 3-3 Appropriate traffic signal optimization in UB city.

Activity 3-4 Improve information dissemination to road users, such as traffic jam information.

【Activity for Output 4】

Activity 4-1 Develop trends and statistics of vehicles violation of the law and formulate priority measures to improve traffic manners.

Activity 4-2 Introduce overseas examples of measures to strengthen control of vehicles violation.

Activity 4-3 Propose measures to strengthen cooperation between the traffic control center and the traffic police.

Activity 4-4 Conduct educational activities for citizens regarding the improvement of traffic manners.

Inputs (MM): 36 MM for short-term experts and 90 MM for long-term experts
C/P: UB City Urban Development Department, Traffic Planning and Coordination Engineering Department, Road Development Department, MRTD, TCC, Public transport service Department, MRTD Railroads and Shipping Policy Implementation Coordination Bureau, UB City traffic police
Implementation Schedule: 2023～2026

Project overview/ evaluation：18

Project category: F. Technical Assistance	
Project ID: F3	**Project Name**: Urban Drainage Planning and Management Technical Cooperation Project
Location (Name, Khoroo, etc.): UB City	

Overall Goal:

Urban drainage in Ulaanbaatar is improved.

Project Purpose:

Improving the management capacity of the Geodesy and Water Facility Department (GWFD) for urban drainage projects in Ulaanbaatar

Outputs:

Output 1: Capacity to develop plans for stormwater drainage facilities is strengthened.

Output 2: Ability to manage stormwater drainage using GIS is improved.

Output 3: Asset management for the management of stormwater drainage is introduced

Output 4: Implementation capacity for the operation and maintenance of stormwater drainage facilities is strengthened

Output 5: The internal training system of the GWFD is strengthened.

Activities:

【Activity for Output 1】

Activity 1-1	Identify the status of stormwater drainage measures currently being implemented by the GWFD.
Activity 1-2	Based on the issues identified in 1-1, the GWFD will compile the methods and procedures to implement stormwater drainage measures effectively and efficiently in UB City in the future.
Activity 1-3	Compile the details of the development of facilities necessary to implement the methods and procedures proposed in 1-2.
Activity 1-4	Compile the organizational, institutional, and financial reforms necessary to implement the methods and procedures proposed in 1-2.
Activity 1-5	Prepare the implementation schedule based on priorities for the improvement of facilities and organizational, institutional, and financial reforms summarized in 1-3 and 1-4.
Activity 1-6	Prepare a basic plan for the development of stormwater drainage facilities in UB City based on the contents of 1-1 to 1-5.

【Activity for Output 2】

Activity 2-1	Define the plan and operation method by using GIS.
Activity 2-2	Maintain inventory data and GIS database.
Activity 2-3	Provide training on GIS operations (OJT: On-The-Job Training).
Activity 2-4	Compile information of maintenance planning and facility information (manholes, catch basins, pump stations, population, drainage area, etc.) for each drainage management area.
Activity 2-5	Develop a drainage plan based on GIS and actual drainage conditions.
Activity 2-6	Create a standard operating procedure for GIS data entry and update.
Activity 2-7	Update GIS data as a matter of routine.

【Activity for Output 3】

Activity 3-1	Conduct a seminar on the introduction of asset management for executives of the GWFD.
Activity 3-2	Select a pilot parcel for asset management.
Activity 3-3	Evaluate the soundness of the drainage pipeline in the pilot area.
Activity 3-4	Plan renewal scenarios based on the results of the health assessment.
Activity 3-5	Conduct a risk assessment of drainage pipelines in the pilot area.
Activity 3-6	Based on the risk assessment, conduct a priority assessment using a risk matrix.
Activity 3-7	Develop an inspection and investigation plan for drainage pipeline facilities.
Activity 3-8	Develop an "Asset Management Basic Plan" to maintain and manage drainage facilities.

【Activity for Output 4】

Activity 4-1	Select a pilot area to improve stormwater drainage facilities.

Activity 4-2	Investigate the status of the pilot area through review of existing drawings, etc., and field inspection.
Activity 4-3	Formulate a pilot project implementation plan (including the schedule) for the pilot area.
Activity 4-4	Establish a quantitative baseline for the pilot area.
Activity 4-5	Assist in the design of drainage facilities to improve conditions in the pilot area.
Activity 4-6	Implement stormwater drainage measures in the pilot area.
Activity 4-7	Monitor the status of stormwater drainage in the pilot area and prepare a project report.
Activity 4-8	Prepare a "Stormwater Drainage Facility Maintenance Manual" regarding the methods and equipment acquired through the pilot project, introduce it at a seminar, and share it within GWFD.
【Activity for Output 5】	
Activity 5-1	Identify training needs for the GWFD.
Activity 5-2	Develop an overall training program (systematic map) required by the GWFD.
Activity 5-3	Create a training database (assume Excel) to be conducted by the GWFD.
Activity 5-4	Create an internal training supervision manual.
Activity 5-5	Conduct training on training supervision for staff in charge of internal training.
Activity 5-6	Develop a training plan (training modules) in coordination with the technical staff responsible for training in the Bureau of Surveying and Stormwater Facilities.
Activity 5-7	Prepare for the training, including the teaching materials and study of methods, measuring the effectiveness of the training in cooperation with the technical staff in charge of training in the GWFD.
Activity 5-8	Conduct training of trainers (TOT).
Activity 5-9	Analyze the results of each training program and provide feedback for the next training plan.
Inputs (MM): 70 MM for short-term experts	
C/P: UB City, GWFD, Urban Development Department, Road Development Department	
Implementation Schedule: 2023～2026	

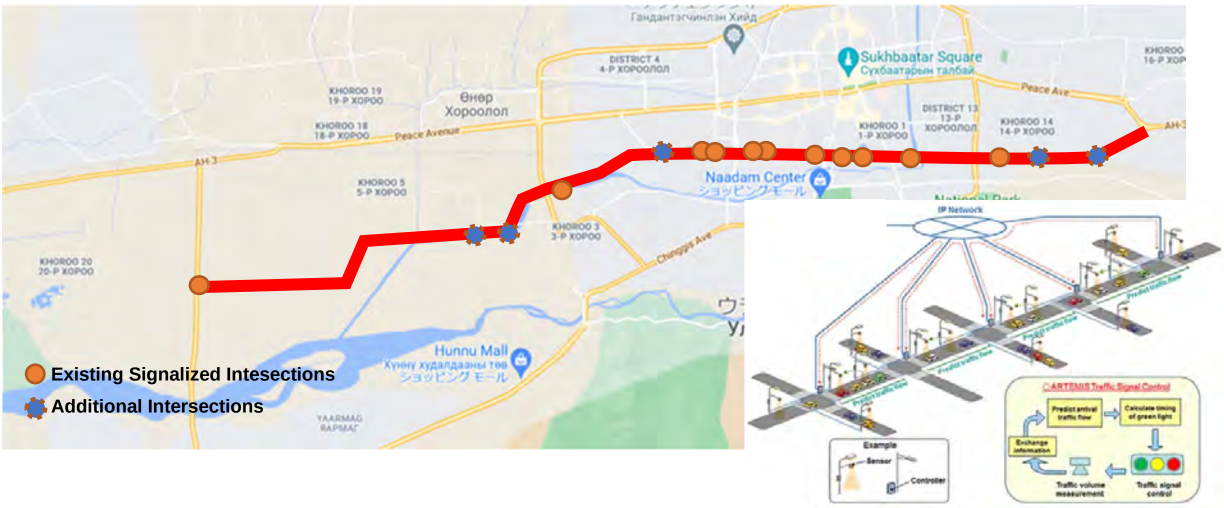
Project Overview/Evaluation: 19

Project category: G. Traffic Management

Project ID: G1 | **Project Name**: Self-Actuated Signal Project

Location (Name, Khoroo, etc.): See Following Location Map

Location Map:



Project Outline:
The UB Traffic Control Center (TCC) was established with the assistance of South Korea's grant aid; however, the system and equipment have not been updated. Although the traffic lights themselves are functioning, police officers must still manually control the traffic intersections during peak hours. The self-actuated signal control, developed in Japan, will determine the optimum cycle time in real-time by exchanging information between traffic signal controllers and intersections. The Self-Actuated Signal Control System will be introduced on the east–west corridor from Narni Road to Sonsgolon Road to divert the traffic from Peace Avenue.

Self-Actuated Signal Control Device	: 1 set/Intersection; total 16 locations
Vehicle Detector	: 4 set/Intersection; total 64 sets
Project Cost	: 11.4 mil. USD

Development impact: ・ Improved traffic flow in the subject intersections, reduced stopped delay, shorted waiting queue, reduced vehicle emission, improved traffic safety in the intersection, reduced transportation costs, reduced vehicle operating costs and reduced travel time costs are expected. ・ According to experience in Moscow, five of the self-actuated signal control were installed, and the traffic congestion was mitigated by 20% on average.	**Rate (5: High effect)**: 1 2 3 4 5
Investment effect: ・ Replacement of the existing signal control device or new installation at a non-signal intersection that will not require large-scale construction work and budget will cause a high investment effect.	**Rate (5: High effect)**: 1 2 3 4 5
Japanese technical features: ・ Image diagnostic Technology with Artificial Intelligence ・ Self-Actuated Signal Control System ・ Utilization of DX technology	**Rate (5: Technical feature)**: 1 2 3 4 5
The capacity of implementation agencies: ・Capacity for Project Implementation: No critical issues for implementation since the work is only to replace the signal control device. ・O&M after completion of the Project: Maintenance-free because of the self-activating time cycle of traffic signal by computer processor during the 10-year life span. ・Others: Spare parts may be required to be ready for machine trouble in the future.	**Rate (5: Enough capacity)**: 1 2 3 4 5
Feasibility from environmental impact aspect: ・ Decrease in vehicle emissions, such as CO_2 and NO_x, will be expected due to mitigation of traffic congestion at intersections.	**Rate (5: High feasibility)**: 1 2 3 4 5

Project Overview/Evaluation: 20

Project category: F. Technical Assistance	
Project ID: F3	**Project Name**: Capacity Development for Transport Planning and Traffic Management
Location (Name, Khoroo, etc.): All of Ulaanbaatar City	
Overall Goal: To mitigate road traffic congestion in UB City	
Project Purpose: Enhancement of traffic planning and traffic management in UB City	
Outputs: Output 1: Strengthen of identification of issues and formulation of improvement plans Output 2: Strengthen traffic management	
Activities: **【Activity for Output 1】** Activity 1-1 Document review and Organizational Analysis Activity 1-2 Identifying and addressing issues in the transportation network of the entire UB urban area (Identification of bottleneck based on survey and whole of planning evaluation based on demand forecast.) Activity 1-3 Technical assistance for the development of intersection improvement plan (Intersection improvement and design.) Activity 1-4 Technical assistance for the development of urban road infrastructure plan (Increasing capacity for the changing operation of urban road facilities, aiming smooth of urban road improvement, traffic assessment of urban development, and road design standard for new urban development policy.) Activity 1-5 Technical assistance for the development of public transportation plan (Provision the knowledge for the public transport system and infrastructure, public transportation of alignment alternative, forecast of public transportation project evaluation, fare revenue, operation and formation of public agencies.) Activity 1-6 Technical assistance for the development of parking facility plan (The possibility of a separate parking facility, parking location certification, obligation parking system by urban development, and improvement of development approvement.) **【Activity for Output 2】** Activity 2-1 Document review and organizational analysis Activity 2-2 Identification of traffic management issues (Monitor the progress of WB project, identify technical elements required even if a control system or technical cooperation is included in WB project, identify other issues for traffic management, and examine the likeliness of utilization of big data for traffic management.) Activity 2-3 Identification of traffic manner issues (Traffic manner issue at the entrance/exit of the building, intersection, illegal parking, U-turn) Activity 2-4 Identification and technical assistance for traffic management issues (Implementation of training in Japan, on-the-job training, seminar, etc.)	
Assumed Input Man-Month (MM): 80 MM for short-term expert	
Target C/P Agency: UB City Urban Development Department, Traffic Planning and Coordination Engineering Department, MRTD, TCC, UB City public transport service department, MRTD Railroads, and Shipping Policy Implementation Coordination Bureau, UB City Traffic Police	
Implementation Schedule: 2023–2026	

Project overview/ evaluation：21

Project category: F. Technical Assistance	
Project ID:	**Project Title**: Capacity Development for Operation and Maintenance of Road and Bridge in Ulaanbaatar City
Location (Name, Khoroo, etc.): UB City	
Overall Goal: For the proper maintenance of roads and pavement in UB City.	
Project Purpose: Develop the maintenance cycle of roads and bridges in UB City.	
Outputs: Output 1: The repair plan for priority bridges in UB City is developed. Output 2: The repair plan for priority roads in UB City is developed. Output 3: Pilot Project of repair work for road and bridge in UB City is implemented. Output 4: Issues on design and construction for roads and bridges in UB City are identified and recognized.	
Activities: **【Activity for Output 1】** Activity 1-1. Conduct the baseline survey on bridge maintenance system in UB City Activity 1-2. Propose sustainable bridge inspection procedure in UB City Activity 1-3. Conduct bridge inspection based on bridge inspection procedure proposed by 1-2 for all bridges in UB City Activity 1-4. Formulate a mid-term bridge maintenance plan and select the priority bridges to be repaired Activity 1-5. Develop a bridge repair plan for the priority bridges. **【Activity for Output 2】** Activity 2-1. Conduct the baseline survey on road maintenance system in UB City Activity 2-2. Propose sustainable road inspection procedures in UB City Activity 2-3. Conduct road inspection based on road inspection procedure proposed by 2-2 for all arterial roads in UB City Activity 2-4. Formulate a mid-term road maintenance plan and select the priority road to be repaired Activity 2-5. Develop road repair plan for the priority road **【Activity for Output 3】** Activity 3-1. Implement a pilot project for repair of bridge based on the repair plan proposed in 1-5 Activity 3-2. Implement a pilot project for repair of road based on the repair plan proposed in 2-5 Activity 3-3. Compile overall achievement of the inspection, repair plan, and implementation of repair work for bridge and road, and introduce it to UB City government and MRTD Activity 3-4. Make a recommendation on budgetary allocation for the maintenance of bridges and roads based on the pilot project **【Activity for Output 3】** Activity 4-1. Summarize the issues on design and construction quality of bridge based on activities in Output-1. Activity 4-2. Summarize the issues on design and construction quality of road based on activities in Output-2. Activity 4-3. Make a recommendation for improvement of design and construction quality of road and bridge based on the Activity 4-1 and 4-2. Activity 4-4. Share the experience and issues of the Project with Mongolian Road Association and Mongolian University of Science and Technology through Seminar and etc.	
Input (MM): 70 MM for short-term expert	
Counterpart Agency: Road Development Department of UB City (/Policy and Planning Department of MRTD)	
Implementation Schedule: 2023–2026	
Note: ・Development of the database for Asset Management is ongoing (Chinese system) under the Project for Ulaanbaatar Transport Infrastructure Asset Management and Design for Resilience (WB 2020–2022) ・It will be effective that quality control issue is highlighted through maintenance activity such as inspection and repair work since awareness of issues on quality control in Mongolia is not so high. ・Insufficient budget for maintenance and less practical experience in repair work are the typical bottlenecks for maintenance activity in UB City. ・Bridge and road inspection procedures need to be reviewed for sustainability by using new technology under fewer human resources for the maintenance work. ・To supplement future human resources to be responsible for future maintenance activity, it would be important to share the knowledge and the experience of the project with private, industry, and academic sectors.	