CHAPTER 4 FORMATION OF PROJECT PLAN

In this chapter, the development plan of this project is formed considering the necessity of the infrastructure in the center of Ho Chi Minh City due to the construction of UMRT Line 1. This project plan is based on the following three points as described in "Chapter 3 the Current Issues and Solutions of the Project Area". The schematic design of Ben Thanh Central Station Project is performed through the study on the planning policy and the basic layout of the underground facilities.

- Construction of Overall Underground Terminal to ensure Smooth Connection of Public Transport
- Creation of an Attractive Underground Space
- Formation of Underground Pedestrian Network connecting New Buildings and Traffic Nodes

In the study, at first the volume of the future pedestrian flows in Ben Thanh will be estimated in consideration of the operation of UMRT Lines and the urban development on surrounding private ground. Based on the number and ratio of the future pedestrians by each direction, the planning policy is established to serve as the main frame of this project. According to this planning policy, the schematic design for the underground facilities (the metro station, underground plazas, underground passageways, retail stores, and so on) is performed. After the study for construction methods and technical issues, the construction cost will be estimated.

4.1 DEMAND FORECAST ON UNDERGROUND FACILITIES

4.1.1 Methodology

On the underground development area on this survey, there are two aspects: as a comprehensive underground station and a underground commercial mall. Approach of demand forecasts on these two aspects are totally different, therefore the estimates for number of users are conducted by summing up the results of the ones of these two aspects.

Figure 4.1 shows the flow chart of demand forecasting on underground facilities on this survey.

For users of underground stations including transferring passengers, the demand forecasting system which has been used for several projects including HCMC Line-1 and the detail of this will be described in the next section. The target year of developing infrastructure of this survey is set to 2050, therefore, long time assumption is set based on the demand forecasting system on Line-1.

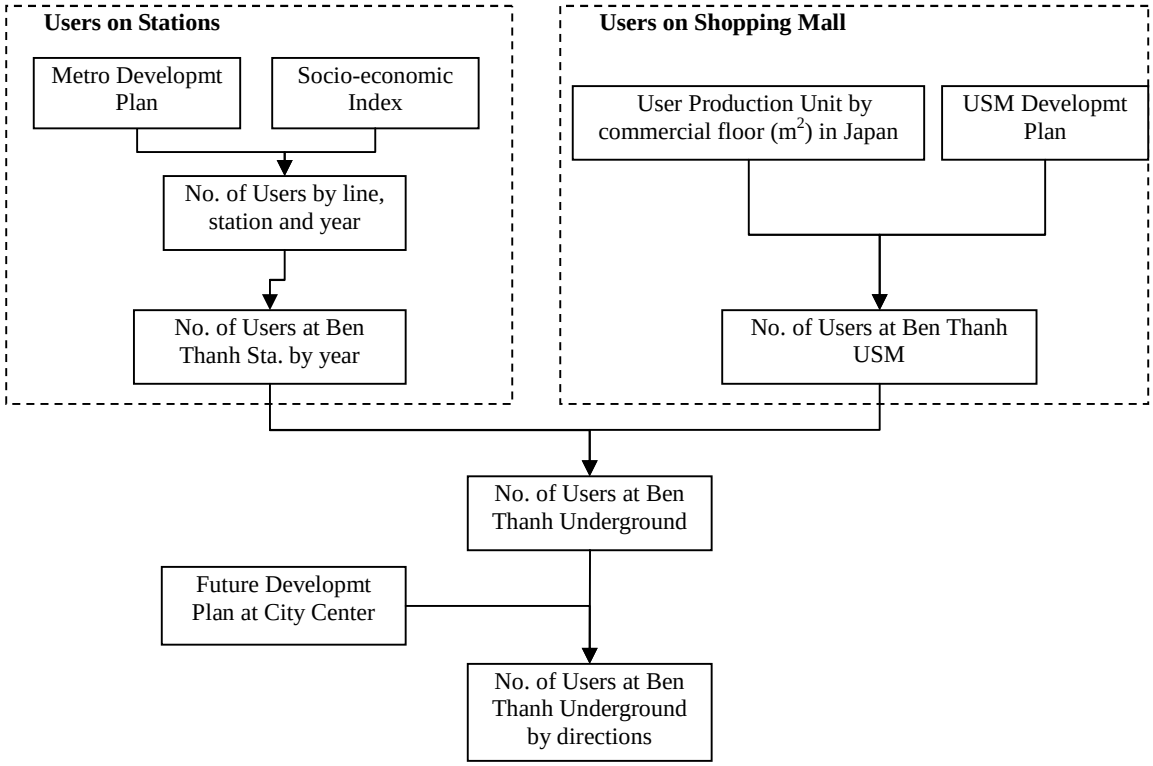


Figure 4.1 Flow Chart for Estimating Number of users at Ben Thanh Underground

4.1.2 Number of Users at Ben Thanh Station

1) Methodology

This demand forecasting system in this survey is to estimate the future demand of passengers of each urban railway line by assuming future socio-economic status including population by area, alignment and location of the stations of lines as well as the service level of urban lines based on the current transport behaviors of the citizen in HCMC.

4 steps method which is a conventional methodology for traffic demand forecasting is used for this. This method is composing by 4 components, namely "generation/attraction", "distribution", "modal share" and "traffic assignment". The conceptual flowchart is shown in Figure 4.2. "Future population by wards" and "future development plan by urban railway lines" are the inputs specifically, the outputs are traffic volume (number of passengers) of each road and urban railway line. The parameters to estimated as each 4 step is also needed.

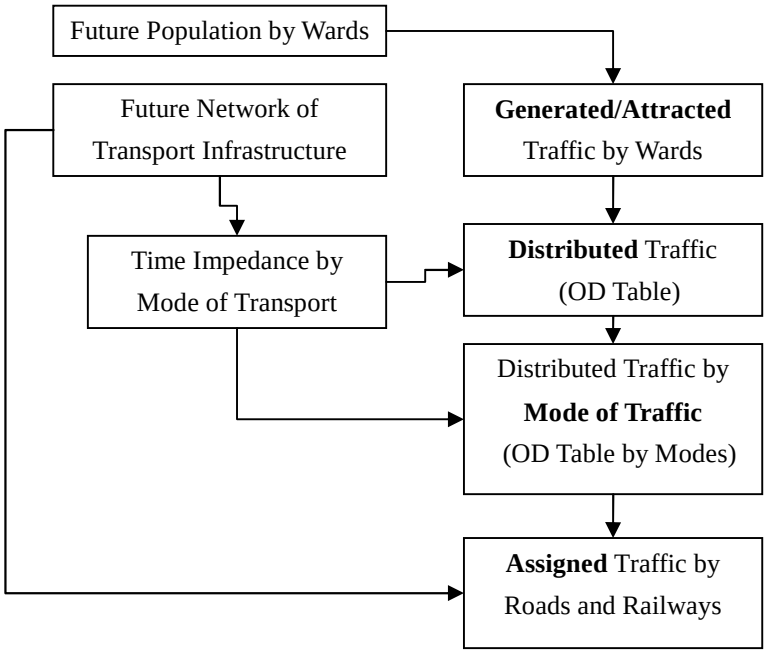


Figure 4.2 Flowchart for Demand Forecasting on Users of Urban Railway

In this survey, it is used that the result of population estimation (day time and night time) by wards of the study entitled "Amendment of Urban Master Plan in HCMC for 2025" done by Ho Chi Minh City People's Committee subcontracting to Nikken Sekkei in 2007. Parameters for estimation are from JICA Study entitled "Ho Chi Minh City Transport Master Plan (HOUTRANS)" in 2004.

Moreover, other assumptions for estimation are as follows:

- Modal share of public transport including buses is estimated as 16% in 2020. The political target of this modal share by the government is 30% in 2010 and 50% in 2020, however, this target seems too ambitious considering current modal share of public transport is about 8%. Therefore the modal share of 50% in 2020 is regarded too high.
- On the other hand, the value of 16% with completion of 6 lines of urban transport in 2020 seems feasible considering the modal share for public transport has reached 4 times in less than 10 years.
- All 6 urban railways are assumed to complete in 2020.
- The fare in 2020 is set to 5,000 VND plus 500VND/km (year 2006 price)

The demand in 2050 which is used for design target of infrastructure is estimated by assuming long term socio economic condition. It is hard to estimate this because there is no future population by wards and future transport network in such long term, however the demand is forecasted based on the demand of 2020 by assuming long term socio-economic status as shown in Table 4.1.

Table 4.1 Assumed Socio-Economic Status in 2050

	2020	2050
Population in HCMC (Million)	9.0	13.5
Modal Share of Public Transport (%)	16.0	30.0
Trip Demand on Public Transport (Mil/day)	6.88	19.35

2) Result of Estimation of Ben Thanh Station Users

Table 4.2 shows the result of numbers of estimated daily users of Ben Thanh Station in 2025 and 2050. It is estimated that there would be 50,500 and 73,600 passengers daily who will go in/out fro Ben Thanh Station in 2025 and 2050 respectively.

Table 4.2 Result of Estimated Number of Users at Ben Thanh Station

(Pax/day)

		2025	2050
Transfer	Line 1 <> Line 2	59,400	126,500
	Line 1 <> Line 4	38,300	50,100
	Line 2 <> Line 4	21,300	28,800
Station <> Outside		50,500	73,600
Total		169,500	279,000

4.1.3 Number of Users at Ben Thanh Shopping Mall

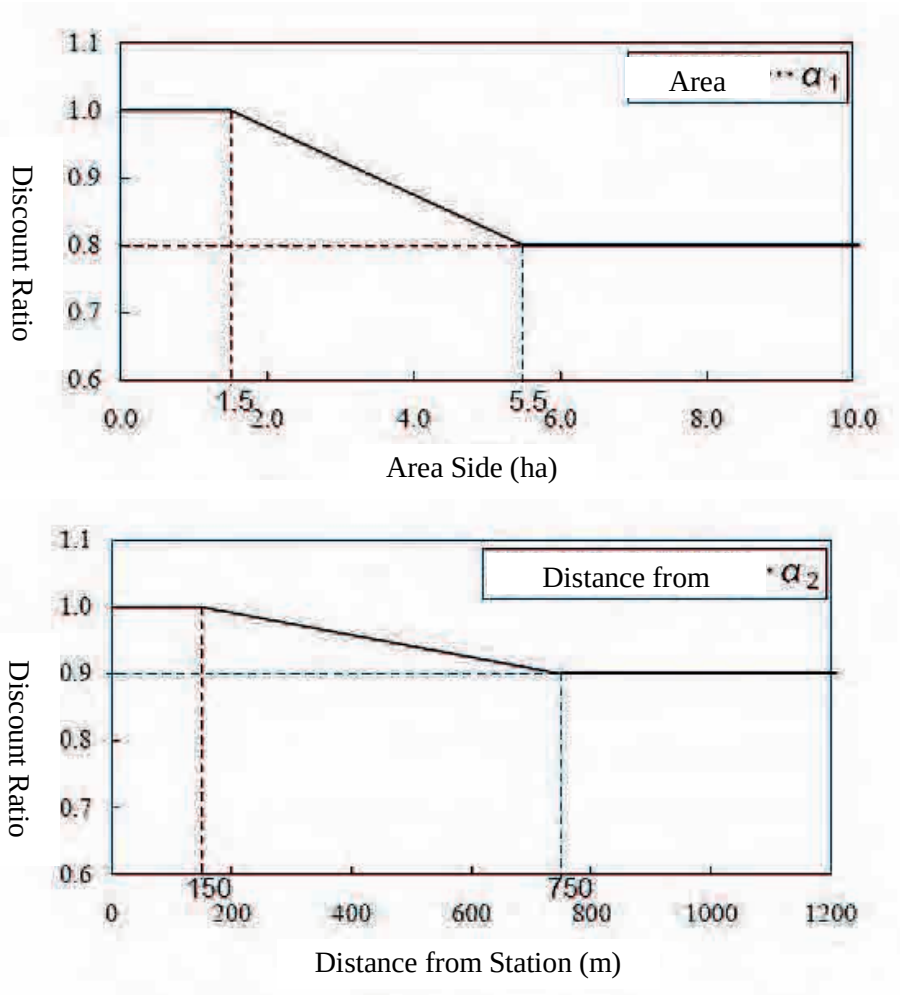
1) Methodology

Next, the estimation of number of users at the planned underground shopping mall is conducted. The production unit for number of users of shopping mall in city center, illustrating "Transport Planning Manual for Large Developments" issued by Ministry of Land, Infrastructure, Transport and Tourism, Japan, is used Ben Thanh area can be regarded as the most congested city center area categorized in the Japanese manual, the production units on this category is shown in Table 4.3.

Table 4.3 User Production Unit for Commercial Facilities in Japan

	Production Unit (pax/ha/day)
Weekday	20,600
Weekend	21,800

Source: "Transport Planning Manual for Large Developments", MLITT



Source: "Transport Planning Manual for Large Developments", MLITT

Figure 4.3 Adjustment of Production Unit by Size of Commercial Area and Distance from Station in Japan

Figure 4.3 shows the idea of adjustment of production unit. From the experiences, discount rate are defined by size of commercial area and distance from station. This production unit and discount rate are used for this survey as a matured urbanization in 2050. For the estimation of 2025, it is assumed that 60% of the demand of 2050 based on the result of demand forecasting on railway users.

2) Result of Estimation of Ben Thanh Shopping Mall Users

The commercial development area size under planning in this survey is shown in Table 4.4. According to this, the commercial area is planned as 1.93ha, therefore discount rate of 95%, without the one from distance from railway station, will be adopted based on the Figure 4.3.

Table 4.4 Planned Development Area for Ben Thanh Underground Shopping Mall

(m^2)

	Area for Mall	Area for Aisle
Beneath of Ben Thanh Roundabout	10,789	11,470
Beneath of Le Loi Street	8,588	9,000
Total	19,377	20,470

Table 4.5 shows the result of estimation of daily users of Ben Thanh Underground Shopping Mall in 2025 and 2050. It is estimated that there would be 22,800 weekday and 25,500 weekend users in 2025 and 37,900 weekday and 42,400 weekend users in 2050 respectively.

Table 4.5 Result of Estimated Number of Users at Ben Thanh Underground Shopping Mall

(pax/day)

	2025		2050	
	Weekday	Weekend	Weekday	Weekend
Beneath of Ben Thanh Roundabout	12,700	14,300	21,100	23,800
Beneath of Le Loi Street	10,100	11,200	16,800	18,600
Total	22,800	25,500	37,900	42,400

The results at 4.1.2 and 4.1.3 can be summarized at Table 4.6.

Table 4.5 Result of Estimated Number of Users at Ben Thanh Underground Facilities

(pax/day)

	2025		2050	
	Weekday	Weekend	Weekday	Weekend
Beneath of Ben Thanh Roundabout (including Station)	63,200	54,700	94,700	82,700
Beneath of Le Loi Street	10,100	11,200	16,800	18,600
Total	73,300	65,900	11,500	101,300

Note: The weekend railway users are assumed as 80% of weekdays.

Based on this result, the weekday users is estimated more than the weekend users, therefore the estimated number of weekday users is used for designing purpose.

4.1.4 Number of Users of Underground Facilities by Directions

1) Methodology

In this section, the number of users of Ben Thanh Underground Facilities by directions are estimated for the purpose of designing entrances. The formula is shown below.

$$T_{ij} = P_{ij} * N_i$$

$$P_{ij} = \frac{\exp \frac{V_j^{\beta}}{d_{ij}^{\alpha}}}{\sum_{ij} \exp \frac{V_j^{\beta}}{d_{ij}^{\alpha}}}$$

Where

T_{ij}: Traffic volume between underground area i and city block j on ground (pax/day)

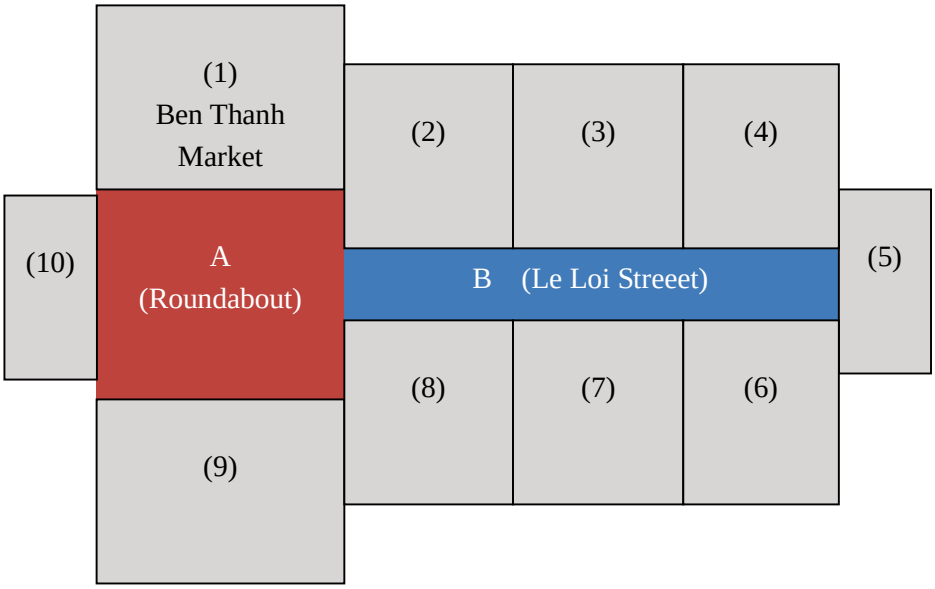
P_{ij}: Possibility to go to/from city block j for users of underground area i

$d_{ij}{}^{\alpha}$: Distance between underground area i and city block j on ground (m)

$V_j{}^{\beta}$: Development Volume of city block j on ground (Commercial area, m^2)

α, β: Parameters, set to α =-0.001、 β =0.01

The development volume is obtained from “Detailed Master Plan and Development Guidelines for the Central Area of HCMC” currently been conducting by Nikken Sekkei. Figure 4.4 shows the result.



Block	Area (m^2)	Block	Area (m^2)
(1)	250,000	(6)	255,000
(2)	126,000	(7)	231,000
(3)	123,000	(8)	256,000
(4)	105,000	(9)	246,000
(5)	203,000	(10)	320,000

Source: "Detailed Master Plan and Development Guidelines for the Central Area of HCMC", Nikken Sekkei

Figure 4.4Planned Development Volume of City Block on ground at Ben Thanh Area

2) Result of Estimation of Ben Thanh Underground Facilities by Directions

Table 4.6 shows the result of the estimated daily users of Ben Thanh Underground Facilities by directions. Figure 4.5 illustrates those. This result says that it needs higher capacity of entrances in Ben Thanh roundabout side than Le Loi side.

Table 4.6 Estimated Daily Users of Ben Thanh Underground Facilities by directions

(2025, 000 pax/day)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	total
A	9.2	2.4	1.9	1.4	3.2	6.3	6.1	8.5	8.4	15.7	63.2
B	1.2	0.4	0.4	0.3	0.8	1.5	1.3	1.5	1.0	1.8	10.1
total	10.4	2.8	2.3	1.7	4.0	7.8	7.4	10.0	9.4	17.5	73.3

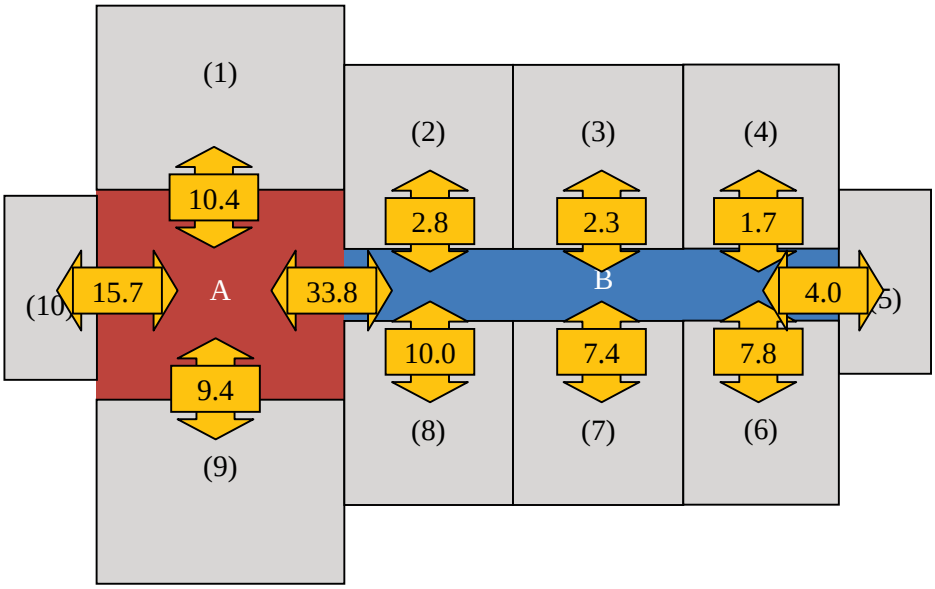
Note: A-B, (1)-(10) are corresponding the ones in Figure 4.4.

(2050, 000 pax/day)

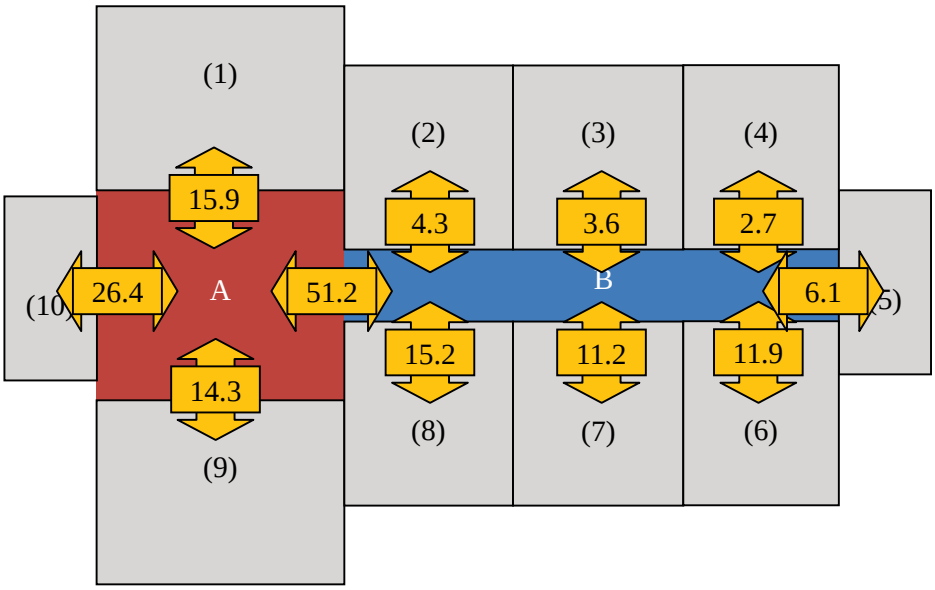
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	total
A	13.9	3.6	2.9	2.1	4.8	9.4	9.1	12.8	12.7	23.5	94.8
B	2.0	0.7	0.7	0.6	1.3	2.5	2.1	2.4	1.6	2.9	16.8
total	15.9	4.3	3.6	2.7	6.1	11.9	11.2	15.2	14.3	26.4	111.6

Note: A-B, (1)-(10) are corresponding the ones in Figure 4.4.

2025



2050



(000 pax/day)

Figure 4.5 Estimated Daily Users of Ben Thanh Underground Facilities by directions

4.2 PLANNING POLICY OF THE PROJECT

The planning policy of Ben Thanh Central Station Project is established in consideration with UMRT Central Station for Line 1, 2, 3a, and 4 and the urban development on the surrounding private ground. The policy is based on the following three points described as the necessity of the infrastructure in the center of Ho Chi Minh City

- Construction of Overall Underground Terminal to ensure Smooth Connection of Public Transport
- Creation of an Attractive Underground Space
- Formation of Underground Pedestrian Network connecting New Buildings and Traffic Nodes

As for "Construction of Overall Underground Terminal to ensure Smooth Connection of Public Transport", the planning of the passageway layout and the pedestrian flow line is very important to ensure the smooth travel between Ben Thanh Central Station and other public traffic facilities like bus terminal. In this case the whole planning of Ben Thanh Central station with 3 platforms of 4 UMRT Lines is performed in consideration with the smooth transfer from one line to another. Therefore the planning policy of Ben Thanh Central Station is also established.

With regard to "Creation of Attractive Underground Space", points of the planning are the clear layout of underground pedestrian passageways and the planning of the urban open space where everyone can take a rest and relax. In the underground space people can not understand easily the direction just like in the labyrinth without clear layout of passageways, so it is easy to lose the way. Therefore, the passageways should be arranged in composition with the main line and subsidiary lines for people to understand their location easily. In addition, the underground plazas with large atriums giving underground space natural sunlight are constructed and this makes the underground pedestrian urban space attractive and comfortable. In this manner, underground plazas help people to understand their location in underground space. Furthermore the passageways furnished with retail stores on both sides will become vibrant urban space and it is fun to walk in the underground urban space.

For "Formation of Underground Pedestrian Network connecting New Buildings and Traffic Nodes", the pedestrian passageways should be arranged to ensure high accessibility to not only public traffic facilities but also surrounding new buildings. This higher connectivity forms the larger pedestrian underground network and makes moving to surrounding area easy and comfortable, so it becomes basic for the interactive evolution. The asset value of private buildings with high accessibility from the public traffic facilities rises, and the passenger increase because visitors to the buildings use public traffic means. In addition, visitors to Ben Thanh area walk around this area through underground pedestrian network and bring the bustle to the underground urban space

The planning policy of Ben Thanh Central Station Project is established in consideration with above mentioned matters.

4.2.1 Planning Conditions

In planning Ben Thanh Central Station and Underground Shopping Mall (USM), the planning conditions agreed with Management Authority of Urban Railways (MAUR) is shown below.
Furthermore, some conditions may be change due to the progress of the UMRT Line1. Therefore, in case the planning condition is modified, the review in the design works on the next stage should be necessary.

1) Over Planning

- JCA Study Team follows the Ho Chi Minh city plan for the planning of this project regarding the layout of underground facilities (pedestrian passageway, plaza, shopping mall, and so on) and surface structures (stairways, ventilation shaft, and so on) in principle.
- As for the design of the Ben Thanh central station including future metro lines, all station functions and facilities of UMRT Line-1, 2, 3a, and 4 shall be located together in the Central Station.
- Regarding the underground development including 4 UMRT Lines and underground shopping mall, some options for the development sequence should be considered. Consequently, the comparison study on development sequence is performed. In this comparison study, the development of the Line 1 project, which is the most expedited and whose preliminary design has been already completed, should have the first priority for development.
- The facility room such as electrical room, mechanical room, emergency generator room, and disaster prevention room shall be provided in the Ben Thanh Central Station individually for each metro station (UMRT Line 1, 2, 3a, and 4) and underground development.
- Current bus terminals in the South side of the Quach Thi Trang rotary in front of Ben Thanh market will be moved to the West side of September 23rd park before construction.
- Existing underground utilities such as water pipe, electrical cables, etc shall be moved to the area that they will not influent the construction of this project in advance to the construction.
- Basically Vietnam building disaster standards are adopted for disaster prevention plan of underground development. However Japan disaster standards are adopted for the matters which Vietnam standards

2) Metro Planning

- There are no disaster plan standards in Vietnam. For this reason, following approval by the Ho Chi Minh City Fire Department of the disaster plan based on Article 29 in the Ministerial Ordinance for Establishing Technical Standards Relating to Railways" established by Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLITT Ministerial Ordinance No.151, December 2001), this plan was used for the design of the Ben Thanh Central Station.
- The ticket gate shall be integrated for each metro line (UMRT 1, 2, 3a, and 4).

(1) Line1

- In principle, JICA Study Team follows the latest design of UMRT Line-1 provided by MAUR.
- However, JICA Study Team shall review and propose some modifications on the following points:

i) Type of the tunnel structure between Ben Thanh and Opera House stations
With consideration to the impact of the construction of underground shopping mall and Line-4 to Line-1 tunnel, bored tunnel applied between Ben Thanh and Opera House stations could be modified to cut and cover tunnel.

ii) Facility layout at Ben Thanh station
With consideration to the more efficient and economical air conditioning and tunnel ventilation at Ben Thanh Central Station, the facility layout of Line-1 could be reviewed and modified.

In addition to the above two points, in order to optimize the terminal station with the consideration to the more efficient transfer and attractive underground space, the station planning could be revised.

(2) Line2

- The horizontal alignment shown in the received drawings shall be unchanged.
- However, the location of scissors crossing shall be clarified and reviewed.
- The vertical alignment shall be reviewed according to the vertical alignment of Line-4 and Ben Thanh station layout.

(3) Line3a

- UMRT Line-3a to be considered as the extension of Line-1, so the stations of Line-3a is the same as Line-1.

(4) Line4

- The horizontal alignment shown in the received drawings shall be unchanged except for the reverse curve located near Ben Thanh station.
- The vertical alignment shall be reviewed according to the tunnel structure of Line-1 and Line-4 especially at the crossing section of these two lines.
- The location of the platform of Line-4 shall be adjusted according to the reviewed vertical alignment.
- The station for Line 4 shall not be a terminal station, so the scissors crossing shall not be located in Ben Thanh station.

4.2.2 Planning Policy of the Project

The basic planning policy of Ben Thanh Central Station Project is established according to the planning conditions described in "4.2.1 Planning Conditions".

In the beginning, the planning policy for the improvement in Ben Thanh area including on-ground and underground is established. The points of the planning based on the necessity of the infrastructure are concretely set as the whole planning policy.

Next, the policy of the planning on the basement 1st floor is established – the underground shopping mall - which is the main part of underground development in this project. This planning policy for the underground shopping mall is studied in consideration with the affect to UMRT Line 1, especially the affect to the procedure for Line 1 construction.

The planning policy for Ben Thanh Central Station is established as the main underground facility in this project.

1) Whole Planning Policy

The whole planning policy for the improvement in Ben Thanh area including on-ground and underground is established as Ben Thanh Central Station Project. The project improvement area is decided in consideration with the location of UMRT facilities like Ben Thanh station and Opera House station, and the bus terminal planned in the Urban Planning of Ho Chi Minh City. The points of the planning based on the necessity of the infrastructure are concretely set as the whole planning policy.

(1) Project Improvement Area

The project improvement area is decided in this section. As the basal condition, the scope of this project is set around the vicinity of Ben Thanh station up to Opera House station. In this area, the urban issues appear due to the construction of UMRT Line 1, and the underground development of the existing center of Ho Chi Minh City is planned in the Urban Plannig of Ho Chi Minh City.

In this scope of the project the project improvement area is decided in consideration with the connectivity to the public traffic facilities and the private buildings based on the underground development area in the Urban Plannig of Ho Chi Minh City. The range of the project improvement area is only beneath the public street, not including the private on-ground, because of the public urban space improvement. The private urban development by the developer with the right is expected on the private on-ground, and that development will be connected with this project. As for the setting of this project improvement area the relative and/or critical facilities are mentioned in the below table.

Table 4.8 Relative Facilities on Setting of Project Improvement Area

Items	Relative Facilities
Traffic Facilities to be connected	• UMRT Ben Thanh Central Station • UMRT Opera House Station • Bus Terminal (beneath September 23rd Park) • BRT Terminal (beneath Ham Nghi Street) • Taxi Bay on-ground
Private Buildings To be connected	• Urban Development around Quach Thai Trang Rotary • Urban Development along Le Loi Street
Underground Development Area in the Urban Planning of Ho Chi Minh City	• Underground beneath September 23rd Park • Underground beneath Quach Thi Trang Rotary • Underground beneath Ham Nghi Street • Underground beneath Le Loi Street • Underground beneath Nguyen Hue Street
Underground Space beneath the Public Street	• Quach Thi Trang Rotary • Le Loi Street • September 23rd Park

The range of the project improvement is roughly divided to two areas. One is the surrounding area of Ben Thanh station, and the other is Le Loi Street area. They are defined as following and the project improvement area is shown in Figure 4.6.

① Ben Thanh Station Area

(Underground Space surrounding UMRT Ben Thanh Station beneath Quach Thi Trang Rotary and a part of September 23rd Park)

- South-east side : The range including current bus terminal on Quach Thi Trang Rotary considering the connectivity with the private buildings
- South-west side : The range up to bus terminal beneath September 23rd Park planned in the Urban Planning of Ho Chi Minh City (not including bus terminal)
- North-west side : The range in front of Ben Thanh Market
- North-east side : The range beneath Quach Thi Trang Rotary considering the connectivity with the private buildings and the range up to BRT terminal beneath Ham Nghi Street

② Le Loi Street Area

(Underground Space up to Opera House Station beneath Le Loi Street)

- South-east side : The range beneath Le Loi Street considering the connectivity with the private buildings
- South-west side : to be connected with Ben Thanh Station Area
- North-west side : The range beneath Le Loi Street considering the connectivity with the private buildings
- North-east side : The range beneath Le Loi Street up to Opera House Station

In this project improvement area, the location of the public traffic facilities and the relative facilities to be connected with this project is shown in Figure4.7.

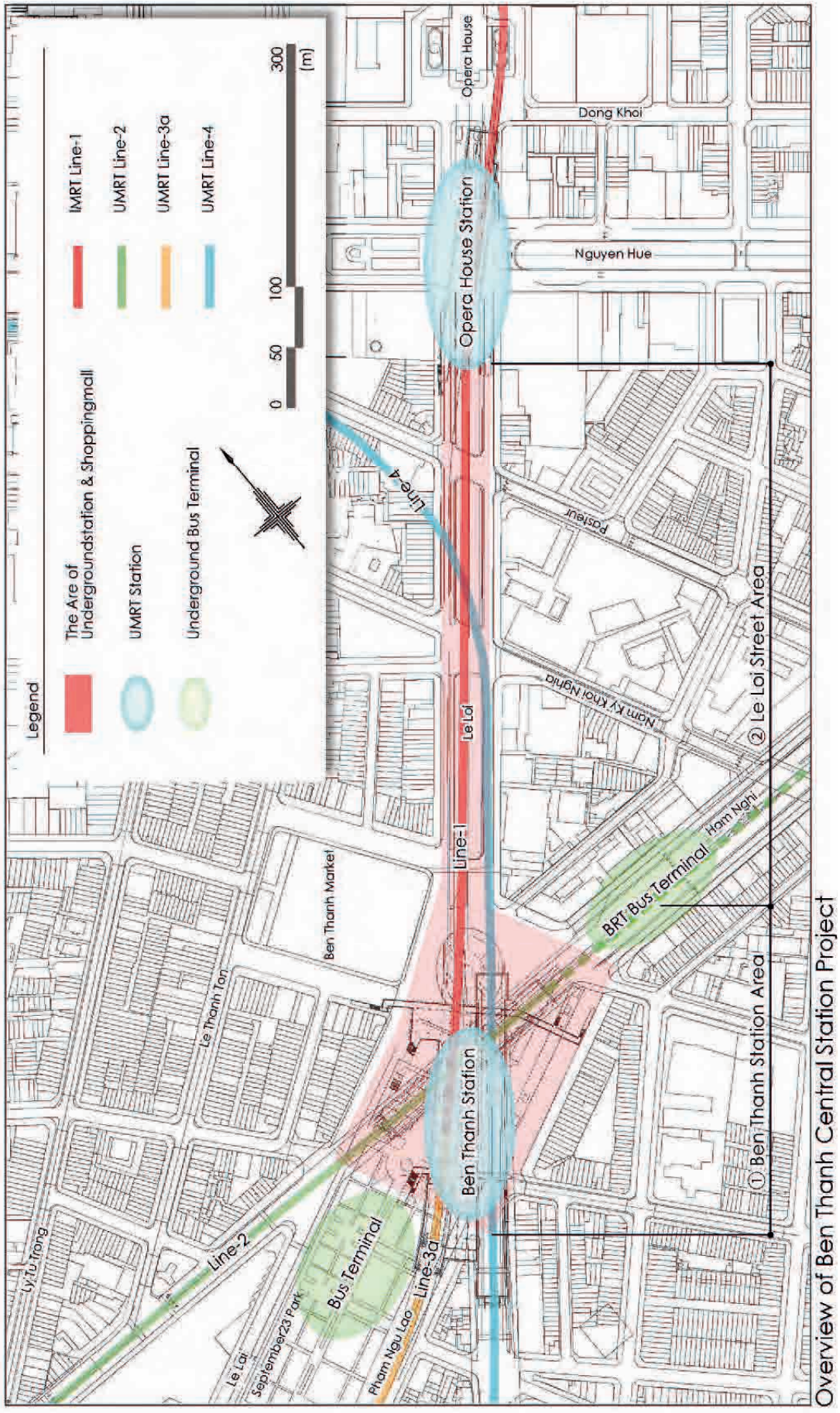


Figure 4.6 Project Improvement Area

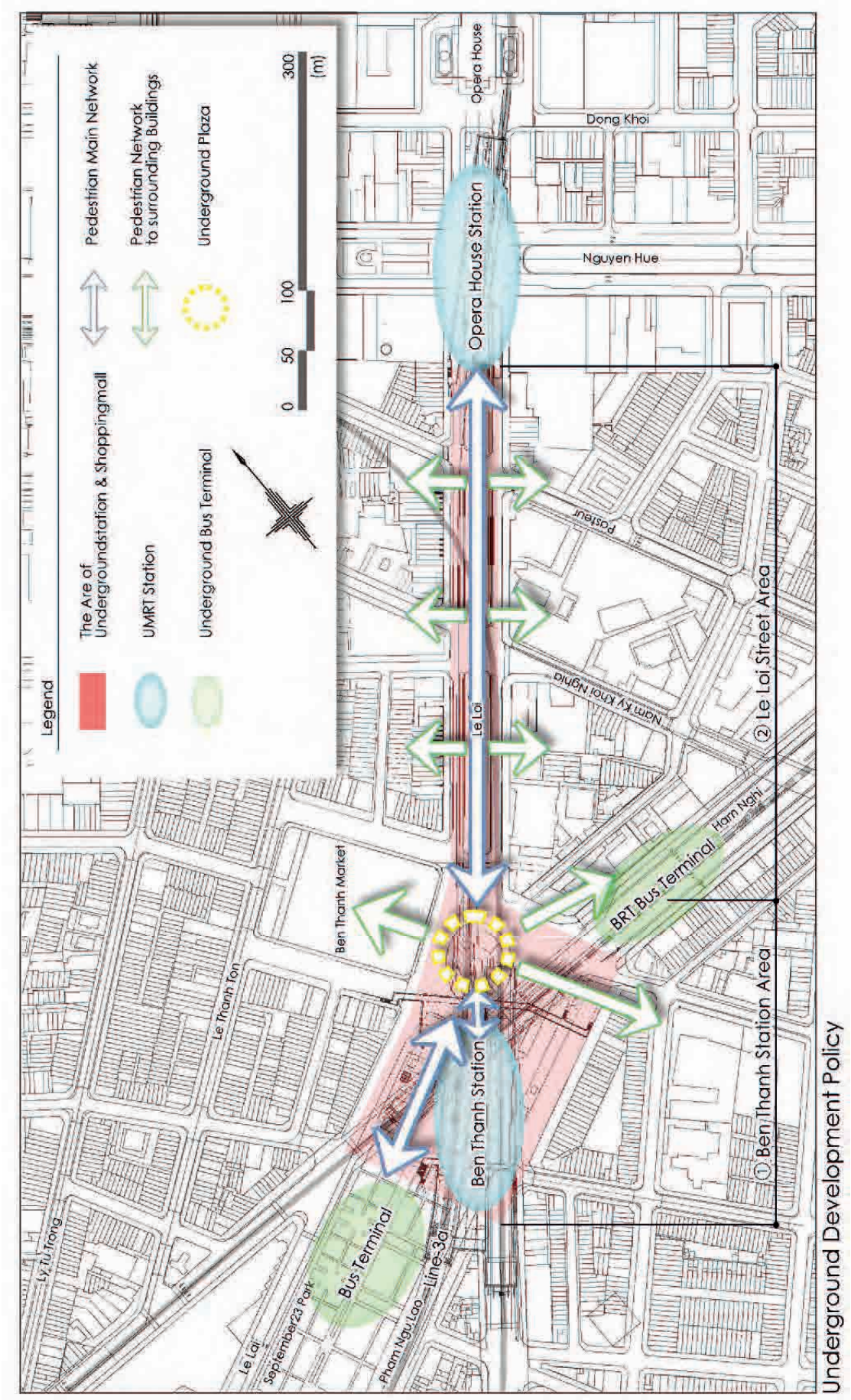


Figure4.7 Relative Facilities to be connected with this Project

(2) Whole Planning Policy

a) Whole Planning Policy

The planning policy for the improvement in Ben Thanh area is studied including on-ground and underground. The points of the planning based on the necessity of the infrastructure are concretely set as the whole planning policy in the project improvement area. The whole planning policy is described as following, and shown in Figure 4.8.

- Construction of Overall Underground Terminal to ensure Smooth Connection for Public Transport
  - Higher connectivity of Ben Thanh Central Station to bus terminal and BRT terminal
  - Simple layout of underground passageways to travel comfortably between public traffic facilities
  - Whole planning of Ben Thanh Central Station with 3 platforms of 4 UMRT lines to ensure the smooth transfer from one line to another

- Creation of Attractive Underground Urban Space
  - Underground urban space with open space is for passengers to take a rest and relax
  - Clear layout of underground passageways in composition with main line and subsidiary lines
  - Underground plazas with large atriums is to give underground space natural sunlight
  - The passageway with retail stores on both sides is to make underground urban space vibrant and joyful

- Formation of Underground Pedestrian Network connecting New Buildings and Traffic Nodes
  - High accessibility to surrounding new private buildings through simple layout of underground passageway
  - Underground pedestrian network to make the move to surrounding area easy and comfortable

The policy of on-ground planning is shown in Figure4.9 in consideration with the whole planning policy of the underground urban space.

b) Structural Concept

In planning the underground development, it is necessary to set up an underground space in such place as can be used by a certain amount of people. Horizontally, the underground space will be located under Le Loi from Ben Thanh Station to Opera House Station, taking into account the circulation of passengers from/to UMRT stations and the connection with basement floors of new buildings to be constructed adjacent to Le Loi. Vertically, the underground space will be placed between the ground level and the top of UMRT structure.

The underground space will be planned in conformity with the detailed city planning and architectural design guideline for the city center which is currently studied by the Department of Planning and Architecture as stated in Section 2.3. Concretely, Le Loi is planned to be reconstructed into a transit mall with priority to pedestrians by formation of historical streetscape securing the vista into Opera House; the roundabout in front of Ben Thanh Market is to be reformed into a pedestrianized plaza surrounded by Ben Thanh market and other historical buildings. The project's underground space will be provided with plazas as well as stairs, elevators and other facilities for raising and lowering people, so as to enable the underground space to be functionally integrated with the aforesaid on-ground transit mall and pedestrianized plaza.

In particular, the front of Ben Thanh Market will have a large atrium connecting the underground plaza with the on-ground pedestrianized plaza so that sufficient natural sunlight can pour into the underground space to make amazing impressions on underground people. In the detailed planning of the city center under study, a bus terminal is to be constructed under 9/23 Park. At the entrance into the bus terminal, an atrium will be provided to connect the on-ground park with the underground terminal space. This atrium will be constructed as unique space where people on the ground can look over passengers moving in Ben Thanh Station. These atria above the ground will have a cylindrical structure made of transparent, thermal-insulated materials.

Underground passages will be composed of the main line circulating from Opera House Station to the underground bus terminal through Ben Thanh Station and the subsidiary lines which connect with the BRT (Bus Rapid Transit) terminal to be constructed under Ham Nghi in the city center detailed planning and with basement floors of buildings to be newly constructed along Le Loi. The aforesaid two atria will be located on the main line in such a manner that a naturally lit plaza can produce attractive underground space and give the main line a direction definite irrespective of underground location. In addition, the underground passage will be constructed as a shopping mall furnished with retail stores on both sides. It is expected that this thermally insulated underground passage or mall will become vibrant urban space with comfortable indoor conditions not affected by the local hot climate.

Ben Thanh Station intersectionally receiving 4 lines of UMRT is to be so constructed that transfer from one line to another line can be facilitated. Higher connectivity of UMRT with the bus terminal and the BRT terminal will be ensured through the underground passage. Also, Ben Thanh Station is to have a linear well through which passengers can look down from the concourse at a moving UMRT train. This will contribute to making the underground space more attractive.

Figure4.8 Underground Planning Conceptual Diagram

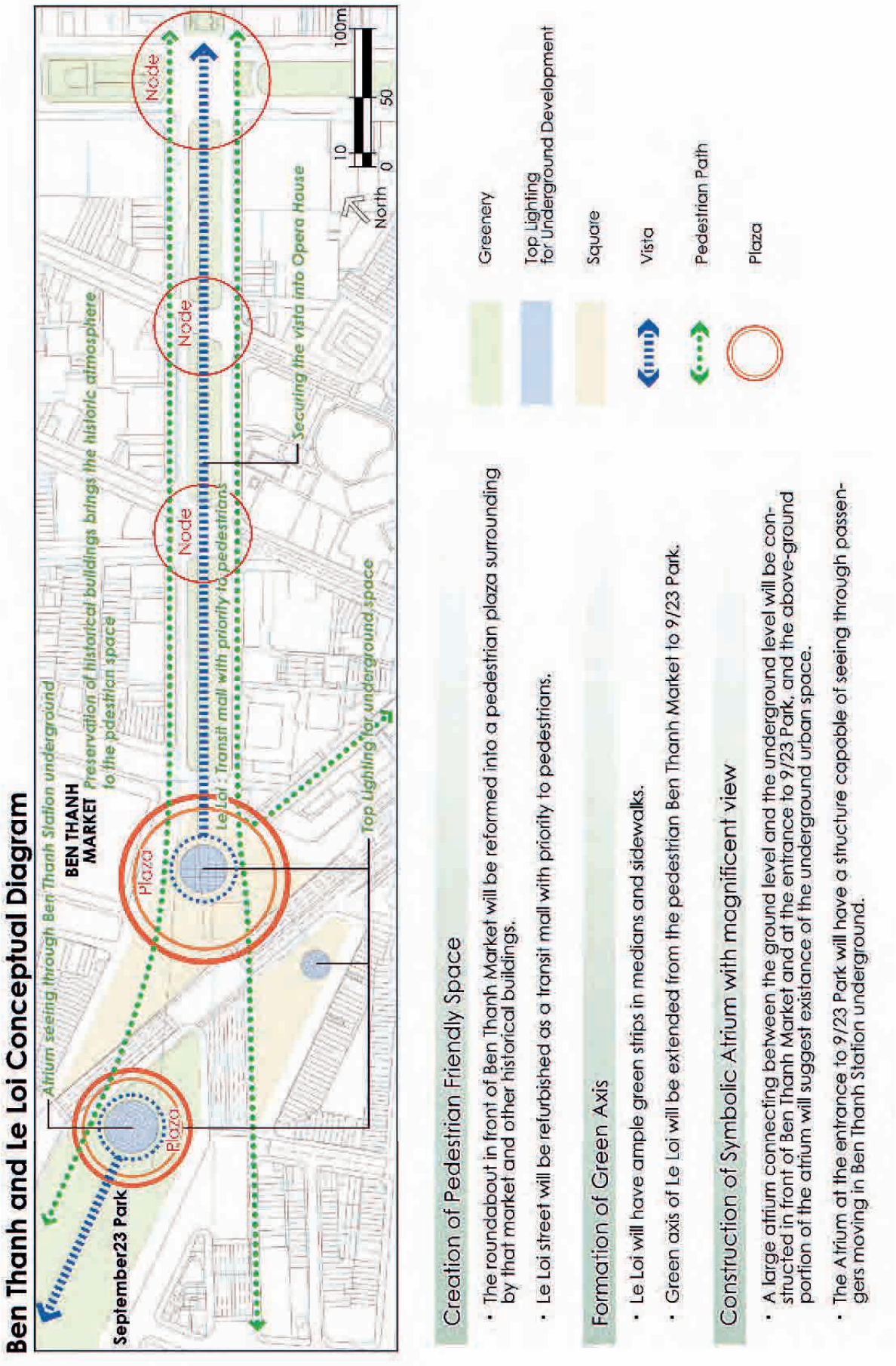


Figure4.9 Ground Planning Conceptual Diagram

2) Proposal of Underground Space Design

In the design of the underground facilities on the basement 1st floor, not only UMRT Line 1 project planning but also Line 2 and 4 project planning should be considered and some arrangement among these project planning is necessary. Especially UMRT Line 1 project has been already on the tendering stage for the design and the construction, so it is necessary to study the impact on Line 1 carefully. In this case, not only the design change of Line 1 but also the affect to the tendering procedure and the construction schedule should be studied. The planning policy with the large influence to the design of underground development is clarified through the comparative study.

(1) Underground Development in Ben Thanh Station Area

The arrangement and adjustment among the planning of UMRT Line 1, 2, and 4 at Ben Thanh Central Station is necessary for the design of the underground development in the Ben Thanh station area. These UMRT projects proceed individually, and the project progress is much different among the projects. UMRT Line 1 is on the tendering stage for the design and the construction. For the UMRT Line 2 the feasibility study has been just finished. UMRT Line 4 is on the stage that the initial feasibility study has been reported. And the feasibility study for the underground shopping mall is now performing in this survey. In those planning there is some uncertain element, and the timing of the construction and the operation for these projects is not clear at this moment.

However the design of the underground development depends on the construction sequence and timing of relative projects in the planning of the underground development in the Ben Thanh station area. In case that the underground shopping mall is constructed simultaneously with the station construction for the UMRT projects at Ben Thanh Central Station, the design will be made most reasonable and suitable as a central station for the smooth transfer and high accessibility to each platform. On the other hand, in case of the separate construction of all projects, the underground development has to be designed and enlarged step by step corresponding to the planning of the previous project. This process affects not only the whole project plan but also the construction method, so the construction cost will increase.

Therefore the comparison between two design methods on the underground development in the Ben Thanh station area is studied. One is the Independent Design which each project is designed separately corresponding to the procedure of each project, and the other is the Integrated Design which the overall design through the rearrangement and the adjustment of each project planning is performed. In case of the Independent Design, the UMRT Line 1 design is considered unchangeable because the preliminary design for Line 1 has been completed.

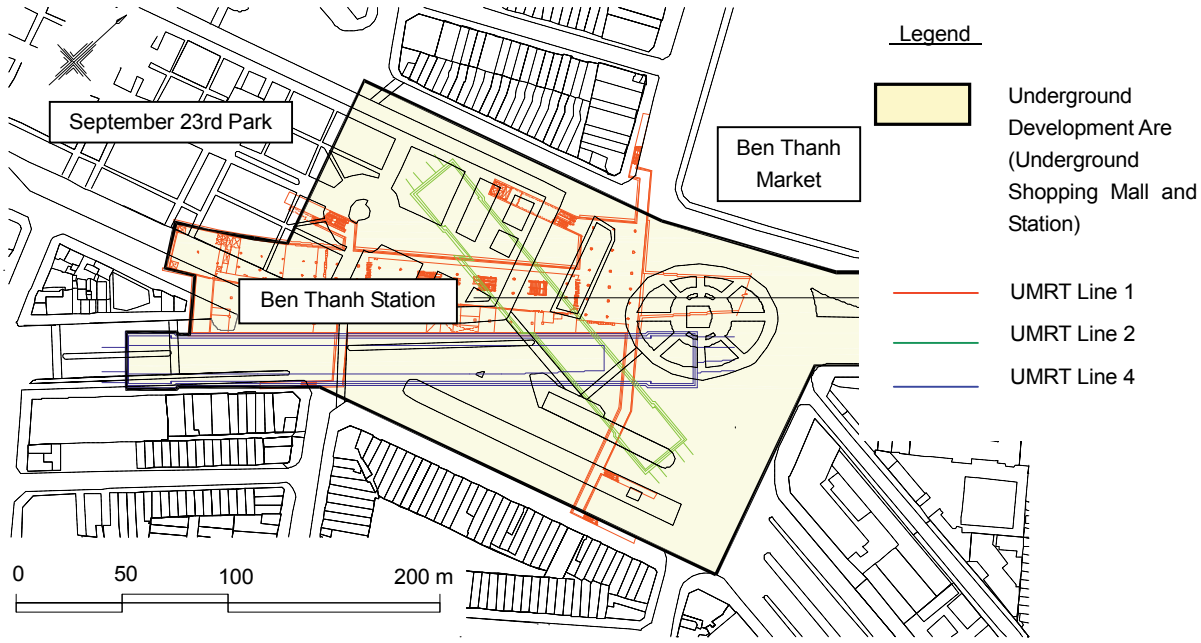


Figure 4.10 Relative project in Ben Thanh station area

The comparison options are mentioned below, and the comparison table is shown in.

Option 1 : Independent Design (Each project is designed separately)
Option 2 : Integrated Design (All projects are designed as one whole project)

The most important point on the comparison study between the aforesaid two options is the convenience of the transfer between one platform to the another as a central station. The comparison on the transfer route among three platforms and the study on the location of elevator directly reaching each platform from the paid concourse is performed. On the other hand, from the viewpoint of the urban planning for the center of Ho Chi Minh City, the comparison on the creation of the attractive and comfortable underground space and the connection to the public transportation such as the underground bus terminal is also studied. Furthermore, the impact on the UMRT Line 1 project that has already been completed the preliminary design is taken into consideration.

The summary of two options is shown in Figure4.11 and Figure4.12, and the comparison table is shown in Table4.9.

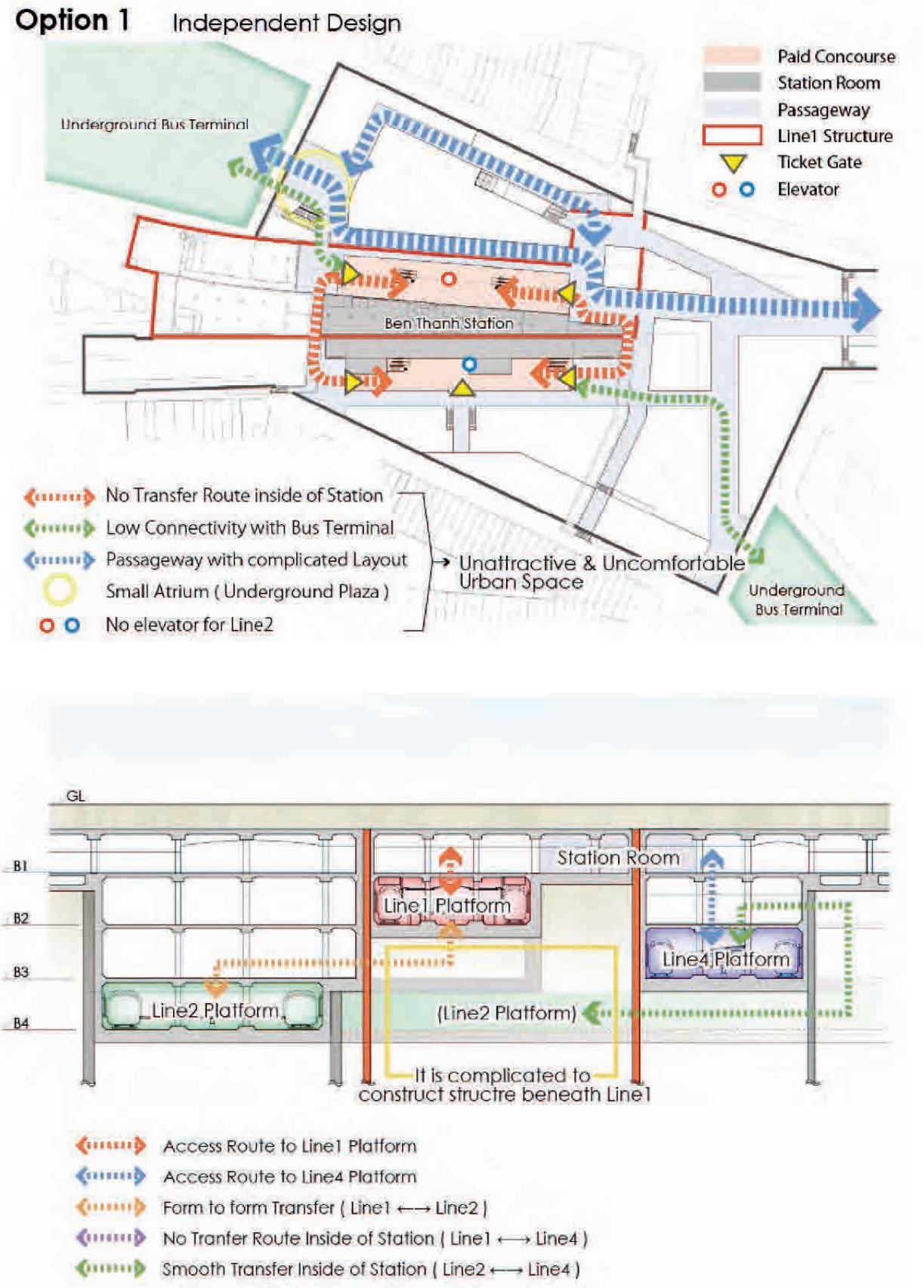


Figure4.11 Independent Design for central station planning

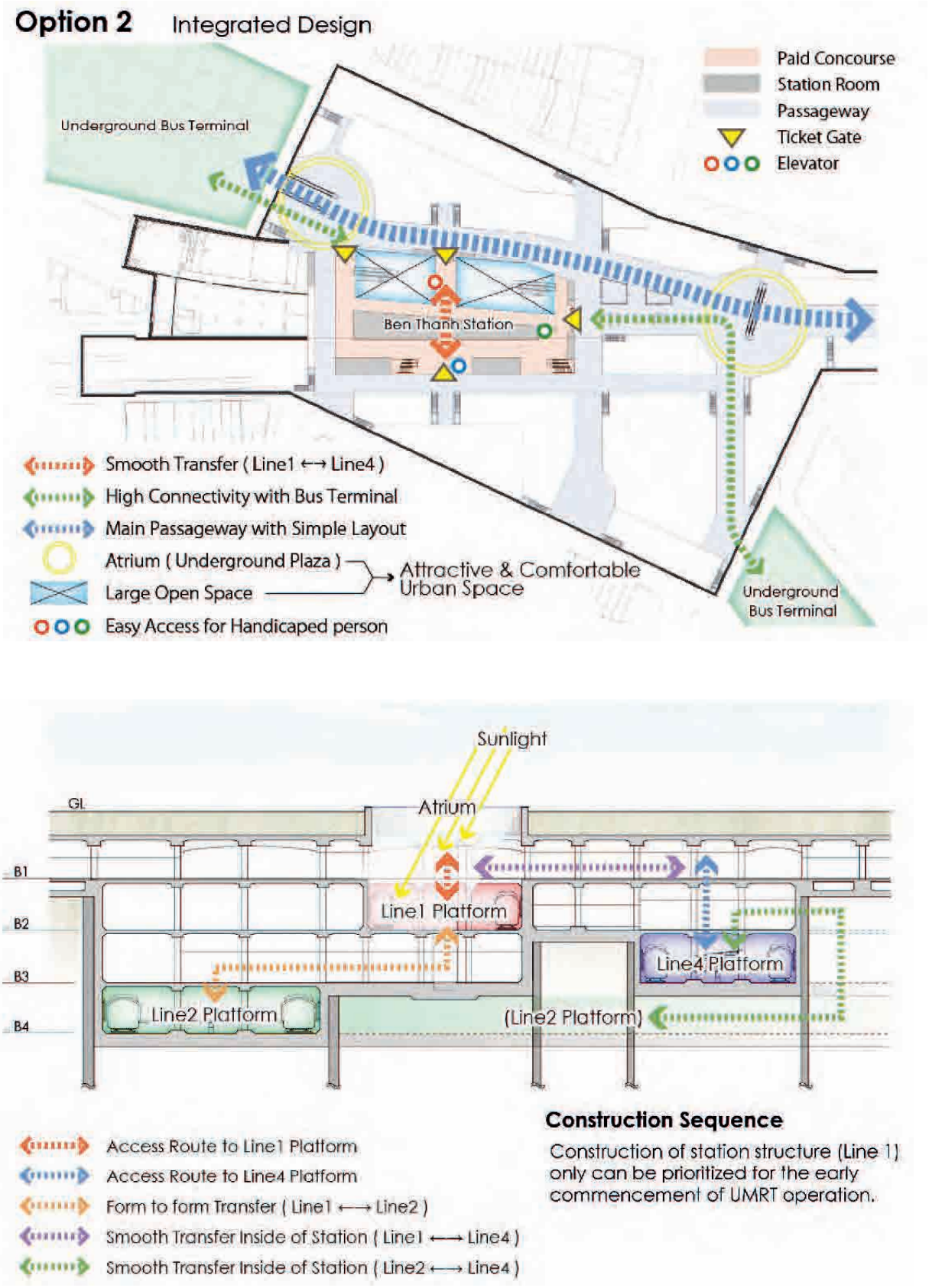
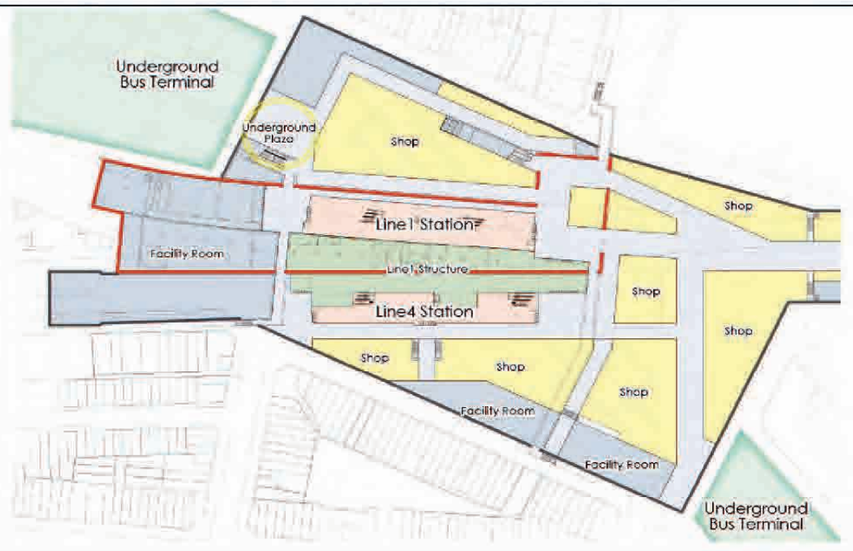
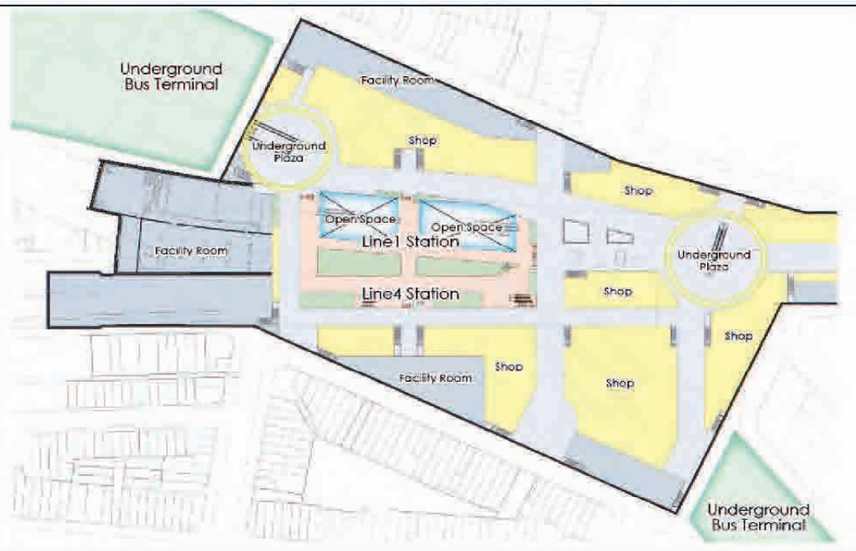


Figure4.12 Integrated Design for central station planning

Table 4.9 Comparative study for the planning policy of the underground development in Ben Thanh Station area

			Option 1		Option 2	
1	Outline of the Alternative	Planning Concept	Each facility for Line 1, Line 2, Line 4, and USM is designed and constructed separately.		Designing all facilities for Line 1, Line 2, Line 4, amd USM on the whole, the structure is constructed simultaneously.	
		Construction Sequence	(1) Line 1 → (2) USM → (3) Line 2 → (4) Line 4		(1) Line 1 + USM + Line 2 + Line 4 (Only concrete structure is constructed for Line 2 and Line 4 station)	
2	B1 Floor Plan					
3	Planning of Central Station		* The concourse of Line 4 is devided from the Line 1 concourse, so the connectivity is very bad for the passenger to transfer between Line 1 and Line 4. * There is no elevator from the concourse on B1 floor to the platform of Line 2 directly.	C	* The passenger can easily transfer between Line 1 and Line 4 through the concourse on B1 floor. * All platforms for Line 1, Line 2, and Line 4 can be approached for the handicapped person using the elevator from the concourse on B1 floor directly.	A
4	Impact on Line 1	During Tender Procedure	* In principle no design change is required for Line1 from Tender Drawings. (The openig on the wall for the future connectivity with USM should be taken into consideration on Line 1 design)	A	* The big design chage is indispensable, so the current tender procedure should be revised. * It could be proposed that Ben Thanh Central Station Project including the USM is devided from Line 1 Project.	B
		During Operation Period	* Line 1 can be operated in advance of Line 2, Line 4, and USM. * Monitering of the impact on the Line 1 structure is necessary especially during Line 2 construction.	B	* The schedule of completion of Ben Thanh station for Line 1 may be delayed. (Even if Ben Thanh station can not be constructed at the same time as the other part of Line 1, the passanger can approach the center of HCMC when Line 1 is operated up to Opera House station.)	B
5	Urban Planning	Plan of Plaza and Passageway	* Due to the structure of Line 1, the arrangement of the underground plaza and passageway is very complicated like a labyrinth. * It is difficult for people to understand the point where they are located on B1 floor, so it is hard to move from one place to another in the USM.	C	* The underground plaza and the passageway can be arranged simply in the direction along Le Loi street and the crossing direction. * People could easily understand the point where they are located on B1 floor, and there is no stress and no inconvenience to move to the destination.	A
		Attractive Urban Space Development	* Since it is difficult to arrange the effective large underground plaza which has the open space up to aboveground in order to bring the light, the attractive urban space can not be created.	C	* The underground plaza can be arranged effectively as the urban core, and it provids the large open space up to aboveground and brings the light to B1 floor. Therefore the attractive and comfortable underground urban space would be developed.	A
		Connectivity with Bus Terminal	* The accessibility from the metro station to the adjacent bus terminal is bad because of the complicated arrengement of the passageway.	C	* People can easily approach the adjacent bus terminal from the central station because of the simple arrangement of the passageway.	A
6	Construction Workability		* The construction of Line 2 is very difficult because the construction has to be done beneath the Line 1 concrete structure.	C	* Since all concrete structure is constructed simultaneously, the construction is not so difficult.	A
7	Comprehensive Evaluation		**Not Recommended** + Major advantages of Option 1 are as follows; Basically no design change is required for Line 1 - Major disadvantages of Option 1 are as follows; The concourse of Line 4 is devided from the Line 1 concourse, so the connectivity between Line 1 and Line 4 is bad. The arrangement of the plaza and passageway is very complicated and it is hard to move from one place to another (ex. from metro station to bus terminal).	B	**Recommendation of JICA Study Team** + Major advantages of Option 2 are as follows; Major disadvantages of Option 1 are resolved. + Major disadvantages of Option 2 are as follows; The current tender procedure should be revised and Ben Thanh Station to be devided from Line 1 Project.	A

Note
USM : Underground Shopping Mall

"A" : EXELENT
"B" : GOOD
"C" : BAD

As shown in the comparison table, in case of the Option 1 (Independent Design) the transfer from one line to another is not smooth as a central station, so Ben Thanh Central Station becomes inconvenience and uncomfortable for the passengers. That is since the previous project design does not consider the other following project planning. In addition, because the UMRT Line 1 structure is completed prior to the other projects and the shape of the other project structure should be adjusted to the Line 1 structure shape, the layout of the underground pedestrian passageways is made unclear like the labyrinth. The pedestrian in the underground passageways can not understand how to walk to the destination, so it is easy to lose the way. Further, regarding the construction because the UMRT Line 2 structure should be constructed beneath the Line 1 structure, the Line 2 construction becomes difficult and high risky, and the construction period is extended, so the construction cost increases. Therefore, Option 1 (Independent Design) has much disadvantage. The advantage is only no impact for the current procedure of UMRT Line 1 project.

On the other hand, in case of the Option 2 (Integrated Design), the high connectivity among three UMRT platforms is ensured to make the transfer from one line to another smooth as a central station, so Ben Thanh Central Station becomes convenience and comfortable for the passengers. In addition, through the clear layout of the underground pedestrian passageways the high accessibility to the public traffic facilities like the bus terminal is ensured, so it is easy for the underground pedestrian to move to the destination comfortably. Further, as the large atrium is planned above the Line 1 platform, the attractive urban space which is suitable for the center of Ho Chi Minh City can be created. Regarding the construction, the standard construction sequence can be performed because of the simultaneous construction of the whole structure, so the construction cost becomes reasonable. Therefore in Option 2 (Integrated Design), the comfortable and attractive underground urban space can be created in the center of Ho Chi Minh City. However, Option 2 has two points of disadvantage. One is that the design change is necessary for the Line 1 project of which the preliminary design has already been completed, and the other is that the tendering procedure of the Line 1 project should be revised.

Through this comparative study, Option 2 (Integrated Design) is strongly recommended. As a result of consultation with HCMC people's committee, the implementation of Integrated Design for Ben Thanh Central Station has been officially determined. In addition, Ho Chi Minh City expresses that the commercial operation of Line 1 is expected to start as early as possible.

(2) Underground Development in Le Loi Street Area

The arrangement and adjustment between the UMRT Line 1 tunnel and the underground shopping mall structure is necessary for the design of the underground development in the Le Loi street area. In addition the UMRT Line 4 tunnel should be considered. That is because the Line 4 tunnel is located in parallel to the Line 1 tunnel near Ben Thanh Station and passes beneath the Line 1 tunnel at the cross point in the middle between Ben Thanh Station and Opera House Station and goes to the Pasteur street.

The shield tunnel is adopted in the current UMRT Line 1 design for a part of tunnel section beneath Le Loi Street. However, in this shield tunnel section the tunnel structure interferes with the underground shopping mall structure, so the underground shopping mall can not be constructed above the Line 1 tunnel and the area of the underground development decreases. On the other hand, in case that the tunnel structure is changed from the shield tunnel to the cut and cover tunnel, the underground shopping mall can be constructed above the Line 1 tunnel. Therefore the area of the underground development expands and the underground shopping mall can be connected with the basement of surrounding buildings. Thus the attractive and comfortable underground urban space can be created to contribute to the economic growth in Ben Thanh area.

UMRT Line 4 tunnel is planned as the shield tunnel. However, Line 4 tunnel does not interfere with the underground shopping mall structure because the location of this tunnel is deeper than the Line 1 tunnel. The Line 4's tunnel has no issue for the relation with the Line 1 tunnel in the parallel section since there is enough distance between Line 1 and Line 4 tunnels. On the other hand, at the cross section between Line 1's and Line 4's tunnels the necessary distance between two tunnels should be kept and the solution of construction method like the soil improvement should be performed corresponding to the construction method of each tunnel.

In consideration with the above mentioned, the underground planning policy in the Le Loi street area is studied. The current plan of the relative projects is shown in Figure 4.11.

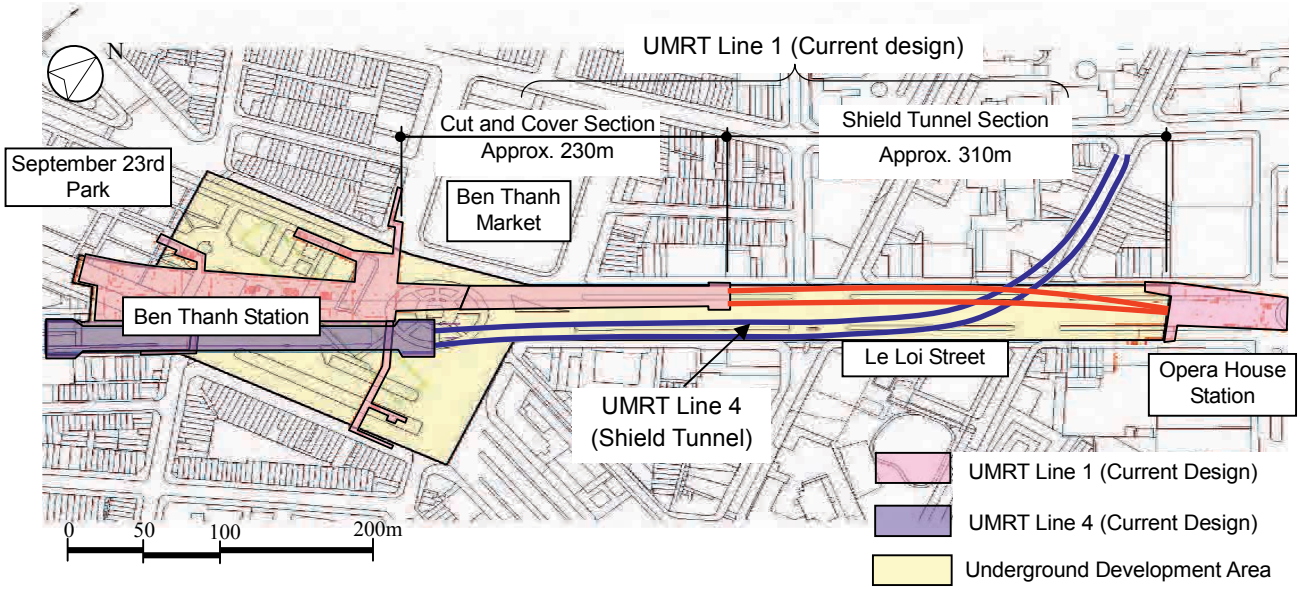


Figure 4.11 Relative project in Le Loi street area

Based on the current planning of each project, the comparison between two construction methods on the underground development in the Le Loi street area is studied. One is that the current design of UMRT Line 1 tunnel is not changed and the area of the underground development decreases, and the other is that the Line 1 tunnel structure is changed from the shield tunnel to the cut and cover tunnel and the area of the underground development expands. In addition the cut and cover tunnel for Line 1 has two options. One is that the Line 1 tunnel and the underground shopping mall are constructed simultaneously, and the other is that the Line 1 tunnel is constructed prior to the underground shopping mall. This is because the difference of the project procedure between Line 1 and the underground development should be studied in the comparison. The underground development is under the feasibility study as a PPP project. However, the Line 1 project is on the tendering stage of the design and construction, so the Line 1 project is prior to the underground development. Thus, the comparative study is performed among the following three options.

Option 1 : Shield tunnel for Line 1
(No design change for Line 1 tunnel)

Option 3 : Cut and cover tunnel for Line 1
(Design change for Line 1 tunnel and simultaneous construction of Line 1 tunnel and underground shopping mall)

Option 3-1 : Cut and cover tunnel for Line 1
(Design change for Line 1 tunnel and construction of Line 1 tunnel prior to underground shopping mall)

In the initial study for the construction method in the Le Loi street area, the comparative study of Option 2 is performed. Option 2 is that the both construction method of Line 1 and Line 4 tunnels is changed to cut and cover method. However, the result of the initial study shows that the impact on the Line 1 project is too large and the increase of the construction cost is so high because of very deep excavation. Therefore, Option 2 is omitted in the detail comparative study.

The comparison items in the comparative study among these three options take up the impact on the Line 1 and Line 4 projects as basic items. The main viewpoints are the influence to the project implementation schedule and the affect to the construction cost. In addition, because the area of the underground development is different among the options, the comparison items also take up the influence to the urban planning and the affect to the investment efficiency of the private sector for the underground shopping mall. In these items, the viewpoints of the urban planning are the connectivity with the surrounding private buildings and the creation of the attractive and comfortable urban space for the future. And the investment efficiency is evaluated according to the internal rate of return and the net present value of the cash flow in the private sector.

The outline of the three options is shown in Table 4.10, and the comparison table is shown in Table 4.11.

Table 4.10 Construction method of underground shopping mall and Line 1 tunnel beneath Le Loi Street

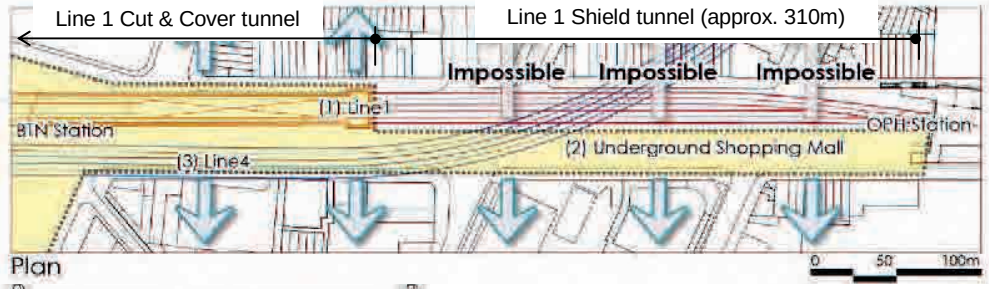
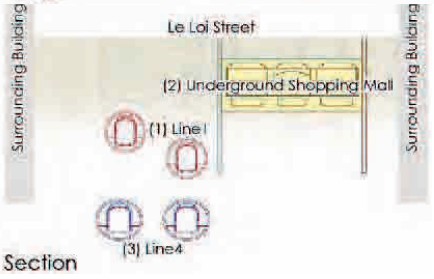
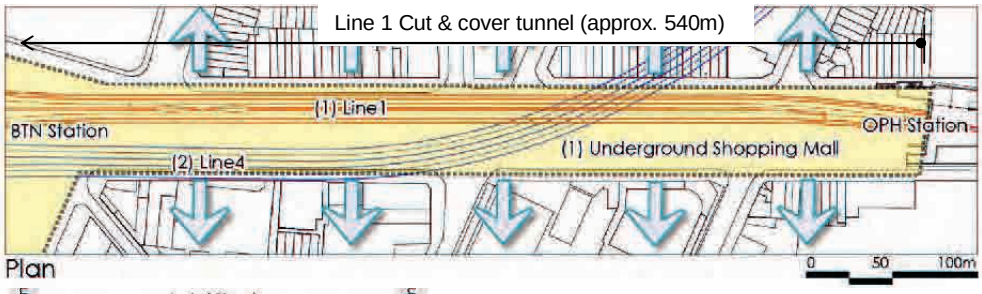
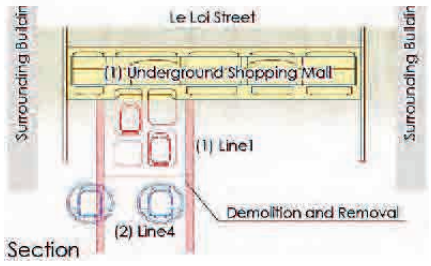
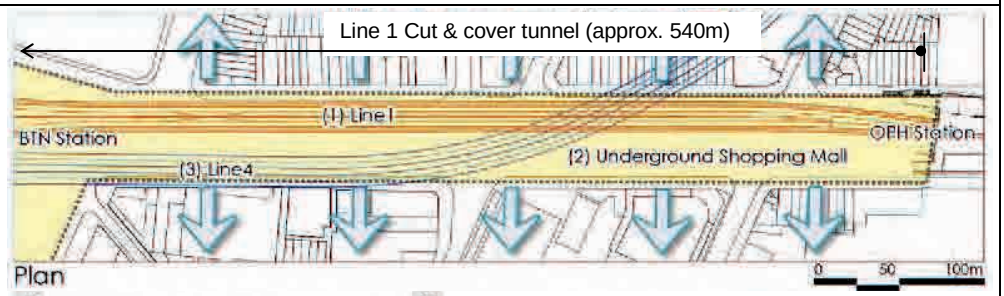
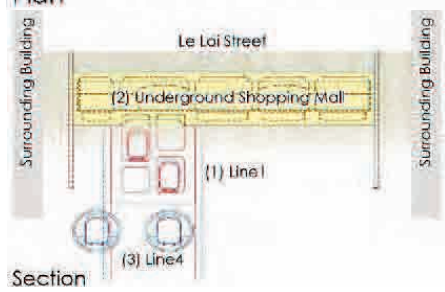
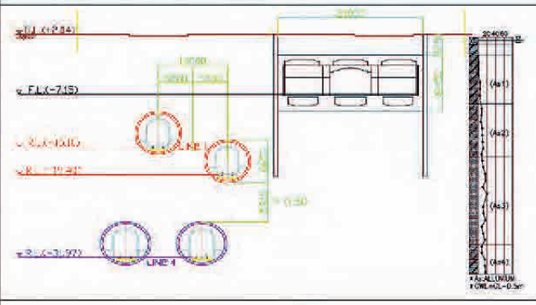
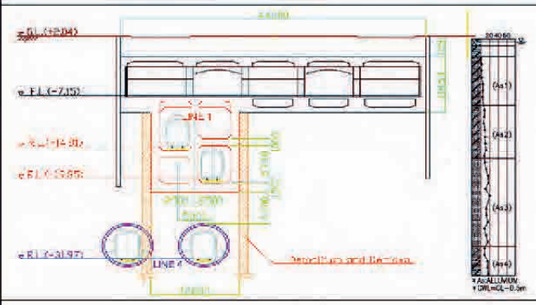
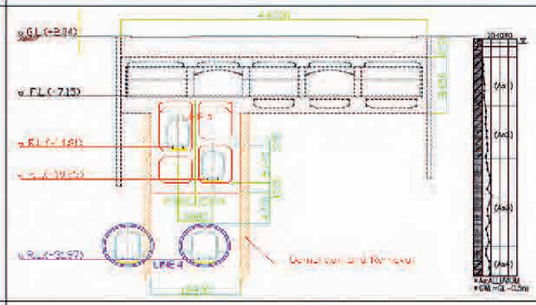
	Outline of option
Option 1	  ・Construction Method Line 1: Shield Tunnel Line 4: Shield Tunnel USM : Cut & Cover Tunnel ・Construction Sequence : ①Line 1 ②USM ③Line 4 ・No design change for Line 1 tunnel ・The area of USM becomes small
Option 3	  ・Construction Method Line 1: Cut & Cover Tunnel Line 4: Shield Tunnel USM : Cut & Cover Tunnel ・Construction Sequence : ①Line 1 & USM ②Line 4 (simultaneously) ・Design change for Line 1 tunnel ・The area of USM becomes large
Option 3-1	  ・Construction Method Line 1: Cut & Cover Tunnel Line 4: Shield Tunnel USM : Cut & Cover Tunnel ・Construction Sequence : ①Line 1 ②USM ③Line 4 ・Design change for Line 1 tunnel ・The area of USM becomes large

Table 4.11 Comparative study for the planning policy of the underground development in Le Loi Street area

			Option 1		Option 3		Option 3-1	
1	Outline of the Alternative	Type of Tunnel	* Line 1 : TBM * Line 4 : TBM		* Line 1 : C&C * Line 4 : TBM		* Line 1 : C&C * Line 4 : TBM	
		Construction Sequence	(1) Line 1 → (2) USM → (3) Line 4		(1) Line 1 & USM → (2) Line 4		(1) Line 1 → (2) USM → (3) Line 4	
		Other Conditions	* No design change is required for Line1 from Tender Drawings * Development area of USM is restricted		* No restriction is required for USM project		* No restriction is required for USM project	
2	Cross Section	(KM0+436 of Line 1)						
3	Rail Level at Cross Section	Line 1	-19.40		-19.85		-19.85	
		Line 4	-31.97		-31.97		-31.97	
4	Impact on Line 1	During Construction Period (including Tender Procedure)	* No preparatory work for USM and Line 4 is required	A	* The revision of the tender document is required. (The necessity of the revision of Preliminary Design of Line 1 Project is to be clarified) * Diaphragm wall has to be demolished and removed during the construction period of Line 1.	B	Same as Option 3	B
		Necessary Time for Construction	* No delay for Line 1 construction	A	* Line 1 construction to be postponed for approx. 4 years until PPP project will be approved.	C	* Approx. 6 months for the approval and the design change of Line 1 Project would be necessary. (The arrangement of tender schedule will be required.)	B
		During Operation Period	* Line 1 tunnels will be affected by the construction of Line 4 tunnels which underpass the Line 1 tunnels with minimum of half diameter of the shield tunnel	B	* No impact on the Line 1 tunnels is expected from USM projects	A	Same as Option 3	A
5	Line 4 Construction	During Design Period	* The alignment of Line 4 can be revised after the construction of Line 1	B	* The horizontal alignment of Line 4 has to be fixed by the detailed design of Line 1	B	Same as Option 3	B
		During Construction Period	* Monitoring of the impact on Line 1 tunnel is necessary	B	* Monitoring of the impact on Line 1 tunnel is necessary	B	Same as Option 3	B
6	Urban Planning	Developing area of USM	approx. 18 500 m^2	C	approx. 25 500 m^2	A	Same as Option 3	A
		Construction of Passageway connecting USM with Surrounding Buildings	* The construction of the passageways which connect between the USM and buildings on the northwest side of Le Loi Street would be difficult. This is because the embedment of the retaining wall for the passageways would be hindered by the shield tunnel of Line 1, which causes the boiling destruction at the excavation bottom and the large deformation of the retaining wall.	C	* The underground passageways connecting the USM and buildings along Le Loi Street would be safely constructed because the embedment of the retaining wall could be sufficiently secured.	A	Same as Option 3	A
		Attractive Urban Space Development	* Since the connection between the USM and buildings on the northwest side of Le Loi Street wouldn't be secured, attractive and comfortable underground spaces wouldn't be developed.	C	* Since there is no restriction to connect the USM and buildings along Le Loi Street to be caused by the underground rail structure, developing attractive and comfortable underground spaces is expected.	A	Same as Option 3	A
7	Investment Efficiency for USM		* The investment efficiency for USM is marginal for private sector investment as the equity internal rate of return is 16% with NPV of private sector net cash flow is estimated at 1.9 times of initial equity investment. * The rentable ratio for the store in USM, which is the ratio of shop area to USM area, becomes considerably smaller.	C	* The investment efficiency for USM is sufficient for private sector investment as the equity internal rate of return is nearly 20% with NPV of private sector net cash flow is estimated at 2.6 times of initial equity investment. * The rentable ratio for the store in USM, which is the ratio of shop area to USM area, becomes considerably larger.	A	Same as Option 3	A
8	Construction cost performance	UMRT (CP-1) Construction	100 *	A	106 *	A	106 *	A
		USM Construction	100 *	-	114 *	-	114 *	-
		UMRT and USM Construction	100 *	-	109 *	-	109 *	-
9	Comprehensive Evaluation		**Not Recommended** + Major advantages of Option 1 are as follows; No design change is required for Line 1 Alignment of Line 4 can be reviewed and modified in the future - Major disadvantages of Option 1 are as follows; The developing area for USM has to be reduced for approx. 7000 sq.m The attractive and comfortable underground space wouldn't be developed. The investment efficiency for USM would not be so good.	B	**Recommendation of JICA Study Team in case of PPP project approval in early stage** + Major advantages of Option 3 are as follows; Major disadvantages of Options 1 and 2 are resolved or mitigated + Remaining major disadvantages of 3 are as follows; Only the horizontal alignment of Line 4 has to be fixed in the detailed design of Line 1	B	**Recommendation of JICA Study Team** + Major advantages of Option 3-1 are as follows; Major disadvantages of Options 1 and 2 are resolved or mitigated + Remaining major disadvantages of 3-1 are as follows; Only the horizontal alignment of Line 4 has to be fixed in the detailed design of Line 1	A

Note
TBM : Tunnel Boring Method
C&C : Cut and Cover
USM : Underground Shopping Mall

* Construction cost performance
1 . Assuming construction cost of Option 1 is 100.
2 . The cost of UMRT (CP-1) is the Construction Cost of Package 1 (Underground Section), HCMC Urban Railway Construction Project, Line 1.

"A" : EXCELLENT
"B" : GOOD
"C" : BAD

As shown in Table 4.11, in case of Option 1 (Shield tunnel for Line 1), the underground shopping mall can not be constructed above the Line 1 tunnel due to the interference with the Line 1 tunnel. Therefore the connectivity of the underground development with the new private buildings on the northwest side of Le Loi Street can not be ensured, and the formation of the underground pedestrian network can be insufficient in the future. The area for the pedestrian walking around becomes small, and the comfortable and attractive urban space can not be created. Further, it is estimated that the investment efficiency for the underground shopping mall in the private sector is not so good due to the small area of underground shopping mall. On the other hand, the impact on the UMRT Line project is small because of no design change for the Line 1 tunnel. It is not necessary to change the current documents for the tender of the design and construction, and there is no influence to the tendering procedure. When the UMRT Line 1 project has to be advanced in top priority, Option 1 is the best solution. However, because the future urban development is restricted, Option 1 is not recommendable.

In case of Option 3 and Option 3-1 (Cut and cover tunnel for Line 1), the underground shopping mall can be constructed above the Line 1 tunnel due to the design change of the Line 1 tunnel to the cut and cover tunnel. Since the underground development can be connected with the new private buildings along Le Loi Street, the underground pedestrian network can be formed sufficiently in the future. It is comfortable and convenient for the pedestrian to access to the adjacent facilities like the traffic facilities and/or the surrounding buildings, so the pedestrian is expected to walk around in the wider area. Therefore the attractive underground urban space can be created. On the other hand, according to the design change to the cut and cover tunnel in the shield tunnel section (the length: approx. 310m) between Ben Thanh Station and Opera House Station, it is estimated that the construction cost increases. For the construction cost of Line 1 underground section (CP-1), when the construction cost of Option 1 is 100, the one of Option3 and Option3-1 is 106, so 6% increase of the construction cost is estimated. Further, there is some affect on the schedule of the UMRT Line 1 project. The difference between Option 3 and Option 3-1 is the size of the influence to the schedule of the Line 1 project.

In Option 3 the underground shopping mall is constructed simultaneously with the UMRT Line 1's tunnel. In this case for the construction of the underground shopping mall which is expected to be developed as a PPP project, the project approval is necessary. However, the period of the project approval as a PPP project is assumed to be 3 or 4 years. Therefore, to construct the underground shopping mall simultaneously with the Line 1 tunnel, UMRT Line 1 should be extended since the construction of the underground shopping mall as a PPP project is approved. The UMRT Line 1 project is assumed to be a considerably late.

In Option 3-1 the UMRT Line 1 tunnel is constructed prior to the underground shopping mall. In this case the construction of the Line 1 tunnel does not have to extend until the project approval of the underground shopping mall as a PPP project. However, it is necessary to revise slightly the tendering documents and the process due to the design change of Line 1's tunnel. As for this revision process, however, the procedure in Ho Chi Minh City is not clear at the moment, the period of the revision work and the approval is assumed to be approximately from 3 to 5 months.

Through above mentioned comparative study, Option 3-1 is recommended as the best solution for the urban development in the center of Ho Chi Minh City considering the future, even though there is some impact on the UMRT Line 1 cost and schedule. This proposal has been approved in the consultation with the Task Team for Ben Thanh Central Station Project

3) Construction Sequence

(1) Unified Construction and Phased Construction

In the integrated design for the Ben Thanh Central station including the underground shopping mall, there is a large difference for the progress among 4 UMRT lines and underground shopping mall. Consequently, some options for the construction sequence can be considered. Therefore, the option study for the construction sequence of 4 UMRT Lines and underground shopping mall should be performed. The items to be studied are the timing of commercial operation of Line 1, the workability of construction, the influence on urban environment (such as traffic diversion during the construction period) and construction cost. According to the viewpoints of these items, the following two options can be considered for the construction sequence.

Option 1 : Unified Construction (3 UMRT Stations and Underground Shopping Mall are constructed at the same time)

Option 3 : Phased Construction (Preceding the construction of Line 1 for early commercial operation)

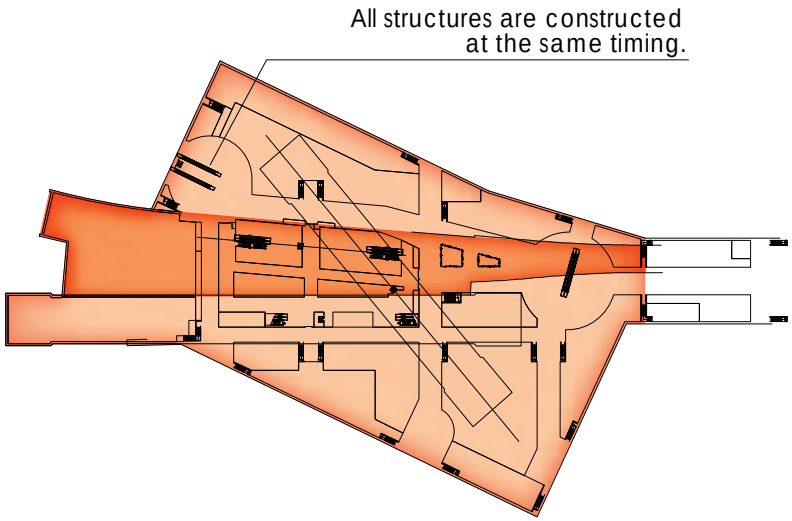
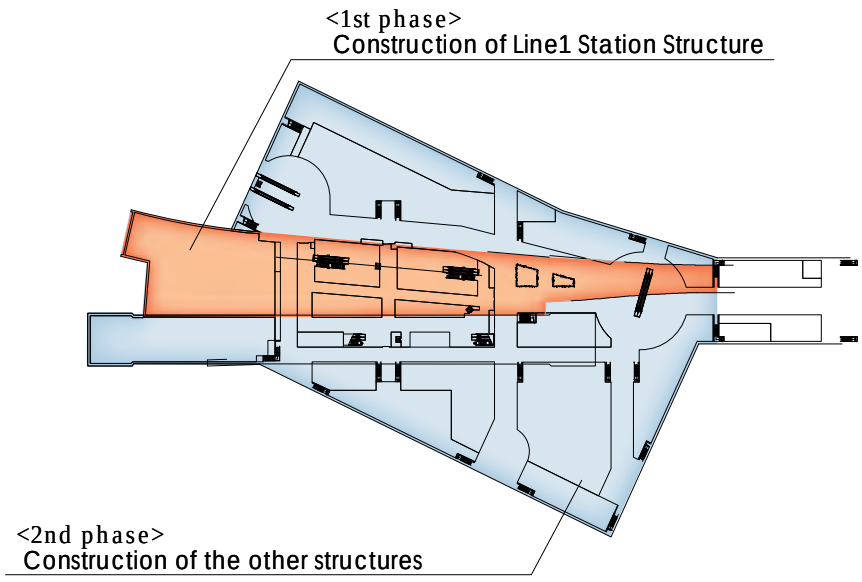
The comparison table of these two options is shown in Table 4.12. At first, comparative study of Option 2, in which the north side of underground shopping mall shall be constructed at the same time with Line-1's station, was performed. However, the result of the initial study shows that Option 2 has no advantage considering each comparison items such as the early opening of Line 1, the construction workability, and the construction cost. Therefore, Option 2 is omitted from the comparison table.

Regarding this comparison study, Option 1 (Unified Construction) is desirable from the viewpoints of construction planning and construction period. However, due to the uncertainty of the project scheme and schedule for the underground shopping mall and UMRT Lines except Line 1, simultaneous construction can not start until these project scheme and schedule are clarified. Especially, the project scheme of the underground shopping mall, which is under the feasibility study, has not yet been fixed; therefore 3 or 4 years are estimated to be necessary for the approval of this project. Thus, the considerable delay of the timing for starting Line 1 commercial operation is indispensable.

On the other hand, in case of option 3 (Phased Construction), through the integrated design the timing of commercial operation can be brought as early as possible. However, the planning of the phased construction is necessary. In addition, there is disadvantage that the total construction period is extended due to the two divided construction periods and the total construction cost would increases.

Accordingly, these two options have both advantages and disadvantages considering the overall comparison. However, UMRT Line 1 project funded by Japanese ODA has already proceeded with the development plan. The project schedule of UMRT Line 1 must not be delayed by the time the schedule of underground shopping mall is clarified. Furthermore, the early opening of Line 1 commercial operation is the priority of Ho Chi Minh City. Considering those facts, Option 3 is adopted as the feasible option in order to obtain the early opening of Line 1 as the first priority.

Table4.12 Comparison study on construction sequence

	Outline of Option	
Option 1 Unified Construction		
	Advantage	・The total construction period is not very long. ・Total cost is less than Option 3 ・Construction planning is not difficult and complicated
	Disadvantage	・Opening of Line1 operation is considerably delay
Option 3 Phased Construction		
	Advantage	・Early opening of Line 1 operation
	Disadvantage	・Long construction period ・Total cost is more than Option 1 ・Phased construction planning is necessary.

(2) Construction of Line 2 in Phased Construction

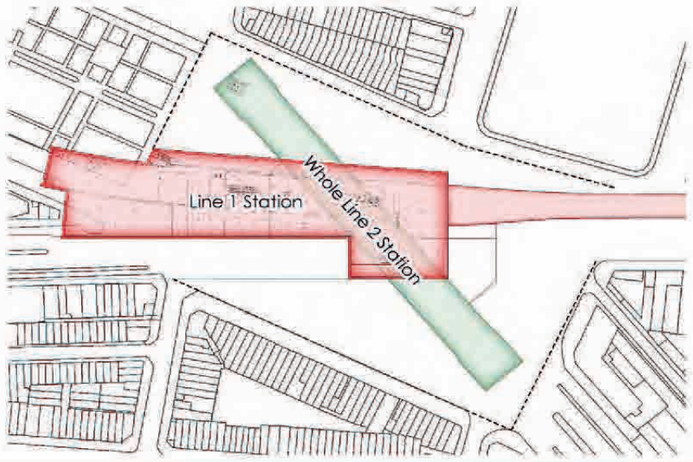
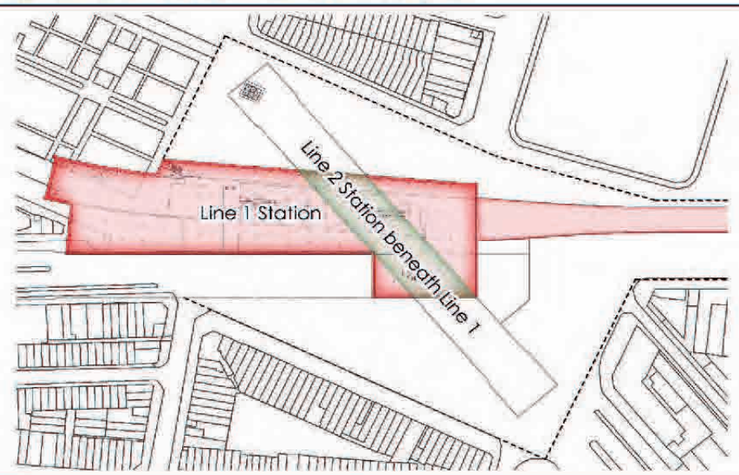
In Option 3 (Phased Construction) the simultaneous construction of Line 2 station with Line1 station is studied as shown below. In Ben Thanh Central Station, the platform of Line 2 is planned to be placed at the deepest and intersect slantwise beneath the Line 1 Platform. Since all of station structures are constructed by the cut and cover method from the ground, Line 2 station structure beneath the Line 1 station has to be constructed in the 1st phase at the same timing as Line 1 construction. Thus, the comparative study on the construction part of Line 2 station structure in the 1st phase is performed for the following two options.

Option 3 : Whole Line 2 station structure is constructed simultaneously with Line 1 in 1st phase

Option 3-1: Only partial structure of Line 2 beneath the Line 1 is constructed simultaneously with Line 1 in 1st phase

The first items to be considered in comparative study between these two options are the impact on the station structure, operation and the opening time of Line 1. The important notice for Line 2 construction and construction cost of Line 2 are also under studying. In addition, the design standard for the disaster prevention applied to the design of Ben Thanh Central Station was considered. The comparison table is shown in Table4.13.

Table 4.13 Comparative study on the Construction of Line 2 Station in 1st Phase

			Option 3		Option 3-1	
1	Outline of the Alternative	Planning Concept	Construction of Line 1 station and whole Line 2 station in 1st Phase		Construction of Line 1 station and Line 2 partial station in 1st Phase	
		Construction Sequence	【1st Phase】 ・Line 1 Station ・Whole Line 2 Station → 【2st Phase】 ・Line 4 Station ・Underground Shopping Mall Note: Construction of Line 2 and Line 4 station includes only civil works.		【1st Phase】 ・Line 1 Station ・Line 2 Station beneath Line1 → 【2nd Phase】 ・Remaining of Line 2 Station ・Line 4 Station ・Underground Shopping Mall Note: Construction of Line 2 and Line 4 station includes only civil works.	
2	Construction planning in 1st Phase					
3	Impact on Line 1	Structural	* Because 2nd phase construction has some distance to Line1 platform and the excavation is shallower, the risk is much lower than Option3-1.	A	* As the construction of Line 2 station in 2nd phase is adjacent to Line 1 station, the risk is high for the settlement of Line 1 station and/or the uplift due to soil improvement works. * Due to the demolition of diaphragm wall in 2nd phase, there is some risk that Line 1 station is damaged.	C
		Operational	Same as above	A	* There is some risk that the vibration and the noise caused by Line 2 construction adjacent to Line 1 station have bad influence on Line 1 train operation in 2nd phase. * The accessibility for the Line 1 station is restricted by the construction of Line 2 station.	C
4	Impact on Line2 Station		* As the whole structure of Line 2 is constructed at same time, there is no risk caused by the joint for diaphragm wall and structure of Line 2 station due to phased construction.	A	* During the construction period, it is impossible for the 2nd phase diaphragm wall to be connected with the 1st phase wall completely, therefore the risk is hight for water leakage and discharging of background soil from this joint. * There is higher risk for water leakage on Line 2 station structure from the construction joint between phase1 and phase2.	C
5	Design Standards for Disaster Prevention		* The design standards for disaster prevention of Line 2 station could be the same as Line 1 station. * The BTN Central Station could be designed and constructed in accordance with unified design standard for disaster prevention based on japanese standard.	A	* In the case of application of design standard for disaster prevention different from Line 1 station due to Line-2 Station receive funding from sources different from Japanese ODA, then it is possibly complicated and difficult to unify the design standard and have an Integrated Design for BTN Central Station.	C
6	Construction Cost of Line 2		1st phase 5,900 2nd phase 0 Total 5,900 mil.JPY Note: The construction cost for Line 2 shows only Civil Works.	A	1st phase 1,400 2nd phase 5,000 Total 6,400 mil.JPY Note: The construction cost for Line 2 shows only Civil Works.	B
7	Implementation Period of Line 1 (CP-1)		88.0 months	B	84.0 months	A
8	Comprehensive Evaluation		Recommendation of JICA Study Team + Major advantages of Option3 are as follows; The total construction cost of Line 2 is lower than Option3-1, although the cost in 1st phase is higher . The many risk for construction and operation of Line 1 and Line 2 could be declined. - Major disadvantages of Option3 are as follows; The completion timing of line 1 (CP-1) will be delayed for just only 4 months to compare with option3-1. (The timing of commercial operation might not be delayed by adjusting to CP-3 works)	A	Not Recommended + Major advantages of Option 3-1 are as follows; The completion timing of line 1(Cp-1) could be 4 months earlier than Option-3. (It does not mean that the timing of commercial operation could be earlier than Option-3) - Major disadvantages of Option 3-1 are as follows; There are many risks for construction and operation of Line 1 and Line 2. The total construction cost of Line 2 is higher than Option 3.	B

"A" : EXELENT
"B" : GOOD
"C" : BAD

As shown in the comparison table, in case of Option 3-1 (the construction of the partial Line2 station structure beneath the Line1 only) there are many risks. Since the construction of Line 2 station in 2nd phase is adjacent to Line 1 station, the risk is higher for the settlement of Line 1 station and/or the uplift due to the soil improvement works. And due to the demolition of diaphragm wall in 2nd phase, there are some risks that Line 1 station structure could be damaged. In addition, there is some risk that the vibration and the noise caused by Line 2 construction adjacent to Line 1 station would have bad influence on Line 1 train operation in the 2nd phase construction. And the accessibility for the Line 1 station is restricted by the construction of Line 2 station. The bad influence is not only on Line 1 station but also for Line 2 station which should be considered. During the construction period in 2nd phase, it is impossible for the 2nd phase diaphragm wall to be connected with the 1st phase wall completely; therefore the risk is high for water leakage and discharging of background soil from this joint. Furthermore, there is higher risk for water leakage on Line 2 station structure from the construction joint between 1st phase and 2nd phase.

On the other hand, in case of Option3 (the construction of the whole Line 2 station structure at the same timing as Line 1's) these above mentioned risks are low. Therefore, the safe construction and operation could be ensured.

From the other view point, if the donor for the Line 2 station is different from Line 1 station in case of Option3-1, the different fire prevention design standard could be applied in one central station. Therefore the planning and the design of Ben Thanh Central Station are anticipated to become difficult and complicated. As for the construction cost, the phased construction is a little more expensive than the unified construction. The advantage of Option 3-1 is that the completion of civil construction of Line 1 is 4 months early to compared with Option 3. However, by adjusting the E&M work schedule for the railway, Option 3 does not have many disadvantages for the timing of Line 1 commercial operation.

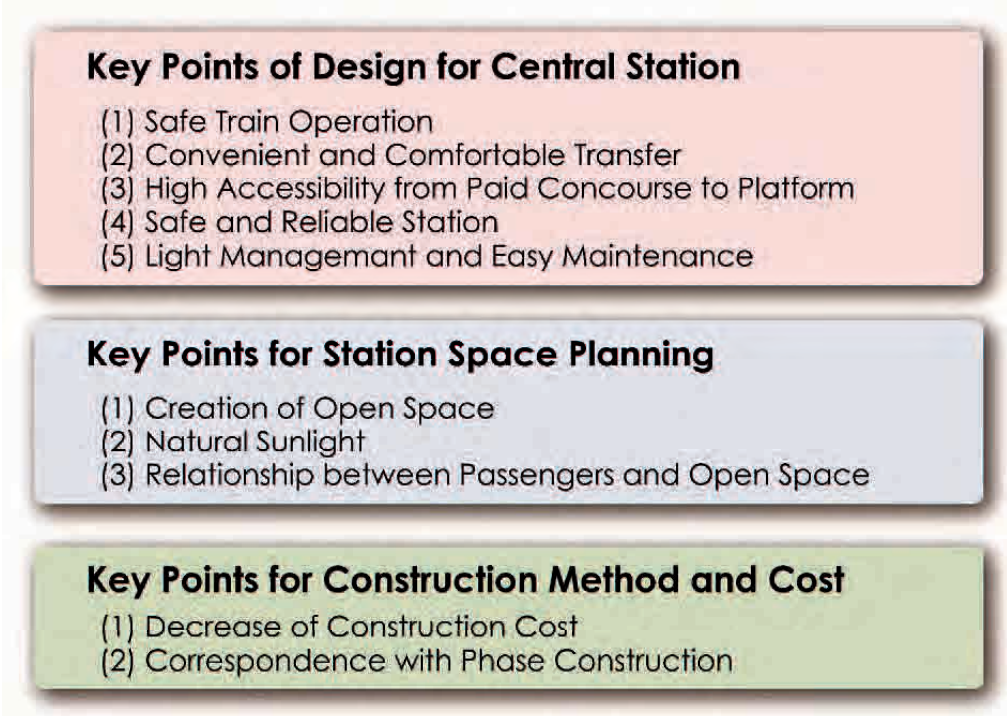
Through above mentioned comparative study, Option 3 (the construction of the whole Line 2 station structure at the same timing as Line 1) is recommended. Regarding this comparative study, in the consultation with MAUR, JICA and consulting team of Line 1, it has come to the conclusion that the same timing construction of Line 1 and whole Line 2 station structure is desirable, from the technical viewpoints. Therefore, in this survey, the whole station structure of Line 2 is constructed in 1st phase in case of phased construction.

3) Policy for planning of joint Ben Thanh Central Station

Since there are three platforms for 4 UMRT Lines 1, 2, 3a, and 4 in Ben Thanh Central Station, the planning of this central station should be comprehensive and convenient for the passengers to transfer from one platform to another. Therefore, the planning of the compact station is necessary as the platforms of UMRT lines are placed closely. On the other hand, considering that this central station is located in the center of Ho Chi Minh City, it is preferable to create the attractive and comfortable urban space with the large open space and the big atriums. Thus, Ben Thanh Central Station planning needs to take into account these two requirements.

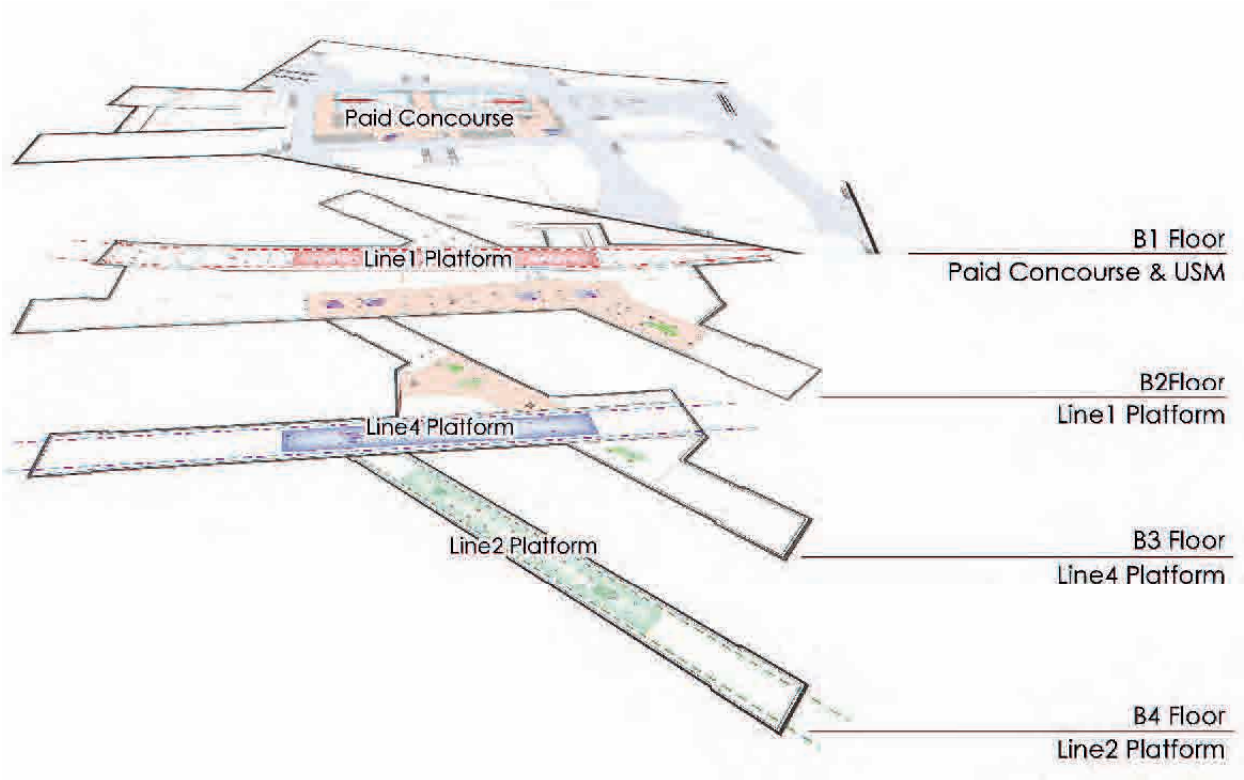
Fegure4.14 Concept for the design of Ben Thanh Central Station

In this project, the planning of the smooth transfer has the first priority. Next is the planning for an attractive urban space, which is suitable for the center of Ho Chi Minh City. Furthermore, in consideration of phased construction, the key points of the planning are determined as follows.



Fegure4.15 Key Points for design of Ben Thanh Central Station

In Ben Thanh Central Station,, the platform of Line 3a is same as Line 1 because Line 3a is an extension of Line 1, therefore there are three platforms for 4 UMRT Lines which are planned to be placed closely. Through this planning of the platform location, the smooth transfer among three platforms is ensured. This basic layout of UMRT Line platforms and the paid concourse in Ben Thanh Central Station are shown below based on to the information of UMRT Lines from MAUR. As shown Figure4.16 Ben Thanh Central Station will have four basement floors.



Fegure4.16 Basic Layout of Ben Thanh Central Station

For reference, the station layouts of three major subway transfer stations in Japan (Kasumigaseki Station, Ginza Station, and Otemachi Station) are shown in Figure4.17, with a diagram of the same scale as Ben Thanh Central Station. According to this figure, Ben Thanh Central Station has much more convenience for transferring from one platform to another.

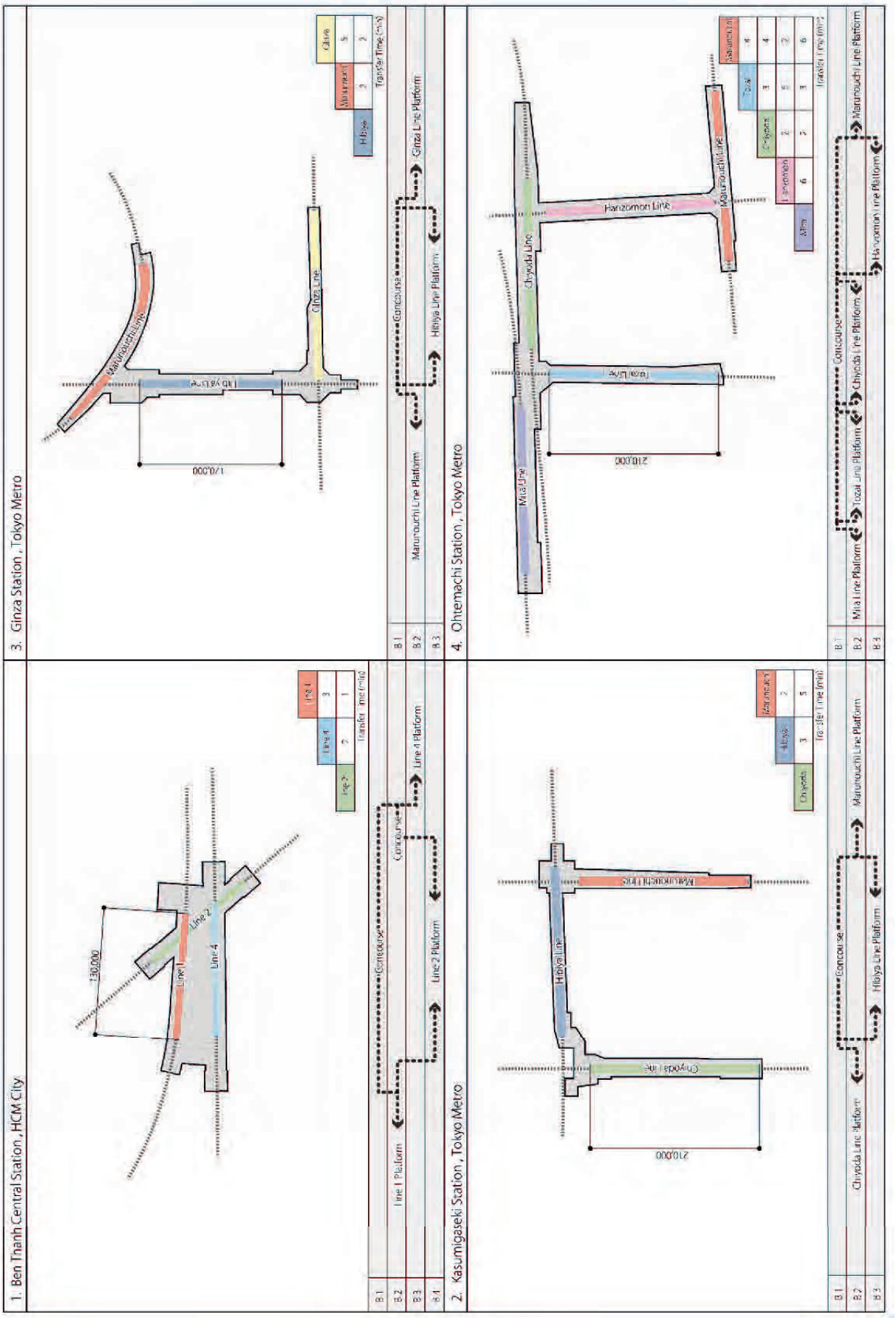


Figure 4.17 Comparison of platform layout with major subway stations in Japan