

3.3 Proposed Improvement Measures for Delhi Metro Intermodal Function

The selected four (4) Delhi Metro stations, representing four (4) typical groups, were studied to identify possible directions of the improvement of their intermodal transfer functions/systems as follows.

3.3.1 Suburban – Regional Center Station (**Shahdara Station**)

There are 24 stations that can be categorized as “Suburban–regional center stations”. Among them, Shahdara Station is selected as a representative of this station type, that is, a station located in the regional center in suburban areas. This station requires comprehensive development with an integrated bus terminal.

(1) Current Issues Identified from the Survey of Existing Conditions

On observing the usage of the station plaza, it is found that transfer between train and bus is inconvenient. The bus station is located away from the station, because private car parking areas and motorcycle parking areas are located on both sides of the pedestrian entrance in the front of the station. The bus terminal for feeder mini-bus is not build, so the passengers use road side of the arterial road for loading and unloading. These boarding activities create an obstacle of drive lanes that become a course of traffic congestions during rush hours. Rickshaws, which are used by many passengers, stay on the road spaces around the station.



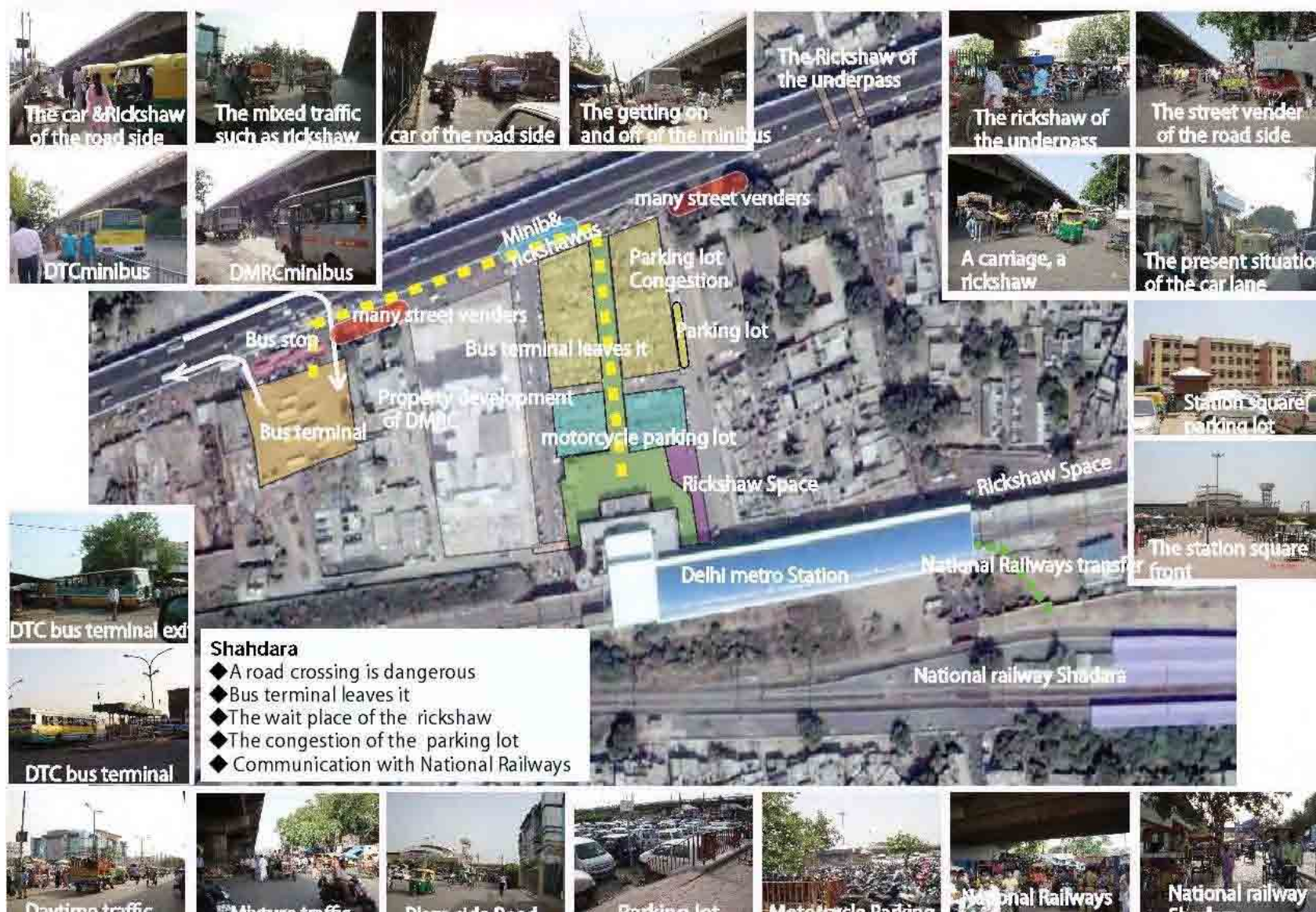
(2) Proposed Measures for the Improvement of the **Shahdara Station**

Physical problems and identified planning issues against a convenient transfer system are summarized in Table 3.3.1. This table also indicates proposed ideas on how to improve the station. The Improvement is proposed in a phased manner: Phase 1 and Phase 2, as follows.

Table 3.3.1 Issues and Measures for Improvement of the Shahdara Station

	Overall Intermodal Functions	Station Facilities	Pedestrian Facilities	Bus Facilities/Services	Taxi/Auto/Rickshaw	Private Vehicle Facilities/Parking	Indian Railway Facilities/ Services
Site Observation	It has a station plaza and connections with various transfer modes.		It is dangerous to cross the road.	Bus terminal is located far from the station due to the land limitation.	Rickshaws standby beside roads to railway station.	Car and motorcycle parks are always congested.	
Findings from Questionnaire Survey			<ul style="list-style-type: none"> - There are requests for installation of roofs (including green shelters), moving walkways for pedestrian passages to be used for transfers, etc., partly because walking distance between the station and the access modes tends to be long. - Over half of requests of pedestrian facilities made by Metro users transferring to/from DTC bus are especially concentrated on safe pedestrian crossing facilities. 	<ul style="list-style-type: none"> - Improvement needs of bus facilities/services take up half of the total improvement needs for both Metro users and non-Metro users. - Major improvement need is for bus services such as new feeder bus routes, and more frequent and punctual bus services. - Requests that are related to further enhancement of the convenience are remarkable including shorter bus stop intervals, construction of bus shelters (including waiting facilities and information boards), introduction of a common Metro-bus card system, and synchronized Metro-bus operation. 	<ul style="list-style-type: none"> - Metro users request more space for an auto rickshaw/ rickshaw stand. 	<ul style="list-style-type: none"> - Many non-Metro users request more private vehicle facilities/parking. - While motorcycle park & ride users often request expansion of motorcycle parks, car parks, and bicycle parks, car park & ride users request expansion of car parks only. - There are also significant shares of requests for parking restriction against non-Metro users, pick-up/drop-off space for private vehicles, closer connection between parking facilities and the station. 	<ul style="list-style-type: none"> - There are many requests for improvement of the railway service such as frequency and punctuality. - Enhancement of intermodal functions between railway and the Metro is also requested such as shortcuts to transfer by a dedicated passage and synchronized Metro-rail operation.
Improvement Measures	<ul style="list-style-type: none"> - Signal control of traffic around the station - Readjustment of facility layouts in the station plaza - Coordination among different transport modes - Common smart card system with bus and railway 	<ul style="list-style-type: none"> - Additional security check lines, etc. 	<ul style="list-style-type: none"> - Comfortable pedestrian passage connecting with railway station and bus terminal (green shelter) - Pedestrian crossings and signals 	<ul style="list-style-type: none"> - Extension of bus services into station plaza and construction of bus bay - New feeder bus routes - Coordination of timetable with the Metro 	<ul style="list-style-type: none"> - Relocation of standby space for taxi, auto, and rickshaw 	<ul style="list-style-type: none"> - Parking garage - Parking restriction against non-Metro users without smart card - Space for pick-up/drop-off 	<ul style="list-style-type: none"> - Improvement of railway station facilities - More frequent and punctual railway services - Coordination of timetable with the Metro
Examples of Improvement	<ul style="list-style-type: none"> - Rearrangement of flows of access traffic to station plaza and readjustment of connections to the trunk road - Example of layouts for access transport facilities in station plaza (Nagaoka) - Renovation of the station by adding sub-center functions and commercial facilities - Cases of Pasmu, Suica, etc. 						

Figure 3.3.1 Issues for Improvement of the Shahdara Station



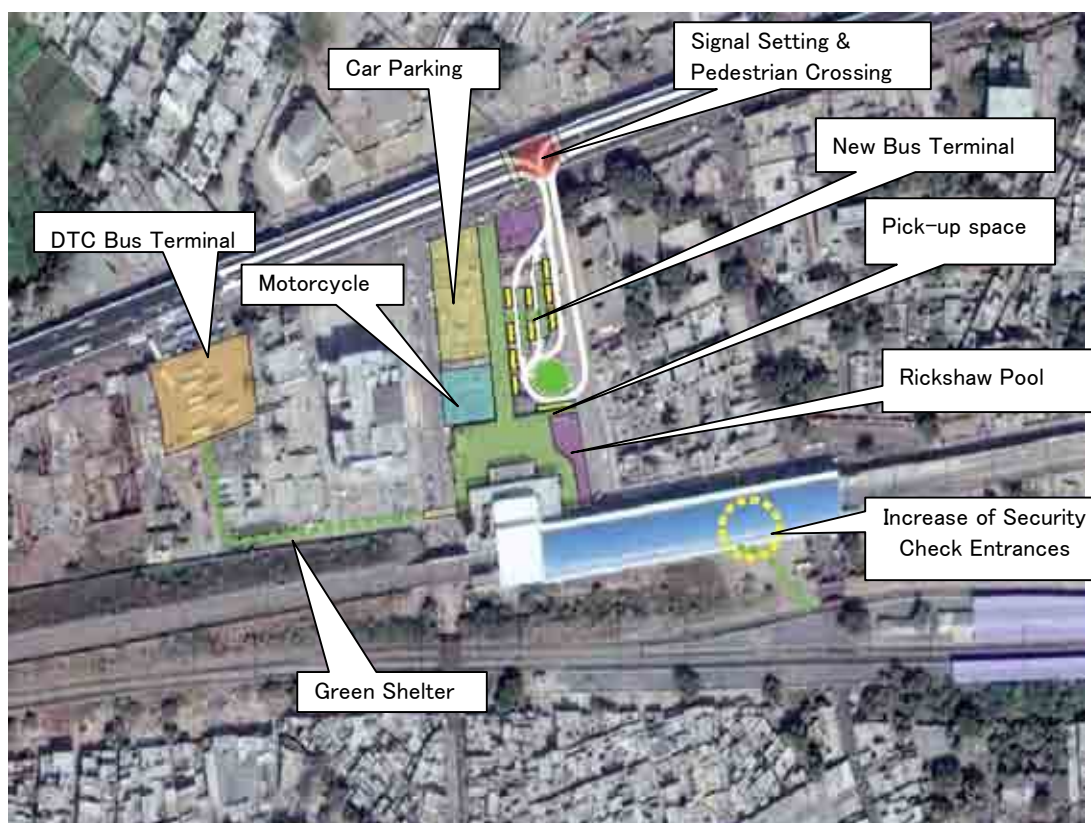
Short-term Measures

Based on the Interview Survey, it is identified that the most significant priority issue is to improve the connectivity with feeder bus services, as the existing bus terminal is located about 300 meters far from the Shahdara Station. More than half of respondents pointed out the needs of improvement of pedestrians' safety and comfort levels. Thus, the short-term improvement shall include these measures at least and some other physical improvement of intermodality, including the proposed ideas as follows (see Figure 3.3.1):

- In order to improve the connectivity with the bus and Metro services, the space for car parking adjacent to the station be partially converted to a terminal for the bus, including the installation of pedestrian's crossings and signaling systems on the arterial road to/from the Station;
- The pedestrian path to/from the existing bus terminal (DTC's facility) be improved with shelter (green shelter) for more comfortable access to the Station;
- Passengers' drop-off/pick-up apron for cars and motorcycles be placed in front of the Station;
- Rickshaw pools be collectively placed to mitigate traffic congestions; and
- The number of windows/entrances for ticketing and security checking be increased to mitigate congestions at peak hours.

Figure 3.3.2 Proposed Improvement Directions of the Shahdara Station

Phase 1: Short-term Actions



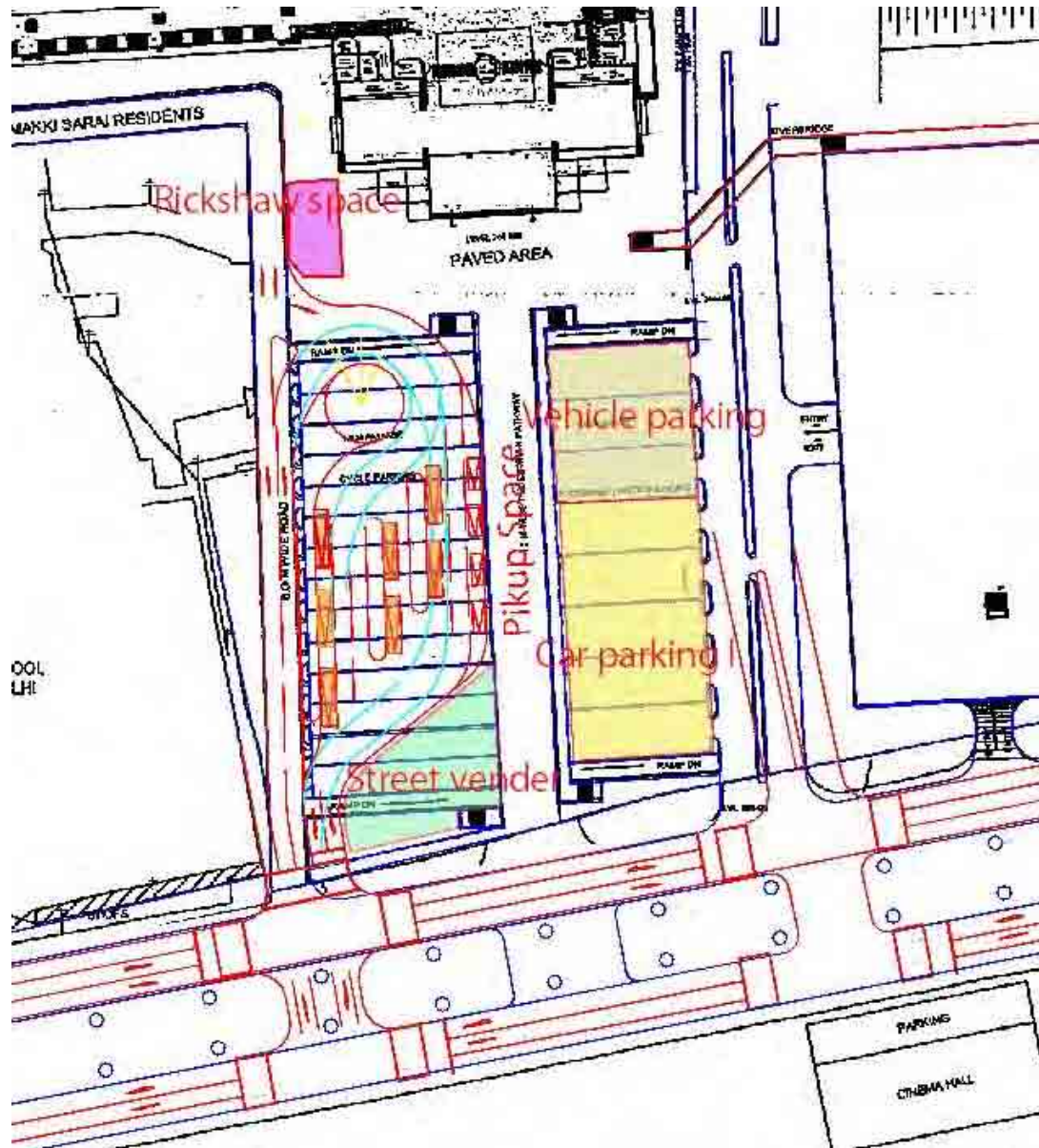
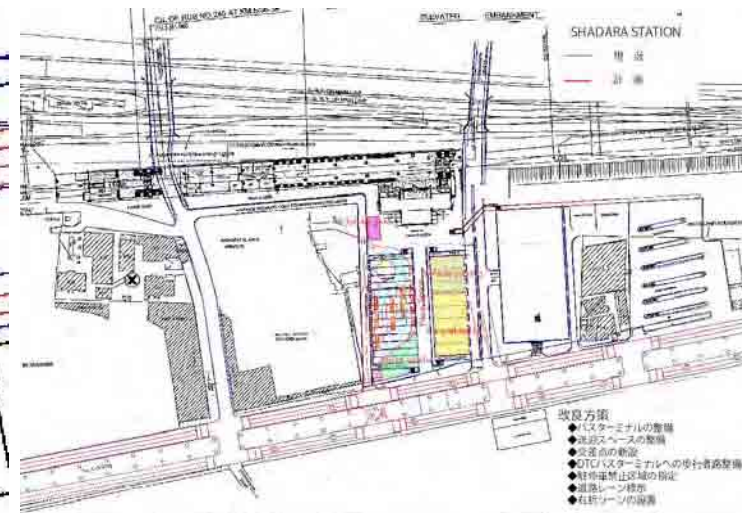


Figure 3.3.3 Short-term Actions – Road indication example



Medium- and Long-term Measures

The Station Plaza should be designed and redeveloped in such a way that usages of public transportation modes are given priority with the following measures (See Figure 3.3.2):

- Expansion of the bus terminal facilities and taxi/Rickshaw pools;
- Expansion of temporary parking space and drop-off and pick-up aprons; and
- Construction of a Multi-storey Car Parking Building.

Phase 2: Medium- and Long-term Actions



Source: JICA Study Team

(3) Example of Improvement Measures

Many examples of station plaza development can be seen in Japan Railway stations. Nagaoka Station is one of the cases, as an example to rectify the flow of vehicles by mode, to separate the flow of buses, taxis and private cars, and to divide entrances and exits of vehicles. The number of passengers is 22,725 people per day and the area size of the station plaza is 12,000 m². Bus terminal is connected by the underpass with the station as well as between each bus platform.

3.3.2 Suburban Station (Janak Puri West Station)

Janak Puri West Station is an elevated railway station above a road in the suburban area. It does not have a station plaza, has no parking areas but offers feeder bus services. Surrounding area development is not planned by DMRC. The station is a representative of the suburban station in station type. Besides Janak Puri West Station, there are 16 other similar stations in station type.

Janak Puri West Station requires development of spaces for a feeder bus station, private car, auto and cycle Rickshaw parking spaces and other terminal facilities, because it is a station used by many commuters to central areas.

(1) Issues from the Survey of Existing Conditions

At the Janak Puri West Station, there is a space to set up bus bays, next to the elevated railway station. However, the rickshaws go where there are waiting customers. In this case, it is under the elevated railway station and they become obstacles to the flow of traffic. They even wait around bus bays and become an obstacle in the driving lanes of an arterial road. Especially, during peak hours, rickshaws overflow to the driving lanes, mixing with route buses that load and unload passengers on the street, and this causes traffic congestions. The parking areas adjacent to the Delhi Metro station are full of motorcycles and private cars.



Rickshaws pool under the elevated railway track

Because the station is set up on an arterial road, passengers change transport modes between the Metro on the arterial road, so keeping spaces for bus bay and rickshaw parking lots is necessary in order not to block the driving lanes.



Congested motorcycle parking under the elevated railway track

To develop necessary facilities in front of the station is required by re-development of station and its entire area, because the station is located in the build-up area and securing new spaces is difficult. The findings above are summarized in Table 3.3.2.

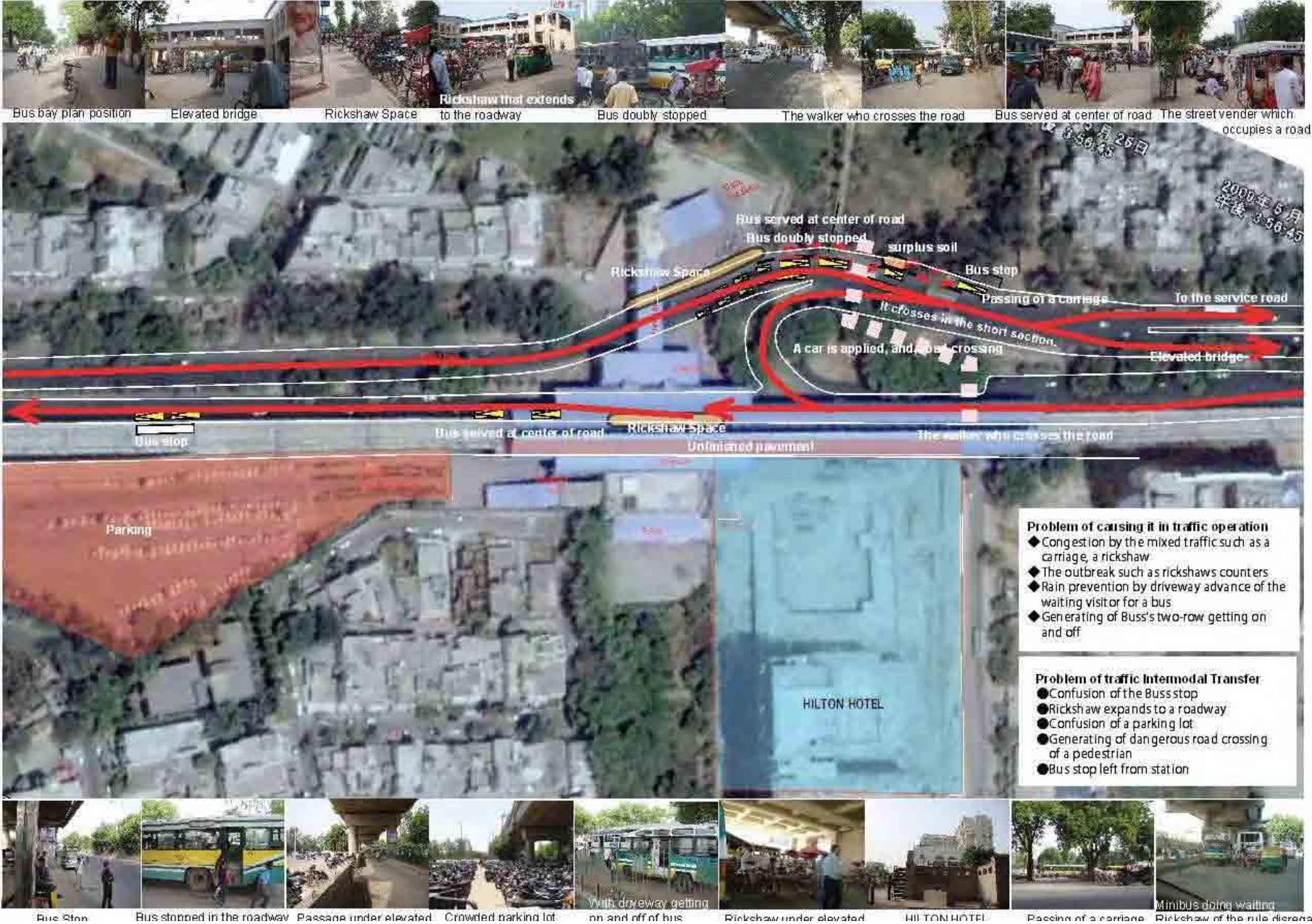


Rickshaw space

Table 3.3.2 Issues and Measures for Improvement of the Janak Puri West Station

	Overall Intermodal Functions	Station Facilities	Pedestrian Facilities	Bus Facilities/Services	Taxi/Auto/Rickshaw Facilities	Private Vehicle Facilities/Parking
Site Observation	Though it is a medium-scale station with feeder bus services as well as parking facilities, it has no station plaza and hence it is considered that facilities/services of each access transport mode need to be improved.		It is dangerous to cross the road.	While DMRC feeder buses stop close to the station, DTC buses stop at the bus bay located at the frontage road which is far from the station.	Rickshaws wait for passengers on the trunk road, causing traffic congestion.	Car and motorcycle parks are congested and need to be expanded.
Findings from Questionnaire Survey		<ul style="list-style-type: none"> - The share of Metro users who are dissatisfied with station and pedestrian facilities is greater than those of other stations. - There are requests for additional security check lines, automatic ticket vending machines, and waiting facilities such as benches. 	-While the station has an elevated structure over the trunk road, there is no passage available through the station. Thus, there are requests for pedestrian facilities.	-The majority of requests made by Metro users are related to bus facilities/services such as new feeder bus routes, increase in service frequency, and improvement in punctuality.		<ul style="list-style-type: none"> - Private vehicles take up about 30% of total access modes which is relatively large. - Improvement needs about private vehicle facilities/parking are relatively large especially among non-Metro users. - Major requests for improvement include expansion of the car and motorcycle parks, provision of pick-up/drop-off space, parking restriction against non-Metro users, etc.
Improvement Measures	<ul style="list-style-type: none"> - Separation of flows of access traffic to station from trunk road traffic - Coordination among different transport modes 	- Additional security check lines, waiting facilities, etc.	-Free pedestrian passage (with escalators) in the station	<ul style="list-style-type: none"> -New feeder bus routes -More frequent bus services -Shorter bus stop intervals -Coordination of timetable with the Metro -Bus bays and shelters 	<ul style="list-style-type: none"> - Rules for using standby space for rickshaws - Securing space for auto rickshaw and rickshaw pools 	<ul style="list-style-type: none"> - Parking restriction against non-Metro users without smart card - Parking garage - Securing pick-up/drop-off space and enforcement of regulations
Examples of Improvement	<ul style="list-style-type: none"> - Examples of securing space for station plaza through redevelopment, etc. - Examples of efficient use of station plaza - Cases of commuter railway stations - Moriguchi Station, Suita Station 					

Figure 3.3.4 The trouble spots of the present situation around Janak Puri West Station



(2) Proposed Measures for Improvement of the Janak Puri West Station

According to the result of the Interview Survey, the backwardness of the bus services was also pointed out by many respondents for the Janak Puri West Station as well. Thus, main issue for this station is to improve the feeder bus system so as to assure the smooth and efficient intermodal function.

Short-term Measures

To keep smooth traffic flows on the arterial road, there is a high demand to create spaces for bus bays and rickshaw parking lots. The following physical improvement is recommended to be carried out (see Figure 3.3.3):

- To develop bus stops (bus bays with shelters) by using the land owned by DMRC and the right of way of adjacent roads;
- To expand the Rickshaw pools by using the DMRC-owned land;
- To locate a free pedestrian path connecting the north and the south entrances of the Station; and
- To place a drop-off/pick-up apron attached to the Station.

Figure 3.3.5 Proposed Improvement Directions of the Janak Puri West Station

Phase 1: Short-term Actions

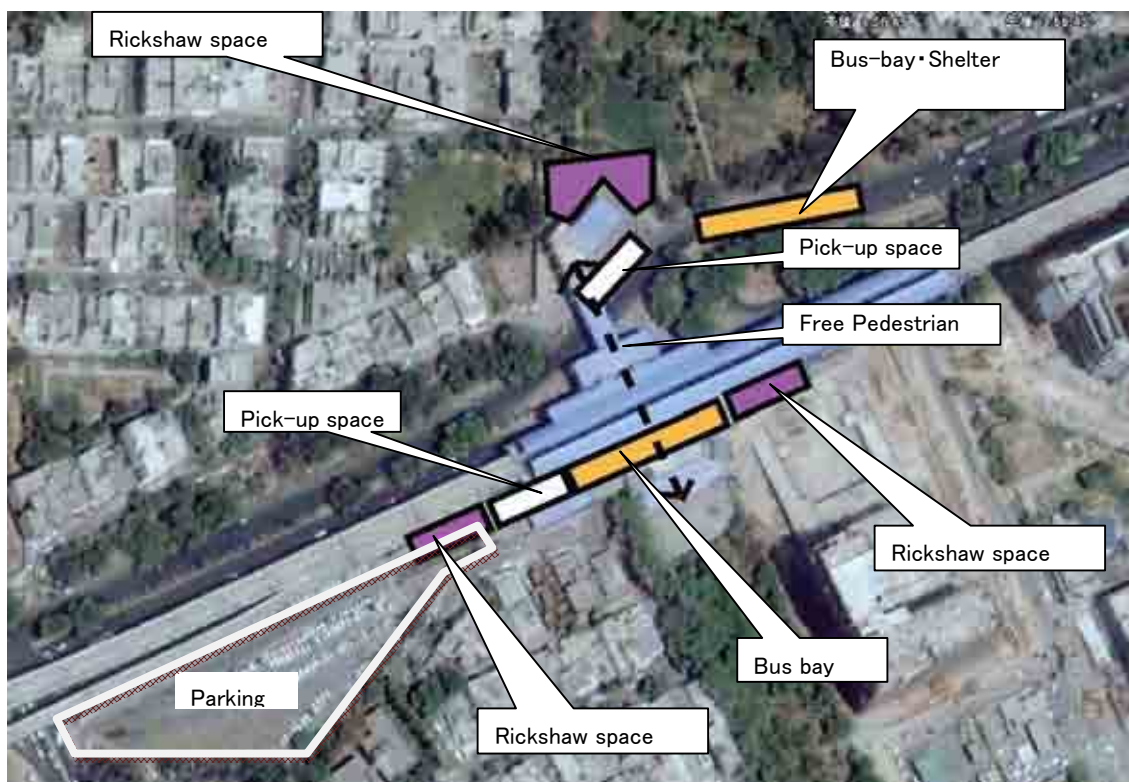
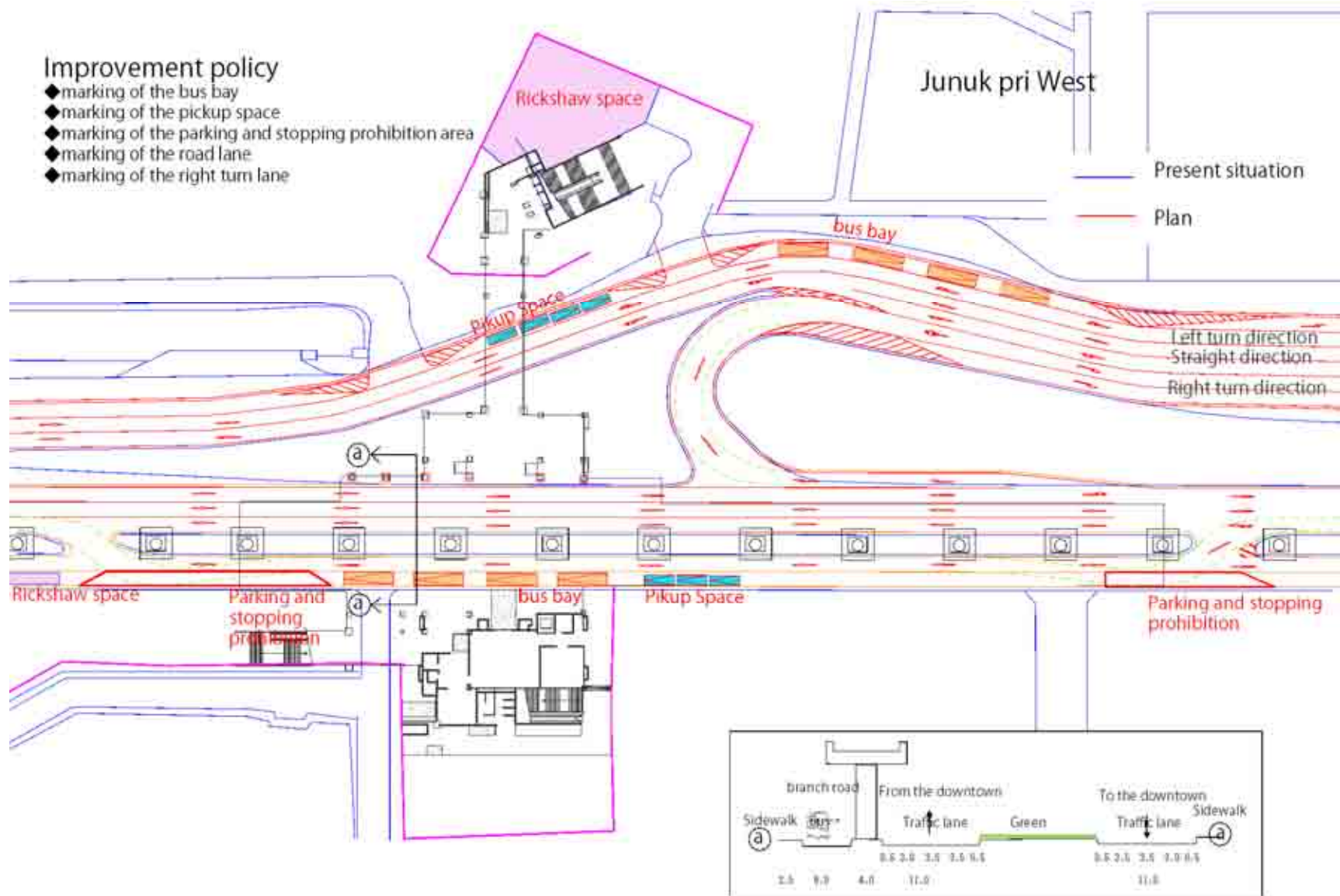


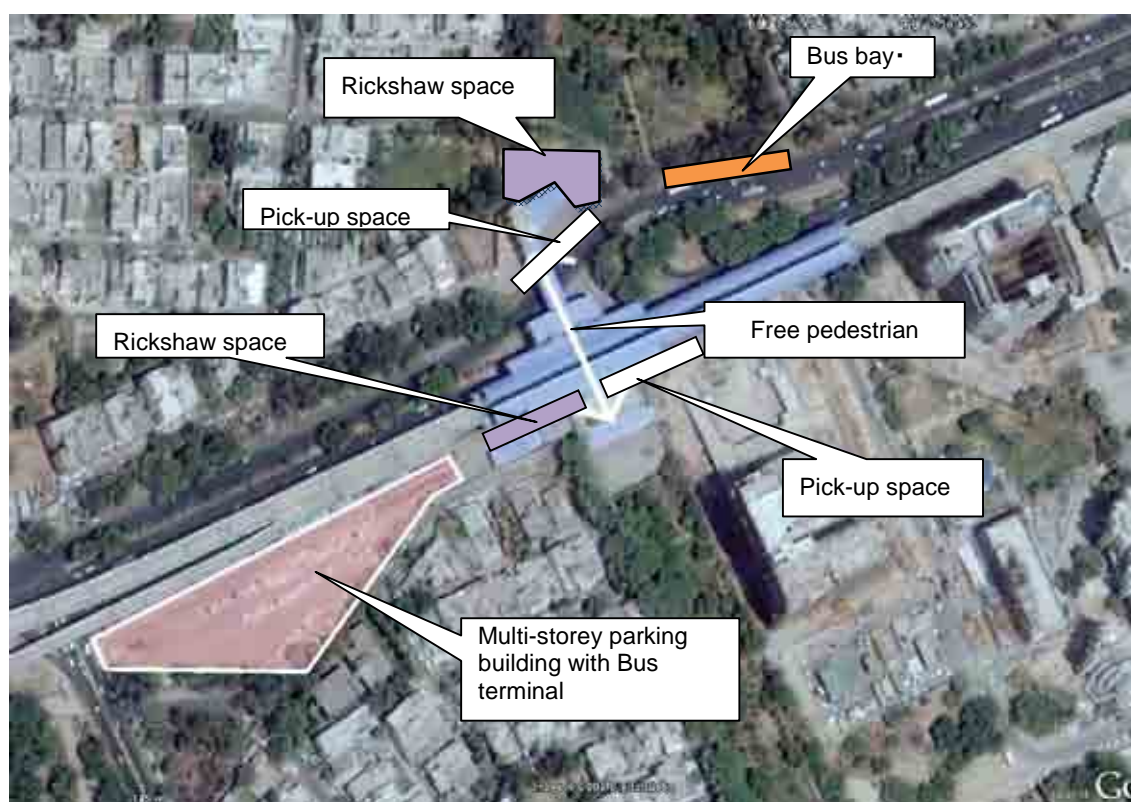
Figure 3.3.6 Short-term Actions—Road indication example



Medium- and Long-term Measures

A comprehensive bus terminal with fully functioning feeder services needs to be developed at this station, taking into account the need highly requested by Delhi Metro users. To this end, the existing vehicle parking area, of which the land belongs to DMRC, is recommended to be converted to a multi-storey parking building where a bus terminal and commercial facilities shall be located. Even though this project will require a considerable amount of investment, such an intensive use of the limited land will made the investment feasible.

Phase 2: Medium- and Long-term Actions



(3) Example of Improvement Measures

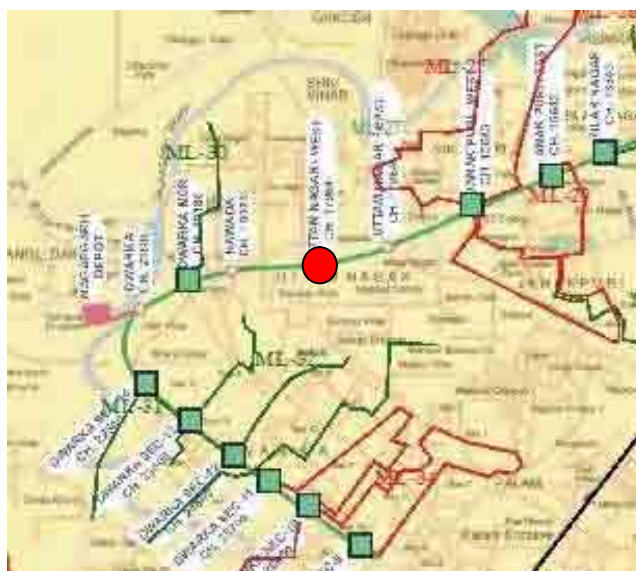
A number of examples of the comprehensive station development can be seen in Japan Railway stations such as Moriguchi Station and Suita Station, which are provided a vertical structure to the intermodal system.

3.3.3 Suburban Station (**Uttam Nagar West Station**)

This is an elevated railway station above a road located in the suburban area. There are no station plaza and feeder bus services, but vehicle parking lots are available. This is a representative of the stations without surrounding area development by DMRC. Eight (8) other stations belong in this type.

(1) Issues from the Survey of Existing Conditions

The roads around the Uttam Nagar West Station are not developed enough, so there are no feeder bus services available. Passengers who cannot commute on foot between homes and this station use Sector 12-14 stations traveling by feeder bus. Improvement of the access roads conditions, along with development of the station, will give a great impact on the promotion of the station use. Thus, it is required to implement road development projects around the station, including improvement of access roads to the station. It is also necessary to consider changing the local bus routes around the station and to introduce feeder bus services at the station. According to the opinion survey results, the demand for the feeder bus service is very high because users of the Uttam Nagar West Station are mostly pedestrians. However, based on the observation of the road conditions around the station, there are no good roads that can allow a bus to run, so feeder bus routes are not developed. An area improvement project around the station to enhance access roads to the station is needed. The findings through the surveys are summarized in Table 3.3.3.



No direct feeder bus services are available to/from the Uttam Nagar West Station

(2) Proposed Measures for Improvement of the Uttam Nagar West Station

The Uttam Nagar West Station needs a comprehensive development project of the station, including development of access roads, station plaza and the areal development around the station. Development of the intermodal functions of urban railways needs not only development of Metro-related facilities but a more comprehensive development that includes road network development around the Station and feeder bus system.

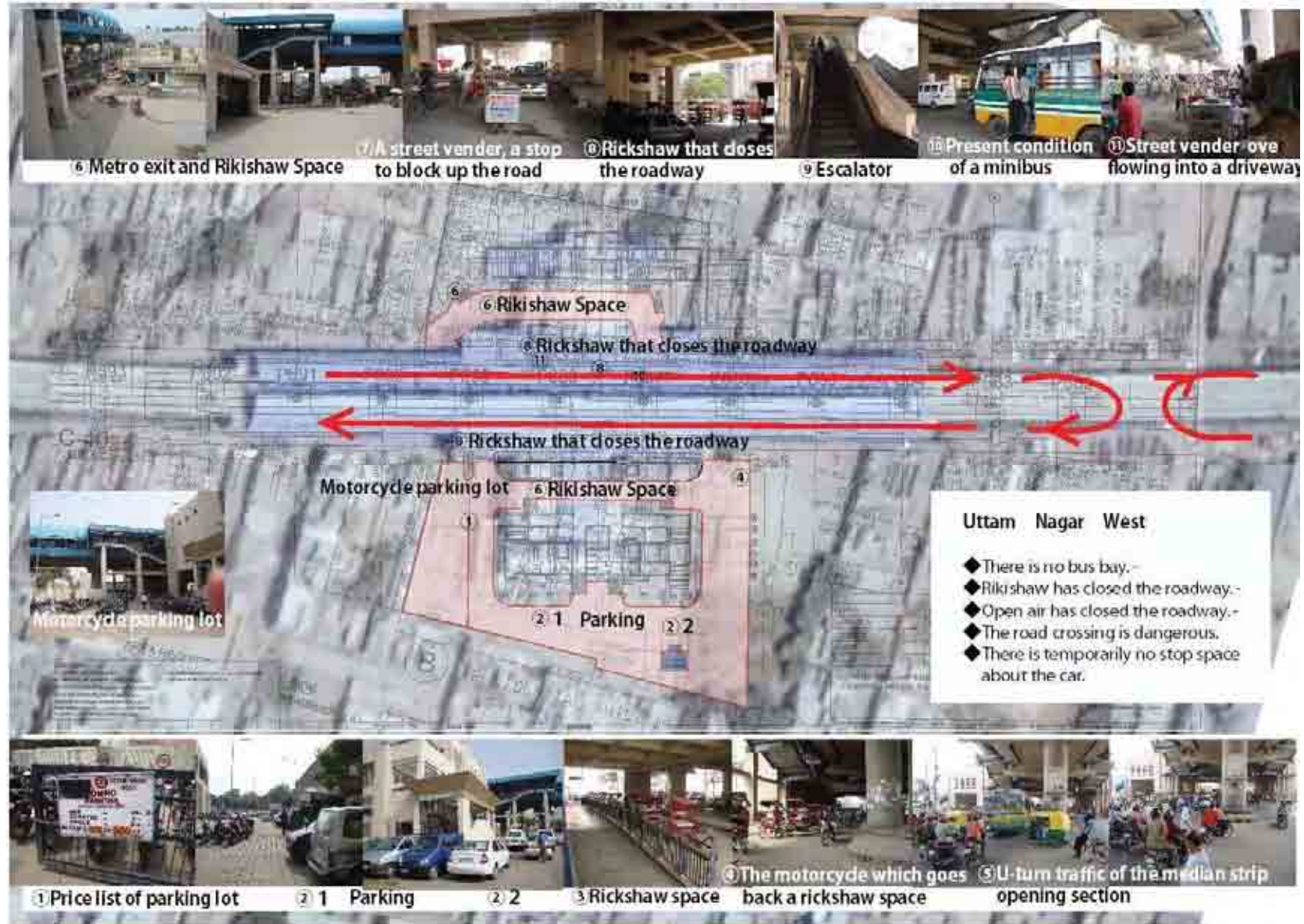


Rickshaws pool under the elevated railway track

Table 3.3.3 Issues and Measures for Improvement of the Uttam Nagar West Station

	Overall Intermodal Functions	Station Facilities	Pedestrian Facilities	Bus Facilities/Services	Taxi/Auto/Rickshaw Facilities	Private Vehicle Facilities/Parking
Site Observation	It has no station plaza, and feeder bus services and parking facilities are also non-existent. Available services and facilities for access transport are thus limited to walking, rickshaw, etc.		In spite of the large number of pedestrians, pedestrian facilities are insufficient, and it is dangerous even to cross the road.	Since there are no access roads available for buses, feeder bus routes are non-existent.	Though there are rickshaw pools, rickshaws encroach into the trunk road, causing congestion.	There are no parking facilities.
Findings from Questionnaire Survey	<ul style="list-style-type: none"> - 80% of Metro users access the station by walking and the remaining are likely to use rickshaws. - Non-Metro users also pointed out dissatisfaction with intermodal transfer functions rather than travel cost. 			<ul style="list-style-type: none"> - The share of complaints about bus facilities/ services is overwhelmingly large among both Metro users and non-Metro users. - Though new (feeder) bus services are requested as an access mode to the station, the roads are currently not wide enough for buses to pass through the urban areas around the station. 	<ul style="list-style-type: none"> - Metro users request more pick-up/drop-off space of rickshaws, which are virtually the only access transport mode available. 	<ul style="list-style-type: none"> - Taxis and auto rickshaws are often used as an access mode. - Improvement needs for taxis and auto rickshaws take the largest share among Metro users, including providing taxi bays, securing space for pick-up/ drop-off, etc.
Improvement Measures	<ul style="list-style-type: none"> - Development of access roads - Establishment of a “District Redevelopment Council” to secure the space for station plaza through redevelopment - Coordination among different transport modes 		<ul style="list-style-type: none"> - Free pedestrian passage (with escalators) in the station 	<ul style="list-style-type: none"> - Provision of feeder bus terminals and services - Construction of access roads for buses through a land readjustment project. 	<ul style="list-style-type: none"> - Securing space for rickshaw pools - Alleviation of congestion by regulating the usage of standby space for rickshaws - Securing space for auto rickshaw pools 	<ul style="list-style-type: none"> - Parking garage for bicycles and motorcycles - Construction of car parks and access roads - Securing pick-up/drop-off space
Examples of Improvement	<ul style="list-style-type: none"> - Examples of community development around stations - Cases of developing small squares in urban areas 					

Figure 3.3.8 Issues for Improvement of the Uttam Nagar West Station



Short-term Measures

The first priority should be given to the following items (see Figure 3.3.5):

- Development of Rickshaw pools in the north and the south gates of the Station in association with rules and regulations on usage of the space;
- Installation of an elevated free pedestrian passage connecting with both gates;
- Placement of a car drop-off/pick-up apron at both gates; and
- Construction of elevated bicycles/motorcycles parking facilities.

Figure 3.3.9 Proposed Improvement Directions of the Uttam Nagar West Station

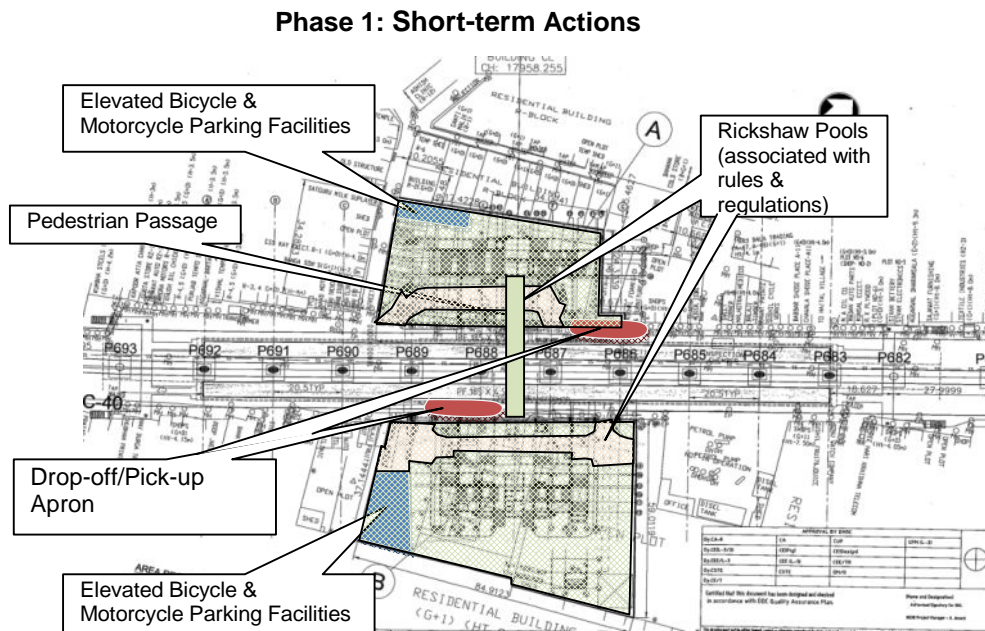
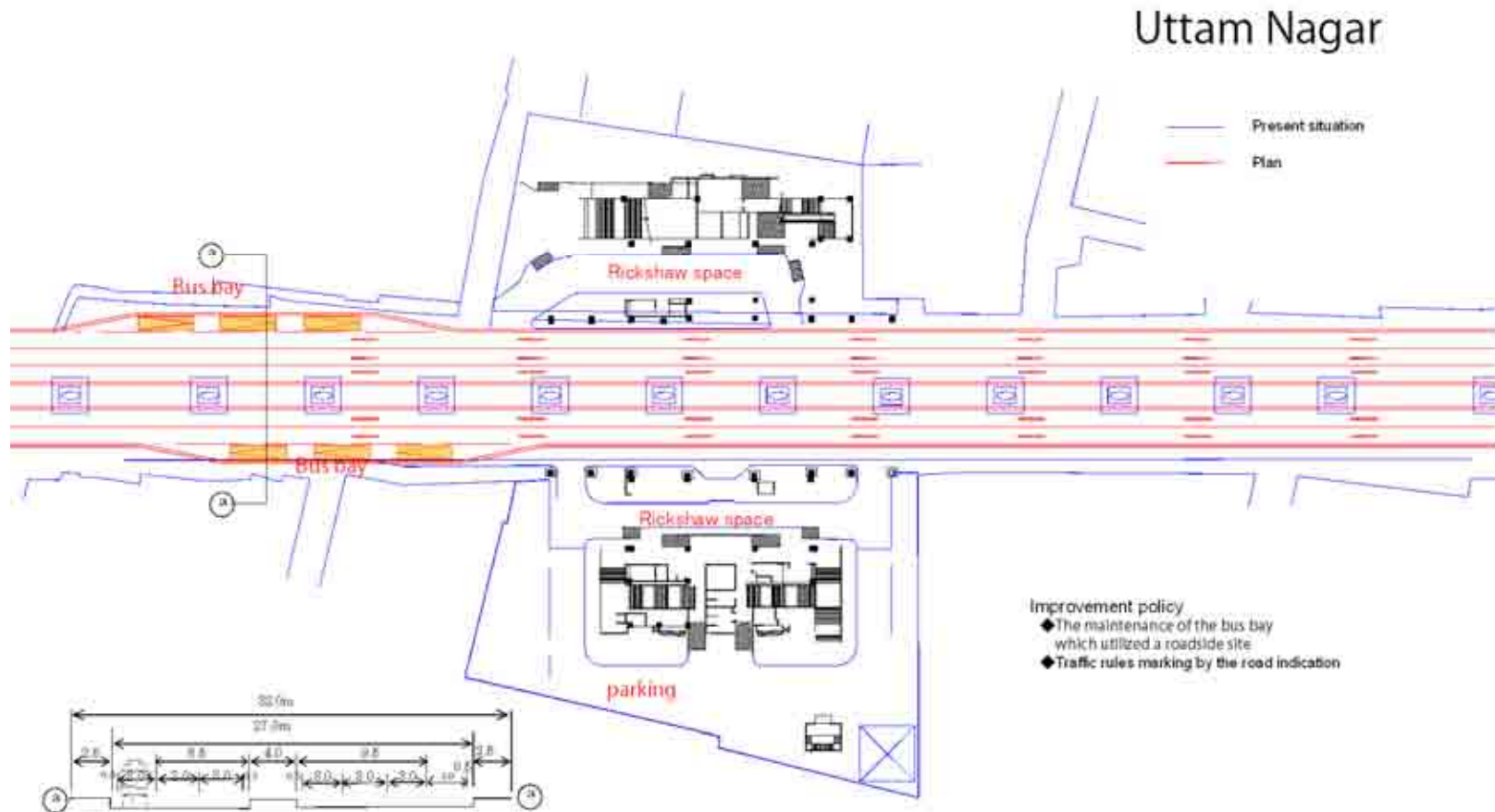


Figure 3.3.10 Short-term Actions—Road indication example

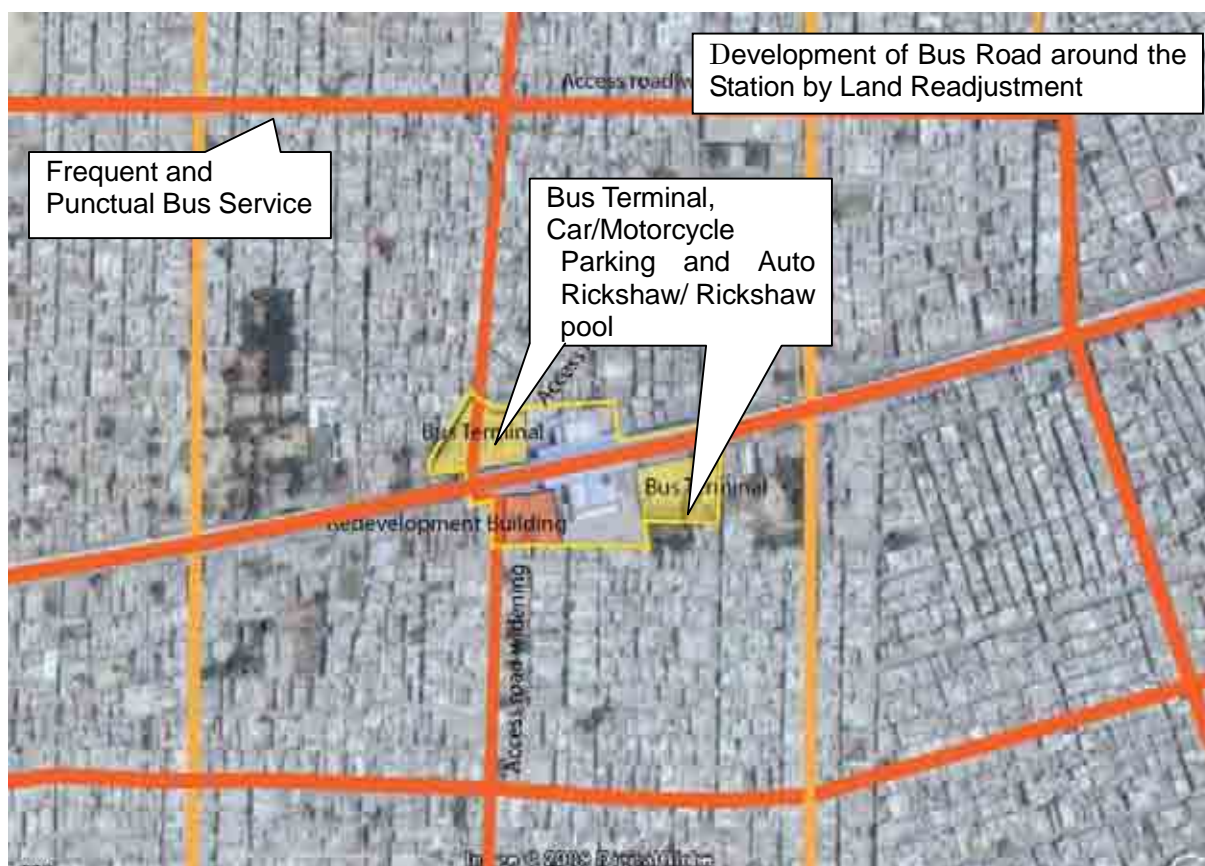


Medium- and Long-term Measures

There exist a number of constraints against development of intermodal facilities at this station, that is, no land space for a station plaza and no access roads for feeder bus services.

In the long-term, a comprehensive redevelopment project, including a station plaza and access roads to the station, is required under close coordination with the urban planning department of Delhi City. Also, coordination with different service providers, including route bus services, feeder bus services, taxi services, and auto and cycle rickshaw services, are very important, besides revising the legal system for the development of urban facilities. A proposed structure of the surrounding area redevelopment is delineated on Figure 3.3.6.

Figure 3.3.11 Proposed Improvement Directions of the Uttam Nagar West Station
Phase 2: Medium- and Long-term Actions



3.3.4 Urban Center Station in CBD (**Rajiv Chowk Station**)

Rajiv Chowk Station is a representative station that is located in the urban center, and the number of passengers increases steadily. Because the station is the intermodal point between Lines 2 and 3 in the urban corridor, it serves the largest number of passengers in the Delhi Metro System. The station is characterized by no station plaza, no parking spaces, no development plan around the station by DMRC, but feeder bus services are available. There are 17 other similar type stations.

(1) Issues from the Survey of Existing Conditions

Rajiv Chowk Station is located in the middle of the CBD in Delhi City. It will have the third line in the phase II and become a very important intermodal point of the three Metro lines. Especially, because Rajiv Chowk already has the function as a central park of the CBD, it will add a new transport hub function besides the function of a large public space. Currently the ground level is used for parks, the underground level is used for a shopping center, and the Metro station is located underneath the shopping center. Majority of users of the Metro are workers engaged in the business sector.



The entrance of the Underground Shopping Arcade

As the intermodal function of transportation, the use of private vehicles and Auto Rickshaws is allowed only in the inner ring road. For the public bus services, bus stations are located on the radial roads outside of the outer ring road. Because the bus stations are spread around the Rajiv Chowk, passengers have to walk a long distance to get a bus ride, and it is very difficult and frustrating for passengers to transfer from one bus to another and then learning that they have made a mistake. A good information system for bus station is required.



Surrounding area of the entrance of the Rajiv Chowk Station

Overall issues as mentioned above are summarized in Table 3.3.4.

Table 3.3.4 Issues and Measures for Improvement of the Rajiv Chowk Station

	Overall Intermodal Functions	Station Facilities	Pedestrian Facilities	Bus Facilities/Services	Taxi/Auto/Rickshaw Facilities	Private Vehicle Facilities/Parking
Site Observation	While it has no station plaza, the number of passengers who use this station is very large. While walk is the dominant access mode, there are also a variety of access modes and thus intermodal functions need to be enhanced.	The station is located under the ground, and integration with the adjacent shopping complex is important.	Locations to cross the outer ring road are limited.	As buses are prohibited to enter the inner ring road, the distance to transfer between Metro and bus is long.	Pick-up/drop-off of passengers is allowed on the inner ring road.	There are only private parking facilities, which are always congested.
Findings from Questionnaire Survey	<ul style="list-style-type: none"> - Metro users' level of satisfaction in terms of intermodal functions is relatively higher compared to that of suburban stations. - About 90% of passengers access the station by walking. 	<ul style="list-style-type: none"> - Since many passengers concentrate at this station, there are relatively more requests for additional security check and ticket vending facilities and equipment to reduce the queue of passengers. - As the platforms and trains are always crowded with passengers, alleviation of congestion is also requested. 		<ul style="list-style-type: none"> - The share of complaints about bus facilities/services is relatively small as compared to the suburban stations'. - In addition to the basic improvement needs for new feeder bus routes, more frequent bus services, and punctual bus services, accessibility between the station and the bus terminals located outside the ring road is an issue which is also related to pedestrian facilities. 	<ul style="list-style-type: none"> - Taxis and auto rickshaws are often used as access modes. Improvement needs for taxis and auto rickshaws take the largest share among Metro users, including providing taxi bays, securing space for pick-up/drop-off, etc. 	
Improvement Measures	<ul style="list-style-type: none"> - Urban complex integrated with commercial facilities and transportation terminals. - Coordination among different transport modes 	<ul style="list-style-type: none"> - Additional security check lines, etc. - Additional entrances/exits of the station - Integration of station facilities and commercial facilities 	-Additional pedestrian road crossing facilities (signals, subways, etc.)	- Enhancement of connectivity with the station through provision of several bus bays on the inner ring road by direction	- Provision of taxi bays and auto rickshaw bays	<ul style="list-style-type: none"> - Enforcement of regulations for pick-up/drop-off - Securing space for parking (transportation terminal)
Examples of Improvement	<ul style="list-style-type: none"> - Kyoto, Forum des Halles - Redevelopment of CBD stations 					

(2) **Proposed Measures for Improvement of the Rajiv Chowk Station**

Rajiv Chowk Station will be a multi functional railway station with a feeder bus terminal and parking spaces for a shopping center and business center on the underground level, keeping the parking space in the ground level as it is. To bring the bus terminal and car parking functions in the underground level, horizontal mobility switches to vertical movement and the distance of movement is shortened and comfort of the movement can be secured.

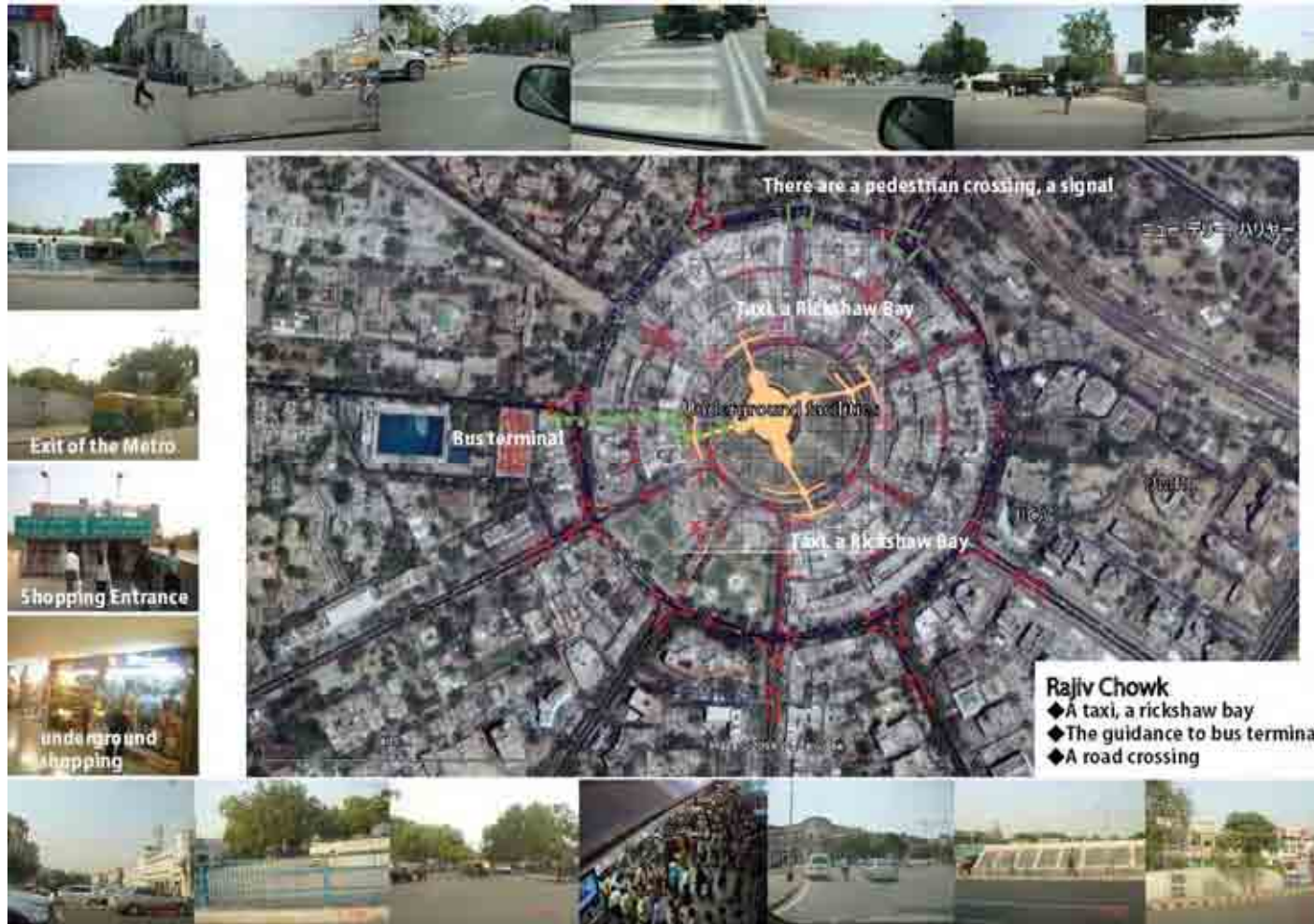
Short-term Measures

It is urgent to strengthen intermodal functions, including the following measures (see Figure 3.3.7):

- To alleviate passenger congestions at peak hours, because of less capacity in ticketing and security checking, by increasing the number of entrances;
- To expand feeder transport capacities of, in particular, taxis and auto-rickshaws, because majority of Metro users transfer to these modes;
- To place more pedestrian crossing facilities cum signaling systems for passengers' safety on the inner ring road; and
- To install a bus information system for feeder bus services which are available on the outer ring road.

Figure 3.3.12 Proposed Improvement Directions of the Rajiv Chowk Station

Phase 1: Short-term Actions

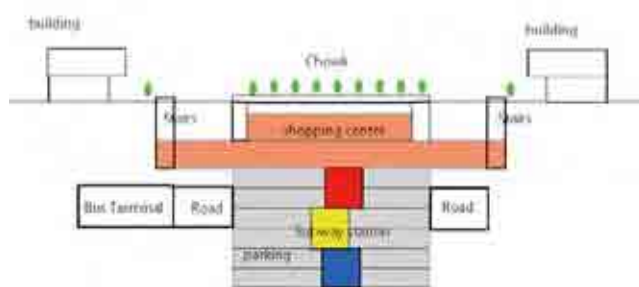
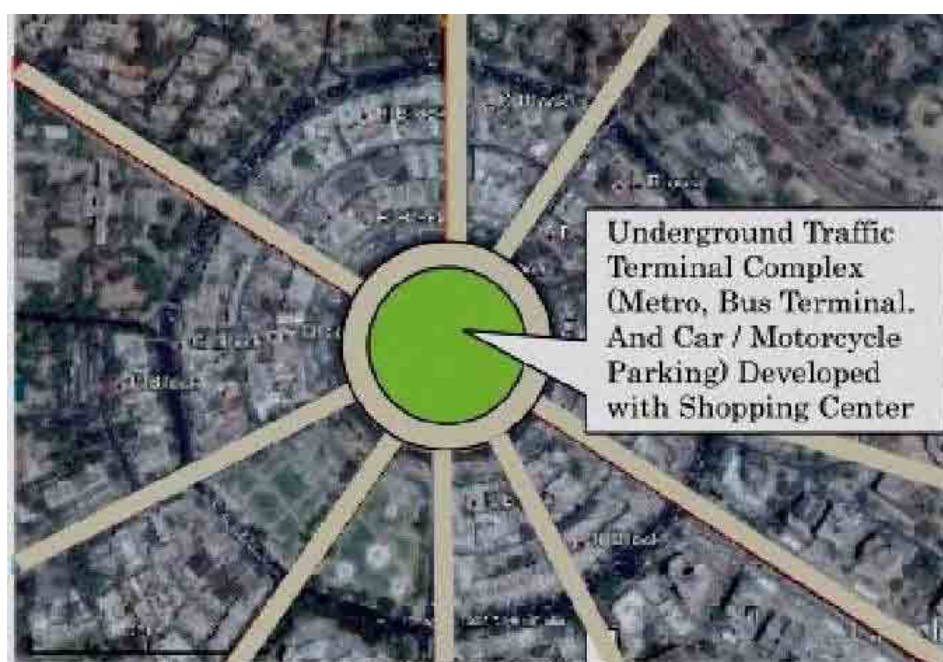


Medium- and Long-term Measures

For the long term, a redevelopment project to strengthen the intermodal functions should be implemented, taking into account the following aspects:

- To relocate the bus terminal currently located on the outer ring road onto places nearby the Station;
- To expand the parking capacity of cars and motorcycles, by efficiently integrating dispersed parking lots and provision of a parking information system showing on-time availability of parking lots; and
- Simultaneous with construction of the Metro, urban functions, such as private car parking spaces that are required for business areas, can be built. Besides, cultural facilities and service facilities can be established and improved.

Phase 2: Medium- and Long-term Actions



Section of the Rajiv Chowk Station (Use of Underground Space)

(3) Examples of Improvement Measures

Many cases of developments for multi complex transportation terminals in urban areas are done through station re-development projects in Europe and the U.S.A. and revitalized as agglomeration of multi urban functions, having new roles as the urban hubs.

Station re-development projects in Europe show examples to utilize the underground and ground levels in order to secure public spaces in the urban area. For instance, re-development projects in Forum des Halles in Paris, Stockholm urban center, and La Défense in Paris apply the methods of three-dimensional land use in the urban center.

4. Proposed Measures for the Improvement of Intermodal Functions

Significant measures for strengthening the intermodal mobility of the metro system are proposed in terms of short-term and long-term perspectives.

4.1 Short-term Measures

4.1.1 Physical Improvement of Railway Stations

(1) Smooth Movement by Introduction of a Barrier-free System

A barrier-free system needs to be introduced for ensuring smooth movement of passengers or handicapped people in particular. Their vertical movements should be supported by elevators and/or escalators in order to make their transfer from one transport mode to another as easy as possible.

(2) Commercial Utilization for Space of Concourse

It is often observed in the world that many large-scale railway stations are renovated to function as a multi-functional commercial center in addition to their transport function. A wide variety of shops, restaurants and urban services like banks, nursery service facilities, government information desks, post offices, etc. are located at the concourse of the stations. This provides daily conveniences for passengers on one hand, and financial profits to the station management on the other hand.

4.1.2 Improvement of Intermodal Facilities

Since the railway is a network utility, the intermodal transfer system at railway stations should be improved to ensure the convenience of transfer from one public transport mode to another with less impedance on passengers. The following measures deserve to be implemented for this purpose:

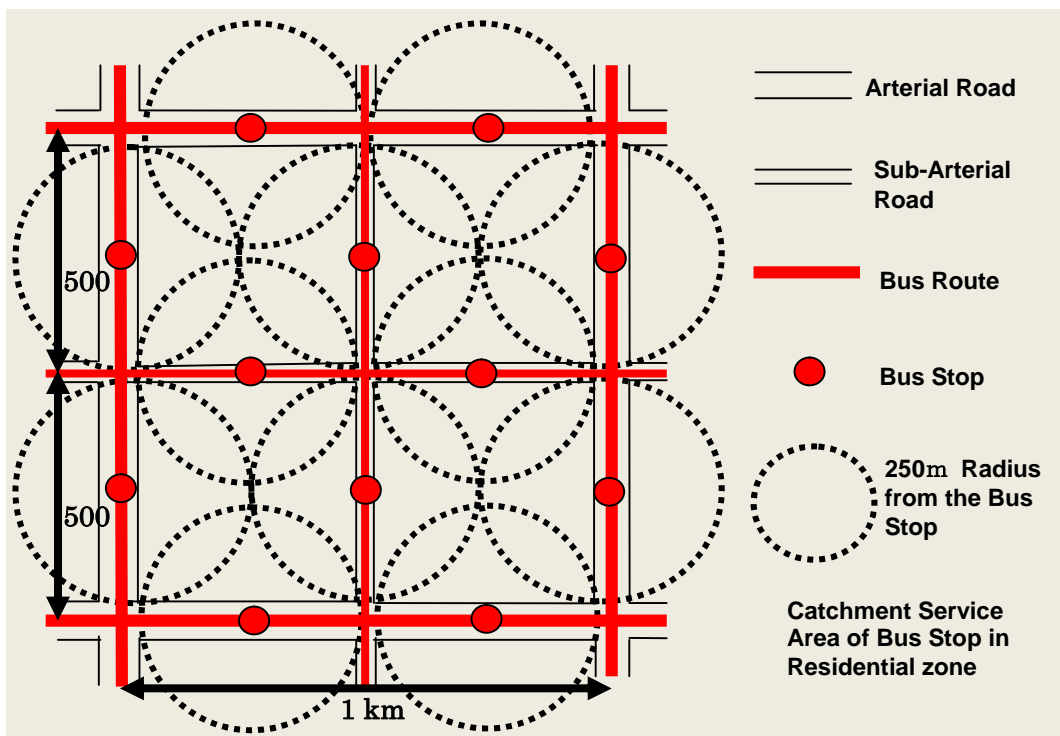
- 1) To improve the user-friendliness of the transport facilities, by providing pedestrian walkways, car parking lots and other transport services;
- 2) To upgrade the convenience level for transferring activities, by improving physical conditions such as shortening the walking distance for transferring from the metro to

another mode and provision of Information on timetables and operational conditions;

3) To prepare the safe and comfortable waiting space for transferring passengers.

4.1.3 Uplifting of Feeder Bus Services

According to the result of the Household Interview Survey by JICA, more than half of the metro users residing in suburban areas desire the improvement of feeder bus services in terms of: 1) accessibility to bus service; 2) frequency of the services; and 3) punctuality of the operation. This is the most vital point to strengthen the intermodal system of the overall public transport network.



Source: JICA Study Team

Figure 4.1.1 A Conceptual Structure of Bus Service Network

4.2 Medium- and Long-term Measures

4.2.1 Integration and Coherence with Urban Development Plans in the Metropolitan Area

Needless to say, the establishment of a functional public transport network is one of the most important planning issues in urban development planning for the Metropolitan Area. The following should be addressed in this regard:

(1) Integration with Transportation System and Appropriate Land Use

In order to effectively use public transportation as a means to combat urban traffic problems, one should not only improve the railway system, but also ensure that the surrounding land is used in such a way as to encourage the use of the metro system. Both land use and transport infrastructures should be integrated under a concept of “**Transit Oriented Development (TOD)**”, and the promotion of high-density commercial land use for around metro stations will benefit both the urban economy and the operation business of the metro system as a whole.

Corridor areas where served by the metro system will be endowed with great potentials for urban development such as housing, and industrial and commercial facilities, thereby bring a significant impact onto the urban structure. The Delhi Metropolitan Area is the case, and the Metro system has brought a wide variety of opportunities for the suburban development with new housing areas and shopping centers.

(2) Establishment of A Comprehensive Urban Transport Development Master Plan

The Delhi Metropolitan Area has been structured with the major public transport system whose trunk function shall be given to the metro system. The development of a comprehensive public transport system is the most practical way to mitigate the road traffic congestions in the central business district (CBD) and fringe areas to/from suburban areas where traffic flows always exceed the road capacities in peak hours. It is expected that the metro system can urge commuters residing in suburban areas to shift from cars to the public transportation mode.

The functional public transport system in the metropolitan area requires an integration of the CBD and suburban areas with a seamless transport network which is structured with trunk and feeder systems. For the materialization of this total mechanism, the deliberate development activities shall be conducted under a comprehensive urban transport master plan, coherent with the urban land use plan on a long-term vision.

4.2.2 Measures and Directions for Station and its Vicinity Area Development

(1) Station Surrounding Area Development

The station itself is a traffic generator and attractor, thereby contributing to commercial

and business development in its surrounding area, where the land values and real estate values are often highly appreciated, because of its latent economic potentials. The urban development is likely to be stimulated by a station's impact. Thus, making use of such an economic function endowed with a railway station, its vicinity should be deliberately developed.

(2) Formulation of a Consensus Building Process among Stakeholders

A number of stakeholders should be involved in the improvement of the intermodal facilities, that is, the government authorities in charge of transportation, urban planning and environmental administrations, public transport operators, related business entities and users. Therefore, it is essential that a process of consensus building among these stakeholders from the stage of planning of development targets to the implementation of measures and projects/programs be clearly established for the station and its surrounding area in particular.

4.2.3 Area Development along Railway Corridors Initiated by the Railway Operator

(1) Railway Operator's Multi-functions

A classic concept is that the railway operator is purely responsible for providing safe and comfortable railway transport service for users. However, today, it has been recognized that the railway operator also has a responsibility for the urban development along with the railway service corridor. This may bring another business opportunity for the operator to gain off-rail business revenues to ease its financial constraints. In this regard, the railway operator may take part directly and indirectly in urban development projects such as:

Station's Vicinity Area Development: As mentioned above, the station and its vicinity areas possess great opportunities for commercial, business, industrial and some socio-cultural development. The operator may construct a station plaza building at its own land property, and/or connect the station with development projects implemented at its surrounding area.

Housing Development along Railway Corridor Areas: The more residents live in the areas accessible to the metro service, the more metro ridership can be expected. Housing development is an effective tool to increase the latent demand for the metro system. Given good access roads, feeder bus services and park-and-ride facilities, the housing projects will be further attractive, thereby facilitating both private and public-initiated housing projects. It is a rational business strategy that the railway operator take part in these projects.

(2) Possible Model of the Operator's Participation in Development Projects

The metro service itself is highly public, and not necessarily profitable, as proven by other

cases throughout the world. Keeping quality service usually requires a tremendous amount of costs, but the revenue from fare box cannot increase to cover the required cost, because the fare level is often controlled by some pro-poor political groups and/or the government from a viewpoint of social considerations, not from a market pricing standpoint. In many cases, even if the recurrent cost for operation and maintenance can be covered by fare revenues, the initial investment cost cannot be recovered. Thus, metro operators always face a financial difficulty.

The metro service should be financially sustainable, and the metro operator shall be financially robust. The real estate properties, if it owns, should be economically utilized to make money to fulfill a financial gap between the fare revenues and the necessary cost for sustainable operation. For this purpose, one of possible and expansive strategies is to establish a joint venture business relation with private developers who have sufficient know-how on real estate projects and financial capability.

4.2.4 Shared Budgetary System for Project Implementation

Several kinds of physical and engineering works should be implemented for strengthening the intermodal system. To this end, a rational and sustainable budgetary system needs to be pursued. The following Japanese system is recommended to be explored in India:

Tripartite Sharing for Station Plaza: Since a station plaza is regarded as a vital urban facility to be addressed by the city planning policy, the cost of the station plaza is shared equally with three parties, that is, the railway operator, the local government and the central government. So, the railway operator shall owe one third of the total project cost.

Bilateral Sharing for Road Flyover : Since a road flyover to cross over railway will benefit both sides of users, the construction cost shall be shared with two parties, that is, the railway operator and the road administrator. So, the railway operator shall owe half of the total project cost.

Earmarked Budgetary System: Surcharge on fuel, tax related to car ownership, fine of traffic violation are all earmarked for the development of transport facilities such as roads, traffic management, safety facilities and railway-related facilities of station parking, park-and-ride facility, and so on.

Finance from CDM: It has been widely recognized throughout the world that the railway system is an environment-friendly transportation mode, and effective for reduction of CO₂ in the transport sector. Reforming of the urban structure with some railways has been more popular in many cities, taking into account energy-saving and the global environment. In this connection, the projects to enhance the metro service can be recognized as a CDM (Clean Development Mechanism) project; therefore, its deduction of CO₂ can be finically traded.

4.3 Organizational Mechanism

4.3.1 Proposed New Organizations

The improvement of the intermodal transfer system of Delhi Metro, based on the users' needs, is a vital element to facilitate people's modal shift to the railway-based transportation, as discussed earlier. The intermodal mobility is uplifted by not only the physical improvement such as station plaza, car parking and bus terminal development, but also the introduction of soft components such as a common ticketing system, an integrated operation with timetable adjustment to minimize transferring time loss. This practice has been proven in many cities in Europe and Japan.

Recognizing the improvement needs of Delhi Metro mentioned above, it is proposed to establish two organizations to facilitate both the hard and soft components for the integrated intermodal mechanism as follows:

(1) Establishment of the “Delhi Metro Intermodal Transport Committee (DMITC)”

Objectives: DMITC is an institutionally recognized place to confer on policies and strategies for the enhancement of intermodal functions of Delhi Metro in association with the urban planning polices, and to concretize the projects to implement the strategies.

Members: The members of DMITC are representatives of the metropolitan planning-related authorities (the government side) and the railway-based public transport operators (the railway side). Table 4.3.1 presents stakeholder groups who shall take part in discussions at DMITC. As basic directions and strategies are identified at DMITC, taking into account users' needs, some representatives of citizen's groups are to be involved in DMITC as well.

Table 4.3.1 Proposed Stakeholder Groups for the “Delhi Metro Intermodal Transport Conference (DMITC)”

Stakeholders		Responsibility
Government Side	Ministry of Urban Development, GOI	Transport & Urban Development Policy
	Delhi Govt.	Transport & Urban Development Policy in Delhi
	Delhi Municipal Corporation	Urban Transport Planning & Urban Development
	New Delhi Municipal Corporation	Urban Transport Planning & Urban Development
	Delhi Police	Traffic Management & Regulation
Railway Side	DMRC	Development of Railway Transfer Functions
	Indian Railways	Development of Railway Transfer Functions

Source: JICA Study Team

Functions: The basic function of DMITC is to identify priority projects/programs based on necessary policies, strategies and measures that, in turn, are based on the citizen's needs to improve the intermodality of the railway system. It is important that those are linked, coherent with urban planning orientations launched by local governments in the Delhi Metropolitan Area. DMITC should be practical rather than debate-oriented. It is a vital task for DMITC to identify the project owner/executer of the priority project in such a way that a concrete action to materialize the project may be smoothly and promptly taken.

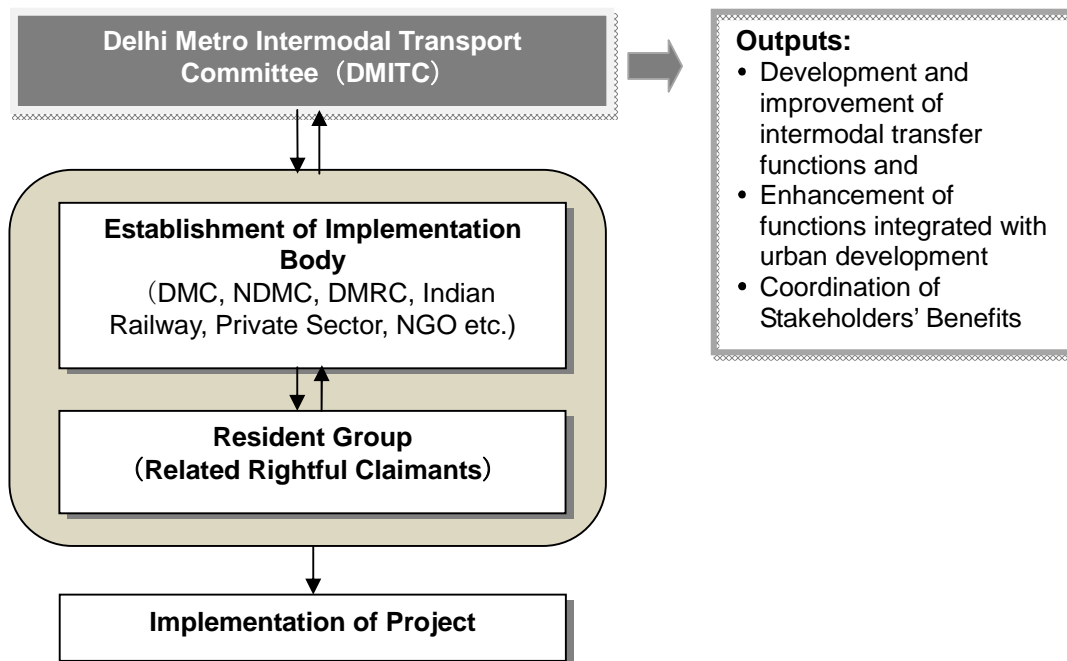


Figure 4.3.1 Proposed Functional Structure of DMITC

(2) Establishment of the “Delhi Transport Alliance (DTA)”

Objectives: A smooth and seamless public transport network is an ideal structure, and to this end, it is also ideal that all public transport modes are managed in an integrated fashion for operation and ticketing. DTA shall function as a monogenetic coordinating organization to introduce common technologies and systems to uplift the intermodality of the public transportations in the Delhi Metropolitan Area.

Members: All public transport operators and their associations such as Indian Railways, Delhi Metro, bus, taxi and other important organizations of paratransit, are the members of DTA.

Functions: DTA's major function is to facilitate joint efforts with public transport operators to optimize their profits and modernize the management of their organizations,

through maximization of users' benefits. Under this arrangement, DTA shall tackle the following issues:

- Proposal of a rational fare structure for each public transportation;
- Introduction of a joint-ticketing and/or integrated system;
- Reviewing of rational and efficient bus service routes in consideration of the Metro System;
- Adjustment of operation timetables to minimize transferring time loss;
- Joint public campaign for promotion of users' manners/norms/rules;
- Proposal of justifiable subsidies and various support of the government; and
- Other current issues arising at the operation sites.

In order to materialize an integrated system, the government sector is also significant in terms of provision of policies, regulations and subsidies on operators. Figure 4.3.2 shows a basic concept of the functional framework with four (4) significant parties related to the public transport system development as a whole.

The underlying concept of "**Transport Alliance**" is popular in France (Syndicat des transports d'Île-de-France) and Germany. Most of public transportation operators had suffered from chronically financial deficits due to increase in operation costs and decrease of users, under lack of government policies on how to make use of public transport systems in the urban development structure. Along with a public recognition on the environment-friendly city, the public transport system has been given a high priority to the urban development management policy. It is a fact that DTA has contributed greatly to materialize such a policy through revitalizing and/or modernizing the system and operation. This encouraged citizen's modal shift to public transport modes, thereby resulting in the somewhat sustainable public transport operation.

Direct introduction of such a Europe-born system into the Indian society might not be necessarily appropriate; however, a similar concept has been successfully applied in other countries in Asia like Japan and Singapore. For the sake of materialization of an integrated operation system, an organization of the DTA deserves to be pursued in Delhi.

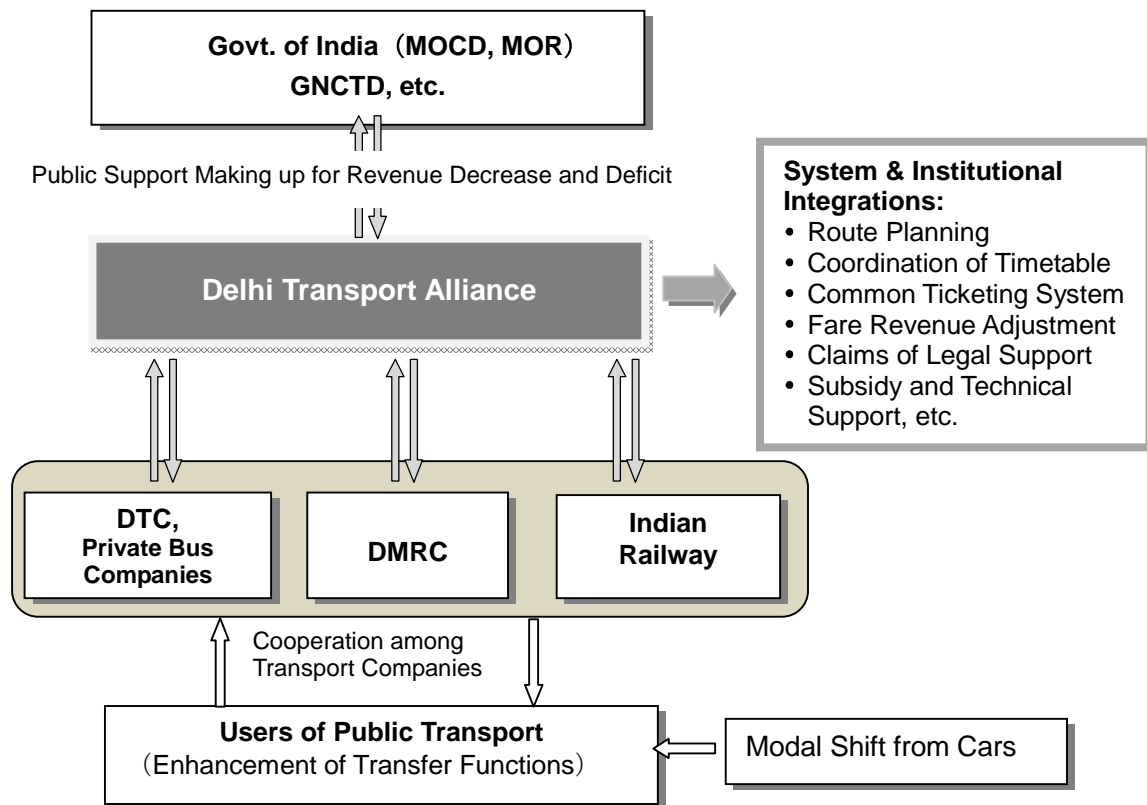


Figure 4.3.2 Proposed Functional Framework for Integrated Management System of Public Transportation

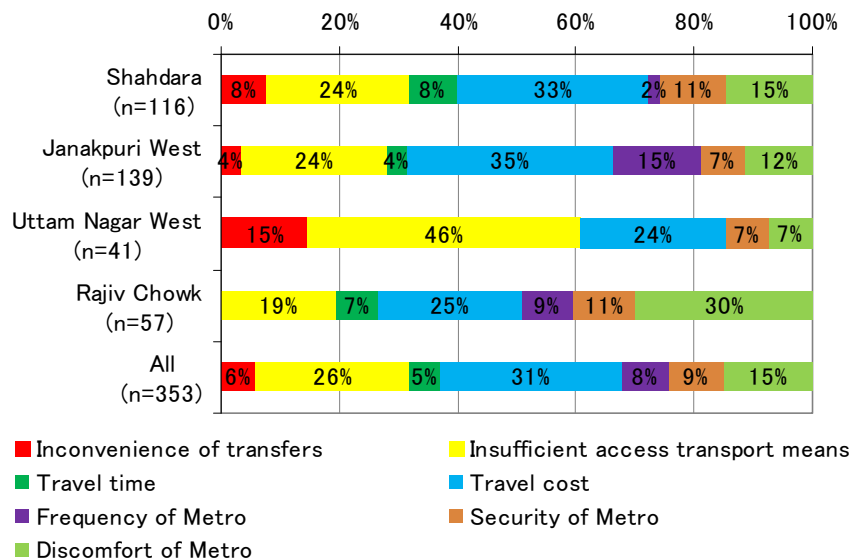
4.3.2 Rational Fare and Integrated Ticketing Systems

At present, DMRC has installed the automatic ticketing system with the issuance of prepaid cards, and offers a 10% discount for the prepaid card users. This modern system has been applied only for the Metro service, not for other transportation modes being operated by different operators such as bus and parking. The Metro card users can receive a privilege for free bicycle parking, by showing the card. DMRC has a plan to apply a similar system for car and motorcycle parking services.

Introduction of a more systematic integrated ticketing system with Indian Railways, DTC bus and private buses have become a vital issue today. Through a common ticketing system, users will be able to get more attractive services like fare discount for transferred mode and mitigation of time loss for ticket purchase.

According to the interview survey to non-Metro users at four stations, it is noted that 31% of respondents pointed out the expensiveness of the Metro fare as the main reason why they do not use the Metro (refer to Figure 4.3.3). The fare must be a vital factor to promote Metro use. If a Delhi Metro user, traveling from A to B, transfers to bus at C, he or she has to pay the Metro fare (p1) between A and C, and a bus fare (p2) between B

and C. The total transport cost (p_3) will be simply (p_1+p_2). If p_3 is significantly higher than the bus fare (p_4) between A and B, no one will shift from the bus service to the Metro service. The integrated ticketing system will allow for a fare adjustment to keep a competitive level for transferring passengers, by providing a discount fare service for the transferred mode.



Source: JICA Study Team

Figure 4.3.3 Main Reasons of Non- Metro Users

As one of the feasible fare integration systems, a **zone fare system** deserves to be studied for its possible introduction. This system is a simple mechanism that a fare even for using different transport modes is the same as long as the travel is made within the same zone, and that such an integrated fare will be increased when the travel is made to another zone. The concept of the zone fare system is illustrated in Figure 4.3.4.

Under such an integrated fare system, a fare revenue sharing method shall be established among the public transport operators that take part in the system. As mentioned earlier, the Delhi Public Transportation Operators Union (DPTOU) will function as the coordinating entity for establishing a rational system as well as the fare revenue sharing method.

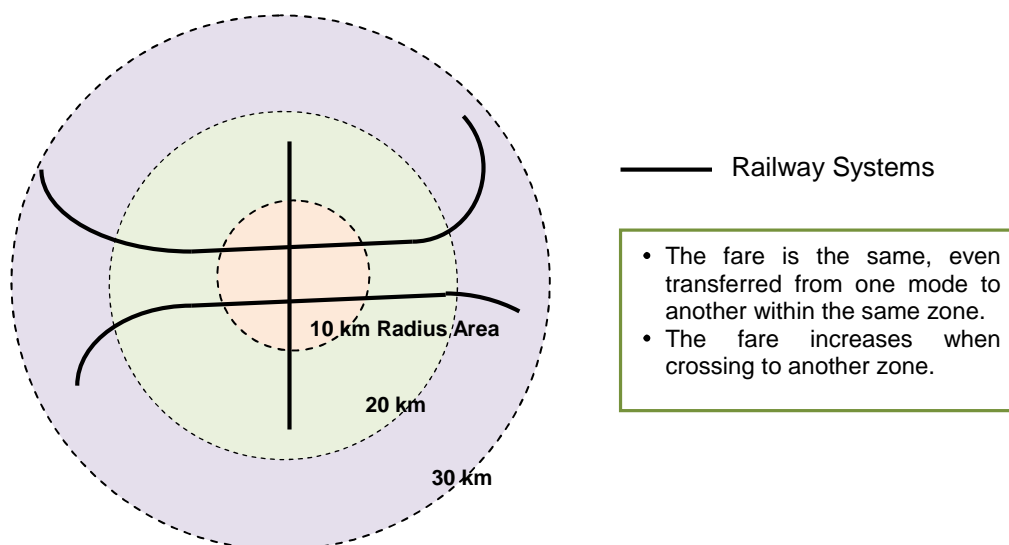


Figure 4.3.4 Concept of Zone Fare System

4.3.3 Government Interventions for Strengthening Intermodality of Public Transport

Governmental support is essential to improve the entire intermodal system in the Delhi Metropolitan Area, in terms of administrative and financial support for both physical and institutional development.

As for the physical improvement, the intermodal transfer facilities such as bus terminal, car parking, taxi stand, paratransit waiting pool and pedestrian path need to be developed not only for the Metro station, but also in linkage with the urban development in the surrounding area. It is noted that the station plaza, therefore, is often recognized as an urban service facility, not a part of the station.

In Japan, the project of development of a station plaza, aiming to strengthen intermodal linkage with different modes, is fully subsidized in the urban planning institutions by the government sector, and several measures for the project implementation have been linked with a legal framework such as “Land Readjustment System (LRS)”. LRS is often applied for the land development with infrastructure development at a certain target district. For financing the station plaza project, a budget sharing mechanism is also regulated in such a way that the project cost shall be shared equally by three parties of the railway operator, the local government and the central government, that is, each party shall share one third of the total cost. This Japanese experience may be introduced in India.

In the meantime, introduction of the integrated ticketing system with special discount will require governmental financial support to make up for the operator’s loss, if it happens. The manner of the government support depends on the social norm and/or common

understanding of the society on the public transport system. In France, the budget for supporting public transportation operators has been earmarked through the public transport tax. In Japan, it is accepted by citizens that the quality service of public transport systems may be supported by tax money, or additional financial burdens of individuals and companies. Discussions on justifiable and rational financial support and subsidies need to be further facilitated in the Indian society, too.

There is another issue related to the global environment, or mitigation of CO₂ emission from the transport sector. Delhi Metro is installed with a power renewable braking system (braking itself regenerates power), thereby saving on electric power by 33%. This system has been first registered as a CDM (Clean Development Mechanism) project in the transport sector throughout the world. By the introduction of this system, 200,000 tons of CO₂ are reduced in five (5) years. Thus, the governmental support will be justified from an environmental policy point of view.

4.3.4 Establishment of Monitoring System to Identify Citizen's Needs

The improvement of the intermodal transfer system of Delhi Metro aims to increase its ridership, by maximizing users' utility and uplifting its satisfactory level of mobility by public transport systems. To this end, people's needs should be continuously grasped and assessed through a user monitoring system, and appropriate, admissible and timely measures should be formulated based on the needs assessment.

5. Knowledge Sharing and Information Dissemination

5.1 Conduct of the Delhi Workshop

An open-door workshop to introduce outcomes of the study was held in Delhi in August 2009. It is expected that this workshop will initiate to organize a “Delhi Metro Intermodal Transport Conference” where stakeholder groups are collectively coordinated with a single purpose that the Delhi public transportation system shall be efficiently, functionally operated for all citizens to have quality public transport services. This workshop invited, but was not limited to, representatives from public transport service providers, NGOs, academic institutes concerned, government officials in charge of city planning and development, transport and environment as well as DMRC.

The agenda of the workshop, at least, includes:

- Current performance and future plan of Delhi Metro
- Existing problems and issues to improve the *intermodality* in the Delhi Metro System
- Findings and implications of the Questionnaire Survey
- Necessary measures to formulate an overall intermodal system in Delhi (Theory and Reality)
- Proposals of strategic projects/programs and actions

5.2 Proceedings of the Workshop

5.2.1 General

A total of 65 personnel participated in the workshop for **Improving Intermodal Transfer Functions of Metro Stations**, which was held in the Indian International Centre on 12th August, 2009. The workshop was organized by JICA in coordination with Delhi Metro Rail Corporation (DMRC). Main delegates are listed in the last pages in the proceedings.

5.2.2 Opening Speech

(1) Opening Remarks: Mr. H. Irigaki, Chief Representative, JICA India Office

The Workshop commenced with Mr. Irigaki's opening remarks, addressing the objectives of and expectations on this workshop as follows:

- This workshop is being organized for the above subject by JICA in association with Delhi Metro Railway Corporation. The outcome of this workshop program can be used for future metro projects coming in India in mega-cities.
- Phase I of the Delhi Metro project (65.1km long) had been financially supported by Japanese Yen loan since 1996 with a total loan amount of JYN 178 billion and for Phase II loan amount of JYN 28.8 billion (total JYN 206.8 billion) upto 2006. Phase I was completed in November, 2006 and Phase II is scheduled to be completed by 2011.
- JICA extended its support in technical matters on Delhi Metro in respect of: 1) rolling stock and track; 2) promoting a metro system with cost effective, user friendly manners; and 3) improving the metro system operation.
- In addition to above, JICA has also supported the following: HIV & AIDS measures and employment policies.

(2) Mr. S.K. Lohia, OSD & Ex-officio Joint Secretary, MoUD, Govt. of India

The opening speech was given by Mr. S.K. Lohia, OSD & Ex-officio Joint Secretary, MoUD, addressing the following:

- A number of projects are being carried out in India with the help of JICA. Improvement of Intermodal Transfer is very essential. JICA has studied four (4) different categories of stations of Delhi Metro and highlighted very important issues in the report, which will help in the planning of forthcoming metro projects in the country.
- The metro administration in the country needs to be carefully planned and executed. All pending issues on the metro system for cities all over India were cleared by the ministry on 7th August, 2009.

- Major modes of transport are railways, highways and roads, but earlier there was no special emphasis on Urban Transport. The Urban Transport Policy came into existence in April, 2006. The policy on urban transport has to continually evolve.
- Changes in urban population and economy are to guide certain changes in policy for the urban transport. Vehicular growth in urban areas is 4 times the growth of population. Urban areas contribute 60% of GDP. The main priorities of the Urban Transport Policy are promoting the use of non-polluting vehicles and maximizing the share of Public Transport trips.
- There is a drawback in Delhi Master Plan - it is independent of Transport. There is no synchronization between the land use and the transportation planning. The land use and development is given more priority than the transportation system, then the land use and transport plan should be integrated. The Comprehensive Mobility Plans, which is to be conducted by the Ministry, should target to reduce the time of residence to work place.
- About 10-15% of road users (Private Vehicles) occupy 90% of the road space. For public transport and pedestrian facilities, more space is required. A dedicated path is required for pedestrians and cyclists.
- Public transportation is the most economical system in India. The Metro is most successful in this country. But the Metro cannot go to every corner of the city. It should be supported by HCBS/ BRT and feeders. Therefore, a suitable system is required for overall sustainability.
- There are four layers of integration: 1) Physical integration (feeder & BRT); 2) Multimodal integration system; 3) Operational integration system, and 4) Information integration system. As for the multimodal integration, there should be good integration with feeder services like the auto rickshaw. There should be one single ticket for going from one place to another including feeder service; BRT/Metro and auto rickshaw fare should be Integrated with parking charges.
- Parking is an important area of transport policies. It should be charged according to value of land. A parking strategy should be established. Moreover, paratransit plays an important role.
- There are various agencies, but no coordination. One central planning authority should be established, where at least one to two members from each department (at very senior level officer) should be a member for approving any plan for better coordination and implementation of projects.
- Capacity building is an important issue. This workshop is the best platform where ideas can be exchanged. This is the first step regarding “**Improving Intermodal Transfer Functions of Metro Stations**”. Since the Annual conference in Urban Transport is being held in the first week of December 2009, this conference will be another venue for discussing this issue.
- The country has sanctioned 420 km of BRT in nine (9) cities; and 500 km metro lines will be added in future for an estimated amount of Rs. 90,000 cr. Twenty-five

percent (25%) of the total money will be available from equity or Government, and huge loans from JICA. Courteous support from JICA is highly appreciated.

5.2.3 Presentations

(1) Presentation by Mr. T. Nagai, JICA Study Team Member

A presentation was delivered by Mr. Nagai, regarding current issues and possible improvement measures on intermodal transfer functions of the four (4) Case Study metro stations of Delhi Metro (Uttam Nagar, Janak Puri West, Rajiv Chowk and Shahdara). The highlights of his presentation are as follows:

- Walking is the predominant mode of passenger feeder trips, followed by paratransit, buses and private vehicles.
- The Metro users are dissatisfied by the inadequacy of feeder services, lack of pedestrian facilities, crowding on the train and low frequency.
- The non-Metro users cited low accessibility of metro stations, higher cost and crowding on the trains as the main reasons for not using the Metro.
- A zone-wise unified fare structure integrated with common ticketing for all modes is proposed – ensuring fare integration for passenger from door to door covering all paratransit and public transport modes.
- A unified agency, **DMITC** (Delhi Metro Intermodal Transfer Committee, with representatives from all planning and implementing agencies in Delhi) is proposed for ensuring an integrated mass transport planning.

(2) Prof. Dr. S. Iwakura, Shibaura Institute of Technology, Japan

A presentation was delivered by Dr. Iwakura, regarding the present condition of urban railway network and feeder bus services in the Tokyo Metropolitan Area (TMA). He discussed the following items:

- Urban Railway Network in TMA
- Historical process of Urban Railway Network
- Current issues of Feeder Bus Services in TMA

(3) Presentation by Mr. Y. Kadota, Manager of Planning Division, Headquarters of Railway Undertaking, Tokyu Corporation

A presentation was delivered by Mr. Kadota, regarding intermodal transfer development of the Tokyo Railway. He discussed the following items:

- Service area of Tokyu Lines
- Business performance profile

- Integrated development of railways and cities
- Introduction to intermodal transfer system of the Tokyu Lines
- Case study, taking up some representative stations such as Aobadai Station, Tama-Plaza Station, Kajigaya Station and Musashi-Koyama Station

(4) Presentation by Prof. Dr. P.K. Sarkar, School of Planning and Architecture, New Delhi

A presentation was delivered by Prof. Sarkar, regarding trend in modal split in favor of Public Transport System. He spoke of the following:

- Transport system and characteristics of transport system in Delhi
- Comparison with different cities in the world
- Traffic and transportation problems
- MRTS and its advantage
- Past transportation studies and trend in modal split

(5) Presentation by Mr. B.I. Singal, Director General, Institute of Urban Transport

A lecture was delivered by Mr. Singal, regarding strengthening intermodal transfer function of the urban railway system. He presented the results of a Delhi Government Study on audit of passenger usage of Delhi Metro Stations. Majority of feeder trips are by walking, but pedestrian walkways are generally in bad shape and road-crossing facilities are inadequate. Regarding this point, the following are noted:

- All bus stops are on road – not properly integrated with Metro Stations, leading to long walking and crossing of roads, particularly highlighted at Welcome and Seelampur. The study found that about 39% of bus stops involved 100m - 200m walk for commuters.
- About 25% of bus stops require the pedestrian to cross the roads to access the Metro leading to pedestrian vehicle conflict.
- Limited Park & Ride facility available at metro station. Out of 59 stations, 45 stations have parking facilities mostly for private vehicles.
- Feeder RTV services have mostly replaced the bus trips (very few other mode trips have shifted to these RTVs), and they are competing with the buses.

5.2.4 Panel Discussion

After the individual lectures by the delegates, a panel discussion was held on the subject of implementation system for improving intermodal transfer function in terms of coordination among stakeholders and institutional and legal aspects. The panel was moderated by Dr. Katsuhide Nagayama, Team Leader of JICA Study Team, and

co-moderated by Mr. Anuj Dayal, Chief PRO, DMRC. In the panel, the following issues were discussed

- Coordination between different modes and Integration of fare system
- Land for Intermodal Transport facilities
- Responsibility of feeder system for Delhi Metro
- Indian Railways-Ring Railway
- Auto Rickshaw & Cycle Rickshaw at every station.
- Long walk at Rajiv Chowk
- Intermodal transfer from Metro to Cycle

Many constructive and informative comments were raised by representatives from different entities concerned, including the private sector and NGOs. The following are noted:

(1) Mr. Rajeev Malhotra, Chief Regional Planner, NCR Planning Board, MoUD

- Physical integration is very essential. Cycle rickshaw can go up to 3-4 km, but there is no parking for them and traffic police is penalizing them for stopping at station.
- Re-densification of settlement along the Metro corridor is required. Land for intermodal transfer facilities and proper coordination is also essential. Due to lack of coordination, sub-city Dwarka metro station, ISBT and Railway station are about 500m apart from each other, thereby resulting in transfer problems for passengers. Thus, a horizontal and vertical integration is essential.
- DTC should not be competitor of the Metro, and a common ticketing is essential.

(2) Mr. Krishna Kumar, General Manager, ISBT

- Developing intermodal transfer facility at ISBT-Delhi is very difficult as land planning has been done by DDA and road connectivity has been planned by PWD. Nobody has thought about cyclists. Now GM/ISBT cannot do the entire planning, and it is very difficult to solve the mess.
- The different agencies have their committed plans for the work. Nobody is willing to move from their sanctioned plans. This can be solved if the planning is done with proper coordination at planning stage.
- Feeder services are normally for short distances between 10-11 km corridors. There is no coordination between feeder services and DTC; they should not go for competition but rather cooperation.

(3) Mr. Rajeev Chaudhary, Ministry of Railway, Railway Board

- Initially, Ring Railway was constructed to bypass the freight trains from Main line Nizamuddin, New Delhi and Old Delhi Railway stations.
- During the Asiad games, efforts were made to run the passenger trains through Ring Railway. But due to poor connectivity with the Ring Railway and city bus /IPT and residential areas, running of passenger train through Ring Railway was not successful.
- Presently, freight trains are moving through Ring Railway and traffic has also increased substantially. If passenger trains start, then freight trains will be affected.
- Ring railway is an opportunity for NCR. A lot of improvement is required for providing accessible approaches - which is very difficult.
- Intermodal issue for metro system: Every city has a different character, and India is not a rich country; hence, an underground or elevated or vertical integration is not possible for every city. Scarcity of land is also a factor.
- About integration and coordination between different the agencies, a monthly meeting can be organized and a joint committee (forum) can be formed and all integration can be done at the planning stage. In the case of Dwarka, there was a failure of integration/coordination between the agencies. Committee should be headed by a senior person who can ensure attendance for all.
- An institutional mechanism is very essential. UMTA for Delhi has yet taken place. In the construction of Metro Phase-I, 26 agencies were involved and monthly meetings were organized.
- NCR has planned a 100-meter wide corridor along NCR for railway (double line) and road. The State Government has been asked for demarcation of land.

(4) Mr. Vikas Kumar, General Manager, DMRC

- The Metro is the system capable of carrying the highest volume of passengers; others are complementary. Integration should be such that majority of the public can use it. For the station integration, Railway is planned to function as an outer Mass Rapid System.
- A common body should be planned and piece-meal planning should be avoided, UMTA (single agency) should be there to oversee the planning rather than different individual agencies doing it.
- Provision of pedestrian facility to the Metro by bus, auto-rickshaws: Problems for providing such facilities can be resolved with the help of MCD & Delhi Governments. Adequate space for feeder vehicles, bus and auto planning should be made.
- Who will run the feeder? The answer is DTC . It has already running feeders at some stations. The timetables of feeders and the Metro should be synchronized.

- In Bangalore, metro stations have been provided with interchange facility of bus, auto and rickshaw. There is no conflict among them.
- Recently, an experiment to promote metro parking to be used by Metro users has been started. Planning for multilevel parking is in progress. Definitely, it will help the Metro users.
- For de-congestion, an integrated fare system should be started from one destination to other destinations with different modes with single fare.

(5) Mr. S.K. Lohia, OSD & Ex-officio Joint Secretary, MoUD, Govt. of India,

- **Feeder Services:** Who should provide? In the City of Bogota, feeder buses are free of cost and being run by main line operator. Interchange is planned in such a way that feeders can go upto the main line system.
- Stand-alone feeder system is not profitable. Feeders should not have long routes. Feeders should be subsidized by main route operator. Fare integration should be there.
- No surveys have been done for planning DMRC feeder routes.
- **Interchange:** The interchange should be planned to save time and cost. Pedestrian planning is essential. Walking should be minimized. Even walking 100 m is very difficult in Delhi. Importance should be given to Pedestrian facilities.
- Vertical integration of metro. Cost is a major concern in India. In most of the world, the metro system is elevated. Underground cost is very high. It has to be balanced. BMRC is providing vertical integration. Interchange should be provided even for a length of 100-200 m
- **Major Issues:** A common agency should exist (like UMTA). UMTA, Delhi is pending. UTTIPEC is existing and is headed by the Lt. Governor. Meeting is held every month.
- **Ring Railway:** The Ring Railway was constructed in 1969, when it was outside of settlements of Delhi; now it is in the heart of the city. The Ring Railway is to be developed with proper approaches and linkages with feeder services.
- Cycle Rickshaw may be made as a feeder. Cycle Rickshaw is renamed as **Eco-Cab**. This will be available with short message service (SMS). Bus stands for the Metro should be as close as possible to the Metro station.
- India is providing solutions for the whole world, so there is no reason why India cannot do the same for its own cities.

(6) Mr. Rajesh Soni, Mahamantri Taxi Union, Delhi.

- There are no stands for auto/taxis/ rickshaws at metro stations. Police are harassing them for standing at metro stations. Provision of 15-20 auto/taxis/rickshaws will help

the commuters for further onwards journey. A stand for 50 autos/taxis should be provided at Rajiv Chowk, because there are more passengers at Rajiv Chowk.

(7) Mr. Rajesh Agarwal, Social Worker

- We are working for cooperative auto system which will be available on call. Every auto will be mounted with GPS and will be coordinated centrally. A software program is being developed by Prof. Jhunjhun Wala, IIT, Chennai. This system will be available within a year.
- Limited space for auto stands should be provided at each metro station.

(8) Representative from RWA, Dwarka, Delhi

- A Metro station at Sector 8 is not yet opened, but station at Sector 9 is opened. Feeder services are only connected with Sector 9, where most of the passengers riding at Metro station Sector 9 are those from Sector 8. So feeder services with Sector 8 are very essential. In addition to that, a Metro station at Sector 8 should also be opened at the earliest so that a maximum number of passengers from Sector 8 can avail themselves of the Metro use from stations at Sector 8 only.
- The routes for feeder should be re-routed. At present, they are connected mainly to institutional areas. They should connect to residential areas also.

(9) Managing Director, Bangalore Metro Railway

- Intermodal planning should start from pedestrian facilities. There should be a common authority for policy making, not for operation.
- No solution is good for all time. Bangalore metro has been planned in consultation with Bangalore Transport Authority and system has been negotiated.

(10) Representative, Kolkata Metro Railway Corporation, Kolkata

- Due to land scarcity at Howrah and Mahakaran, no space is available for inter-modal transfers.
- Metro is unloading huge passengers of these stations, which required sufficient bus facility. Separate bus bays are required for metro stations.

(11) Representative, Transport Specialist, Chennai

- This is an issue of great concern; that the share of public transport is decreasing. Drastic action is required to reverse it. The modal share for Public Transport has reduced from 61% (2001) to 45% (2007) in Delhi and from 49% to 38% in Chennai.
- To reduce congestions in CBD areas, a congestion pricing system should be provided.

- Intermodal integration is a must; we have a problem of space. Some technology is required for the improvement. There is no plan for metro before 10 years, so requisite land requirement was made.
- Regarding policy and guidelines etc., directions should come from the highest authority of State/Central Government.

(12) Mr. Savin Bhatia, NIPON

- Commuters are our main clients. Therefore, for the commuters, pedestrian facilities like walkway, subway, escalator, FOBs should be planned in a well thought of manner.
- Coordination between different agencies should be there.
- Commuters should get economic fare prices and reduction in time. At present, average salary in Delhi is Rs. 6000/- per month. The average citizen cannot afford to ride the Metro. Cost of tickets should be brought down compatible to the average income of the city through subsidies.

(13) Abhay Negi, DGM, RITES Ltd., New Delhi

- A recent RITES study shows that Public Transport share in Delhi has been reduced from about 60% in 2001 to 45% in 2007. As highlighted by Prof. Sarkar, the WSA study has projected that with the current state of affairs, it is likely to reduce to 26% by 2026. The main reason is that though the National Urban Transport Policy talks about promoting Public Transport and Non-motorized modes; even the Master Plan for Delhi - 2021 has a stated goal of ensuring 80% trips by Public Transport and promoting non-motorized transport, yet most of the transport projects in the City are being executed with the main aim of facilitating private motorized vehicle movement.
- This is indeed a very alarming situation and all efforts should be made to reverse it. Cycle-rickshaws, the major modes of paratransit access for residential areas are also severely hampered by the lack of organized parking space at the station and also the fact that they are banned on most of the arterial roads that the stations are located. Auto-rickshaws lack parking spaces at the stations as well, and due to their restricted numbers, are unable to provide the desired level of feeder services.
- It is time that the different agencies in the cities integrate not only their planning but also implementation and operation functions for transport projects and infrastructure. UTTIPEC/ proposed UMTA should have a strong mandate and also a strict supervisory role in this aspect.
- With a safer and more accessible mobility and interchange mechanisms ensured by such a transport network, it will facilitate walking, cycle rickshaws, auto-rickshaws and even normal DTC/ blue-line buses to act as more effective feeder systems to Delhi Metro.
- Park-and-ride facilities have higher percentage of metro passengers parking at stations near end terminals such as at Dwarka Sector 9 and Yamuna Bank.

- City-wide zone based Fare integration for all modes as proposed by JICA is the ideal solution for intermodal integration. However, DMRC can make a start by integrating the fare structure/ ticketing of its metro feeder buses and the trains.
- City policy level revisit on the cap on total number of auto-rickshaws is required with a view to improve their availability as a feeder mode and for general improvement in city-wide mobility.

(14) Mr. A. Dayal, Co-moderator

In the closing address, Mr. Dayal expressed his energetic views:

- For Delhi Metro, a total of 35 studies have been carried out since the beginning. After a long period, the project was materialized. In the construction of the Delhi Metro Phase I, 26 agencies were involved and monthly meetings were organized. The State Government has played a major role. The role of JICA was also very important.
- However, **this subject has so far been grossly ignored.** This is the beginning of the story. I hope that in subsequent meetings and actions, we can reach our goals. We are thankful to JICA for showing their interest and highlighting the vital issues in their report and also for organizing this successful technical workshop on **Improving Intermodal Transfer Functions of Metro Stations.**

<End>

* * *

Main Attendees:

Indian Side

- Mr. S.K. Lohia, OSD & Ex-officio Joint Secretary, MoUD, Govt. of India
- Prof. Dr. P.K. Sarkar, School of Planning and Architecture, New Delhi
- Mr. B.I. Singal, Director General, Institute of Urban Transport.
- Mr. Anuj Dayal, Chief PRO, DMRC, New Delhi
- Mr. Rajeev Malhotra, Chief Regional Planner, NCR Planning Board, MoUD
- Mr. Krishna Kumar, General Manager, ISBT
- Mr. Rajeev Chaudhary, Ministry of Railway, Railway Board
- Mr. Vikas Kumar, General Manager, DMRC
- Mr. Rajesh Soni, Mahamantri Taxi Union, Delhi
- Mr. Rajesh Agarwal, Social Worker
- Representative from RWA, Dwarka, Delhi
- Managing Director, Bangalore Metro Railway
- Biswas, Kolkata Metro Railway Corporation, Kolkata
- Transport Specialist, Chennai
- Mr. Savin Bhatia, NIPON
- Abhay Negi, DGM (Urban Transport), RITES Ltd., New Delhi
- Mr. S. Sivamathan, Addl. General Manager (Finance), DMRC

JICA Side

JICA India Office

- Mr. H. Irigaki, Chief Representative, JICA India Office
- Ms. Y. Asakuma, Senior Representative, JICA India Office
- Mr. T. Kon, Representative, JICA India Office
- Mr. M P Singh, Principal Development Specialist, JICA India Office
- Ms. C. Sharma, Assistant Project Officer

JICA H.Qs, Tokyo

- Prof. Dr. S. Iwakura, Shibaura Institute of Technology, Japan
- Mr. Y. Kadota, Manager of Planning Division, Railway Undertaking, Tokyu Corporation
- Mr. S. Kameda, Program Officer
- Ms. Y. Kanno, Assistant Director, South Asia Dept.

Study Team

- Dr. K. Nagayama, Team Leader
- Mr. T. Nagai
- Mr. K. Ozawa
- Dr. S. Yagi

* Logistic Support: by Mr. M. Samuel, BASIC 4 Advertising PVT. LTD.

6. Recommendations

Although the accurate figure of the current population in the Delhi Metropolitan Area cannot be identified, it may account for about 20 million as of 2009, compared to the census figure of 13.8 million in 2001, based on an assumption that more or less one million people are being added every year. Under this rapidly growing metropolitan area, Delhi Metro, a significant transportation mode, is/will be undoubtedly contributing to mitigate a huge economic loss due to traffic congestions, therefore, the investment on the Metro Project is economically rational and feasible.

However, it can be said that the Metro project has not been necessarily integrated with urban development projects under a holistic master plan on the long-term perspectives, and cross-departmental coordination for land use and/or urban facilities development in association with the Metro development has not been sufficient. This is an opportunity loss, otherwise further effective economic benefits would be generated. It is essential to formulate a platform where close coordination with MOUD, ISBT, Municipal Governments and DMRC is facilitated to make the best use of the massive investment for Delhi Metro. In this regard, some recommendations are made as follows:

6.1 Intermodal Development at New Stations in Phases 3 and 4

Promotion of people's usage of public transportation modes is one of vital issues to mitigate chronically serious traffic congestions on roads. For the sake of this solution, the intermodal functions at major stations along the Metro need to be strengthened. As proven by the Interview Survey, conducted by JICA Study Team, the majority of the Metro users pointed out the necessity of access improvement, as the most significant condition.

Many existing stations were constructed on elevated structures on busy arterial roads. Such a location condition is likely to cause traffic congestions due to the mix of access-traffic to the station and through-traffic. A station plaza is deliberately planned and constructed to accommodate intermodal facilities and better accessibility to the station for the next phases of Delhi Metro, learning from other experiences as well as based on assessment of the current situation, as follows.

6.1.1 Planning Issues on Intermodal Facility Development

(1) Land Acquisition for Station Plaza Development

The station plaza is a key to strengthen the intermodal functions, providing feeder transportation services and urban services which are convenient for users. The land acquisition, however, is always a problem in practice. In order to secure the land for the station plaza, a concept of “transport-led urban development” needs to be employed in integration with an urban development project. It is a rough idea that a well-functional station plaza requires more or less 4,000 - 5,000 m², accommodating feeder bus services and space for its traffic circulation.

(2) Formulation of Station Vicinity Transport Plan

The system of traffic flows and circulations in the station vicinity areas should be thoughtfully designed. It is often observed in stations constructed in Phases 1 and 2 that the entrances of the station face directly with an arterial road, thereby interrupting smooth traffic flows on the arterial road. Such traffic struggles in front of the station should be avoided for stations to newly be constructed in Phases 3 and 4.

A transport assessment study, taking into account traffic impacts by the station, should be conducted for each station, prior to the design work. Based on the traffic demand forecasts, a traffic management system at the vicinity areas should also be planned in such a way that the generated traffic by many different modes can be properly managed with less traffic congestions.

(3) Development of Bus Terminals

According to the Interview Survey, the most desired facility/service of users is to improve the accessibility to/from the Metro stations with feeder buses. It should be noted that the convenient usage of bus services linked with the Metro is particularly important. Bus terminals are expected to be developed, attached to the Metro station, based on the Station Vicinity Transport Plan, as mentioned above.

(4) Effective Utilization of Available Public Space

Locations of new stations for Phases 3 and 4 should carefully be determined at the sites where exists spacious land available along roads, sidewalks and publicly owned land areas. These land areas can be converted for station plazas to locate a feeder bus terminal, or parking space for feeder transport modes, including paratransits.

(5) Smooth Traffic Flows and Circulations

A smooth traffic circulation system should be designed for incoming and outgoing traffic at the station plaza, installing a reliable signaling system and right/left-turn dedicated lanes at main intersections for access to the station. The available space within the right of way is utilized at maximum level for the traffic management engineering.

(6) Provision of Different Types of Parking Space

Many stations along Delhi Metro have placed parking lots for cars and motorbikes, but not sufficient enough. In order to encourage car/motorbike users to shift to the Metro system, inter-connectivity between cars and the Metro needs to be ensured, providing with different types of parking and/or pick-up facilities for Park-and-Ride and Kiss-and-Ride Systems. These facilities are convenient for those who are commuting-time conscious, residing in suburban areas and working in the central business district.

(7) Placement of Rickshaw Pools and Loading Zones

Although it is a fact that rickshaws' occupation at the station is one of hampers against smooth traffic flows, it is not recommended to drive them out of the station, taking into account their significance as a feeder mode. An orderly layout of rickshaw pools and loading zones should be designed, and at the same time, rules and regulations for rickshaws' operation and usage at the station space should be made, making a consensus with the Rickshaw Drivers Association, DMRC, Police Department and City Government.

(8) Securement of Vendors' Space

It is often observed in existing stations that many vendors occupy the road space, thereby causing traffic congestions and chaotic situation at peak-hours. The space for vendors should be deliberately prepared so as to prevent them from encroaching in roads and traffic space. Thus, a comprehensive land use plan, or a zoning system is necessary to be prepared for each station.

(9) Uplifting of Passengers' Convenience Level at Station

In general, the quality level of station facilities and equipment is assessed high, having escalators and modern lighting and signs. Making use of the station's function as an activity center, the station's space may be fully utilized for provision of a wide variety of public and commercial services. The station building, providing rental floors, may be developed as a business center, a commercial center, a culture center and/or a governmental center. Active promotion of such real estate business and commercial operations deserves to be pursued as a measure to strengthen the financial basis of DMRC.

6.1.2 Planning Issues on New Stations Integrated with Urban Development

(1) Ridership Estimate at New Stations

For forthcoming Phases 3 and 4, a number of stations will be newly constructed at virgin areas where urban development will be accelerated, once the station and the Metro service is available. The number of passengers boarding and alighting at all stations needs to be projected as a rational reference for engineering design and spatial planning

of the stations. Planning indicators for transportation such as ridership of the Metro system and usage of feeder bus services and other modes are obtained through a Person Trip Survey, and the demand analysis is subject to conditions of human settlements and economic activities to be performed in the service catchment area of the station. Therefore, it is recommended that a comprehensive station plan should be formulated at each station, based on such a rational data basis, derived from transport behavior surveys.

(2) A Priority Development of Access Roads

A critical factor must be development of access roads to new stations in practice. Road construction will become more difficult after construction of a station than before. The land acquisition of the access road, if is necessary, should be undertaken as soon as possible and it is recommended that the access road is constructed even before the station comes.

(3) Establishment of Executing Body for Station Plaza Development

At present, the station plazas are developed and maintained by the Metro operators, DMRC. However, as mentioned repeatedly, the responsibility for intermodal facilities shall be assumed by both the rail operator and the urban development manager, because the quality of intermodality affects urban mobility, or the urban economy as a whole. A demarcation system of financial and administrative responsibilities for the station plaza needs to be established, and maintained under a functional management body which involves urban development-related authorities and their stakeholders as well as DMRC. In this regard, it is recommended that the **Delhi Metro Intermodal Transport Committee** (DMITC) is established as soon as possible.

6.2 Coherence of Rail and Urban Development

The urban railway network project is always expected to be implemented in association with urban development projects related to or supported by the new transport network. Give a coherence of the two, investments on both sectors are economically effective and beneficial to each other. In this sense, the following four (4) measures are recommended to be undertaken by the authority relevant to urban planning and development as well as DMRC. JICA's assistance is further expected to support the execution of these measures.

(1) Needs to Build a Comprehensive Urban Transport Master Plan

It is often observed in Delhi Metro that no sufficient linkage between the Metro and feeder transport services have taken place. In other cities such as Metro Manila and Bangkok, the urban railway systems are being developed under a master plan addressing land use cum transport systems on long-term perspectives.

Needless to say, the Metro system shall function as a public transport corridor in the entire public transport network, because of its massive transport capacity; at the same time, the Metro shall be a trunk axis of the entire urbanization structure, which will affect

economic potentials along the axis. Therefore, without coherence of development strategies between the Metro system and the urban development, economic rationales of both investments are not assured. Therefore, an integrated implementation in close coordination with urban planning-related authorities of both central and local governments is essential to achieve more beneficial outcomes from the project.

(2) Periodical Monitoring for Integrated Project Implementation

The development of the Metro system is time- and money-consuming work in a long term; therefore, socioeconomic conditions at the time when the project was planned and designed are greatly changed when the project is completed. It is natural that a gap between the plan and the reality takes place in the course of the project implementation. A flexible system to adjust the project to meet a practical reality needs to be established at the implementing body, DMRC, under close consultation with relevant authorities. For this purpose, an appropriate monitoring system should be formed from the technical and financial viewpoints.

This is a substantial need of JICA as well which is providing financial support. The intermediate monitoring and technical assistance from a financier's point of view shall be undertaken periodically, and some amendment of the investment scheme, if necessary, shall be timely made in such a way that economic benefits of the investment will be maximized. In this sense, if the necessity of an additional investment for a sub-project relevant to strengthening of intermodal functions is identified on a rational basis, JICA shall be flexible to amend the bilateral agreement. It is often seen that a related project, which requires a small investment, may bring a great benefit on the entire project.

(3) Establishment of Holistic Urban Transport Database for Delhi Metropolitan Area

In order to justify such a huge public investment for the Metro system, a holistic urban transport database should be developed to facilitate a rational project evaluation. Without reliable and updated data/information on residents' transport behaviors, any quantitative analysis to depict a rational investment scheme cannot be made, and long-term perspectives on urban changes by impacts of the Metro system cannot be predicted on a scientific basis. This means that given no reliable database, all decision-making cannot help being subjective, controversial and/or politicized. Currently, Delhi Metro is in such case.

It is strongly recommended that a Comprehensive Urban Transport Master Plan in the Delhi Metropolitan Area (CUTMAP-DMA) be conducted, including the holistic transport data base building. The basic urban structure addressed by CUTMAP-DMA should keep a basic consistency and coherence with the existing Delhi Metropolitan Area Master Plan, but the transport sector should be deepened in consideration of the integrated public transport network system. This study needs to justify projects in the forthcoming Phases 3 and 4, and technical and financial assistance of JICA is expected for their conduct which is organically linked with the financial assistance for Phases 3 and 4.

A presentation document

1. Current Issues and Improvement Measures of Intermodal Transfer

Functions of Metro Stations:

Mr. T Nagai, JICA Study Team

2. Present Condition of Urban Railway Network and Feeder Bus Service in

Tokyo Metropolitan Area:

Prof. Dr. S. Iwakura,

Shibaura Institute of Technology

3. Intermodal Transfer Development of Tokyu Railways at Stations:

Mr. Y Kadota,

Manager of Planning Division, Headquarters of Railway

Undertaking, Tokyu Corporation



Table of Contents

1. Study objectives and approach
2. Identification of current issues of intermodal transfer functions
3. Improvement measures of intermodal transfer functions
4. Implementation system

1. Study Objectives and approach

1-1 Study Objectives

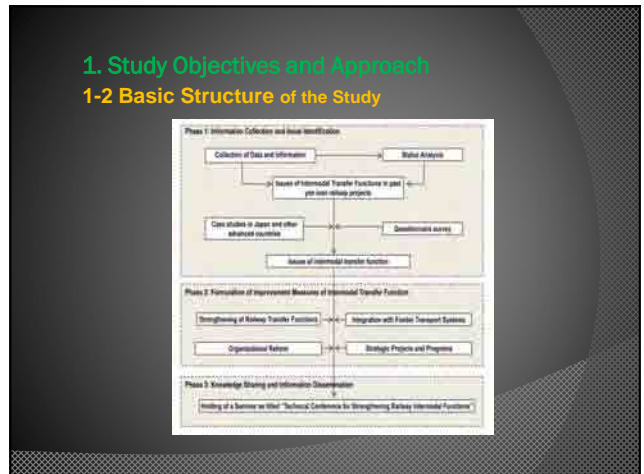
To identify current problems and vital issues of intermodal transfer functions at railway stations and to formulate improvement measures for the intermodal transfer functions to facilitate more passengers' use of the railway systems

Target of the Study:

To build an effective promotion policy for public transportation usage in Delhi Metropolitan Area, by improving intermodal transfer functions of the stations

Expected Outcomes:

to prepare strategic projects and / or programs to implement the policy above. The outcomes of this study is expected to be a model for other cities



1. Study Objectives and Approach

1-2 Technical Points of View

Point 1: Classification of railway stations for characteristics of stations and catchment influential areas

A Relation between Development of Transfer Facilities and Control Capacity of Railway Access Traffic

Sources: A Study on the Station Place Analysis of Private Railways

1. Study Objectives and Approach

1-2 Technical Points of view

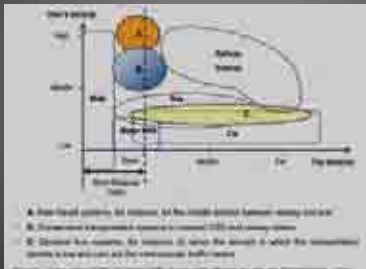
Point 2: Integration with feeder systems, including pedestrians for non-resistant distance transfer

The distance for which the pedestrian can walk without any repulsiveness, and the psychological length of the time limit

Items	Walking Distance or Time without any Repulsiveness	Source
Ordinary city roads	400m	Sweden-Runde Technology Institute
Roads and road streets	200m	
Congested roads	30 to 50% increase	
Urban	100m	UK Road & Transportation Research Institute
	50m	
Cities in East South Asia (in metropolitan)	100 to 200m	Transportation Economy Research Institute, Japan
Control of bus stops and car parks	50m	
Residential area adjacent crosswalk	20m from the crosswalk	Research in USA & Europe
Residential area adjacent traffic signal	10m along for opposite walk	
Walking time for railway crossing	40 seconds	Japan National Railway
Average walking distance for speed camera	100m	

1. Study Objectives and Approach
1-2 Technical Points of View

Functional Locations of Transportation Means in Relation between Trip Distance and User Density



1. Study Objectives and Approach
1-2 Technical Points of View

Point 3: Seamless intermodal transfer between the railway and other traffic means

Psychological time to show the repulsiveness for the Transfer of the mass transit

	Psychological time, given an hour for a ride on railway and bus
When walking to the station and bus stop	1.75 times
When transferring	2 times
When walking	3 times

Source: French National Research Institute

2. Identification of Current Issues of intermodal transfer functions

2-1 Interview Survey

- Objectives of Interview Survey**
- 1) To grasp the characteristics of Metro users and non-Metro users in different category of stations and their districts within the catchment influence areas of the stations
 - 2) To grasp the improvement measures of intermodal transfer functions desired by Metro users
 - 3) To clarify the reasons why non-Metro users utilize other traffic means and the improvement system of intermodal transfer functions with which non-Metro users are likely to utilize Metro

- Basic Framework of Interview Survey**
- 1) Total number of sampling
Home and Enterprise Interview Survey: 500
Intermodal Transfer Passenger Interview Survey: 400
 - 2) Zoning Indicators in Catchment Influence Area of Station for Sampling
Distance from Station: 1 km / Over 1 km
Walking Distance from the Nearest Bus Stop: 10 minutes / Over 10 minutes
Bus Service: DMRC Feeder Bus / DTC + Private Bus / Both

2. Identification of Current Issues of intermodal transfer functions

2-2 Classification of Metro Stations for Survey

- Station Category 1 Representative Candidate Station: SHAHDARA
Suburban station group with the station plaza, feeder buses, and car parks etc. and passengers estimated to increase smoothly within the control capacity of station plaza and access roads
- Station Category 2 Representative Candidate Station: JANAKPURI WEST
Suburban station group without the station plaza and passengers estimated to face limits in future although passengers are increasing at present with feeder buses
- Station Category 3 Representative Candidate Station: UTTAM NAGAR WEST
Suburban station group without the station plaza and feeder buses or car parks, which catchment influence area is limited to the walking area, and the passengers estimated to face limits in near future, although increasing at present
- Station Category 4 Representative Candidate Station: RAJIV CHOWK
Station group in C.B.D. which has no station plaza but in which passengers are increasing smoothly with feeder buses

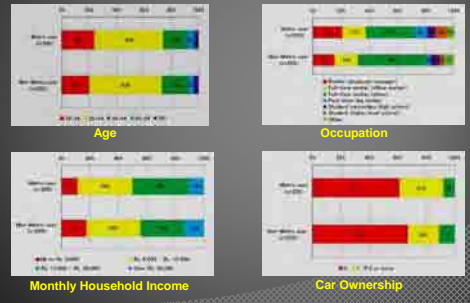
Classification of Metro Stations by their characteristics

Classification of Metro Stations by their characteristics

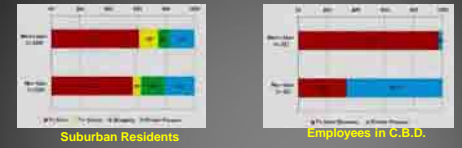
2. Identification of Current issues of intermodal transfer functions

2-3 Findings of Interview Survey

2-3-1 Attributes of Respondents



(2) Trip Purpose

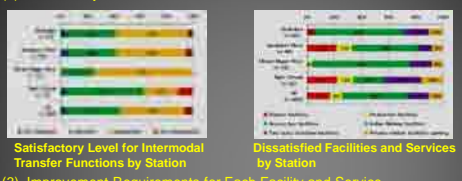


2-3-2 Satisfactory Level and Improvement Requirements of Metro Users

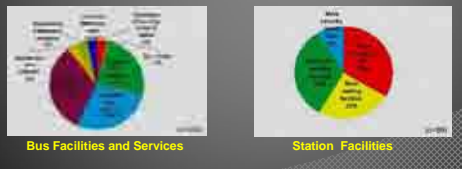
(1) Access Traffic Means to Station



(2) Satisfactory Level

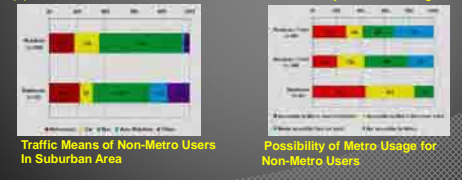


(3) Improvement Requirements for Each Facility and Service

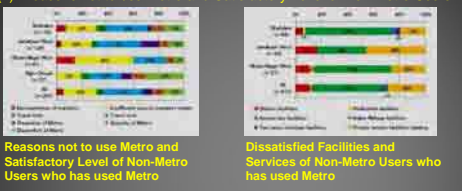


2-3-3 Satisfactory Level and Improvement needs of Non-Metro Users

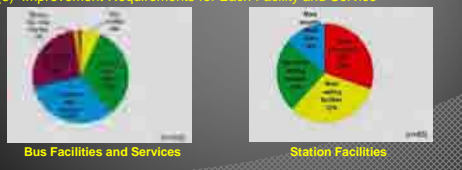
(1) Traffic Means of Non-Metro Users and Possibility of Metro Usage



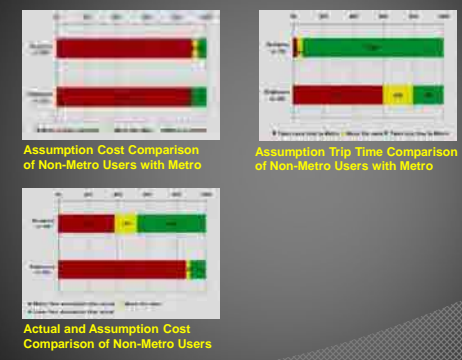
(2) Reasons not to use Metro and Satisfactory Level of Non-Metro Users



(3) Improvement Requirements for Each Facility and Service



(4) Analysis on Consciousness of Non-Metro Users for Metro Usage



Facilities of Taxi, Auto Rickshaw, and Rickshaw

2-3-4 Satisfactory Level and Improvement Requirements of Intermodal Transfer Passengers

(1) Satisfactory Level for Transfer Functions with Other Modes

Satisfactory Level of Metro Users for Transfer with Other Modes

Dissatisfied Facilities and Services of Metro Users

(2) Improvement Requirements for Each Facility and Service

Station Facilities

Pedestrian Facilities

Indian Railway Facilities and Services

DTC Bus Facilities and Services

Motorcycle Parks

Car Parks

2. Identification of Current issues of intermodal transfer functions

2-4 Awareness of Issues for Intermodal Transfer Functions

(1) Awareness of Issues of Metro Users

Station Category	Priority Issue	Other Issues
Station Category 1 (SHAHDARA)	Insufficient Access Bus Service (Route, Frequency, Punctuality)	Space for Auto Rickshaw / Rickshaw Stand / Drop Off Private Vehicle Facilities / Parking
Station Category 2 (JANAKPURI WEST)	Insufficient Access Bus Service (Route, Frequency, Punctuality)	Free Passage with Escalator / Lift in the Station Pedestrian Facilities
Station Category 3 (UTTAM NAGAR WEST)	No Wide Road for Feeder Buses	Space for Auto Rickshaw / Rickshaw Stand / Drop Off Private Vehicle Facilities / Parking
Station Category 4 (RAJIV CHOWK)	Space for Auto Rickshaw / Rickshaw Stand / Drop Off	Space for Access Bus Facilities Security Check Line

(2) Reasons for Non-Metro Users not to Use Metro

Station Category	Priority Issue	Other Issues
Station Category 1 (SHAHDARA)	Travel Cost	Insufficient Access Transport Means Discomfort of Metro
Station Category 2 (JANAKPURI WEST)	Travel Cost	Insufficient Access Transport Means Frequency of Metro
Station Category 3 (UTTAM NAGAR WEST)	Insufficient Access Transport Means	Travel Cost Inconvenience of Transfers
Station Category 4 (RAJIV CHOWK)	Travel Cost	Insufficient Access Transport Means Discomfort of Metro

(3) Awareness of Issues of Transfer Passengers with Other Modes

Transfer Mode	Priority Issue	Other Issues
Indian Railway Transfer	Station Facilities (New Ticket Vending Machine, Waiting Facility, Security Line, Escalator, etc.)	Insufficient Indian Railway Service (Frequency, Punctuality, etc.) Pedestrian Facilities
DTC Bus Transfer	Station Facilities (Same as above)	Insufficient Access Bus Service (Route, Frequency, Punctuality) Pedestrian Facilities
Motorcycle Park & Ride	Private Vehicle Facilities / Parking	Station Facilities (Same as above) Pedestrian Facilities
Car Park & Ride	Private Vehicle Facilities / Parking	Station Facilities (Same as above) Pedestrian Facilities

3. Improvement Measures of Intermodal Transfer Functions

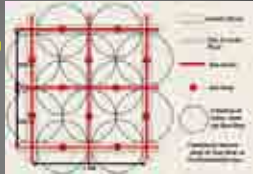
3-1 Improvement Requirements Identified by the Survey

	Access Road and Feeder Bus System	Intermodal Transfer Functions around Station
Station Category 1 (SHAHDARA)	*Enhancement of Bus Service Level (New Route & Stop, Frequency, Punctuality, etc.)	*Provide More Spaces for Auto Rickshaw / Rickshaw Stand / Drop Off *Private More Vehicle Facilities / Parking
Station Category 2 (JANAKPURI WEST)	*Enhancement of Bus Service Level (New Route & Stop, Frequency, Punctuality)	*Provide Free Passage with Escalator / Lift in the Station *Develop Pedestrian Facilities
Station Category 3 (UTTAM NAGAR WEST)	*Urban Development for Providing Bus Roads	*Space for Auto Rickshaw / Rickshaw Stand / Drop Off *Private Vehicle Facilities / Parking
Station Category 4 (RAJIV CHOWK)	*Provision of Access Bus Facilities near Station	*Provision of Auto Rickshaw / Rickshaw Stand / Drop Off Facility near Station *Improve Security Check Line System
Transfer Functions with Other Modes	*Improve Station Facilities (New Ticket Vending Machine, Waiting Facility, Security Check Line, Escalator, etc.) *Enhance Indian Railway Service Level (Frequency, Punctuality, etc.) *Improve Access Bus Service (New Route & Stop, Frequency, Punctuality, etc.) *Provide More Private Vehicle Facilities / Car & Motorcycle Parking *Provide Comfortable Pedestrian Facilities with Green Shelter *Review the Fare System and Synchronize the Timetable of Different Modes	

3. Improvement Measures of Intermodal Transfer Functions

3-2 Basic Planning System of Bus Route and Bus Stop

Restructuring Bus Route and Bus Stop System for Improving Accessibility to Metro Station



Principal of City Planning Road in Residential Area
 Interval of Arterial Road: 1km
 Interval of Sub-Arterial Road: 500m



Planning Principal of Bus Route and Bus Stop
 Interval of Bus Route: 500m at maximum
 Interval of Bus Stop: 400-500m
 Catchment Service Area: 200-250m of Radius from Bus Stop

3. Improvement Measures of Intermodal Transfer Functions

3-3 Case Studies on Intermodal Transfer Functions

(1) Station Square

Kaihjin Makuhari Station in Makuhari New City Center

South Station Square (Taxi Pool)

North Station Square (Bus Terminal)

3. Improvement Measures of Intermodal Transfer Functions

3-3 Case Studies on Intermodal Transfer Functions

(2) Traffic Terminal Complex



Los Angeles Green Line 1-105 Station

Location Map	Bus Way
Park & Ride	LRT Station

Vertical Transfer among 3 Different Modes



Akihabara Station

Vertical Transfer among 3 JR Lines, Tsukuba Express Line, Tokyo Metro Line and Bus Terminal

3. Improvement Measures of Intermodal Transfer Functions

3-3 Case Studies on Intermodal Transfer Functions

(3) Seamless Transfer by "Transport Alliance System"

Definition of "Transfer Alliance":
 System and organization to develop, operate and control all public transport systems in the unitary manner inside the region

Required four types of cooperation

- 1) Mutual cooperation among public transport operators
- 2) Cooperation between public transport and my car policies
- 3) Cooperation among urban transport policies, city planning and land use policies
- 4) Cooperation among central, state, municipal government, and public transport corporations and companies

Social Background Introduced in Hamburg in 1965

- 1) Enhancement of convenience for users
- 2) To avoid the unnecessary competition among companies
- 3) To save expenditure and get out of deficit

Effectiveness of "Transfer Alliance": Increase of users
Preconditions to introduce "Transfer Alliance": Public support and subsidy for public transport

Outline of "Transport Alliance"

Common Transport Plan

- Railway and bus route planning as a total system
- Promotion of simple transfer
- Coordination of timetables
- Cooperation with regional organization

Cooperative Fare System

- Time shortening with shortest distance
- Rationalization with clear system
- Cooperation with outside system

Fare Revenue Share

- Distribution to corporations and companies
- To keep fairness and incentive

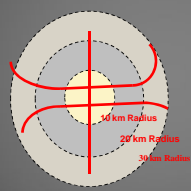
3. Improvement Measures of Intermodal Transfer Functions

3-3 Case Studies on Intermodal Transfer Functions

(4) Seamless Transfer by "Zone Fare System"

Cases

- Germany: Hamburg, Munich, Frankfurt, Dusseldorf, Hanover
- France: Paris

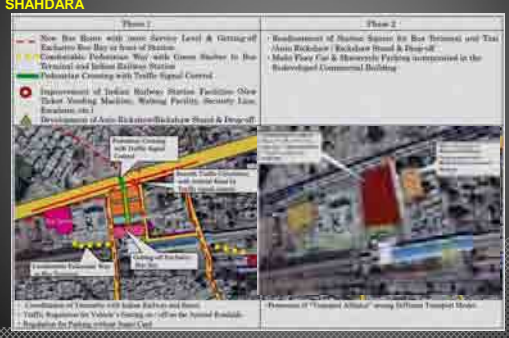


10 km Radius
20 km Radius
30 km Radius

— Metro

*Same Fare within Same Zone in Spite of Transfer with Other Modes
 * Increase of Fare Getting over Zone Boundary

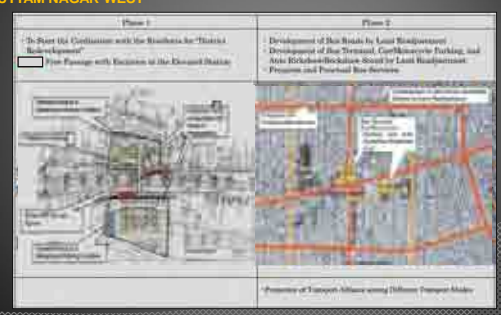
3. Improvement Measures of Intermodal Transfer Functions
3-3 Review of Intermodal Transfer Functions around 4 Stations Based on Interview Survey
SHAHDARA



3. Improvement Measures of Intermodal Transfer Functions
3-3 Review of Intermodal Transfer Functions around 4 Stations Based on Interview Survey
JANAKPURI WEST



3. Improvement Measures of Intermodal Transfer Functions
3-3 Review of Intermodal Transfer Functions around 4 Stations Based on Interview Survey
UTTAM NAGAR WEST



3. Improvement Measures of Intermodal Transfer Functions
3-3 Review of Intermodal Transfer Functions around 4 Stations Based on Interview Survey
RAJIV CHOWK



4. Implementation System

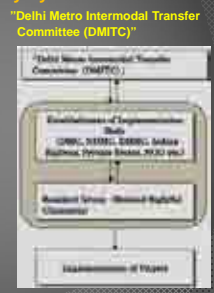
4-1 Basic Requirements for Implementation

- Comprehensive Urban Master Plan Review System**
 - Review of Existing Urban Master Plan (Land Use / Transport) in Case to Construct Urban Railway
 - Review of Existing Project Implementation System
- Legal and Financial Support System**
 - Legally Authorized Planning and Implementation system for Developing Intermodal Transfer Functions together with Financial Support System
- Public and Private Partnership**
 - Citizen's Participation in the Development of Intermodal Transfer Functions
 - Utilization of Private Vitality for Development

4. Implementation System

4-2 Institutional Development for Improving Intermodal Transfer Functions of Urban Railway System

- To establish two organizations for improving the intermodal transfer functions in terms of both hardware and software policies
- "Delhi Metro Intermodal Transfer Committee" (Purpose)
 - Development and Improvement of intermodal transfer functions of urban railway stations and enhancement of functions integrated with urban development of surrounding area
- "Delhi Transport Alliance" (Purpose)
 - Realization of comprehensive public transport systems for which Delhi citizens are attracted in alliance among transport-related corporations and companies



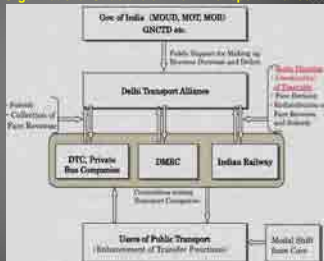
4. Implementation System

4.2 Institutional Development for Improving Intermodal Transfer Functions of Urban Railway System

Organizational Structure of "Delhi Transport Alliance"

Character of "Delhi Transport Alliance"
 - New Type of Transport Alliance Growing Itself in Autonomic Manner
 - To Target Solution of Issues based on Citizen's Needs
 - To Own Mutual Interest in Common

Issues to be Studied
 - Route Planning
 - Fare System
 - Timetable
 - Service Level
 - Marketing
 - Financing etc.



APPENDIX





Present Condition of Urban Railway Network and Feeder Bus Service in Tokyo Metropolitan Area

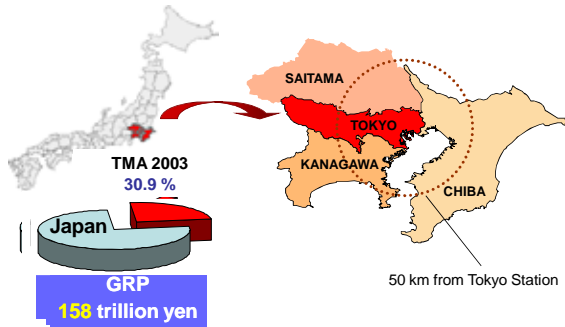
Prof. Dr. IWAKURA Seiji
Shibaura Institute of Technology

Contents

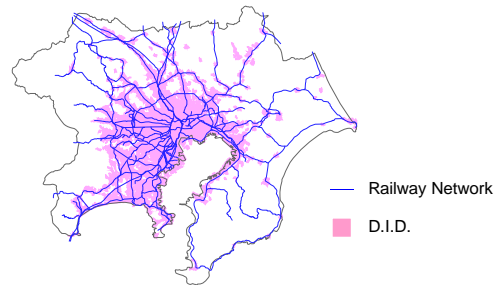
1. Urban Railway Network in TMA
2. Historical Process of Urban Railway Network
3. Current Issues of Feeder Bus Service in TMA

1. Urban Railway Network in TMA

Tokyo Metropolitan Area

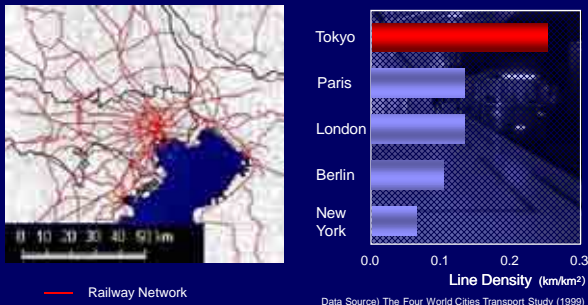


Railway Oriented High Density Urban Development



D.I.D.: Densely Inhabited District, population density over 4,000 persons/km² and resident population of over 5,000.

Urban Rail Network in TMA



Among the world's major metropolitan areas, railway route density is highest in TMA

Major Public Transport System in TMA (2002)

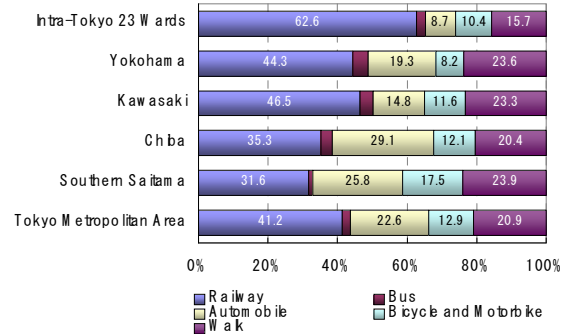
	Route Length (km)	Averg. Daily passenger ('000)	
Subway	333	8,006	<ul style="list-style-type: none"> City governments (45%) Tokyo metro (55%)
JR	887	14,457	Formerly national rail, now privatized
Pvt Rail	1086	13,576	<ul style="list-style-type: none"> 15 pvt companies Commuter lines
Bus	14,122	4,584	<ul style="list-style-type: none"> City governments Private operators Mainly feeder to railway
Tram	17	109	Main mode in the city core until the system was phased out in 1960s

Hierarchical Urban Railway Network

Railway Type	Station Distance	Operating Speed *
Shinkansen Railway (Bullet Train)	30 – 50 km	120 -130 km / hr
Inter-city Train (Japan Railways)	5 – 6 km	50 - 60 km / hr
Express Train (Private Railways)		
Ordinary Train (Private Railways)	1 – 2 km	40 - 45 km / hr
Subway	0.5 – 1 km	30 - 35 km / hr
Monorail / AGT	0.5 – 1 km	20 - 30 km / hr
Trunk Bus	0.2 – 0.3 km	10 – 20 km / hr
Community Bus	– 0.1 km	– 10 km / hr

* Includes stoppage time at station

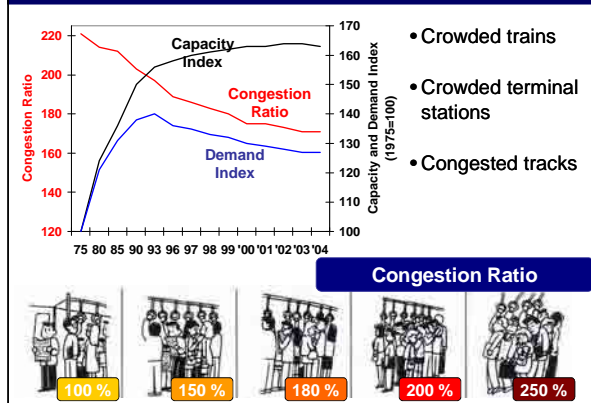
Modal Share of Commuters



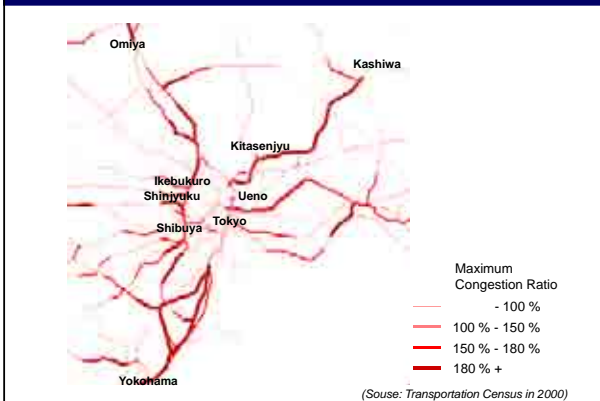
Peak Hour Crowdedness Due to Higher Demand



Peak Hour Problems in Tokyo Urban Railway System

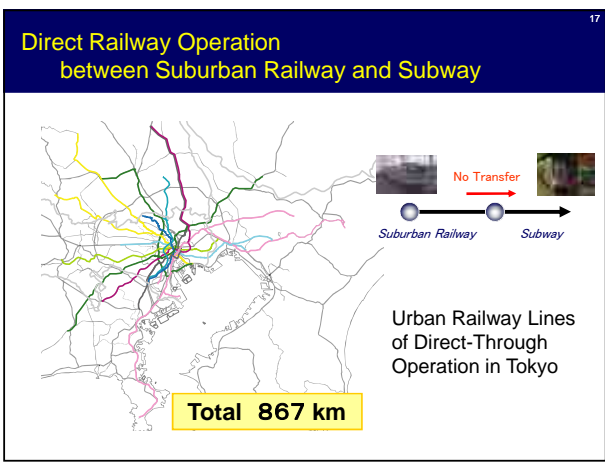
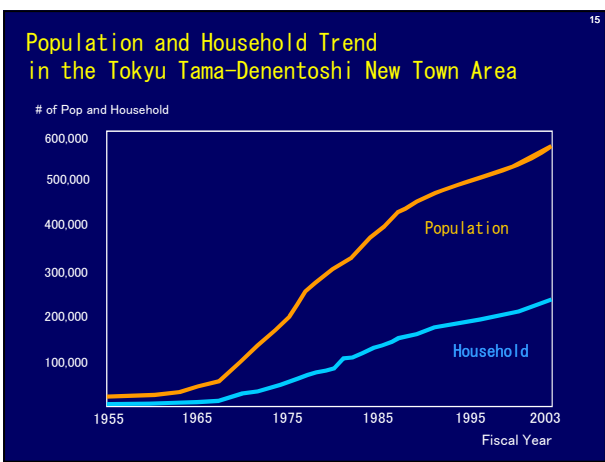
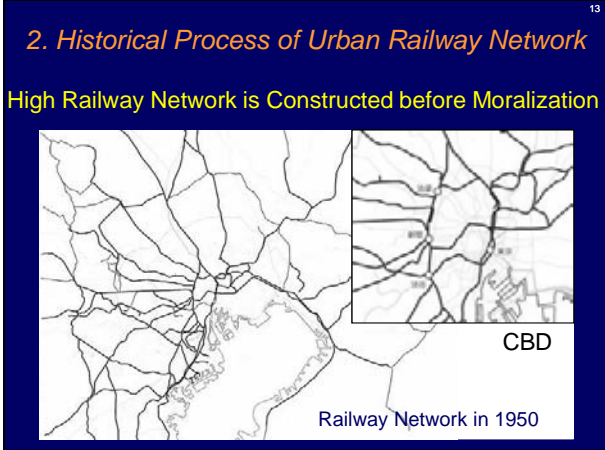


Ratio of Congestion in TMA



Urban Railway Network Long Range Plan -2015





- ### Direct Railway Operation between Suburban Railway and Subway
- For Suburban Railway Operators**
- Shorten Time Distance to Downtown
 - Development of Area along Railway
 - Reduction of Congestion in Downtown Terminals
- For Subway Operators**
- More Demand
 - Availability of Railway Yard in Suburban Location

3. Current Issues of Feeder Bus Service in TMA

Present Condition of Bus Service

- Primary-feeder service to railways
- Operated by private companies and city government
- Generally no competition between bus and railway

Present Condition of Bus Service

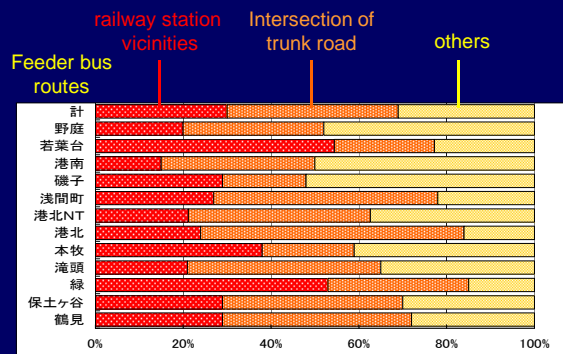


- Low velocity around the station

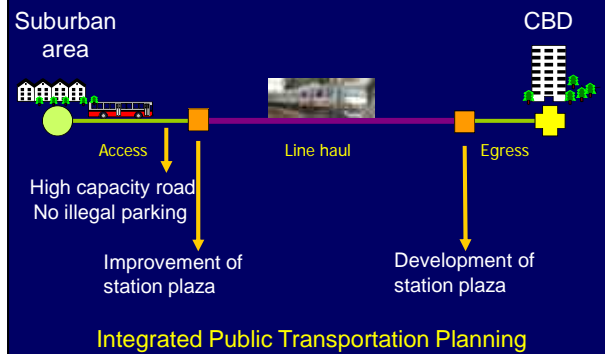


- Low road capacity
- Small station plaza

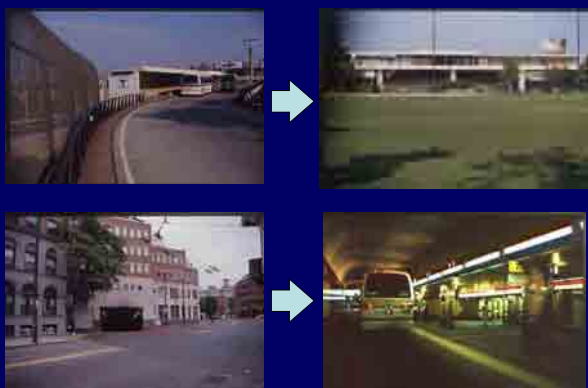
Road section of low velocity (under 10km/h)



Total Speed Management



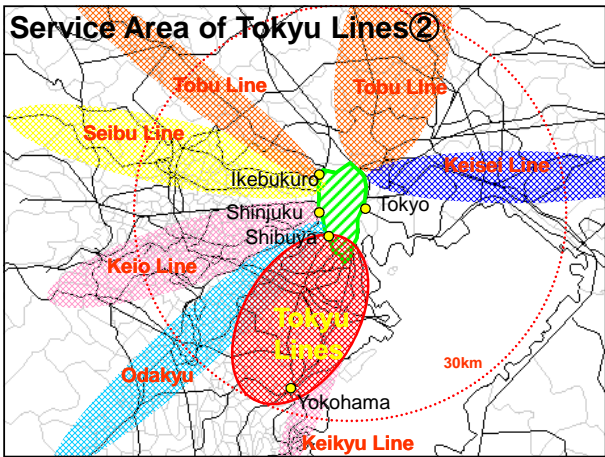
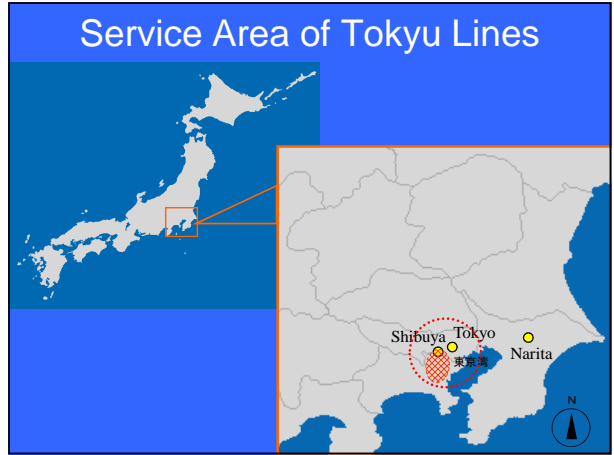
Good practice of feeder bus service in Boston



Utilization of underground space after open cut construction

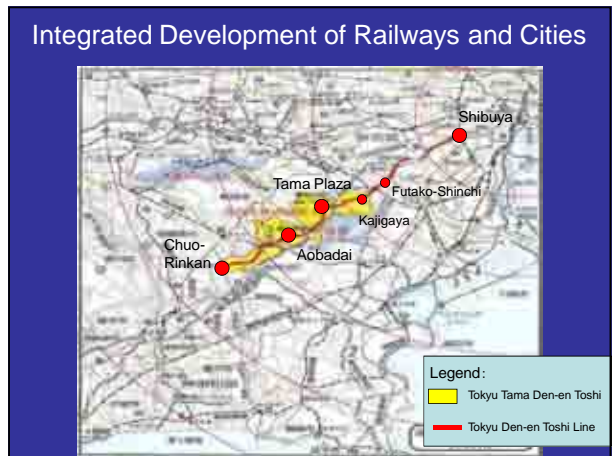


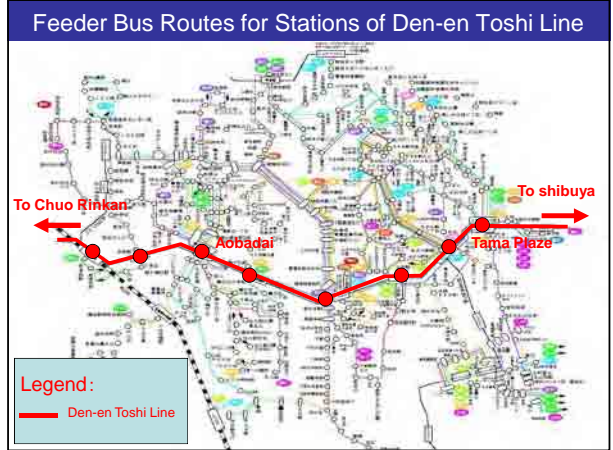
Thank you for your kind attention



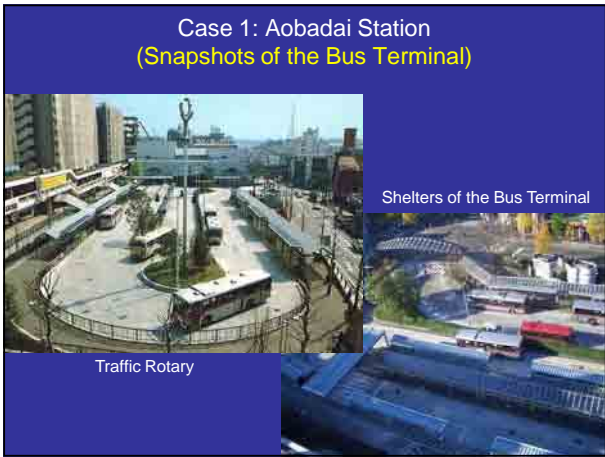
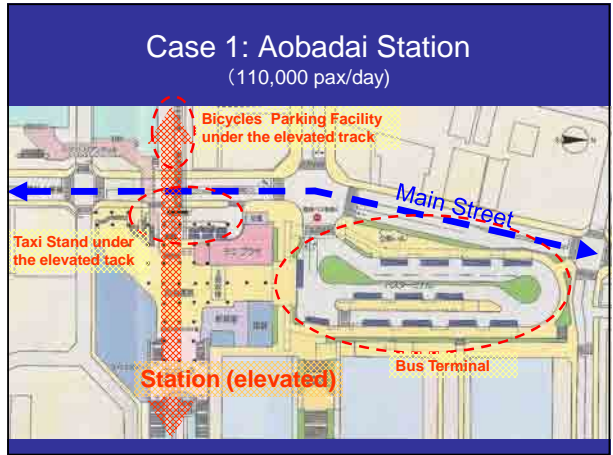
Business Performance Profile (FY2008)

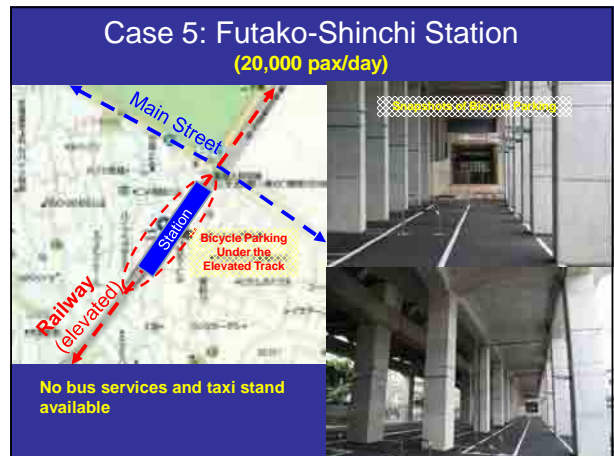
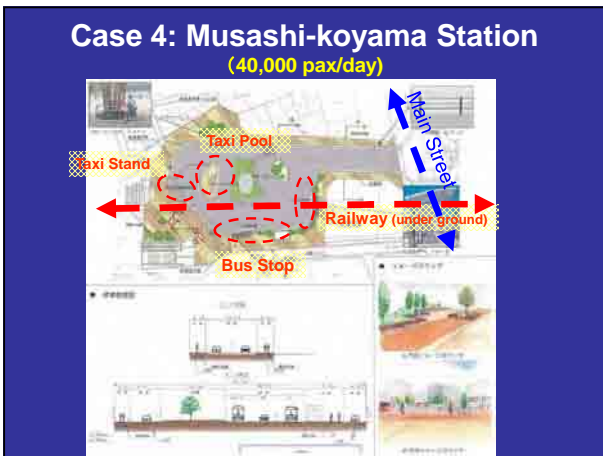
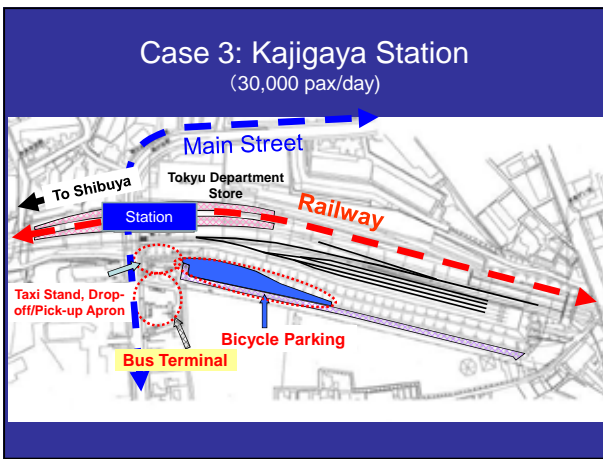
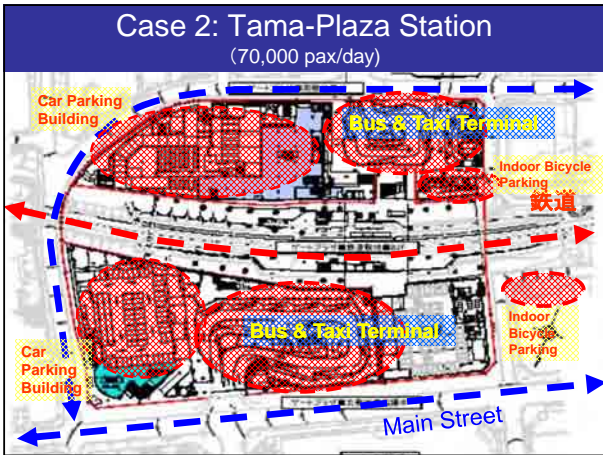
- **Total Ridership**
1.065 billion pax/year
(or 2,920,000 pax/day)
- **Annual Profit**
142.2 billion Yen = US\$1.5 billion
- **No. of Total Employees**
About 3,400 persons
- **Operation-Km and Stations**
102.9km · 98 stations





Introduction to Intermodal Transfer Systems of Tokyu Lines





Basic Development Concepts on Intermodal Facilities

(1) Stations with Feeder Bus Services

- Locate **Bus Terminal/Bus Stops** near by the station
- Locate **Taxi Stands** so as not to intersect with bus traffic flows

(2) Stations without Feeder Bus Services

- Place **bicycles parking** facilities near by the station
- Develop a **station plaza** for a new station

Conclusion

Provision of the best services for users is the best way to enhance the economic values of the areas along with the railway as well as the railway itself.

Thanks....



**The Study on
Strengthening Intermodal Transfer Functions of
Urban Railway Systems
Main Text**