Technical Note on Micro Estimation of Urban Railways and High-Speed Railways Investment Needs

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1. Introduction

Recent economic development and population growth in Asia has caused traffic congestion and corresponding air pollution, negatively impacting the urban environment.

One effective method for dealing with traffic problems in cities is to improve public transportation systems such as urban railways. Urban railway networks such as MRT (Mass Rapid Transit) are both started and expanded in countries such as India, Malaysia, Thailand, and the Philippines. Furthermore, MRT operation in countries such as Vietnam, Indonesia and Bangladesh will begin in near future, and in Cambodia, an urban railway plan has been proposed by a JICA survey. Recently, the development of railway systems in Asian is increasing.

High-speed railways, responsible for high-speed mass transport between cities, are also being developed. Currently, some countries like India, Thailand, Malaysia-Singapore, Vietnam, and Indonesia are planning their high-speed railway projects and are proceeding to the implementation stage.

Developing countries have few previous experiences introducing urban and high-speed railways. It is difficult to assess the current demand through macro estimations. For this reason, this research study estimates the overview of the plans in Asian countries. I believe that the results of this survey will help to estimate the future demand for railway systems in Asia.

2. The growth of Asian countries and the trend of railway needs

Before estimating urban railway and high-speed railway investment needs, I explain in this chapter recent growth and railway demand in Asia. I also highlight points to be considered when assessing long-term demand in the future.

2-1 The growth of Asian cities and the trend of railway needs

The growth and development of Asian cities is remarkable.

As one example, I show the increase of traffic in the city of Phnom Penh in Cambodia in Figure-1.

In Phnom Penh, Japan International Cooperation Agency (JICA) conducted a Person Trip Survey (a household survey focusing on traffic conditions) in 2000 and 2012.

The traffic volume in Phnom Penh city has increased by 2.5 times from 2000 to 2012. In particular, the rapid growth in the volume of motorcycle traffic in 2012 far exceeds former study's prediction.

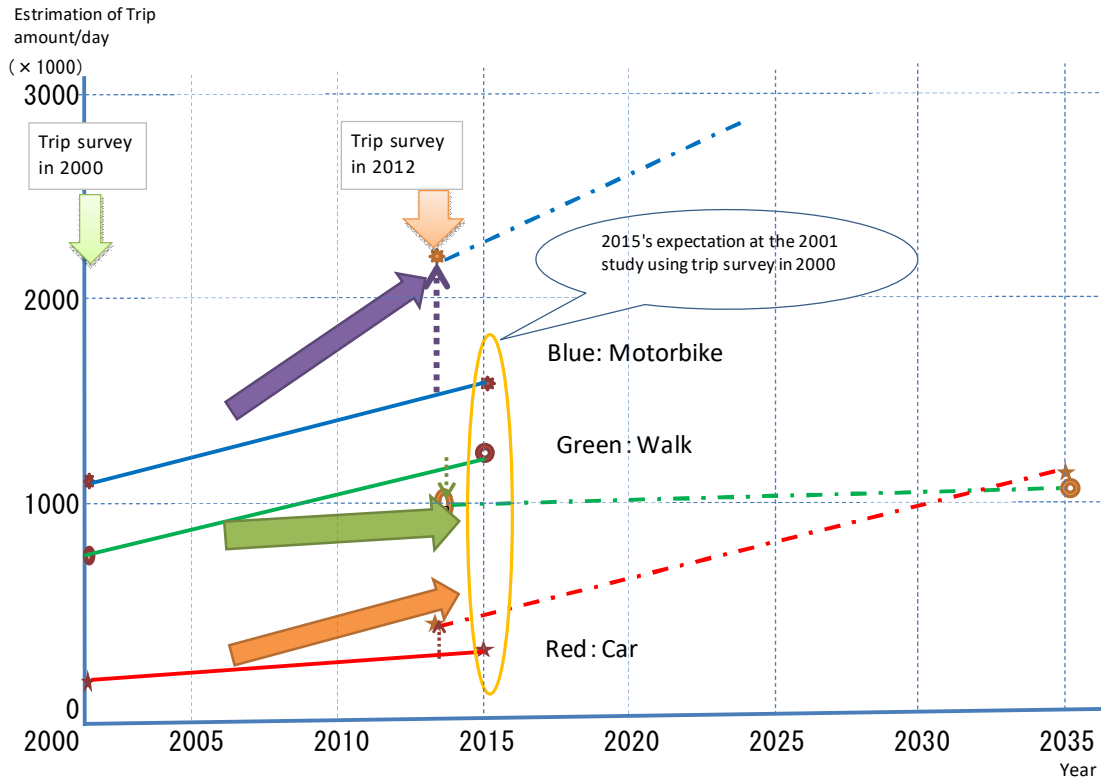


Figure-1 Phnom Penh urban transportation Study case

Next, Figure-2 shows how the development phases of the cities are related to the timing to start operating their metro systems in Asia. The trends of urban population and GDP per capita are plotted in the figure. The solid line shows US$ 3 billion of the product of per capita GDP multiplied by urban population. Dotted line shows US$ 30 billion of that. In JICA's survey, the time to start the metro operation in the respective cities (These cities are shown by cross marks) mostly falls between two lines. Currently, there are cities such as Quezon (the Philippines), Yangon（Myanmar）, and Hai Phong (Vietnam) in this range, and Phnom Pen is approaching this range(These cities are shown by circle marks). This indicates that railway

construction plans will start in many Asian cities in the near future.

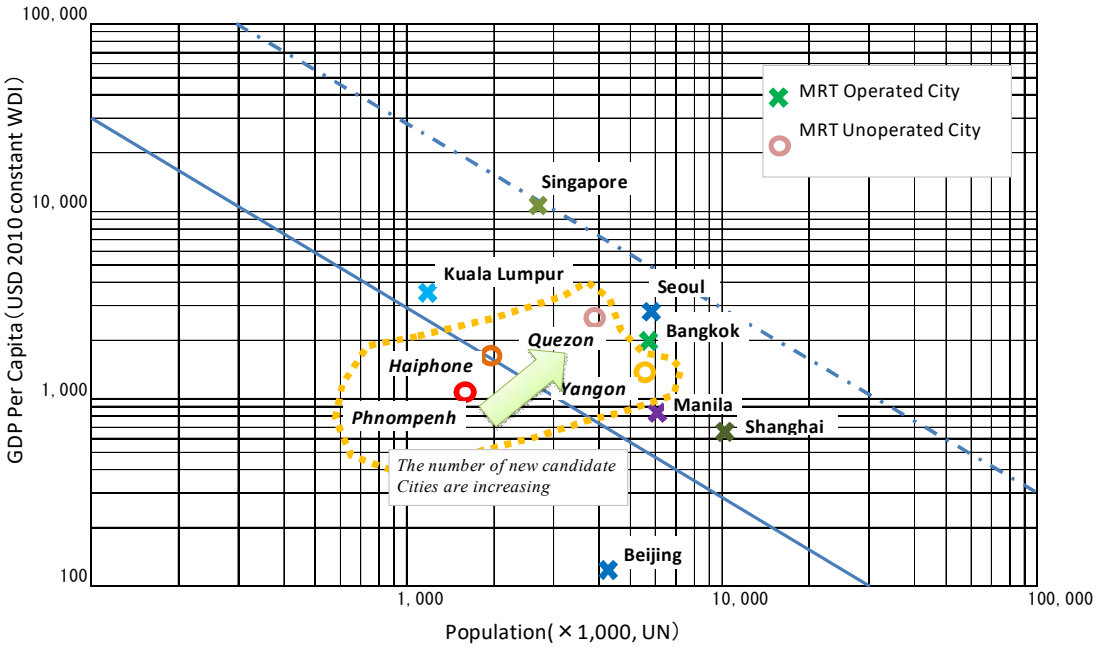


Figure-2 Per Capita GDP and Urban Population at the Time of MRT Introduction

Note: The red solid line indicates the GRDP of US$3 billion and the dotted line the GRDP of US$30 billion (constant 2010US$). GRDP of each city is calculated by multiplying the city population by GDP per capita.

Source JICA Report ：The Research on Practical Approach for Urban Transport Planning 2011

In this micro estimation, I find and summarize the existing plans. However, most existing plans will be completed by around 2023. It is also necessary to consider the forecasted demand in cities where plans are considered afterward that point.

2-2 Impact of high-speed railway and issues to consider

Demand for high-speed railway in the Asian region is increasing as the demand for mass transportation between large cities increases. In this research, I summarize existing plans for high-speed rail, which is necessary—as is true of urban railways—to estimate the long-term demand for high-speed railways in these areas.

However, high-speed railways require high investment, operation costs and technologies for operation and maintain the system. To facilitate high-speed railway investment, it is necessary to consider various conditions for appropriate management and investment recovery. For this reason, I think that predicting future plans is more difficult than pridections for urban

railways. In this chapter, I will discuss an example showing the importance of considering the profitability of high-speed railways.

High-speed railways are used for inter-city transport. The competitor for this service is airplane. The benefit of the high-speed railway, it is not only transportation for between the starting and ending points, but also for dealing with various intercity transportation on the way. In order to raise the value of the high-speed railway, it is also important to develop urban area along railway lines and increase the intercity transportation on the way.

See Box Articles

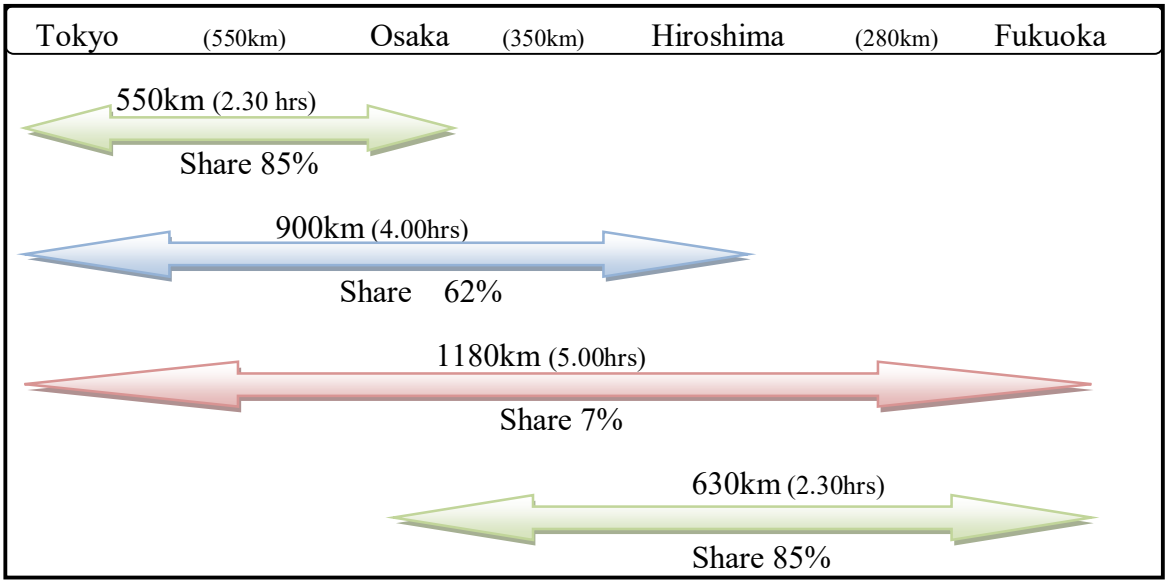
Box Articles: Japanese Shinkansen Experience

(1) Japanese experience; Shinkansen and airplane share

(Note : Shinkansen is Japanese High-speed Railway)

Between Tokyo-Hiroshima city, it takes 4 hours by Shinkansen. Shinkansen has been competing with airplanes to get share of passenger in this section. For destinations closer than that, the share of the Shinkansen is larger. There is only 7% Shinkansen share between Tokyo and Fukuoka where the traveling time is 5 hours.

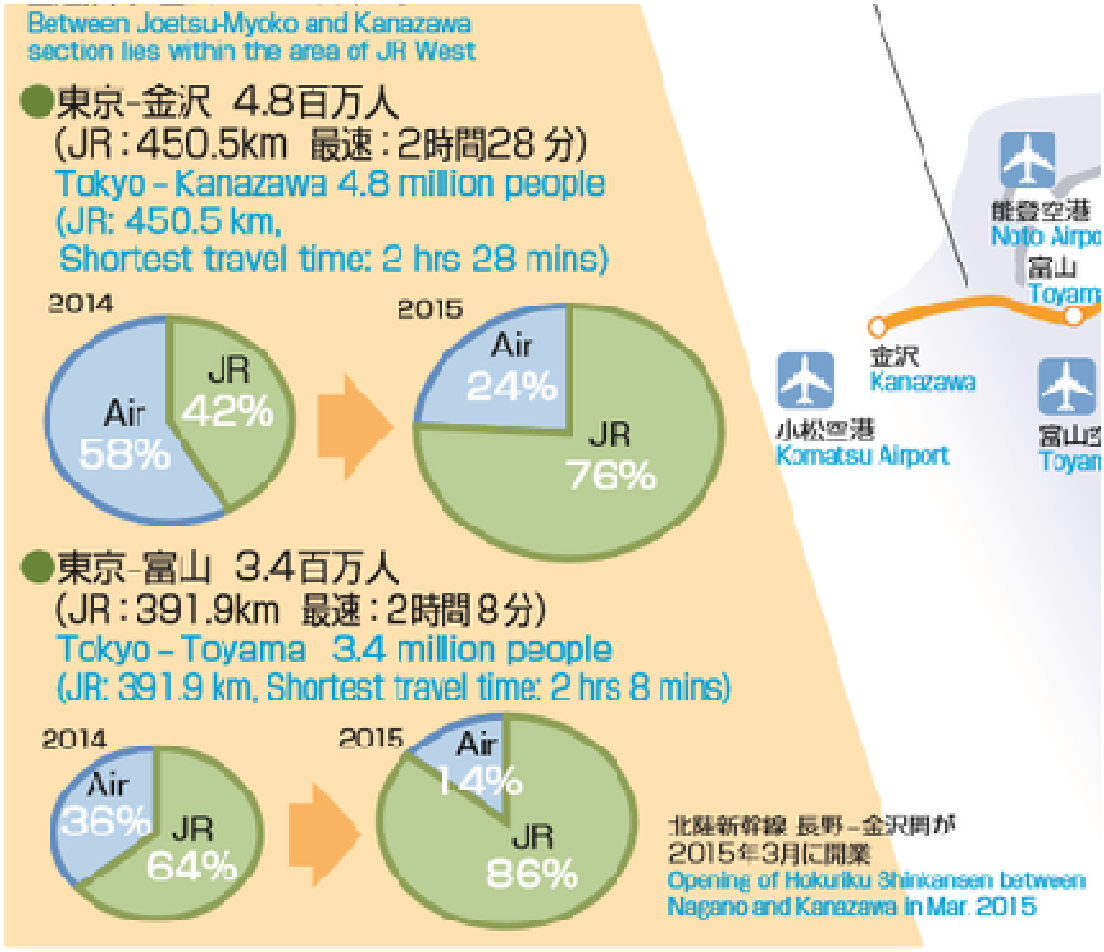
The role of the Shinkansen to deal with various intercity transportations is more important than linking Tokyo and Fukuoka.



Source: JR West Fact Sheet 2016

(2) Impactt of Hokuriku Shinkansen

Hokuriku Shinkansen started it operation in 2015, and has impacted the choice of travel mode. The Hokuriku Shinkansen connects Tokyo to Toyama and Kanazawa in two to two and a half hours, respectively. It can be seen that the percentage of travelers using airplanes versus Shinkansen（Japan Railway：JR) has changed drastically before and after the opening of Hokuriku Shinkansen.



Source：JR East Fact Sheet 2016

Thus, in order to realize a high-speed railway, it is necessary to consider various conditions.

3. Estimation method

I took the following measures to detail each plan:

1) I extracted plans for urban railways and high-speed railways from governments' announcements, news articles, specialty magazines such as Railway Journal, JICA development survey, etc.
2) Based on the above information, I confirmed the official announced plans of the national government, city, and specialty companies like MRT company, or these media reports.
3) Based on information acquired through the public announcements, I extracted information such as project titles, contents of the plans (scale of the projects, routes, project costs, construction periods) and approval information.
4) I assigned the following rank to each project

"A": Construction stage or the plan approved

"B": Detailed information released to the public.

"C": Concept stage, with at least the planned route cleared

Note: In this case, I calculated the cost using the unit price (avarage) of the project in the country or in a neighboring country.

"D": Only the names of plans were mentioned and their contents could not be confirmed

4. Result

The Result of Case 1 (A + B) and Case 2 (A+ B+ C) are shown below.

For reference, I also compared the total infrastructure demand estimate and traffic infrastructure estimate shown by ADB.

(1) Case 1 （A+ B）

(a) Total High-speed railways and Urban railways

	Investment (USD billion)	ADB Trans %	ADB Total %
HSR + URT	1438	17.22%	5.53%
Exclude China	216	2.59%	0.83%
Exclude China and India	97	1.17%	0.37%
ADB 2030 Transportation	8353	100.00%	32.13%
ADB 2030 Total	26000		100%

(b) Urban railways

	Investment (USD billion)	ADB Trans %	ADB Total %
URT	865	10.36%	3.33%

Exclude China	128	1.53%	0.49%
Exclude China and India	64	0.77%	0.25%
ADB 2030 Transportation	8353	100.00%	32.13%
ADB 2030 Total	26000		100%

(c) High-speed railways

	Investment (USD billion)	**ADB Trans %**	**ADB Total %**
HSR	573	6.86%	2.20%
Exclude China	88	1.06%	0.34%
Exclude China and India	33	0.40%	0.13%
ADB 2030 Transportation	8353	100.00%	32.13%
ADB 2030 Total	26000		100.00%

(2) Case 2 （A+ B+ C）

(a) **Total High-speed railways and Urban railways**

	Investment (USD billion)	**ADB Trans %**	**ADB Total %**
HSR + URT	1766	21.14%	6.79%
Exclude China	542	6.49%	2.09%
Exclude China and India	172	2.07%	0.66%
ADB 2030 Transportation	8353	100.00%	32.13%
ADB 2030 Total	26000		100%

(b) Urban railways

	Investment (USD billion)	**ADB Trans %**	**ADB Total %**
URT	912	10.92%	3.51%
Exclude China	175	2.10%	0.67%
Exclude China and India	77	0.92%	0.30%
ADB 2030 Transportation	8353	100.00%	32.13%
ADB 2030 Total	26000		100%

(c) High-speed railways

	Investment (USD billion)	**ADB Trans %**	**ADB Total %**
HSR	854	10.22%	3.28%
Exclude China	367	4.40%	1.41%

Exclude China and India	95	1.14%	0.37%
ADB 2030 Transportation	8353	100.00%	32.13%
ADB 2030 Total	26000		100.00%

From these results the following was extracted:

1) As for Case 2, in relation to the urban and high-speed railways, construction demand is estimated at 1.8 trillion USD for Asia, including China, which is a substantial amount. By comparing the total infrastructure demand of US$ 26 trillion estimated by ADB, the total amount of urban and high-speed railway plans is around 6.79%. This indicates that active investment in the Asian region is taking place.
2) As for Case 2, the scale of these investments between 2016 and 2020 - as most of the available project information relates to these years - is equivalent to 1.1% of the GDP of Thailand, 0.17% of Indonesia's GDP, and 0.26% of the GDP of the Philippines.
3) Most of the existing urban railway plans (Ranked A, B) will be completed in 2023. In most developing countries, it was difficult to identify next plans or visions with clear policy.
4) Some high-speed railways in developing countries adopt a sub high-speed railways (Operates at a speed of 100 to 160 km / h through the improvement of existing railways) at the implementation stage. It is assumed this is based on the financial condition of each country, the construction and operation costs, and so on.

5. Consideration

In this estimation, I compiled, analyzed the plan contents of existing urban railways and high-speed railways. The following points are areas where further consideration is necessary.

1) For urban railways, most of the developed plans are scheduled to be completed by 2023. From now on, we should think about demand as of 2030.
2) For high-speed railways, it is also necessary to consider demand through 2030, taking into consideration the matters stated in 2.(2).

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