

# **Chapter 1: East Asian Infrastructure Development in a Comparative Global Perspective: An Analysis of RIS Infrastructure Index**

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## **1. Introduction**

Infrastructure is a key factor in driving a country's growth and development. As public goods, availability of quality infrastructural facilities assists in mobilizing private investments by reducing the magnitude of required investments. Infrastructure development can also help in narrowing development gaps between developed and laggard regions. Infrastructure, especially transport and connectivity, is crucial for regional cooperation and integration. In the absence of efficient physical connectivity, any initiatives taken towards regional trade liberalization will remain ineffective.

Role of infrastructure in fostering economic development and integration has been supported by the empirical literature. A number of studies have highlighted the importance of physical infrastructure as a determinant of economic growth (e.g. Aschaur 1989; Easterly and Rebelo 1993; and Gramlich 1994; World Bank 1994, for reviews). Favourable role of physical infrastructure in influencing the patterns of foreign direct investment (FDI) inflows has been corroborated by a number of studies (e.g. Loree and Guisinger 1995, and Mody and Srinivasan 1996, Kumar 1998, 2000, 2002a, 2002b). Kumar (2002a) argued that quality of physical infrastructure could be a

particularly important consideration for locational choices for efficiency-seeking or export-oriented FDI flows, a proposition that was supported by the empirical analysis.

A problem faced by empirical studies in a cross-country context while analyzing the role of infrastructure availability is that of measurement of availability of the different components of infrastructure objectively. There are many aspects of infrastructure, for instance, transportation facilities like road network, ports, airports etc., communication infrastructure covering telecommunication network; information infrastructure; energy availability, etc. (see, World Bank, 1994, for indicators of different aspects). A country may be strong in road infrastructure but may have poor telecommunication or information infrastructure. Hence, a measure of either road transport infrastructure or telecommunication infrastructure would not adequately capture the overall quality or availability of infrastructure. At the same time, an objectively measured and constructed single comprehensive indicator of infrastructure availability is very important, but not available. World Economic Forum Reports provide country scores and country rankings on infrastructure, among many other indicators. However, these scores suffer from some problems of measurement and construction that limit their usefulness in quantitative analysis. Firstly, the scores are based on subjective perceptions of businessmen in different countries on different aspects of infrastructure availability and quality and not on any objective measurement. The aspects of infrastructure covered are changed over the years so the rankings of countries are not comparable over time. Finally, different aspects of infrastructure are averaged to obtain a single index of infrastructure.

Assigning equal weights to different aspects of infrastructure, although convenient, may not be appropriate conceptually.

To overcome the problems of infrastructure measurement in inter-country context, Kumar (2002a, 2002b) developed an Infrastructure Index based on six indicators capturing transport infrastructure, communication and information infrastructure and energy availability using principal component analysis for a sample of 66 countries for three points of time viz. 1982, 1989, and 1994. This Infrastructure Index was able to successfully explain the inter-country variation in the patterns and quality of FDI inflows across sample countries, holding other factors constant. In context of South Asia, De and Ghosh (2003, 2005a) constructed a composite index of infrastructure development across the South Asian countries and found that rising inequality in infrastructure are responsible for widening income gap in South Asia. While dealing with infrastructure and regional income, De (2005a, 2005b) constructed infrastructure development indices and found that infrastructure facilities positively influence the countries growth in Asia, where quality of transport infrastructure is an important determinant of Asia's trade and transaction costs. Similar infrastructure indices also constructed by De and Ghosh (2004, 2005b) for Indian states while dealing with infrastructure and development in context of India.

Against the aforesaid background, this paper constructs an Infrastructure Index for 104 countries comprising all the EAS members for three points of time, namely 1991, 2000, 2005 (hereinafter, we call it *RIS Infrastructure Index, RII*). The global coverage enables

us to get a comparative perspective on the infrastructure attainment of EAS countries while three points of time allow us to observe the movement of countries within the sample in terms of development of infrastructure. The paper makes observations on the gaps between EAS countries in terms of infrastructure development, their overtime performance and provides some policy recommendations for narrowing these gaps.

## **2. A Comprehensive Measurement of Infrastructure Availability and Country Positions**

Here, we briefly summarize the methodology and data sources for constructing an RIS Infrastructure Index (RII) covering 104 countries including all the 16 EAS countries. As observed above, there are several aspects of physical infrastructure which complement each other, such as telecommunication, transport, and banking infrastructure. While these indicators are correlated among themselves in some cases (see Canning 1998), none of them will capture the overall availability of infrastructure adequately. A country may have a very good network of roads but a telecommunication infrastructure that is not so good, for example. Therefore, the statistical technique of principal component analysis (PCA) becomes handy in constructing a unique single index that captures the variance or information contained in different variables capturing different aspects of infrastructure. PCA finds linear combinations of the original variables to construct the principal components or factors with a variance greater than any single original variable.

$$RII_{it} = \sum W_{jt} X_{jit} \quad (1)$$

where  $RII_{it}$  = RIS Infrastructure Index of the i-th country (104 countries) in t-th time (namely, 1991, 2000 and 2005),  $W_{jt}$  = weight of the j-th aspect of infrastructure in t-th time, and  $X_{jit}$  = value of the j-th aspect of infrastructure for the i-th country in t-th time point. Each of the 10 infrastructure variables is normalized for the size of the economy so that it is not affected by the scale. Here,  $W_{jt}$  are estimated with the help of PCA.

The aspects of infrastructure covered in the construction of the composite index and their measurements are as follows:

Transport Infrastructure: There could be several aspects of transport infrastructure such as availability of and quality of roads, railways, air transport and ports. In view of the availability of comparable indicators, we have employed following five indicators for capturing the availability and quality of transport infrastructure: (i) Air Transport is captured with the help of passengers carried per 1000 population and air freight million tonnes per kilometres of area, (ii) Road infrastructure is captured by the length of roads network per 10,000 sq. km. of surface area, and percentage share of paved roads, (iii) Railway infrastructure is captured through length of railway lines per 10,000 sq. km. of surface area.

ICT Infrastructure: The availability of ICT infrastructure is captured with the help of teledensity, and density of computers and internet. Total number of telephones (mobiles and fixed line) lines per 1000 inhabitants is a measure of teledensity. Number of personal computers per 1000 inhabitants and internet users per 1000 inhabitants are used to capture IT penetration.

Energy Availability: Energy availability is captured by intensity of energy use viz. energy use (kWh) per inhabitant.

Banking Infrastructure: Domestic credit provided by the banking sector (as percent of GDP) was employed as a measure of availability of banking infrastructure.

The data sources include issues of *World Development Indicators CD ROM*, *CIA Fact Year Book*, country reports (collected through IDE-JETRO), and other secondary sources.

### **3. East Asian Countries in the World in terms of Infrastructure Attainment**

The infrastructure index scores and ranks for the 104 countries for the years 1991, 2000 and 2005 are computed following the methodology outlined above, and are summarized in Table 1. The countries are listed as per their ascending order of ranking in 2005.

Figure 1 presents the rank of countries. The patterns that emerge from the Table 1 are on expected lines, and some important observations are as follows:

First, developed countries occupy the top ten positions in infrastructure development, of which one from North America (USA), two from Asia (Japan and Singapore) and remaining seven countries are from Europe. The bottom ten positions are occupied by LDCs from Africa and Asia. For example, Myanmar and Cambodia are from Asia, and rest eight countries are from Africa. Developing countries occupy the middle portion of the ladder. Given the estimated ranks, LDCs and land-locked countries across the world suffer more due to infrastructure inadequacy.

Second, the East Asian countries (ASEAN+6) comprise a heterogeneous group characterized by wide gaps in infrastructure attainment. As shown in Table 2 and Figure 2, Japan, Singapore, New Zealand, South Korea and Australia find themselves among the first 16 countries in the world. The next group comprises developing countries including Malaysia and Brunei, China, Thailand, and India within 55 countries in the world. Vietnam, Indonesia, Philippines, Lao PDR, Myanmar and Cambodia occupy the bottom six positions in East Asia. In general, the rankings in infrastructure attainment seem to relate to their levels of development.

**Table 1: RIS Infrastructure Index Scores and Ranks of Countries**

	1991		2000		2005	
	Index	Rank	Index	Rank	Index	Rank
United States	25.96	1	22.95	1	20.66	1
<b>Japan</b>	16.28	5	18.65	4	18.58	2
<b>Singapore</b>	15.73	6	20.11	2	17.66	3
Switzerland	19.07	4	19.43	3	17.19	4
Netherlands	14.22	11	17.20	7	17.18	5
Denmark	14.81	9	17.74	6	16.95	6
Sweden	19.39	3	16.89	8	16.70	7
Ireland	10.43	18	14.41	14	16.12	8
United Kingdom	14.87	8	15.59	9	15.93	9
Norway	21.28	2	17.94	5	15.56	10
Germany	13.25	12	15.56	10	15.20	11
Austria	11.96	16	15.14	11	14.67	12
Canada	14.55	10	14.69	13	14.37	13
<b>New Zealand</b>	12.92	13	14.88	12	14.11	14
<b>Korea</b>	7.78	26	13.97	15	13.68	15
<b>Australia</b>	14.92	7	13.00	16	13.67	16
France	12.87	14	12.69	17	13.59	17
Israel	9.72	19	11.37	20	13.28	18
Bahrain	11.99	15	11.41	19	13.09	19
Italy	9.38	21	11.93	18	12.93	20
Slovenia	7.56	28	10.32	24	12.68	21
Qatar	9.70	20	10.83	22	12.11	22
Spain	8.98	22	10.98	21	11.98	23
United Arab Emirates	8.06	23	10.74	23	11.06	24
Kuwait	10.46	17	8.71	26	10.55	25
Slovak Republic	6.63	31	7.77	30	10.38	26
Portugal	6.96	29	9.86	25	10.19	27
Czech Republic	7.96	24	8.19	29	9.64	28
<b>Malaysia</b>	5.10	37	8.65	27	9.21	29

Greece	7.85	25	8.60	28	8.84	30
Croatia	6.20	32	6.47	33	8.48	31
Poland	5.02	38	6.26	36	8.15	32
Hungary	4.95	39	6.34	35	7.99	33
Mauritius	5.15	36	6.40	34	7.41	34
Lebanon	3.90	47	6.86	32	7.35	35
<b>Brunei</b>	7.76	27	7.27	31	7.34	36
Bulgaria	6.77	30	5.19	42	7.18	37
South Africa	3.62	48	5.46	39	6.42	38
<b>China</b>	3.51	49	4.83	43	6.33	39
Jordan	5.28	35	5.28	41	6.19	40
Russia	5.86	33	4.00	48	6.01	41
<b>Thailand</b>	4.17	43	5.48	38	5.89	42
Saudi Arabia	4.48	40	4.09	45	5.88	43
Romania	4.21	42	3.92	50	5.76	44
Uruguay	4.07	44	5.69	37	5.62	45
Ukraine	5.59	34	4.09	46	5.25	46
Turkey	2.59	61	4.00	47	5.21	47
Chile	2.96	57	5.45	40	5.20	48
Egypt	3.98	46	4.18	44	5.09	49
Tunisia	3.18	52	3.49	53	4.58	50
<b>India</b>	3.48	50	3.95	49	4.49	51
Mexico	2.54	63	3.07	58	4.44	52
Sri Lanka	2.57	62	3.18	56	4.35	53
Argentina	2.37	65	3.70	52	4.33	54
Brazil	3.08	54	3.31	54	4.24	55
Oman	2.31	66	3.26	55	4.05	56
Iran	2.73	60	3.07	57	4.03	57
Kazakhstan	4.24	41	2.85	59	3.68	58
Venezuela	3.07	55	2.78	62	3.39	59
Georgia	4.05	45	3.83	51	3.31	60
<b>Vietnam</b>	0.91	92	1.85	75	3.27	61

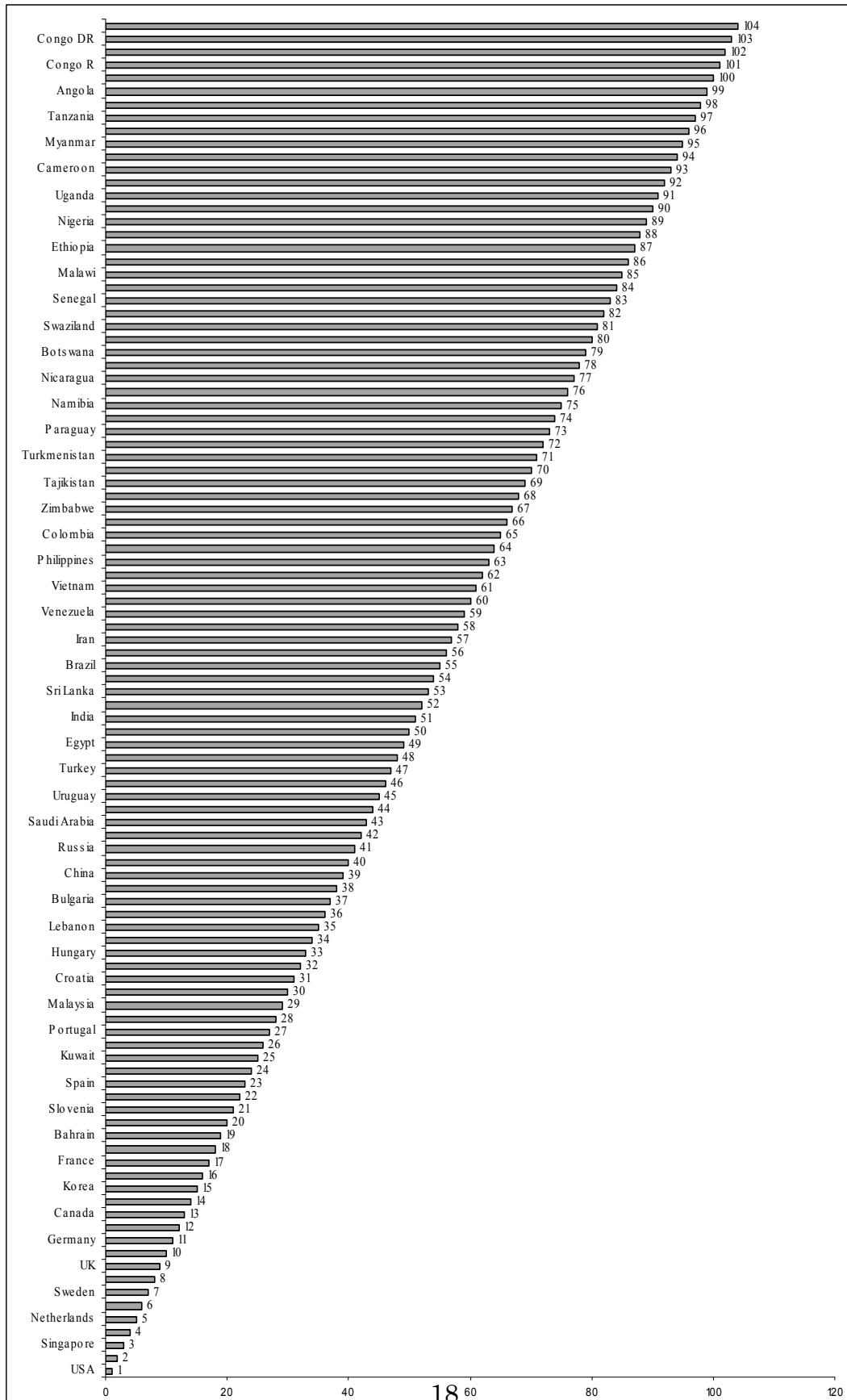
<b>Indonesia</b>	2.23	69	2.74	63	3.21	62
<b>Philippines</b>	1.53	76	2.58	65	2.95	63
Kyrgyz	3.28	51	2.60	64	2.95	64
Colombia	2.24	68	2.11	73	2.92	65
Pakistan	2.39	64	2.26	68	2.89	66
Zimbabwe	1.51	77	2.11	72	2.84	67
Ghana	2.31	67	2.84	60	2.76	68
Tajikistan	3.10	53	2.48	67	2.73	69
Uzbekistan	2.92	58	2.54	66	2.70	70
Turkmenistan	2.97	56	2.79	61	2.65	71
Syria	2.88	59	1.64	77	2.60	72
Paraguay	1.48	78	2.13	70	2.51	73
Bangladesh	1.83	73	2.12	71	2.50	74
Namibia	1.75	75	1.98	74	2.46	75
Peru	1.05	87	1.57	79	2.39	76
Nicaragua	1.79	74	2.23	69	2.35	77
Mongolia	2.05	70	0.95	88	2.29	78
Botswana	0.56	98	1.25	83	2.25	79
Bolivia	1.27	82	1.79	76	1.91	80
Swaziland	1.85	72	1.48	80	1.89	81
Sudan	0.93	91	0.91	89	1.76	82
Senegal	1.25	83	1.27	82	1.62	83
Kenya	1.31	79	1.07	86	1.43	84
Malawi	0.77	95	0.69	92	1.42	85
Nepal	1.29	81	1.37	81	1.38	86
Ethiopia	0.99	89	1.06	87	1.25	87
Zambia	1.93	71	1.60	78	1.24	88
Nigeria	0.75	96	0.52	97	1.24	89
Madagascar	1.30	80	1.14	85	1.19	90
Uganda	0.79	94	0.82	90	1.06	91
<b>Lao PDR</b>	0.55	99	1.19	84	0.87	92
Cameroon	1.00	88	0.64	94	0.79	93

Yemen, Rep.	1.23	85	0.59	96	0.77	94
<b>Myanmar</b>	0.97	90	0.79	91	0.76	95
Mozambique	0.62	97	0.63	95	0.73	96
Tanzania	1.25	84	0.41	99	0.63	97
<b>Cambodia</b>	0.45	100	0.66	93	0.55	98
Angola	1.20	86	0.13	104	0.52	99
Somalia	0.28	103	0.34	100	0.48	100
Congo, Rep.	0.89	93	0.49	98	0.47	101
Central African Republic	0.42	101	0.31	101	0.42	102
Congo, Dem. Rep.	0.40	102	0.14	103	0.26	103
Chad	0.27	104	0.25	102	0.21	104

*Note:* Arranged according to the ranks in 2005. EAS countries have been put in bold.

*Source:* Calculated by authors following the methodology described in the text.

**Figure 1: Rank of Countries in Ascending Order in 2005**



Third, among the 16 East Asian countries, 10 countries successfully enhanced their global ranks between 1991 and 2005, while the same of rest six countries decelerated (Table 2). Among those climbing the ladder in terms of attainment of infrastructure development, most impressive stride has been made by Vietnam that has jumped 31 places (from 92 to 61) over the period 1991 to 2005. Philippines, South Korea, China, Malaysia, and Lao PDR are the countries which have improved their ranks. Among those that have come down the ladder in terms of infrastructure development between 1991 and 2005 are countries like Australia and Brunei (rankings of both fallen by 9 places). Therefore, a regional integration process among the EAS countries should attempt to reduce the infrastructure gaps.

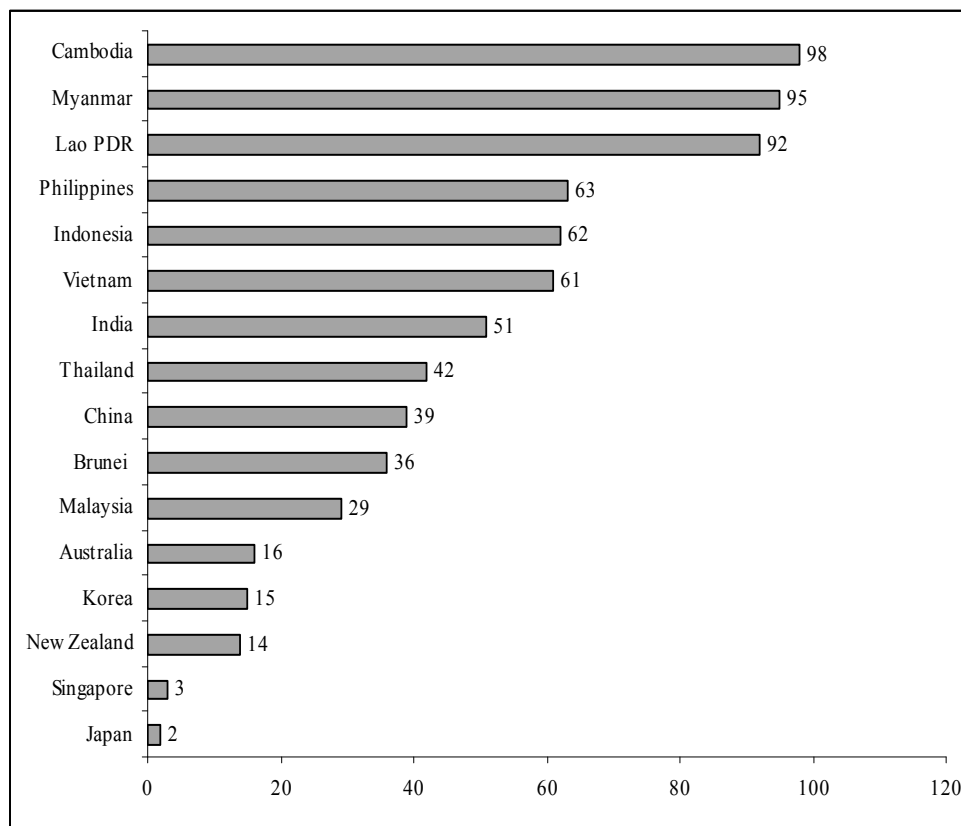
Fourth, the infrastructure gap between the most developed and the least developed in East Asia seems to have widened than narrowed from 5-100 in 1991 to 2-98 in 2005. The resource requirements for bridging these gaps are therefore substantial. The process of regional economic integration has to contribute to narrowing these gaps by providing resources for development of infrastructure.

**Table 2: Evolving Global Ranks of East Asian Countries in Terms of Infrastructure Development**

	1991	2000	2005
Japan	5	4	2
Singapore	6	2	3
New Zealand	13	12	14
Korea	26	15	15
Australia	7	16	16
Malaysia	37	27	29
Brunei	27	31	36
China	49	43	39
Thailand	43	38	42
India	50	49	51
Vietnam	92	75	61
Indonesia	69	63	62
Philippines	76	65	63
Lao PDR	99	84	92
Myanmar	90	91	95
Cambodia	100	93	98

*Source:* Authors based on Table 1.

**Figure 2: Global Ranks of East Asian Countries in 2005**



#### **4. Narrowing the Infrastructure Gaps in East Asia**

As observed above, the gap between the most developed and the least developed in East Asia in terms of the index has widened than narrowed during the period 1991 and 2005. The gaps existing between the EAS countries in terms of level of infrastructure attainment need to be addressed as a part of the programme of regional economic cooperation and integration for promoting balanced regional development. Otherwise, the programmes of regional cooperation could work to further widen the development gaps. In particular, enabling infrastructure needs to be created in the laggard regions and countries so that they can enjoy the opportunities created by regional trade liberalization

and integration. Therefore, Asia's growth potential will be realized only if we can narrow the infrastructure gap.

The resource requirement for bridging or narrowing these gaps is substantial. RIS (2007) estimated that developing Asia including LDCs will need to spend an estimated total of US\$ 412 billion per annum between 2007 and 2012 (or about 7.3% of the combined GDP of developing Asia and LDCs) on infrastructure development such as roads, railways, airways, ports and electricity (see, Table 3). This figure does not include cross-border infrastructure. RIS also estimated that India alone has to spend an investment of about US\$ 410 billion in six infrastructure sectors, namely, road, railways, ports, power, aviation, and urban infrastructure during the period 2007 to 2012 as against the estimated US\$ 384 billion during 2007-2011 by the Planning Commission (Government of India, 2007). These estimates are also in tune with others, as summarized in Table 4.

**Table 3: Annual Infrastructure Investment Needs in Developing Asia**

Countries	Investment (2007-2012)	
	Amount (US\$ billion)	Share in GDP (%)
China	208.33	10.78
India	68.33	9.89
Indonesia	26.67	6.46
Malaysia	13.33	7.87
Philippines	8.33	7.85
Thailand	11.67	7.22
Vietnam	6.67	5.80
Asian LDCs	74.67	4.60
Total	412.06	7.30

*Source:* RIS (2007)

**Table 4: Estimates of Annual Infrastructure Investment Needs in Asia, 2007-2011**

	ADB-JBIC-WB	UNESCAP	RIS
	East Asia excluding South Asia <sup>1</sup>	East Asia and South Asia <sup>2</sup>	South and East Asia <sup>3</sup>
Infrastructure investment (US\$ billion)	165	228	412
Infrastructure investment ( percent of GDP)	6.2	6.8	7.3

*Notes:* 1. Includes East Asia excluding South and Central Asia for the period 2006-2010.

2. Includes East Asia and Pacific, and South Asia for the period 2006-2010. 3. Includes Developing and LDCs in South, Southeast and East Asian countries for the period 2007 to 2011.

*Source:* RIS based on the respective studies.

It is clear that additional resource requirements for meeting infrastructure needs of Asia are at least US\$ 200 billion per year. RIS study also goes on to demonstrate that mobilization of resources on that scale is feasible in the current conditions of Asia with large surplus savings (over US\$ 300 billion in 2004) but they cannot be delivered in full because of a lack of an appropriate regional framework for their mobilization. Hence, these savings and excess foreign exchange reserves of Asia have to be deployed outside the region such as US treasury bonds often earning very poor if not negative real return. Asian countries are now setting up sovereign wealth funds to enhance their returns on these foreign exchange reserves. However, it has been argued by an RIS study that this can be done in a much more effective manner by a regional framework. RIS has proposed a regional mechanism that can borrow from Asian central banks for infrastructure development in a very creative manner to supplement and complement other existing facilities and resources (see, RIS 2007 for further details).

It would appear therefore that the EAS region has resources for meeting the growing resource requirements for infrastructure development and narrow the development gaps to produce win-win outcomes. Needless to mention, the demand impulses generated from financing of additional infrastructure development in poorer countries in the EAS region will add to the dynamism of the region. By generating additional demand impulses within the region such a mechanism might also assist in adjustment with the global imbalances by reducing the dependence of Asia on the West.

## **5. Concluding Remarks**

In the foregoing an attempt has been made to examine the infrastructure attainment of EAS countries in a comparative global perspective with the help of an Infrastructure Index following a methodology developed in earlier RIS studies. In terms of relative ranks, some EAS countries, like Japan, Singapore, New Zealand and Australia find themselves ranked along with the industrialized western countries, others like Thailand, Philippines, China, India, Vietnam occupy middle space and the least developed countries like Myanmar, Lao PDR and Cambodia ranked towards the end of the sample. Some countries have improved their ranks over time while others have slipped down the ranks because of inadequate attention paid to infrastructure development. This RIS Infrastructure Index reveals very wide gaps in terms of infrastructure attainment across the EAS region, which seems to have widened rather than narrowed over time. Hence, infrastructure development in the lagging regions needs to be paid due attention if the regional inequalities are not to widen further. In order to bridge the infrastructure deficits across the region, huge magnitude of resources would be needed which are estimated to be between US\$ 200 to 500 billion per year. On the other hand, the region's foreign exchange reserves now add up to more than US\$ 3 trillion, far in excess of their Balance of Payment liquidity needs and that remain invested in western securities earning negative rates of return in the absence of a regional framework for their fruitful deployment. In that context, an RIS proposal of a regional mechanism to mobilize a

very small proportion of these reserves for development of regional cross-border connectivity and other infrastructure could be highly productive. It might also assist in generation of new demand within the region and help in adjustment with global imbalances. This proposal needs to be examined further by the EAS policy makers including the modalities for operationalizing the regional mechanism through exiting regional institutions or by creating a new one.

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