INFRASTRUCTURE FOR SUSTAINABLE GROWTH: A DEMAND PROJECTION EXERCISE FOR INDIA

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Abstract

Availability of infrastructural facilities is critical for sustainable growth. To achieve and sustain the recent spurt in actual and target growth rates in India shortages in infrastructural facilities must be removed. Here we forecast the physical quantum of demand for selected infrastructural facilities in India over the next fifteen years and estimate the financial implications thereof. Projected demand is substantially larger than present availability and requires c0apital outlay of 6-6.2 per cent of GDP. A dual strategy of heavy investment in creation of new physical infrastructural stock and improving the utilization rate and operational efficiency of existing stock is proposed.

Keywords: Infrastructure; Demand Projection; Sustainable Growth.

JEL Classification: C21; C33; C53; H54; O21.

1. Introduction

High growth and sustainable development are the principal objectives of developing countries in the present world. In a globalised framework, this requires efficiency in production and availability of resources – both material and services – so that output can be augmented up to the fullest potential and prices are competitive. A major precondition for attaining those goals is availability of a host of infrastructural facilities in adequate quantity and of reliable quality. The association between the latter and growth is well documented and a large number of theoretical propositions conclude that the association is quite strong and runs from the former to the latter [e.g. Hirschman (1958), Rostow (1960), Nurkse (1953), Rosenstein-Rodan (1943) and Hansen (1965)]. In the recent decade, this issue has attracted attention worldwide, and the association between Infrastructure Availability and Development/Growth has been widely explored. Some studies, mostly on the developing economies, conclude that the impact of infrastructure on economic development is positive and substantial [e.g. Looney (1981), Antle (1983), da Silva Costa (1987), Aschauer (1989), Garcia-Mila (1992), Easterly (1993), Canning (1993), and others]. Many researchers have commented on this crucial interlinkage and tried to estimate the contribution of infrastructure on national or regional development in India [e.g. Shah (1970), Dasgupta (1971), Pal (1975), Shri Prakash (1977), Gulati (1977), Gayithri (1997), Tewari (1984), Amin (1990), Dadibhavi (1991), Arunkumar (1993), Ghosh (1998), Majumder (2005)]. Surprisingly, there are hardly any studies that attempt to look into the future needs of infrastructure in India. However, no studies on infrastructure can be complete unless there is a vision before the nation – a vision of what it wants to be in near future, what are needed to

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achieve those dreams, and the possible roadblocks. This analysis is all the more necessary as constraints, shortages, bottlenecks, or imbalances in either quantity, quality, or accessibility of infrastructural facilities will invariably lead to deficiency in the overall development performance. Therefore, any policy-making related to infrastructure should start with determining the necessities – the likely demand for these facilities both at current levels of economic intensity and at levels corresponding to desired growth rates. In this paper we seek to forecast the demand for selected infrastructural facilities for India over the next decade and a half so that we have an idea regarding the magnitude of the task facing the economy. We have selected Roads, Railways, Power, Schools & Colleges, and Hospitals for this scenario analysis.[2] It is to be noted that this relates to stocks of these facilities and *not* flow of the services emanating from them or their utilisation rates. In addition to projecting physical quantum of demand for those facilities, we also attempt at indicating the financial implications of realising those levels.

2. Current Endowments of Infrastructure Stock

India, on attaining independence, accorded highest importance to the development of infrastructural facilities in the successive plans and this sector claimed the lion's share of the plan outlays and actual expenditures. If all the ten plans along with the annual plans are considered together, more than 66% of the total allocation went to the infrastructural sectors. Because of such paramount importance being attached to infrastructural development, physical availability of such facilities in India have increased manifold, both at the absolute level, as well as relative to size of the nation and population, i.e. in standardized forms. The endowments of selected infrastructural stocks in India in 2005 is provided in Table 1, normalised with respect to population or area, as the case may be.[3] It also shows the relative position of India compared to certain other country groups as also that of the best and worst states within India. It is evident that we are ahead among the Low Income countries (to which group we belong) in terms of Rail Density alone. In terms of Per Capita stocks of Power Generation, Road length (Road freedom), Schools, and Hospitals, we are not only far behind the High & Middle Income economies and the developed countries, we are lagging behind the average level for Low Income Countries also. Thus there is scope for improvement even when present demands are considered. And then, there are lagging regions within the country as well. Against this existing shortages, the need to estimate future demands becomes all the more important since any imbalance in the quantity or location of the facilities will create bottlenecks for the entire economy and jeopardise the growth process.

One may argue that in the present era infrastructural facilities like Communication, especially Airports and Telecom, should have been considered. But increasing Teledensity and growth of private airlines and air-traffic are very recent phenomenon, and we would not obtain any long run time-series data on these to facilitate meaningful econometric exercise. In addition, these are concentrated mostly among urban, if not metropolitan, areas and people and have had little impact on a substantial mass of our country. Therefore, we have omitted them. Instead, we have selected both economic and social infrastructure facilities that affect almost the whole of the countrymen.

All facilities except Railway Track Length have been normalised using population. For Railway length we have used area for normalising since spatial density of the network is more important compared to people's accessibility, which is related more to rolling stock of the railways.

Table 1. Infrastructure & Selected Explanatory Variables in India & World

Variable	*Unit*	*HIC*	*MIC*	*LIC*	*INDIA*	*Within India*	
						Best	*Worst*
Infrastructural Variables							
Road Length	KM per Lakh Pop	1936	135	140	216	500	95
Railway Length	KM per Th SqKm	25	12	8	21	112	14
Power Gen Capacity	MW per Capita	2364	140	98	97	402	47
Schools	per '0000 Pop	-	-	-	8	23	3
Colleges	per '0000 Pop	-	-	-	0.08	0.20	0.07
Primary Teachers	PER '000 POP	59	40	26	17	35	8
Hospital/ Dispensary	per Mill Pop	-	-	-	34	173	2
Physicians	per Mill Pop	2381	495	89	406	1480	50
Safe Drinking Water	% of pop covered	96	74	62	73	97	20
Explanatory Variables							
Per Capita Income	RS	221600	25000	3900	3172	7837	1240
GDP from							
Primary sector	%	1.8	9.7	25.7	23	41	12
Secondary sector	%	26.9	36.7	25.9	31	51	22
Tertiary sector	%	71.2	53.5	48.3	44	64	27
Population Density	Per Sq Km	28	42	75	330	9185	180
Urbanisation	%	77	44	26	30	97	12
GCA	Hect per person	1.37	0.84	0.61	0.197	0.364	0.004
Completed class 8	%	-	-	-	46	100.0	20.0
IMR	Per '000	5.3	65	107	68	14	96
Vehicle density	Per '000 Person				59.4	272	19

Source: Statistical Abstract, GOI, Various Years, from www.mospi.nic.in; WDR (2002); Economic Survey, Govt. of India - Various Years;

Note: Power Gen Cap is Installed Power Generating Capacity; *IMR* is Infant Mortality Rate; *Vehicle* is Number of Commercial & Non-Commercial Vehicles.

3. Modelling Infrastructure Demand

3.1 Methodology

Modelling demand for infrastructure, or for that matter any other *'input'* for desired developmental goals (or *'output'*) is tricky. One can simply calculate current or historical input-output ratios and use it in conjunction with projected or desired *output level* (GDP, PCI, etc.) to get projected demand for the *inputs*, infrastructure in this case. Though straightforward, this methodology ignores the fact that input-output ratios are themselves variable, more so for infrastructural variables characterised by economies of scale, long gestation period, and indivisibilities, resulting in rapid changes in their impact quotient on development following changes in their quantum. Conversely, the infrastructure required per unit of GDP or PCI would vary with changes in GDP or PCI or other explanatory/independent variables. Thus their modelling has to accommodate not only changing levels of target variables, but also changes in the coefficients associated with those variables in determining infrastructure demand.[4]

Looking from a different side, changes in the income level changes people's demand for different facilities like transport, power, education, and health. Thus, per capita demand for these facilities is surely function of per capita income. In addition, most of these facilities are characterised by networking and indivisibilities, so that their per capita demand reduces with a rise in population density. The same is true for Urbanisation factor also as many of the facilities are urban-centric. Thus our basic model should be of the form:

$$D_{ij} = f\,[PCI_j, PD_j, U_j] \quad \ldots (1)$$

where D_{ij} is Demand for i^{th} infrastructural facility in the j^{th} region; PCI_j, PD_j, U_j are Per Capita Income, Population Density, and Urbanisation Index in the j^{th} region.

We now expand this basic model as follows. Demand for power is divided into three parts – Industrial Demand, Agricultural Demand, and Other Demand, and modelled separately. Moreover, Infrastructural demand would also depend on the structural transformation of the economy. Traditionally, the share of GDP coming from Tertiary sector is taken as an index of structural transformation of an economy. We include this (Ter_%) as an explanatory variable in our model. In addition, specific infrastructural demands are thought to be affected by sector-specific variables.[5] For example, Road requirement would depend on the number of vehicles i.e. vehicle-population ratio (Vehicle); Industrial power demand would depend on proportion of GDP coming from Secondary sector (Sec_%); Power demand by agriculture would depend on per capita Gross Cropped Area (GCA_Pop) & Share of agriculture in GDP (Agr_%); Number of schools would depend on the desired school completion rates of children (Comp8); and for the Health sector, reduction in Infant Mortality Rate (IMR) is taken as the sectoral explanatory variable.

Sometimes researchers argue that due to long gestation period and life of infrastructure stocks, lagged values of infrastructure should also be included in the model. But this is a supply side constraint and inclusion of lagged values would make the model a Supply side model. Since we are trying to project demand irrespective of existing or past supply of infrastructure, we do not include it.

We must mention one inherent assumption made herein. Since we are using existing infrastructural stock as infrastructural demand, we are assuming that the demand has been met in all past periods. While this is definitely not true, we can see it as some kind of *'ex post'* value of demand corresponding to the ruling values of explanatory variables (EV) if we accept that the levels of the EVs themselves were determined and constrained by the infrastructure available. Therefore, once the EV, say GDP, has been determined, a one-to-one correspondence between

[4] This section draws substantially from the methodology used by Fay (1999) with some modifications.

[5] One can also think of additional issues like linkage among the different production sectors, changes in prices & price elasticities, etc. Addressing all these issues would require something similar to CGE models, which we do not attempt here. This may be a possible extension of this paper.

them and stock of infrastructure can be viewed backwards also, i.e. the level of infrastructure would then be viewed as the stock demanded to achieve the resultant level of GDP etc. This is restrictive but quite logical.

The variables are depicted in the natural log form and the complete model is described in Table 2. The EVs of our model then are Per Capita Income (and therefore GDP and Population); Shares in GDP of Agricultural, Industrial & Tertiary sectors; Population Density; Urbanisation Index; GCA-Population ratio; Proportion of children completing Class VIII; Infant Mortality Rate; and, Vehicle-Population ratio. The levels of these EVs for 2005 are given in Table 1.

Table 2. Model Description - Infrastructure as Dependent on Explanatory Variables

Dependent Variable	*Unit*	*Explanatory Variables*
Road Length	KM per Lakh Pop	PCI, Vhcl_Pop Ratio, TER_%, Density, Urbanisation
RailwayLength	KM per SqKm Area	PCI, TER_%, Density, Urbanisation
Industrial Power	KWH per Person	PCI, SEC_%, TER_%, Density, Urbanisation
AgroPower	KWH per Person	PCI, AGR_%, TER_%, Density, GCA_Pop Ratio
OtherPower	KWH per Person	PCI, TER_%, Density, Urbanisation
Schools	per 10000 Pop	PCI, TER_%, Density, Urbanisation, Completed 8
Colleges	per 10000 Pop	PCI, TER_%, Density, Urbanisation
Hospital	per Million Pop	PCI, TER_%, Density, Urbanisation, IMR

Note: *PCI* is Per Capita Income at Constant 1980-81 prices; *Agr_%, Sec_%, Ter_%* are Share of Primary, Secondary, and Tertiary Sectors in NSDP respectively. *Urbanisation* is Proportion of Population in Urban areas; *GCA_Pop* is Gross Cropped Area per person;

3.2 Empirical Estimation

Once we have set the models, we proceed to estimate them empirically. We use the time series data for India and the states for the period 1971-2001 which we have used earlier. The objective is to estimate the coefficients of the EVs in determining per capita infrastructural demand. To accommodate differences across regions in the intensity of infrastructure use, technologies, tastes and preferences, etc. we pool the data set and use Fixed Effects Panel Data Technique for estimation.

It is to be noted that earlier we had observed most of the infrastructural variables to be cointegrated with the developmental variables. In the presence of cointegration, one could have used plain OLS method of estimation also, but we prefer the Fixed Effects Panel Data method as the estimates obtained from this method is consistent even in absence of cointegration.[6]

To check for structural breaks in the associations, we had divided the study period into three decades – 1971-80, 1981-90, 1991-2001, and used Chow test for detection. Except agricultural power demand, none of the other variables are suffering from structural breaks and

[6] The Random Effects model is not used for two specific reasons. First, REM is suitable when the observations are random samples taken from a larger population whereas here we have taken the 15 states of India as observations. Second, REM also assumes that the individual error component is uncorrelated with the regressors, but in our case the state-specific error components are more likely to be associated with the state specific explanatory variables. Hence we use Fixed effect model.

hence the models were estimated using the whole data set. Only for agricultural power demand a structural break was observed, the 1981-90 and 1991-2001 results being different from that of the first decade, but similar among themselves. Therefore, we estimate this demand function using 1981-2001 data to obtain the most recent estimates.

Once estimated, we have tested for goodness of fit and the prospects of dropping/ adding variables. Using F-tests and Log Likelihood ratios, we have tried to eliminate EVs that have limited/ insignificant explanatory power and have retained only those that matter, re-estimating the final models. Thus, Data-mining was consciously adopted to improve the predictive power of the projected demand functions. The estimation results are given in Table 3.

Table 3. Infrastructure as Dependent on Explanatory Variables – Panel Data Results

Dep. Variable	*Road Length*	*Railway Length*	*Industrial Power*	*Agro Power*	*Other Power*	*Schools*	*Colleges*	*Hospital*
	KM per Lakh	*KM per SqKm*		*KWH per Person*		*per '0000 Pop*	*per '0000 Pop*	*per Mill Pop*
PCNSDP	0.056**	0.016	0.749**		1.008**	0.426	0.264	0.101
Vhcl_Pop Ratio	0.214							
AGR_%				-0.337				
SEC_%	0.226**		0.887**					
TER_%	0.218**	0.099**			1.141**			
Density	-0.974				0.701**	-0.944	-0.636	-0.529**
Urbanisation	-0.117				0.378	0.112	-0.163	-0.270
GCA_Pop Ratio				0.488*				
Completed 8						0.142**		
IMR								-0.720**
Fixed Effects								
Andhra Pr	7.58	2.40	-4.06	6.95	-12.85	3.56	0.19	8.72
Bihar	7.73	2.97	-4.19	4.98	-13.29	4.41	0.20	8.02
Gujarat	7.12	2.88	-3.92	7.06	-12.84	2.91	-0.44	9.94
Haryana	7.56	3.05	-4.30	7.15	-13.09	3.11	0.33	8.54
Himachal Pr	7.38	1.08	-4.63	2.62	-11.45	3.08	-0.80	8.52
Karnataka	7.78	2.30	-3.89	6.82	-12.91	3.24	0.51	8.78
Kerala	9.24	2.75	-4.23	4.43	-13.20	3.58	0.37	9.31
Madhya Pr	7.15	2.14	-3.92	6.25	-11.98	3.19	-0.49	7.94
Maharashtra	7.55	2.37	-4.21	6.56	-12.92	2.96	0.20	9.86
Orissa	8.21	2.09	-3.72	4.02	-12.24	3.98	-0.15	8.50
Punjab	8.09	3.27	-3.61	7.46	-13.13	3.50	0.59	9.93
Rajasthan	6.97	2.35	-4.23	6.12	-12.34	2.74	-0.74	8.23
Tamilnadu	8.28	2.92	-4.13	6.81	-13.37	3.46	0.10	8.65
Uttar Pr	7.87	2.94	-4.48	6.11	-13.35	3.74	-0.40	8.83
W Bengal	7.93	3.26	-4.57	4.66	-13.63	4.25	0.38	8.31
Delhi	9.73	4.18	-4.63	4.16	-15.20	5.15	1.94	11.46
India	7.64	2.53	-4.24	6.33	-12.92	3.18	-0.23	9.19
No of Obs.	527	527	527	351	527	527	527	527
Adj R Sq	0.73	0.98	0.73	0.97	0.75	0.28	0.16	0.73

Note: * and ** refers to significance at 5% & 1% levels respectively. Coefficients with significance level more than 10% are not reported; *Comp8* is proportion of Age-specific people completing Class Eight schooling.

Source: Author's Calculation

A few general comments may be made regarding the estimation results. It is observed that PCI and Share of Tertiary sector in GDP have significantly positive coefficients all throughout, confirming our a priori notion regarding increasing infrastructural demand per capita along with a rise in income level and structural transformation of the economy. Network properties and indivisibilities leading to lowering of per capita requirement with increase in population density is found to be true for Roads, Schools & Colleges, and Hospitals. However, Power demand by Non-industrial – Non-agricultural sector is significantly positively associated with both density and urbanisation, indicating perhaps the high per capita power demand in densely populated urban areas due to intense economic activities and heavy use of appliances. Relation of Colleges and Hospitals with Urbanisation is negative, indicating that proliferation of higher educational and medical institutions has not kept pace with urbanisation and per capita stocks of these facilities have come down. Moreover it also indicates that rural areas are being sidetracked during establishment of these institutes.

The model estimates are quite dependable and robust as indicated by the Adjusted R^2 values for Roads, Railways, Power, and Hospitals. For Schools & Colleges however, the estimates are moderately dependable.

4. Forecasting Demand: Projection into Future

We thus have estimated demand function of per capita infrastructure stocks and obtained consistent estimates of coefficients associated with the explanatory variables. Using these results we can forecast demand for infrastructure in the future for expected/ desired values of the EVs. Thereafter, using population projections we can transform them to physical levels of infrastructural stock required. Such an exercise requires the future levels of the EVs and there are two ways to proceed in this direction. Firstly, we can use trend growth rates of the EVs to predict expected levels of them in future and estimate infrastructure demand. This would be Business As Usual Scenario (BAUS). Secondly, we can use some target growth rates to project levels of EVs in the future and then estimate infrastructure demand. This would be the Best Case Scenario (BCS). We explore both these options herein. For the BAUS we use the trend growth rates in the EVs during 1996-2005 for predicting their values in the future. For the BCS we use the target growth rates as envisaged in the '***Vision 2020'*** document of the Planning Commission of India. The projected values of the EVs at the beginning and the end of the Eleventh 5-Year Plan, i.e. at 2007 & 2012, and at 2020 using both these methods are given in Table 4.

Based on these values and the estimated coefficients we can obtain normalised values of infrastructural demand for the period 2007-2020. These are given in Table 5. It appears that the normalised values of infrastructure requirement would steadily rise over the next decade and a half. Since the BAUS estimates of the EVs are lower than the BCS estimates of them, the infrastructure requirement would also be lower in BAUS compared to BCS. It is evident that we would require modest advancement in Numbers of Colleges & Hospitals, Railway Track length, and Agricultural Power demand – mostly to keep abreast of the population growth. This is not particularly unexpected as with falling share of Agriculture in GDP, power required by it will rise slowly, and Railway Services, Medical and Higher educational services would be characterised more by intensive use of existing stocks rather than a marked rise in per capita stock. There would however be substantial increase in per capita demand for Industrial Power, Non-industrial – Non-agricultural Power, and Number of Schools.

Table 4. Projection of Explanatory Indicators 2007-2020

Year	PCNSDP RS	Agr%	Sec%	Ter%	Density Per Sq Km	Urb %	GCA_Pop Hectare Per person	Comp8 %	IMR Per '000	Vehicle[a] Per '000 Person
Scenario I: Explanatory Indicators Growing at Long Run Trend Rate										
2007	3946	19	28	52	378	28	0.19	62	61	57.8
2012	4612	16	26	58	418	27	0.19	77	57	88.1
2020	5919	13	24	70	489	26	0.18	100	51	156.9
Scenario II: Explanatory Indicators Growing at Rates matching with Vision 2020 Targets										
2007[b]	4590	16	33	50	366	30	0.18	70	60	57.8
2012	6524	11	34	54	396	32	0.16	85	44	88.1
2020	11449	7	35	61	450	36	0.14	100	27	156.9

Note: Explanations as in Table 4; a – Growth in Vehicles are imputed at Long Run Trend only as Vision 2020 is silent on this. b - 2007 figures are as per Tenth Plan Mid Term Appraisal Report.

Source: Author's Calculation

Table 5. Model based projection of Key Infrastructure Ratios in India 2007-2020

Year	Road Length Km per Lakh Pop	Railway Length KM per SqKm	Industrial Power (KWH per Person)	Agro Power (KWH per Person)	Other Power (KWH per Person)	Schools Per '0000 Pop	Colleges per '0000 Pop	Hospital per Mill Pop
Scenario I: Explanatory Indicators Growing at Long Run Trend Rate – BAUS								
2007	223.6	21.0	137.3	93.0	210.5	7.8	0.10	38
2012	227.5	21.3	145.2	96.2	297.5	7.7	0.09	39
2020	229.0	21.8	158.7	101.6	517.3	7.8	0.10	40
Scenario II: Explanatory Indicators Growing at Rates matching with Vision 2020 Targets – BCS								
2007	238.2	21.0	177.5	98.0	233.1	8.8	0.10	39
2012	249.4	21.3	235.4	108.2	394.5	9.8	0.09	44
2020	262.9	21.7	370.0	126.9	915.9	11.7	0.10	53

Source: Author's Calculation

Using projected population growth, we now arrive at physical targets for the infrastructural facilities during 2007-2020 (Table 6), and the Capacity Addition required over this period (Table 7). Major observations are as follows:

- Power Generation Capacity has to rise more than three-fold;
- Number of Hospitals, Colleges and Schools must increase by 40-80 per cent;
- Road length has to increase by about 40 per cent; and,
- Railway Track length must rise by 5-7 per cent.

Table 6. Projection of Infrastructure Requirement 2007-2020

Year	Road Length	Railway Length	Power Demand				Power Generation	Schools	Colleges	Hospital
			Industry	Agro	Other	Total				
	KM	KM	Million KWH				MW	Nos	Nos	Nos
Scenario I: Explanatory Indicators Growing at Long Run Trend Rate – BAUS										
2007	2597979	64366	158894	107863	244720	511477	152410	927850	10904	44622
2012	2906315	65016	185646	122910	380254	688810	198995	1024252	11850	49259
2020	3434308	67431	238452	152969	775344	1166765	326965	1199758	13538	57699
Scenario II: Explanatory Indicators Growing at Rates matching with Vision 2020 Targets – BCS										
2007	2669367	64328	198934	109808	261236	569978	153125	986863	11112	41679
2012	3026085	65178	285695	131307	478734	895736	218475	1193107	12398	51268
2020	3621829	66562	509814	174797	1261808	1946419	366315	1616422	14772	71323

Source: Author's Calculations based on Tables 6 and 7.

Table 7. Projected Capacity Addition Requirement during 2007-2020

Year	Road Length	Railway Length	Power Demand				Power[a] Generation	Schools	Colleges	Hospital
			Industry	Agro	Other	Total				
	KM	KM	Million KWH				MW	Nos	Nos	Nos
Scenario I: Explanatory Indicators Growing at Long Run Trend Rate – BAUS										
2007-12	406315	1894	49374	27771	250144	327289	86495	99252	2650	9659
2012-20	527993	2415	52806	30059	395090	477955	127970	175506	1688	8440
2007-20	934308	4309	102180	57830	645234	805244	214465	274758	4338	18099
Scenario II: Explanatory Indicators Growing at Rates matching with Vision 2020 Targets – BCS										
2007-12	526085	2056	140696	34864	352706	528266	105975	268107	3198	11668
2012-20	595744	1384	224119	43490	783074	1050683	147840	423315	2374	20055
2007-20	1121829	3440	370121	77373	1191239	1638732	253815	691422	5572	31723

Note: Power Generation Capacity is calculated assuming PLF and T&D Efficiency to increase by 1 percentage point every year for BAUS. For BCS, PLF is assumed to reach 75% and T&D Efficiency to reach 85% by 2020, increases being evenly distributed over the interim period.

Source: Author's Calculations based on Tables 8 and existing endowment of infrastructure in 2005.

Continuing further, we present the State-wise shortages as would be felt during the Eleventh Plan period if current stocks of infrastructure prevail (Table 8). These are therefore reflecting areas of immediate concern. It is observed that the shortages are most acute in the Power sector, followed by the Colleges and Health Facilities. Among the states, situation is particularly poor in West Bengal, Haryana, Rajasthan, and Maharashtra for all the infrastructural sectors, and also in Delhi for Power, Education and Health sectors. The shortages are not as much in Bihar and Uttar Pradesh as many other researchers report – partly because of low demand in those states due to their stagnating economy and partly because the shortfall lies more in quality and reliability of services in these states than in quantity alone.

Table 8. Statewise Projected Shortages during XIth Plan as % of Current Capacity

Year	*Road*	*Railway*	*Power Generation*	*Schools*	*Colleges*	*Hospital*
Andhra Pr	16.9	7.1	40.2	17.2	23.9	15.8
Bihar	20.1	5.0	44.5	1.5	27.0	23.3
Gujarat	16.1	5.2	42.7	9.8	19.7	15.4
Haryana	20.5	4.6	50.2	11.5	22.8	12.9
Himachal Pr	16.6	1.8	54.9	14.7	19.5	14.8
Karnataka	18.5	1.9	46.3	19.6	25.4	36.3
Kerala	11.5	5.6	52.1	5.6	18.9	10.0
Madhya Pr	20.1	8.5	48.5	9.9	18.7	40.0
Maharashtra	17.4	7.1	42.9	10.2	21.8	20.1
Orissa	9.8	1.9	44.6	11.6	17.7	16.6
Punjab	11.8	4.2	38.5	5.6	22.3	16.0
Rajasthan	23.1	7.4	46.9	12.8	21.4	22.5
Tamilnadu	6.6	5.0	40.5	19.0	21.0	14.7
Uttar Pr	13.6	1.9	40.1	20.9	22.8	21.0
W Bengal	18.2	4.1	52.8	15.5	24.4	17.8
Delhi	6.7	2.9	56.0	21.7	26.3	27.7
India	14.0	1.9	43.5	9.7	22.4	19.6

Source: Author's Calculations based on Capacity Addition Requirements till 2012 and existing endowment of infrastructure in 2005.

We have thus been able to chart out the path before us – the task that needs to be completed in the coming years – both to sustain the present growth and also to reach the *Vision 2020* targets.

5. Financial Implications: How Much Investment Do We Need?

The analysis will not be complete unless we provide ballpark figures regarding the financial commitment required to meet the projected demand. But to do so, i.e. to transform physical targets to financial requirement is a tricky business. Costs vary across the breadth of our large country, between projects, and across scales of operation rendering the concept of per unit costs very difficult to pin point in reality. Still various governmental and non-governmental studies as also the budget documents assign per unit costs for setting up of new establishments – roads, railway tracks, power plants, schools, colleges, and hospitals. We scout these studies and arrive at representative Best Practice Average Costs for the infrastructural facilities.[7] The cost per KM of

7 The reports and documents used for this purpose are Selected Educational Statistics, GOI (for year 2003-04); Investment Opportunities in Infrastructure, GOI (2006); Report of the Committee on India: Vision 2020, GOI (2002); Changing Health Budgets, CEHAT (2006); Highway Sector Financing in India, World Bank (2004, from www.worldbank.org); Indian Electricity Scenario, GOI (2004); Does India Really have a Power Shortage?, India Infoline (2003, from www.indiacore.com); Towards Faster and More Inclusive Growth: An Approach to the 11th Five Year Plan, GOI (2006); and, Demand for Grants by the respective Ministries of Health, Human Resource Development, Railways, and Surface Transport, available from www.indiabudget.nic.in

new road is a weighted average of costs for constructing a 4-Lane National Highway, 2-Lane State Highway, and Standard single lane surfaced road and associated maintenance costs. Railway construction costs reflect both construction of new railroad and signalling etc for it. Costs of additional Power Generating Capacity include per Megawatt capacity addition cost and costs of associated Transmission and Distribution Network. Costs for a new school is average of costs per school under DPEP, SSA, and Dept of Secondary Education. Investment required for a new College is taken from Demand for Grants of the Ministry of Human Resource Development. For costs of setting up a new Hospital/ Dispensary, we have used the CEHAT study on Health Budget in India (CEHAT, 2006). They have talked of four types of institutions – Primary Health Centres, Rural Hospitals, Urban Hospitals, and Tertiary Hospitals. Costs for each of them are averaged using suitable weights to reflect the numbers of each required arriving at costs per hospital.

The results are depicted in Table 9. The figures that come out are really stupendous – we need to invest in the five selected areas of Roads, Railways, Power, Education and Health anything between 58500 to 70500 Billion Rupees at current prices over the 2007-2020 period if we are to continue with our present growth rates (at the lower end) or reach the Vision 2020 targets (at the higher end). This translates to an investment of about 6 per cent of our GDP for sustaining trend growth and 6.2 per cent of GDP for achieving desired growth, invested consistently over a period of 14 years! And one must be careful to note that these are ***only*** Capital costs. Costs associated with operation, like Salaries of Staff, Consumables, Administration costs, and costs of inputs linked to functioning and flow of the services have not been included in our estimates – and these latter costs are both quite substantial in magnitude and recurring in nature. Secondly, these services do not operate in airtight compartments - successful running of them require adequate supply from other sectors too. Railway operation needs Power; Power plants and Vehicles need fuel and energy resources; Schools, Colleges and Hospitals need trained manpower and equipment, and so on. Thus the total financial liability for meeting the projected infrastructure demand shall be substantially higher than our figures. If any, these are floor level conservative estimates of onetime capital outlay. Even then, the task appears magnum – both from the physical size and the investment that it calls in for.

Table 9. Financial Implications of Capacity Addition Requirement during 2007-2020 (Rs Billion)

Year	*Road*	*Railway*	*Power Generation*	*Schools*	*Colleges*	*Hospital*	*Total*	*Avg % of GDP pa*
Scenario I: Explanatory Indicators Growing at Long Run Trend Rate – BAUS								
2007-12	17472	76	6920	99	5	386	24958	8.1
2012-20	22704	97	10238	176	3	338	33554	5.0
2007-20	40175	172	17157	275	9	724	58512	6.0
Scenario II: Explanatory Indicators Growing at Rates matching with Vision 2020 Targets – BCS								
2007-12	22622	82	8478	268	6	467	31923	9.6
2012-20	25617	55	11827	423	5	802	38730	4.8
2007-20	48239	138	20305	691	11	1269	70653	6.2

Note: Cost calculations are as explained in text.

Source: Author's Calculations based on Capacity Addition Requirements from Table 9 and Cost per unit.

6. Conclusion

We have developed a model to predict future demand for infrastructure, which performs reasonably well for the selected indicators. The projected demand is substantially larger than the present availability and the task becomes harder as not only population will rise in future but the per capita demand would also increase. The Capacity Addition required would call in for huge investment amounting to a Capital outlay of 6-6.2 per cent of GDP for the five selected sectors only. Given that the total plan outlay on the Power, Railways, Roads, Education, and Health sectors during the Eighth and Ninth Plans have been 4.2 per cent and 4.0 per cent respectively; the amount of resource mobilization necessary can be easily anticipated. Moreover, the small increase in private sector financing of infrastructure has not been sufficient to offset the impact of the fall in public sector spending (Briceno-Garmendia et al. 2004). One possible way to dent into this awesome job is to use a dual strategy. Along with heavy investment in creation of new physical stock of infrastructural facilities, one must also aim at improving the utilization rate and operational efficiency of existing stock. Improving T&D efficiency and PLF of power sector, removing bottlenecks and widening of existing roads, increasing enrolment in schools and colleges, increasing beds and medical personnel in hospitals and dispensaries, and improving the carrying strength of railways would mitigate some of the shortages looming large before the nation. At the end of the day the services that flow out of the stock matters, just as the numbers of taps do not matter unless water comes out of them! Improvement in the operational efficiency will be helpful in doing more with the same stock and postpone the crisis point further. Still, the bottom line of the path ahead reads that either the funds are arranged for and invested in the future, or everything goes on as usual only to find that the road has ended before reaching the destination.

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