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Forecasting investment and capacity addition in Indian airport infrastructure: Analysis from post-privatization and post-economic regulation era

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ABSTRACT

Indian economy has been on the high growth trajectory for last two and half decades and it is expected to remain a high growth economy for few more decades given the favorable demographic structure and macroeconomic fundamentals. As the per capita income increases in an open economy, the opportunity cost of time consumed for travelling goes up, thereby, the demand for civil aviation increases. Indian economy is no exception as the middle class population, which has been progressively increasing, is opting for safe and less time consuming air travel. The same is true for transportation of high value-added products thorough air freight. In this context, the aim of this study is to forecast air traffic, capacity addition and investment required for capacity expansion in Indian civil aviation sector for next 20 years. In order to achieve this, we have collected last 20 years' data on air traffic, Gross Domestic Product (GDP) and Index of Industrial Production (IIP) from Airport Authority of India (AAI), World Bank website and India STAT website respectively. This data has been used to work out GDP and IIP elasticity of traffic. Using these elasticities, air traffic has been projected for next 20 years, which has been used to forecast required capacity additions and investment. In a nutshell, the findings of this study are that in next 20 years 866 million passenger terminal capacity and 7.53 thousand Metric Tons (MT) cargo terminal capacities will be required at the investment of about US$ 25.94 billion.

1. Introduction

With the advent of economic liberalization during 1991 there has been increase in the economic activities. Additionally with the resultant economic boom, disposable income of individuals has touched new heights. The real per capita GDP of India, which was growing at a compound annual growth rate (CAGR) of 3.9% during 1992–2001, started growing at an accelerated CAGR of over 6% during 2014–2015. Even during the recent global meltdown, India's economy was least affected, and in any case it recovered faster than the recovery of any other economy, thus, explaining the strong economic fundamentals of Indian economy. The recent trend in economic growth reveals that Indian economy is expected to be on a high growth trajectory during the next 20 years and Indian Aviation Sector will also grow at faster pace in tandem with the economy. Thus, along with increase in growth, India would need to develop its' aviation infrastructure in order to accommodate the projected demand.

Before economic liberalization and introduction of open sky policy in 1991, aviation was traditionally viewed as an elite activity. The two government airlines i.e., Air India and Indian Airlines were the only Indian carriers. With the advent of open sky policy, private airlines entered into the Indian sky, first as air taxi operators and then as scheduled operators. Indian aviation sector witnessed an unprecedented change and growth after 2003. During this period, the importance of aviation, for the development of business, trade and tourism was recognized, and the industry saw dramatic reforms across the aviation value chain.

In 2003, there were just three private carriers viz., Jet Airways, Air Sahara and Air Deccan-all operating full service models. The private carriers in those days were limited to operating domestic routes only. In 2015, there are six private carriers viz., Jet Airways, Kingfisher, Spice Jet, Indigo, Vistara and Go Air. These are operating

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List of acronym

GDP	Gross Domestic product
IIP	Index of Industrial Product
AAI	Airports Authority of India
India STAT	Statistical database of India
CAGR	Compound Annual Growth Rate
LCC	Low Cost Carrier
US	United States
MOCA	Ministry of Civil Aviation
ICAO	International Civil Aviation Organization
TU	Traffic Units
RPK	Revenue Passenger Kilometers
RTK	Revenue Tones Kilometers
PPP	Public Private Partnership
FDI	Foreign Direct Investment
DGCA	Directorate General of Civil Aviation
CNS	Civil Navigation Services
ANS	Air Navigation Services
MT	Metric Tones
MPPA	Million Passengers per Annum
MMTPA	Million Metric Tons per Annum
TPA	Traffic per Annum
ATU	Airport Throughput Unit

under nine brand names, and three of them are permitted to operate on international routes.

During the 11th Five Year Plan Period, domestic carriers embraced the Low Cost Carrier (LCC) model. The market share of LCC during 2014–15 had crossed 40% of the total domestic traffic. During the current 12th Five Year Plan period, the domestic traffic for Indian carriers is growing at a healthy average annual rate of around 9%. Also, the traffic growth has resulted in increased capacity utilization of domestic carriers.

Ground handling business at Indian airports has grown to reach a size of about US$ 308 million. This segment also witnessed increased participation of private players, such as, SATS, Celebi, Bird Group, Menzies,[1] etc. In Joint Ventures (JVs), AIR India SATS (AISATS) is a JV between national carrier Air India and Singapore Air Transport Services. In 2011, Ministry of Civil Aviation (MOCA, 2015) announced a new ground handling policy, under which only three ground handlers were allowed at each of the six metro airports in the country. One was an Air India subsidiary, the other a subsidiary of the airport operator and the third one, an entity selected through competitive bidding.

Airports Authority of India (AAI) continued its leadership in creating air connectivity across the country by incurring expenditure to the tune of US$ 1.9 billion during the 11th Five Year Plan period and US$ 10. 8 billion has been planned for the 12th Five Year Plan period. AAI has upgraded and modernized 35 non-metro airports in the country, at an estimated cost of US$ 692 million. AAI is enhancing air connectivity in the Northeast by way of Greenfield airports at Pakyong (Sikkim), Itanagar (Arunachal Pradesh) and Cheitu (Nagaland).

The private sector played a major role during the 11th Five Year Plan in the development of airports through Public Private Partnership (PPP) model. These include development of Greenfield International airports at Bangalore and Hyderabad, and modernization of Delhi and Mumbai international airports through consortiums and Special Purpose Vehicles (SPVs).

In view of the above, airports are being viewed as commercial enterprises rather than public service organizations. Accordingly any progressive commercial enterprises require additional investment to sustain the future growth/addition in demand. The overarching question that arises here, in the above backdrop, is how much future investment is needed in airport sector in order to meet the growing demand of its services. The forecasting of investment requirement, being the major objective of the study, can be achieved with the help of forecasting air traffic, aircraft movement, and capacity enhancement for passenger and cargo terminals for Indian airports. Thus, forecasting of investment in airport sector will enable planners and policy makers to take correct decisions. Additionally, the government would need to allocate sufficient budget for major airports to meet growing demand of airport infrastructure services.

The remaining part of the study is presented as follows: The Section 2 presents the literature survey; Section 3 and Section 4 contain Methodology and Data source and Descriptive Data Analysis including explanation of variables respectively. Results and discussion are described in Section 5 and followed by Conclusions and Policy suggestions are given in Section 6.

2. Review of literature

A smooth-functioning air transport sector offers significant economic development benefits, particularly for landlocked, isolated, and low population-density countries (The World Bank). The ever growing demand for air travel has put pressure on airports to enhance their capacity. Understandably, it is in order to continuously provide smooth service to passengers (Zou, Kafle, Chang,&Park, 2015). The increasing demand for aviation services has led to significant pressure on existing airport infrastructure (Gelhausen et al., 2013; Saldıraner, 2013). Airports are not only locations for transport activity, but also act as hubs of commercial infrastructure (Wells and Young, 2004), that in turn offers numerous opportunities to airport owners to explore the commercial space with resultant enhanced financial gains. Aviation is a driver of economic and social development of a country. The turnover of the Indian Aviation Sector today exceeds US$ 15.38 billion. Private sector has played an unprecedented role for developing the airport sector in the country (Damodaran, 2015). Air Transport can play a key role in economic development and in supporting long-term economic growth. It facilitates a country's integration into the global economy, thereby providing direct benefits for users. It also accrues wider economic benefits through its positive impact on productivity and economic performance (ATA).

Since privatization there has been significant increased investment in Australian airports, with over $2.2 billion invested in new terminals, runways and other infrastructure at the leased federal airports (Australian Government, 2008). The “airport planning paradigm is shifting from the traditional pattern, being determined by high standards, established customers and long-term forecasts, to that of recognizing great uncertainty at forecasts, broad range standards and potential for a rapidly changing customer's base” (de Neufville, 2008; Magalhaes, Reis, & Maca'rio, 2015). Air transport

[1] SATS, Celebi, Bird Group, Menzies are global cargo handling companies.

demand forecasts of the aircraft industry and institutions like ICAO (International Civil Aviation Organization) use the number of passenger kilometers, counted as revenue passenger kilometers (RPK), as a unit of demand (Gelhausen, Berster, & Wilken, 2013). The demand, as measured in RPK, grew even stronger than the number of passengers during the sixteen year period from 1994 to 2010; the demand more than doubled and increased with an average growth rate of 5%.

Kasarda (2006) and Graham (2009) have a view that secondary business, such as, parking, retailing etc. in expanding airports has been increasingly evident. This is based on the fact that aircrafts evolved from its historical status as an innovative transport technology to an everyday transport mode (Stevens, 2006). In view of this the Australian Government recognizes the importance of continued investment in aeronautical infrastructure at airports, and is committed to ensuring infrastructure development (Australian Government, 2008). Crabtree et al. (2015) have forecasted that over the next 20 years, world air cargo traffic will grow by 4.7% per year; air freight, including express traffic, will average 4.8% annual growth measured in Revenue Tones Kilometers (RTKs); airmail traffic though will grow slowly, averaging 1.0% annual growth through 2033. In essence, world air cargo traffic is expected to increase from 207.8 billion RTKs in 2013 to 521.8 billion in 2033.

The literature on liberalization and foreign direct investment in the aviation sectors of India, People's Republic of China, and Thailand brings out a number of key points. Firstly, greater competition has emerged within domestic markets, including from privately owned airlines, especially from low-fare carriers. Secondly, a higher level of foreign participation in airline operations helps provide funding and management capacity that supports the adjustment process required in the incumbent carriers (Findlay and Goldstein, 2004). The long term forecasts of Boeing and Airbus, as well as that of the ICAO, have in common a continuation of the past and development over the next 20 years. Based on this they forecast further liberalization of air transport in future as one of the key drivers of growth, especially in Asian and African regions (Gelhausen, Berster, & Wilken, 2013). FDI inflows in air transport (including air cargo) during April 2000 to January 2015 stood at US$ 562.65 million. Air Costa plans to add eight aircrafts before 2016 to its existing fleet, Boeing is planning to set up an aircraft manufacturing base in India. Vistara has signed an inter-line agreement with Singapore Airlines and Silk Air & Tata Group has launched its full-service Vistara Airline on January 9, 2015 (IBEF, 2015).

The entry of low-cost carriers, pioneered by Air Deccan, helped to greatly reduce the costs involved in flying. This helped attracting consumers for whom air travel was only a dream. Now a number of low-cost airlines are operating in India, namely; Go Airways, Spice Jet, Indigo etc., which put together, have a major share of the Indian aviation sector. Thus, domestic participation in this industry is projected to grow by 25–30% and internationally by 15%, increasing the potential customers by about 100 million in 2010. Also, by 2020 the cargo section is projected to rise to approximately three million tonnes (The World Bank). International markets contribute16% in terms of traffic generation and 29% of all connecting passengers in the US airport network (Suau-Sanchez , Voltes-Dorta , & Rodríguez-Déniz, 2015). The number of passengers transported worldwide in air transportation has touched a volume of almost 2500 million in 2010 (ICAO, 2011).

Notwithstanding the above the biggest problem in India is the liquidity crunch. Indian aviation does not have enough funds to meet the growing demand. Therefore, the alternate is to invite FDI (Vidhusekhar, 2014). Director of Civil Aviation (DGCA) guideline suggests that in Greenfield projects, FDI up to 100% is allowed under the automatic route. In case of existing projects, FDI up to 74% is allowed through automatic route, and beyond that and up to 100%, with prior approval of the Government (DGCA, 2013).

The policies of the Indian government encourage foreign participation. Government allows 100% FDI via the automatic route for the green field airports. Also, foreign investment up to 74% is permissible through direct approvals while special permissions are required for 100% investment. Private investors are allowed to establish general airports and captive airstrips while keeping a distance of 150 km from the existing ones. Complete tax exemption is also granted for 10 years. About 49% FDI is allowed for investment in domestic airlines via the automatic route. However, this option is not available for foreign airline corporations. Complete equity ownership is granted to NRIs (Non Resident Indians). Foreign direct investment up to 74% is allowed for non-scheduled and cargo airlines. As a result, all these policies promote foreign investment in this industry (The World Bank).

If traffic reaches levels that are close to the maximum throughput of the runway system, then the airport encounters not only problems of maintaining good quality of operations, but is faced with the fact that future traffic growth cannot be accommodated any more (Gelhausen, Berster, & Wilken, 2013). Zhang (2003) has a view that China lacks an efficient logistic-related infrastructure, which includes not just airport capacity, but road networks and technological capabilities as well. Thus, modern transportation, communications, and logistics systems are essential to support major airports like Shanghai, Beijing, Guangzhou, and Shenzhen to become regional air-cargo hubs. Some important airports, partly main hub airports have been struggling already for years with capacity constraints, among them are: London, Heathrow, Frankfurt, Paris Charles de Gaulle in Europe, and New York LaGuardia in the USA (Gelhausen, Berster, & Wilken, 2013).

Crabtree et al. (2015) have also projected that Asia will continue to lead the world in average annual air cargo growth, with domestic China and intra-Asia markets expanding 6.7% and 6.5% per year, respectively. The Asia–North America and Europe–Asia markets will grow slightly faster than the world average growth rate. Latin American markets with North America and Europe will grow at approximately the world average growth rate, as will Middle East markets with Europe. The growth of established markets is slower than the growth of the developing markets. In the light of this fact North America and Europe air cargo growth rates are below the world average rate. The Indian aviation industry is forecasted to grow phenomenally in the coming years. The Vision 2020, announced by the Civil Aviation Ministry, conceives building infrastructure to support 280 million customers. Investments to the extent of US$ 110 billion are envisaged by 2020. About US$ 30 billion for development and sprucing up of existing airports and US$ 80 billion for building new fleets is being estimated (The World Bank).

Investment forecast for airport infrastructure, such as; for passenger terminal, cargo terminals and Air Navigation Services (ANS)/Communication and Navigation Services (CNS) services have not been observed in any of the literature as of now. This study is unique and one of its kind in bridging the literature gap in forecasting such investment requirement. This is attempted by forecasting air traffic, aircraft movement, and capacity addition for passenger and cargo terminals for Indian airports.

3. Methodology and Data source

The historical data collected from AAI for the period 1995–96 to 2014–15 for all Indian airports traffic (together) has been used for econometric modeling. GDP (1995–96 to 2014–15) of India collected from World Bank website has been used as explanatory variable for forecast of International passengers and domestic

passengers. Index of industrial production (IIP) for the time period 1995–96 to 2014-15 has been used as explanatory variable for forecast of Cargo traffic.

Initially, trend analysis with linear model and econometric analysis with linear regression model, double log/exponential model taking real GDP of India as independent variable and air passenger traffic as dependent variable were undertaken. However, we got some disadvantages in linear models, which start underestimating the future air traffic. Underestimates also continue to increase with increase in time horizon in long term forecast; therefore, linear models were not selected. The final double log model was selected because it gives increasing increments with the increase base of traffic which is validated statistically, based on 20 years historical data for air traffic.

The aircraft movements have been projected based on the ratios of passengers to number of aircraft movement. The detail methodologies both for passenger and cargo traffic have been explained in the following sections.

3.1. Methodology of estimating past CAGR of air traffic

3.1.1. Relationship between passenger traffic and economic growth

Economic growth affects air passenger traffic significantly. Similarly, industrial output also affects cargo traffic significantly. This has been established by all international organizations viz. International Civil Aviation Organization, Airport Council International Europe, Aircraft Manufacturers and operators of the major airports worldwide. Thus, the response of passenger air traffic due to change in economic growth, and the response of cargo traffic due to change in industrial output plays an important role in estimating the growth rate of air traffic. This can help in arriving at future forecast of investment in aviation sector with a view to meeting growing demand of aviation services.

In view of the above, we assume an exponential relationship between passenger air traffic and economic growth, and between cargo air traffic and industrial output. By this logic, the relationship between passenger traffic and economic growth can be written as:

$$P_t = f(Y_t) \tag{1}$$

Where, P: passenger traffic.
Y: GDP (proxy for economic growth).
t:Time period.

Assuming exponential relationship between passenger traffic and economic growth, we can write:

$$P_t = \beta_1 Y_t^{\beta_2} \tag{2}$$

Taking natural log to both side of eq. (2), we get,

$$\ln P_t = \ln \beta_1 + \beta_2 \ln Y_t \tag{3}$$

Differentiating both sides of eq. (3) w. r.t. Y_t,

$$\frac{1}{P_t}\frac{dP_t}{dY_t} = \beta_2 \frac{1}{Y_t}$$

$$\Rightarrow \frac{Y_t}{P_t}\frac{dP_t}{dY_t} = \beta_2 \tag{4}$$

Now in eq. (4), ceteris paribus β_2 measures the elasticity of passenger traffic due to change in economic growth. That is how much passenger traffic is responding to percentage change in economic growth keeping all other factors constant.

3.1.2. Relationship between cargo traffic and industrial output

Similarly, the relationship cargo traffic and industrial output can be written as:

$$C_t = f(Q_t) \tag{5}$$

Where, C: cargo traffic.Q: industrial output.t: Time period.

Assuming exponential relationship between cargo traffic and index of industrial production, we can write:

$$C_t = \alpha_1 Q_t^{\alpha_2} \tag{6}$$

Taking natural log to both side of eq. (2), we get,

$$\ln C_t = \ln \alpha_1 + \alpha_2 \ln Q_t \tag{7}$$

Differentiating both sides of eq. (3) w. r.t. Q_t,

$$\frac{1}{C_t}\frac{dC_t}{dQ_t} = \alpha_2 \frac{1}{Q_t}$$

$$\frac{Q_t}{C_t}\frac{dC_t}{dQ_t} = \alpha_2 \tag{8}$$

Now in eq. (4), ceteris paribus α_2 measures the elasticity of cargo traffic due to change in industrial output. That is how much cargo traffic is responding to percentage change in industrial output keeping all other factors constant.

3.1.3. Future growth of passenger traffic

We have considered the elasticity β_2 and economic growth rate (R) to compute future compound annual growth rate (CAGR) of passenger traffic. Accordingly, the projected CAGR can be written as:

$$\mu = \beta_2 R \tag{9}$$

Where, μ_2: CAGR of passenger traffic.R: economic growth rate.β_2: GDP elasticity of passenger traffic.

The μ arrived above is then adjusted for decreasing trend in GDP elasticity of passenger traffic and increase in air fare (passenger yield) in real terms.

3.1.4. Future growth of cargo traffic

We have considered the elasticity α_2 and index of industrial production (IIP) to compute future compound annual growth rate (CAGR) of cargo traffic. So the projected CAGR can be written as:

$$\omega = \alpha_2 \lambda \tag{10}$$

Where, ω: CAGR of cargo traffic.λ: IIP of industrial output.α_2: IIP elasticity of cargo traffic.

The ωarrived above is then adjusted for decreasing trend in IIP elasticity of cargo traffic and increase in air fare (passenger yield) in real terms.

3.1.5. Projected aircraft movement

The aircraft movements have been projected based on forecast of the ratio of passengers to number of aircraft movement.

3.1.6. Methods of forecasting investment in airport sector

The plan period wise traffic forecast has been used to work out capacity addition for passenger and cargo terminals and ANS/CNS. These capacity additions have been used to derive investment requirement on the basis of norms used during previous five year plans.

Table. 1
Descriptive statistics.

Variables	Min.	Max.	Mean	Std. Dev.
International Aircraft Movement (IAM)	92.52	345.36	196.20	95.16
Domestic Aircraft Movement (DAM)	314.73	1257.66	727.40	369.54
Total Aircraft Movement (TAM)	407.24	1603.02	923.60	464.07
International Passenger Traffic (IPT)	11.45	50.80	25.21	13.12
Domestic Passenger Traffic (DPT)	23.85	139.33	62.96	40.82
Total Passenger Traffic (TPT)	36.50	190.13	88.17	53.87
International Cargo Traffic (ICT)	452.85	1542.55	928.62	404.61
Domestic Cargo Traffic (DCT)	196.52	985.02	496.90	253.33
Total Cargo Traffic (TCT)	649.37	2527.57	1425.53	656.17
Gross Domestic Production (GDP)	448.72	1584.72	891.06	359.21
Index of industrial production (IIP)	123.3	373.2	238.13	89.70

Source: Compiled by the authors

4. Descriptive Data Analysis

The descriptive statistics at Table 1 and Fig. 1 envisaged that the Indian economy over the annual period from 1995 to 96 to 2014–15 would grow at a rate of 6.8%, while, its industrial output would grow at 6.5% for the same period. It also has been observed from Table. 1and Fig. 1 that during the period 1995–96 to 2005–06 the international and domestic passenger traffic increased by 10.1% and 13.3% respectively, whereas the total passenger's movement registered a maximum growth of 12.4% CAGR.

The international passenger traffic had increased from 11.45 million in 1995–96 to 50.80 million in 2014–15, leading to an increase of 4.4 fold. The domestic passenger traffic had increased from 25.56 million in 1995–96 to 139.33 million in 2014–15 which works out to be 5.5 fold. This highlights that the domestic traffic had increased at a faster rate of 9.3% CAGR as against the corresponding CAGR of 8.2% for international passenger traffic during the same period.

The international passenger traffic has grown at a CAGR of 8.1%, 10.1%, 9.3% and 8.2% during 5 years, 10 years, 15 years and 19 years respectively. The corresponding growth rates for domestic passenger are 9.3%, 13.3%, 11.9% and 9.3% respectively, leading to a growth of 9%, 12.4%, 11.1% and 9% respectively in total passenger traffic.

From the Table. 1 and Fig. 1, it is seen that, in absolute terms, the international cargo traffic had increased from 452.85 thousand MT in 1995–96 to 1542.55 thousand MT in 2014–15 which represents an increase of 3.4 fold or 6.7% CAGR. The domestic cargo traffic had increased from 196.52 thousand MT in 1995–96 to 985.02 thousand MT in 2014–15 representing a growth of over 5 fold or 8.9% CAGR.

The CAGR for international cargo traffic during last 5 years, 10 years, 15 years and 19 years are 4.0%, 6.5%, 7.4% and 6.7% respectively. The corresponding CAGR for domestic cargo traffic during last 5 year, 10 year, 15 year and 19 year are 7.4%, 8.0%, 9.1% and 8.9% respectively. In other words, domestic cargo traffic has been creasing at a faster rate as compared to growth rate of international cargo traffic due to its smaller base, speedy economic development and effort of Government of India to restrict the import in the country.

In absolute terms the international aircraft movements increased from 92.52 thousands in 1995–96 to 345.36 thousands in 2014–15 registering a CAGR of 7.2% or an increase of 3.7 fold. The domestic aircraft movement increased from 314.73 thousands to 1257.66 thousands in 2014–15 representing a CAGR of 7.6% or a growth of about 4 fold (see Fig. 1).

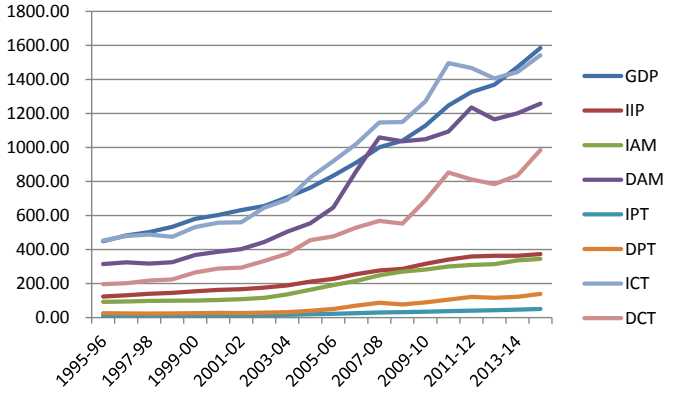

Fig. 1. Trend of economic growth, industrial growth, aircraft movement and air traffic.
Source: Compiled by the authors

5. Results and discussion

5.1. Air traffic elasticities

In this study GDP elasticity and IIP elasticity have been estimated in order to have some basic understanding as to how well passenger air traffic and cargo air traffic are responding to both changes in GDP and IIP respectively. Understanding and use of responsiveness of GDP and IIP, along with their respective future growth rate, are prerequisites in forecasting air traffic which we have attempted in this study. GDP will continue to grow at the rate of 7%–8% up to 2030–31 as per revised forecast of GDP by Government of India. Indian IIP will continue to grow at 7–9% as projected by Government of India.

Table. 2 also elucidates that the GDP elasticity of domestic passenger traffic is 1.64 which indicates that domestic passenger traffic is highly responsive to economic growth i.e. 10% increase in GDP stimulates 16.4% growth in domestic passengers traffic at 1% level of significance. The GDP elasticity of international passenger traffic is 1.28 which indicates that international passenger traffic is also highly responsive to economic growth i.e. 10% increase in GDP stimulate 12.8% growth in domestic passengers traffic significantly at 1% level of significance.

Similarly, the IIP elasticity of domestic cargo traffic is 1.38. This indicates that domestic cargo traffic is also highly responsive to growth in industrial production, i.e. 10% increase in GDP stimulate 13.8% growth in domestic cargo traffic significantly at 1% significant level. The IIP elasticity of international cargo traffic is 1.17 which indicates that international cargo traffic is also highly responsive to growth in industrial production, i.e. 10% increase in GDP stimulates 11.7% growth in domestic cargo traffic significantly at 1% level of significance (see Table. 2).

5.2. Air traffic forecast

Based on the above discussion, the traffic forecast has been prepared making use of elasticities for passenger and cargo traffic

Table. 2
Air traffic elasticities (1995–96 to 2014–15).

Variables	lnDPT	lnIPT	lnDCT	lnICT
lnGDP[a]	1.64*** (0.082)	1.28*** (0.039)	–	–
lnIIP[b]	–	–	1.38*** (0.038)	1.17*** (0.028)

***significant at 1% level ($p < 0.01$).
Note: 1. [a]GDP of India, [b]IIP of India.
2. Standard errors are given in the parentheses.
3. "ln" stands for natural log.
Source: Author's estimation

Table. 3
Traffic Forecast and Capacity addition up to 2031-32.

Forecast period	Passengers(in millions			Cargo (in '000 MT)			Aircraft Movement (in '000)		
	IPT	DPT	TPT	ICT	DCT	TCT	IAM	DAM	TAM
2014–15	50.8	139.3	190.1	1542.49	986.37	2528.86	345.46	1257.56	1603.02
2024–25	109.67	329.77	439.45	3034.31	2129.5	5163.81	679.57	2714.98	3394.55
2031–32	176.11	565.17	741.29	4872.44	3649.59	8522.03	1021.83	4359.66	5381.49
2014-15 to 2031–32 (Capacity Addition)	125.31	425.87	551.19	3329.95	2663.22	5993.17	676.37	3102.1	3778.47

Source: Author's estimation

and ratio trends projection for aircraft movements, which are presented in Table. 3.

Table. 3 Suggests that international passenger traffic is projected to grow at the rate of 7–8% and will reach 176.11 million at the end of 2031–32, whereas domestic passenger traffic is projected to grow at 8–9% and will reach 565.17 million at the end of 2031–32. Thus, the total passenger traffic is expected to touch 741.29 million by the end of 2031–32.

The international cargo has been projected to grow at the rate of 7%, and is meant to become 4872.44 thousand MT by 2031–32 and the domestic cargo traffic has been projected to grow at a relatively higher growth rate of 8% and is expected to hover around 3649.59 thousand MT by the end of 2031–32. The international aircraft movement is projected to grow between 6 and 7% and will reach 1021.83 thousands at the end of 2031–32. With this projection the domestic aircraft moment is meant to touch 4359.66 thousand in 2031–32 with a projected growth of 7–8%.

To handle the above projection there will be a need for capacity addition in major 17 Indian airports viz. Delhi, Mumbai, Bangalore, Hyderabad, Cochin, Nagpur, Chennai, Kolkata, Trivandrum, Ahmedabad, Goa, Calicut, Guwahati, Jaipur, Srinagar, Amritsar and Port Blair to accommodate the projected traffic. The projected traffic can be accommodated in major 17 Indian airports, provided adequate amount of capacity addition with the required amount of projected investment is undertaken by Government of India.

5.3. Capacity addition and investment forecast

As mentioned above, there is a need for capacity addition in Aviation Sector in India. To meet the future air traffic demand, capacity addition is required, which in turn requires the investment in the airport infrastructure, and that includes investment in passenger terminal, cargo terminal, Air Navigation Services (ANS)/ Communication and Navigation Services (CNS), safety & security etc. During the next 17–20 years, an additional capacity of about 866 MPPA will be required besides the existing capacity of 233 MPPA. Out of 866 MPPA capacities, the 366 MPPA is envisaged to be added by end of 2021–22 and another 500 MPPA by end of 2031–32. This will require the augmentation of the capacity by expanding the existing terminals, creating new terminals at Brownfield airports[2] and creation of 30–35 Greenfield airports.

During the next 17–20 years, 7.53 million metric tonnes per annum (MMTPA) cargo capacity is projected to be added. Out of the 7.53 MMTPA, 3.18 MMTPA cargo capacities are envisaged to be added by the end of 2021–22. Another 4.37 MMTPA will be added by end of 2031–32.

Table. 4 shows that investment of US$ 26 million per million passengers is required in passenger terminals and investment of US$ 158 million per million metric tones of cargo is required, which will amount to US$ 22.57 billion for passenger terminals and US$ 1.2 billion for cargo terminals. Beside this US$ 2.2 billion is forecasted for upgraded ANS/CNS services. This will result into a total investment of US$ 25.94 billion by end of 2030–31.

India is an emerging economy, and it does have a potential to grow in future as mentioned above. So far as the trade, tourism, culture, health services and education services are concerned India is highly recognized worldwide. All these sectors as of now have well defined domestic and international air connectivity. But as has already been mentioned our projected air traffic needs major amount of capacity addition in passenger terminals, cargo terminals, air navigation services and air communication services. Therefore there will be a need of total investment of around US$25.94 billion by end of 2031–32, which will generate capacity addition in passenger terminals of around 419% more, in cargo terminals of around 327% more and in ANS/CNS of around 372% more. These will be over and above their respective existing capacity. In order to meet these capacity additions, there will be need of investment of around 263% more in passenger terminals, 328% more in cargo terminals and only 14% more in ANS/CNS by end of 2031–32. These too will be over and above their respective projected investments during 2012 to 2016–17. The target of capacity addition clearly shows that for every five years, the growth rate of capacity addition in passenger terminals must be around 43.5%, for cargo terminals around 40% and for ANS/CNS around 50%. In order to meet these targeted growth rates in capacity addition, the growth rate of investment in every prospective five years span must be around 42.25% in passenger terminals, 47.2% in cargo terminals and 13.24% in ANS/CNS.

The total projected investment of US$ 25.94 billion must be allocated among 17 major airports based upon their Airport Through-put Units (ATU). These are computed considering revenue earned, air craft movement, passenger traffic and cargo traffic of respective air ports. The ATU of India ranges between 1.5 million to 70.3 million with lowest being Port-Blair and highest being Delhi. The percentage allocation of projected investment of US$ 25.94 billion is shown in Fig. 2, which indicates that a maximum amount of US$ 6.51 billion and a minimum amount of US$ 0.14 billion needs to be invested in Delhi and Port-Blair airports respectively.

6. Conclusion and policy recommendations

India, being an emerging economy, has potential to grow along with its trade, tourism, culture, health services and education services. All these sectors have a direct and indirect link with air connectivity domestically and internationally, and the same has already been well defined. However, our projected air traffic needs major amount of capacity addition in passenger terminals, cargo terminals, air navigation services and air communication services to support these sectors. Thus, a sound forecasting of air traffic is a pre-requisite to forecast investment and capacity addition in airport infrastructure, which we have done in our present study.

Our analysis finds that domestic and international passenger traffics are responding well to economic growth. Domestic and

[2] Brownfield airports are existing airports, Greenfield airports are airports developed at new sites.

Table. 4
Forecast of Capacity addition and Investment (US$1 = INR65).

Forecasting period	Passenger terminal		Cargo terminal		ANS/CNS		Total
	Capacity addition (in million)	Investment (US$ in million)	Capacity addition (in '000 MT)	Investment (US$ in million)	Capacity addition (in '000 Movements)	Investment (US$ in million)	Investment (US$ in million)
2012-13 to 2016-17	64	2486	0.6	115	0.32	677	3278
2017-18 to 2021-22	302	4545	2.58	240	0.85	204	4989
2022-23 to 2026-27	168	6526	1.79	344	1.18	523	7394
2027-28 to 2031-32	332	9012	2.56	492	1.51	769	10,274
Total	866	22,570	7.53	1192	3.86	2173	25,935

Source: Author's estimation

international cargo traffic is also responding well to growth in industrial production. However, in order to meet the growing demand of airport infrastructure services in India and to support the trade, tourism, health, education, manufacturing and other service sectors, there is an urgent requirement of capacity addition in aviation sector. This in turn requires the investment in the airport infrastructure that includes investment in passenger terminal, cargo terminal, Air Navigation Services (ANS)/Communication and Navigation Services (CNS), safety & security etc. In this regard our study establishes that out of 866 MPPA capacities, the 366 MPPA is envisaged to be added by end of 2021–22 and another 500 MPPA by end of 2031–32. During next 17–20 years, 7.53 MMTPA Cargo Capacity is projected to be added, out of which, 3.18 MMTPA cargo capacity is envisaged to be added by the end of 2021–22 and 4.37 MMTPA by end of 2031–32. Thus, by end of 2031–32, Indian Government would invest US$ 25.94 billion in major 17 airports, in proportion of traffic handled by each airport, with a minimum of 1% in Port-Blair airport and a maximum of 25% in Delhi airport in order to meet the growing demand of airport infrastructure services.

One can safely say that by adopting scientific forecasting methods, discussed in the paper, will minimize the risk involved and maximize the achievement of planned target. One of the major problems in present planning system was that the cost overruns were indicating increasing trend due to overshoot of actual resource required as compared to planned resources. Thus, this study will help airport infrastructure planner to reduce such cost to a greater extent.

However, the major shortcoming of this study is the unavailability of yield data for passenger and cargo traffic for past 20 years. Consequently, due to data deficiency, price (yield) elasticity could not be worked out, which would have further improved the quality and accuracy of the forecast. Since the study was a long term forecast, therefore, confidence interval has not been worked out. Since long term planning is indicative planning, accordingly, pessimistic and optimistic scenario have not been worked out required for short term and medium term planning.

This study is a novel attempt which will guide airport infrastructure planners and policy makers of India, and also rest of the world to take correct future capacity addition and investment decisions in order to meet growing demand of airport infrastructure services. Timely decision(s) on future capacity addition and investment decision(s) will reduce cost overruns; avoid traffic congestion and also tackle miscellaneous problems pertaining to passenger terminals, cargo terminals Air Navigation Services, Communication and Navigation Services, safety and security etc.

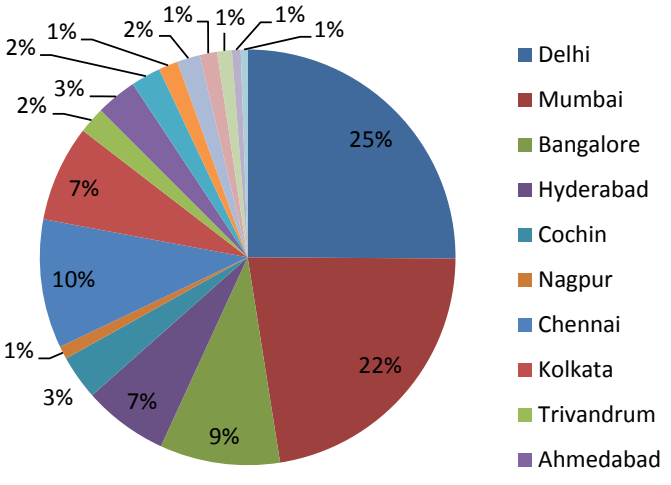

Fig. 2. Allocation of Projected Investment among 17 major Indian Airports.
Source: Compiled by the authors

FIVE YEAR PLAN PERIODS REFERRED IN THE PAPER

Plan	Plan period	Date
11th Plan	2007–08 to 2011–12	1–4–2007 to 31–3–2012
12th Plan	2012–13 to 2016–17	1–4–2012 to 31–3–2017
13th Plan	2017–18 to 2021–22	1–4–2017 to 31–3–2022
14th Plan	2022–23 to 2026–27	1–4–2022 to 31–3–2027
15th Plan	2027–28 to 20231–32	1–4–2027 to 31–3–2032

NOTE: India follows financial year for example 2011–12 represents the Period from 1st April 2011 to 31st March 2012.

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