Modeling the Dynamic Air Transport Industry Aviation Fuel Demand in India

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Abstract — ***This paper proposes a dynamic assessment of the aviation fuel demand and matches its supply in terms of price and quantity. It presents a perspective view of the aviation industry in India in terms of its contribution to the economy, challenges, aviation fuel demand and growth of passenger and freight traffic. A questionnaire survey is carried out to identify the various factors affecting the aviation fuel demand. Factor analysis is used to pick out the significant factors. A multiple regression model is developed to estimate the aviation fuel demand with factors like GDP, situations of negative publicity, price of fuel, competition from premium rail journey, promotions on tourism, cost of air freight, technological development in aircraft type and operation. Test data suggests that air passenger traffic and price of fuel are the two main significant factors affecting aviation fuel demand in India. The model was validated with real data for FY 2011-12 with satisfactory results. The paper contributes in terms of a dynamic construct for aviation fuel demand assessment in India with introduction of a publicity index and concludes that the factors affecting the aviation fuel demand will change from time to time.***

Keywords*- Strategy development, Survey methods, Analysis of Variance, Publicity index, Factor Analysis, Regression Analysis*

1. Introduction

1.1 Importance of aviation sector in India

In the study on the economic impact of Emirates Airlines operations on the Indian economy by the National Council of Applied Economics Research (NCAER), the Director General noted that a well-managed civil aviation infrastructure and efficiently-run, competitive airlines are a must in today's globalised world. The presence of such infrastructure and airlines in India can bring down transport and communication costs, promote commercial and cultural activity, create jobs, and ultimately unify people and markets [1].

After the Indian aviation sector underwent liberalisation in late nineties, it has seen a flurry of private service airlines entering the industry.

The aviation sector in India holds immense potential for growth; more so because it receives great impetus from the booming tourism industry driven by higher disposable incomes and favourable demographics. Also, the robust policy regime created by the Indian Government acts as the blood-line of this industry as suggested by the India Brand Equity Foundation [2].

Oxford Economics in Economic benefits from Air Transport in India writes that air transport to, from and within India creates three distinct types of economic benefit. Typically, studies such as this focus on the 'economic footprint' of the industry, measured by its contribution to GDP, jobs and tax revenues generated by the sector and its supply chain. But the economic value created by the industry is more than that. The principal benefits are created for the customer, the passenger or shipper, using the air transport service. In addition, the connections created between cities and markets represent an important infrastructure asset that generates benefits through enabling foreign direct investment, business clusters, specialization and other spill-over impacts on an economy's productive capacity [3].

1.2 Contribution of aviation sector in India's economy

Association of Private Airport Operators noted that Civil Aviation Sector is of National importance as it contributes significantly to the process of development of the country with as a result of enhanced productivity and efficiency in the movement of goods and services by providing access to safe, secure and affordable Air services and world class infrastructure facilities. The most important contribution Aviation makes to the economy is through its impact on the performance of other industries by enhancing efficiency and competitiveness by offering most efficient and fast transportation facility.

This sector also contributes substantially to the GDP. Civil Aviation sector epitomizes modern, resurgent and fast developing Indian Economy which is moving to be a super power of the world in the near future.

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The contribution of Civil Aviation sector in providing employment opportunities directly, indirectly and induced is immense.

This sector gives fascinating opportunities to an array of industries such as Airports, Airlines, Cargo, MRO, Ground Handling, ANS, Retail business, Real Estate etc. One of the important induced effects of air transport is on the tourism sector of an economy [4].

In the Economic Benefits from Air Transport in India, Oxford Economics, suggests that the aviation sector contributes INR 330 billion (0.5%) to Indian GDP. The aviation sector supports 1.7 million jobs in India. The average air transport services employee generates nearly INR 1.3 million in GVA annually, which is around 10 times more productive than the average in India. The aviation sector pays over INR 87.5 billion in tax including income tax receipts from employees, social security contributions and corporation tax levied on profits.

From visiting family and friends to shipping high value products, 70 million passengers and 1.4 million tonnes of freight travelled to, from and within India. More than 130,000 scheduled international flights depart India annually, destined for 70 airports in 50 countries. Domestically, more than 664,000 flights make 89 million seats available to passengers annually, destined to 73 airports [3].

Table 1. Aviation's contribution of output and jobs to India

	Direct	Indirect	Induced	Total	% of whole economy
Cont to GDP (INR) billion, (A)	147	107	77	330	0.5%
Catalytic (tourism)	181	278	122	582	0.9%
Total including catalytic	328	385	199	912	1.5%
Cont to employment (000s), (B)	276	841	605	1,723	0.4%
Catalytic (tourism)	3,791	2,297	989	7,077	1.5%
Total including catalytic	4,067	3,139	1,593	8,800	1.8%

(A) Contribution to GDP (INR) billion, Aviation (inc Airlines, Airports and Ground Services, Aerospace)
(B) Contribution to employment (000s) Aviation (inc Airlines, Airports and Ground Services, Aerospace)
Source: IATA, ACI, Individual company accounts, Oxford Economics

Today the growth of the Indian air transport industry is increasing at rapid rate due to the various economical and technological reasons. Due to the adaption of the open sky policy in 1990 and several other liberalization policies by the Indian government causes the rapid changes and rapid transformation in the airline industry. The Indian civil aviation too is presently witnessing a boom with a host of private airlines taking to the skies [5].

1.3 Challenges faced by the aviation industry in India

Beside this growth the Indian airline industry also facing some of the major challenges like high aviation turbine fuel prices, overcapacity, huge debt, poor infrastructure, employees' shortage, reserve routes and intense competition [5].

After the liberalization in Indian civil aviation industry increased airlines choice, reduced fares, and increased routes were the major advantages. But the most restricted industry faced the some serious problem after liberalization and these were infrastructure bottleneck, traffic jam, taxation policy, and productivity.

Association of Private Airport Operators viewed that air transport is the fastest and safest mode of transport for relatively long distance. Total air passenger traffic in India has increased from 109 million in 2008-09 to 143 million in 2010-11. Available forecasts suggest that by 2020 air passenger traffic will be around 290-300 million.

To meet this huge air traffic demand, the country will require approx. 350-400 operational airports across the country. This implies that huge private investments will have to be attracted as AAI alone will not be able to raise the funds (Rs. 60 - 70,000 Crores).

Similarly, India is likely to have a 1,000 plus fleet strength of aircraft requiring huge investment of approx. US $ 90 billion.

The effort to be taken by Ministry of Civil Aviation to notify a National Civil Aviation Policy is highly commendable as it will provide a blueprint and a road map/clear vision to all the stakeholders including the government in understanding their respective roles for ensuring the growth and development of the sector in the next decade.

It is also extremely important that the policy should address the discrepancies in the existing rules/acts within the Civil Aviation sector thereby removing scope for different interpretations and to have cohesiveness in interpretation and implementing various rules/regulations.

Airports are a critical part of the transport infrastructure. It is important that Airport Infrastructure gets developed in anticipation of meeting the future growth in demand for air travel. Therefore, well planned, efficiently operating, modern world class airports are important national assets. There is a vital need for the government to come up with the long term policy for the Airport Sector. The policy issues highlighted for discussion by FICCI do not contain Airport as one of the topic. It is very essential that a policy on the Airport must be part of the National Civil Aviation policy particularly the policy on issues of private participation, Greenfield policy, Brownfield policy, Cargo Policy, Hub Policy, development of non-metro airports and at Hilly and

Remote areas etc. The Policy must, most importantly, address the economic viability issues of airports [4].

1.4 The factors normally affecting the aviation fuel demand

Indian civil aviation has experienced a greater growth rate since middle of the past decade and the domestic traffic tripled from approximately 15 to 45 million passengers in the period from 2004 to 2010.

Global aircrafts fuel consumption is expected to rise by 3% to 3.5% and reach between 461Mt and 541Mt in 2036. Domestic and international operations accounts for 38% and 62% of global fuel consumption respectively. Due to higher rate of growth in air transportation network in India resulted in increased fuel consumption of ATF and it went up by about 40% from 3.3 Mt to 4.6 Mt between 2005 and 2010 [5].

Fuel consumption is one of major direct operating cost parameter in the air transport industry. Airbus, (2008) predicted that in 2003, fuel represented about 28% of total operating cost for a typical A320 family operator. By 2006 fuel prices had more than doubled, meaning that fuel now represented about 43% of all operating costs [5]. At one time fuel extraction cost and availability had little impact on the evolution of aviation industry but today fuel conservation is one of most critical concern to aviation industry [6].

Aviation turbine fuel is a major cost element for aircraft and airline operation. The airline operators have to keep this input cost at optimum to grow with the available potential. The petroleum companies in turn will have to position the desired aviation turbine fuel meeting the increasing demand in a growing market. Accessing of the demand thus becomes increasingly important to cater the aviation turbine fuel in the market. In this study, a model is suggested that can forecast the demand of aviation turbine fuel in a dynamic air transport industry that is influenced by various factors not directly related to the operation.

Aircraft fuel consumption during its operation is considered as one of the major challenge in the Indian air transport industry. Aircraft consumes large amount of fuel during its takeoff, climb, cruise, descent, and landing phases of flights. The amount of fuel consumed by an aircraft during its operation from one airport to another depends upon several factors and parameters. Most of the factors are directly controlled by airlines with proper operations planning and strategies. Good flight planning, correct aircraft loading, proper maintenance, flight procedures, and fuel tankering etc. have significant impact on aircraft fuel consumption during its operations. Airline efficiency can be increased by managing the aircraft operations properly. Through proper flight planning aircraft fuel consumption can be reduced. Weight, speed, and wind resistance are the major parameters which effect the fuel consumption to a greater extent during the operations of aircraft. Reducing the weight will reduce the fuel consumption because for lighter the engine will work less. There are several methods which reduces the weight of the aircraft. This includes the using one engine while taxing, using ground tugs for aircraft movement on ground, using ground electric power instead of onboard power, removing non essential items, and proper fuel tankering etc. Hence the aircraft fuel consumption becomes an important issue for the aircraft operations planning. Therefore in such a highly competitive environment optimization of fuel consumption is essential in the airline industry.

Total domestic passengers carried by the scheduled domestic airlines in November 2012 were 5.02 million (465, 000 higher than those carried in October 2012). The number of passengers carried by domestic airlines was 53.4 million between January-November 2012.

The air transport (including air freight) in India has attracted foreign direct investment (FDI) worth US$ 448.40 million from April 2000 to December 2012, as per the data released by Department of Industrial Policy and Promotion (DIPP).

Estimating the overall aviation turbine fuel demand from individual aircraft type and route may not be practical considering various factors. To overcome the challenge a survey was conducted to understand the underlying factors that cause the demand of aviation turbine fuel. At micro level, from the airline operation perspective, optimization of fuel consumption with focus on various parameters identified in various literatures can provide a solution specific to the airline. They add value in terms of aviation fuel efficiency in aircraft and operating airline. At the macro level, to estimate the aviation turbine fuel demand in India, we need a model that uses the underlying factors like economic condition, adverse or positive publicity of the geographical area, air traffic, cargo movement etc. Such factors were identified and the model was evaluated and validated.

2. Literature review

2.1 Growth of civil aviation traffic in India

A Research Study of the Civil Aviation Sector in India found that, over the past ten years the Indian civil aviation sector grew by 14.2% in terms of domestic passengers and 7.8% in terms of air cargo (in CAGR - compound annual growth rate). In 2010-11 six major Indian carriers with around 400 aircraft catered to 143 million passengers, including 38 million passengers that originated abroad. In 2010-11, Indian airlines carried approximately 1.6 million tons of air cargo. Further growth of the aviation sector between 2011- 2013 is estimated at 15% [7].

Up until the late 1980s, India‘s civil aviation sector remained monopolized by India‘s government owned airlines. However in 1986, the Indian government once again granted permission to private sector companies to provide air taxi service. Additionally, India‘s Open Sky Policy of 1990 and the Air Corporations (Transfer of Undertakings and Repeal) Act of 1994 further freed up India‘s civil aviation industry and eradicated the government carrier monopoly.

In 2003 the introduction of a new type of airline service called low cost carriers - LCCs or no-frills air service - by Air Deccan, reinvigorated India‘s civil aviation sector. By bringing competition into the Jet Airlines-Air Sahara duopoly, Air Deccan brought a new competitive spirit to India‘s civil aviation. Furthermore, introduction of low cost airlines also changed the perception that air travel was reserved only for the elites. By 2007 mergers and acquisitions became common in India‘s civil aviation sector. Within a span of two years Air India and Indian Airlines merged, as did Jet Airways and Air Sahara, and Kingfisher Airlines and Air Deccan.

Currently, India maintains bilateral Air Service Agreements (ASAs) with 108 countries. While 72 foreign airlines fly in and out of India, four private domestic carriers - Jet Air, IndiGo, SpiceJet and Kingfisher - fly to 35 destinations in 25 countries. Air India, the national carrier maintains a number of international routes.

Aviation traffic is measured by Passenger Kilometer Performed (PKP) and Tonne Kilometer Performed (TKP). Table 2 shows the change in PKP and TKP over the years in India.

Table 2. Schedule (Domestic + International) services

	Passenger kilometre performed	Tonne kilometre performed	PKP Year on Year growth	TKP Year on Year growth
	PKP	TKP		
	Million	Million	%	%
2001-02	24980	2786		
2002-03	28667	3157	14.8	13.3
2003-04	32674	3559	14.0	12.7
2004-05	40302	4395	23.3	23.5
2005-06	51567	5478	28.0	24.6
2006-07	63874	6606	23.9	20.6
2007-08	77847	8110	21.9	22.8
2008-09	78445	8458	0.8	4.3
2009-10	89443	9487	14.0	12.2
2010-11	103172	10763	15.3	13.4
CAGR (%)	17.1	16.2		

Source: DGCA

The PKP was 24980 million passenger-kilometres in 2001-02. It reached 103172 million in 2010-11 registering a CAGR of 17.1%. On year to year basis the PKP increased by 14% from 2001-02 to 2003-04. A major leap was experienced from 2003-04 to 2007-08 when the year-on-year growth registered was above 23%. Due to recession during the 2007-08 and 2008-09 periods, the dream run suddenly came to a stop. Again the PKP has started picking up from 2009-10 onward to the earlier state of above 14%. Overall the passenger-kilometre in Indian air traffic has been very impressive and the future holds potential.

The growth rate of TKP was also in line with the PKP. In the last ten years from 2001-02 to 2010-11 the cumulative annual growth rate was 16.2%. The impact of recession was felt during 2007-08 and 2008-09 periods, where the year-on-year growth registered was only 4.3%. Excluding this, the general trend of TKP is drawn by PKP. The passenger, freight and mail contributed 92%, 7% and 1% during 2008-09 in ton-kilometres and the proportion is similar in other years. As passenger contributes the maximum in ton-kilometres, the TKP is drawn by PKP.

The PKP as a percentage of seat kilometers available is defined as passenger load factor, PLF. The weight load factor, WLF is TKP as a percentage of ton-kilometres available. Table 3 shows the PLF and WLF in Indian aviation sector over a decade.

Table 3. Scheduled (Domestic + International) services

	Passenger kilometer performed	Tonne kilometer performed	Passenger load factor	Weight load factor
	PKP	TKP	PLF	WLF
	Million	Million	%	%
2001-02	24980	2786	62.2	59.7
2002-03	28667	3157	64.8	62.4
2003-04	32674	3559	65.5	62.4
2004-05	40302	4395	68.4	65
2005-06	51567	5478	68.3	63.5
2006-07	63874	6606	68.4	63
2007-08	77847	8110	67.7	59.8
2008-09	78445	8458	64.7	57.5
2009-10	89443	9487	71.5	62.8
2010-11	103172	10763	75	65.2

Source: DGCA

The PLF varied from 62.2% to 75% from 2001-02 to 2010-11. Till 2008-09 PLF was below 70% and is showing better utilization from 2008-09 onwards to over 70%.

Over the decade the PLF has increased annually by 2.1 percent as shown in Table 4.

Table 4: Scheduled (domestic + international) services

	Passenger load factor	Weight load factor	PLF Year on Year growth	WLF Year on Year growth
	PLF	WLF		
	%	%	%	%
2001-02	62.2	59.7		
2002-03	64.8	62.4	4.2	4.5
2003-04	65.5	62.4	1.1	0.0
2004-05	68.4	65	4.4	4.2
2005-06	68.3	63.5	-0.1	-2.3
2006-07	68.4	63	0.1	-0.8
2007-08	67.7	59.8	-1.0	-5.1
2008-09	64.7	57.5	-4.4	-3.8
2009-10	71.5	62.8	10.5	9.2
2010-11	75	65.2	4.9	3.8
CAGR	2.1	1.0		

Source: DGCA

The PLF was 62.2 percent in 2001-02, and reached its peak at 75 percent during 2010-11. As seen in case of PKP, 2007-08 and 2008-09 witnessed a difficult time for the airline operators with negative PLF growth and dampening the percent utilization of available seats from 68.4 to 64.7 percent. From 2009-10 onward against utilization improved reaching its peak during 2010-11 at 75%. As mentioned by Mazraati (2010), the PLF reached 76.3% globally and Indian airline operators are yet to witness such utilization. In other wards there is sufficient potential available in Indian air traffic operation for improvement.

The WLF also shows cumulative annual growth rate of 1.0 percent over the decade. The WLF in Table 4, increase to 65.2 percent in 2010-2011 from 59.7 percent in 2001-02. Negative trend were seen in 2007-08 and 2008-09, in the similar to PLF. The WLF is higher during the decade compared to the global trend [8].

IATA shows in Figure 1 below, the global aviation 'Industry Outlook' that one unusual feature of aviation markets is the strong divergence between a robust expansion in air travel and the shrinkage of air freight since peaking in early 2010, after rebounding sharply from the recession. In past cycles weakness in air freight has been a leading indicator of weakness in air travel. That has not been the case this time [9].

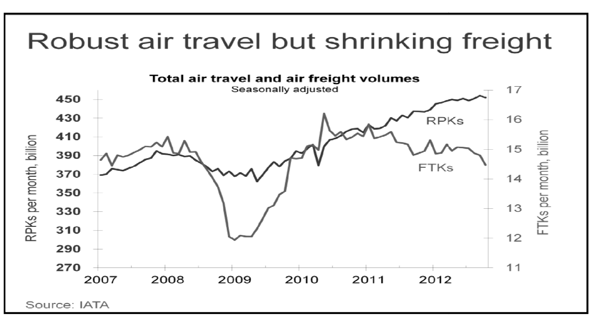

Figure 1. Global total air travel and air freight over the years

In the outlook as seen in figure 2 below, it is mentioned that there is a lot of variation within the aggregate air travel number. On domestic markets China continues to expand very strongly, after a slowdown earlier this year.

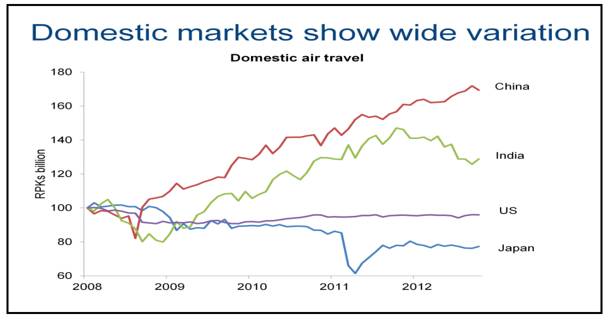

Figure 2. Global domestic air travel over the years, Source IATA

By contrast Indian markets have gone into sharp reverse in 2012, following the problems of Kingfisher and the slowdown of the Indian economy. The US market has barely moved, indicating its maturity and the sluggishness of the economy.

In Japan the domestic market has never recovered to pre-earthquake levels and is currently slowly in decline.

The global outlook on international markets, the Middle East airlines continues to expand at a rapid pace, taking share of long haul markets and developing new E-W markets between Africa and Asia, followed by the Latin American airlines, boosted by strong trade and relatively strong economies.

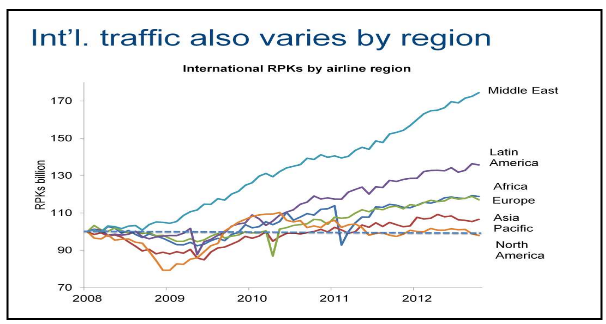

Figure 3. International Revenue per passenger kilometer, Source IATA

North American Airlines have reversed the expansion on international markets seen after the recession. Asia-Pacific airlines, despite the economic strength of their region, have seen the second weakest expansion over the past 5 years.

In the past 40 years the volume of air travel, as measured by worldwide scheduled RPKs (revenue passenger kilometers), has expanded tenfold. This is an expansion three times greater than the growth of the world's economies, which partly reflects the high income elasticity of air travel. It also reflects, and has facilitated, globalization. Air travel has risen broadly in line with world trade during the past 40 years. It has been one of the fastest growing economic sectors as seen in Figure 4 below [10].

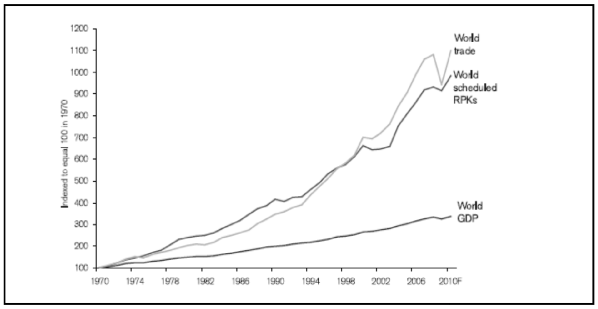

Figure 4. Air travel has expanded tenfold in the past 40 years, Source: ICAO, IATA, Haver

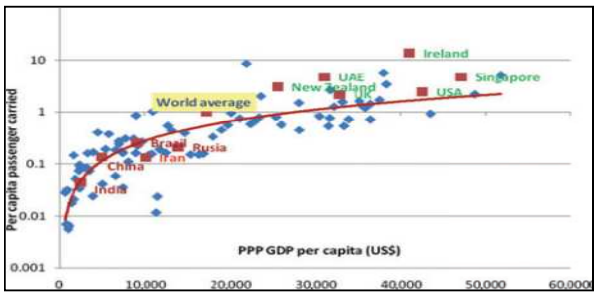

Figure 5. Air travel propensity curve 2007. Source: traffic data from ICAO (2008), and GDP from IMF (2008). [11]

In different region of the world, the economic development, along with other variables such as population, availability of aviation service and affordability, play a great role in aviation traffic growth. Figure 5 illustrates the world aviation travel propensity curve. The per capita aviation travel varies widely among countries. While the world average aviation travel is about one travel per person, it ranged from 0.006 travels per person in Bangladesh to 13.6 travels per person in Ireland in 2007 [12].

Per capita aviation passenger is growing with the increase in real per capita gross domestic product (GDP). The developed countries, with higher per capita income, experience a higher level of per capita passenger compared with middle-level and low-level per capita income. The per capita aviation travel in emerging countries with regard to aviation traffic, i.e. Brazil, Russian Federation, India and China (the so-called BRIC), is below the world average, but these countries are moving much faster along the air travel propensity curve than any other countries.

Distribution of per capita air travel around the world confirms the fact that there is a big potential for air traffic coming mostly from developing countries. They are very far below the saturation point. The emerging countries are not only demanding more air traffic than that of developed countries but also represent a much larger share of the world population, which can be taken as the main source of future air service demand.

2.2 Operational expenses of Indian aviation Industry

Different cost elements, including oil and fuel costs, determine the total operational cost. Some of those elements, such as oil, fuel, landing and its associated airport charge costs, are not fully under the control of the aviation industry. However, a portion of oil and fuel cost per PKP can be reduced through better load management. Oil and fuel contribute the major part of operating costs where its share in total operating costs of scheduled airlines was about 22 per cent in 2005. This share was only 10–15 per cent during the 1990s [8].

The Indian aviation sector operating expenses also has witnessed wide variations over the years. The fuel cost contributed over 20 percent in 2001-02, and reached 42 percent in 2010-11. Figure 6 below shows the changes in the major cost elements over a decade.

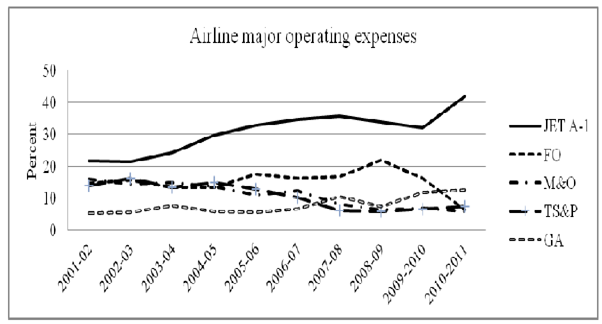

Figure 6. Share of different major cost elements in airline operating cost
Source DGCA

JET A-1:	Fuel cost;	FO:	Flight operation other indirect
M&O:	Maintenance and overhaul;	TS&P:	Ticketing, Sales & Promotion
GA:	General & Administration		

What is encouraging is that the Indian airline industry has evolved through technology and innovation and have reduced the other indirect Flight operation, Maintenance and overhaul, Ticketing, sales and promotional expenses. However, the General and administrative and fuel expenses have increased considerably.

The percentage variation of all the cost elements between 2001-02 and 2010-11 are shown in Table 5.

Table 5. Airline operating expenses in percentage

Cost elements	2001-02	2010-2011	Difference
	%	%	%
Fuel cost	22	42	20
Flight operation other indirect	15	6	-8
Maintenance and overhaul	16	6	-10
Depreciation and amortisation	9	7	-2
User charges & Stationary expenses	10	8	-2
Passenger services	7	5	-2
Ticketing, Sales & Promotion	14	7	-6
General & Administration	5	13	7
Other operating expenses	3	6	4

The change in the change in fuel price in Indian market and cost of flight operation shows similar trends.

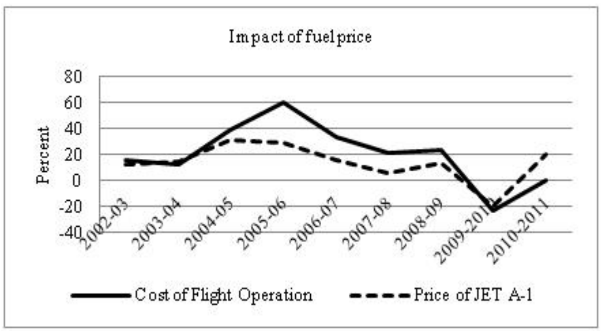

Figure 7. Trend in the change of fuel price and flight operation cost

In the coming years to sustain the airline operating cost and earning profits, the airline companies to innovate operating practices and the fuel suppliers need to access the real demand to serve the industry.

2.3 Aviation business, economic growth and impediment

India‘s civil aviation sector has evolved over time. On February 18, 1911 India‘s first commercial airplane flew between Allahabad and Naini. In 1912, India‘s first commercial international flight operated by the erstwhile Imperial Airways took place and connected Delhi to Karachi and beyond.9 In 1932, J.R.D. Tata flew an air mail service airplane, after which Tata Airlines ventured into scheduled10 air transport services [13].

Transport Corporation of India Limited website recorded that at the time of India‘s independence in 1947, nine air transport companies, carrying both air cargo and passengers, operated in the country [14].

Nathan Economic Consulting India Pvt. Ltd in a research stated that, to further strengthen the national aviation sector, the Government of India and Air India - Tata Airlines was renamed Air India in 1946 – set up a joint sector company, Air India International Ltd. In order to address the deteriorating financial health of India‘s civil aviation sector, the Government of India passed the Air Corporations Act of 1953, which nationalized all carriers providing services within India‘s civil aviation industry [15].

Table 6: Developments in Indian Aviation Industry

	Time line	
1911	India’s first commercial plane	Early market developments
1932	Tata sons ltd started Tata Airlines	
1934	Enactment of Aircraft Act	
1946	Tata Airlines named as Air India	
1948	Joint stock Co-Air International ltd set up by Govt. of India and Air India	
1950		
1953	Nationalization of Aviation Sector by Enactment of Corporation Act	State control
1986	Permission granted to Private air taxi operators	
1990	Enactment of Open Sky Act	
1994	Enactment of Airport Authority of India Act	
1995	Permission granted to Private scheduled Airline Operators	Deregulation and M&A
2003	Entry of low cost carriers	
2007	Major Mergers	
2008	AERA Act	

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India‘s civil aviation sector is much younger than other modes of transportation, and its market structure has changed frequently over the last few decades. India‘s civil aviation sector evolved from a market tightly controlled by the government with two air carrier service providers to a relatively competitive market with a somewhat small number of domestic and international air carriers. Some features of India‘s civil aviation sector include a large number of consumers (passengers and cargo), a relatively small number of airlines with significant market share, significant cost barriers to market entry, differentiated services, and competitive firms affecting each other‘s business decisions. These market characteristics indicate that India‘s civil aviation sector has an inherent oligopolistic market structure. Since within India‘s civil aviation sector, economies of scale and scope exist; in order for each market participant to break even, the firm must achieve a minimum efficient scale of operation.

Total domestic passengers carried by the scheduled domestic airlines in November 2012 were 5.02 million (465, 000 higher than those carried in October 2012). The number of passengers carried by domestic airlines was 53.4 million between January-November 2012. The market share of scheduled domestic airlines for the month of November 2012 was: Air India-20.7 per cent, Jet Airways-18.3 per cent, JetLite-6.9 per cent, IndiGo-27.3 per cent, Spice Jet- 19.5 per cent and Go Air-7.4 per cent. The air transport (including air freight) in India has attracted foreign direct investment (FDI) worth US$ 448.40 million from April 2000 to December 2012, as per the data released by Department of Industrial Policy and Promotion (DIPP).

To mention few key developments and investments in aviation sector, Jet Airways has ventured with CentrumDirect (one of India's leading financial services groups), to offer Foreign Exchange Services to guests travelling abroad. The clients, or the guests, can avail this facility online by providing the stipulated details on the airline's website www.jetairways.com. They will be then contacted by the authorised representatives from CentrumDirect in order to complete transaction. CentrumDirect offers 30 leading world currencies, travellers' cheques and prepaid travel cards across over 40 cities within India.

Singapore's Changi Airport and Switzerland's Zurich International Airport have expressed interest to carry out the operations and maintenance of the modernised terminal of the Netaji Subhas Chandra Bose International Airport, Kolkata. The Rs 2,300-crore (US$ 423.37 million) new integrated terminal has an annual capacity to handle 20 million passengers. It was jointly developed by ITD Cementation India Ltd and its parent company Italian-Thai Development Public Co Ltd, Thailand (ITD).

IBEF in the website mentioned that Hong Kong-based full service airline Cathay Pacific has unveiled its plan to add more direct flights from Mumbai to Hong Kong starting April 2013. The airline will also launch its new product line of the premium economy cabin on this route. Cathay that has India route among the top 10 revenue earners, along with its sister airline Dragonair, flies 46 weekly flights from six ports in India. It recently added Hyderabad in its network with four weekly flights [2].

A number of recent studies have attempted to quantify the long-term impact on a country's GDP that results from an improvement in connectivity. These studies suggest that a 10% increase in connectivity (relative to GDP) will raise the level of productivity in the economy by a little under 0.5% in the long run, with there being a fair degree of uncertainty around this average estimate.

VISTAS consulting mentioned that a much wider 2006 study, based on a cross-country statistical analysis of connectivity and productivity, derived a lower estimate of 0.07% for the elasticity between connectivity and long-run productivity [16].

Given the uncertainty about the correct elasticity, here we adopt the elasticity of 0.07 derived from the 2006 study, as the lowest estimate among the available studies it provides a conservative estimate of the impact of connectivity on long-term GDP. Based on this estimate, a 10% improvement in India's connectivity (relative to GDP) would see an INR 39.3 billion per annum increase in long-run GDP.

Improvements in connectivity contribute to the economic performance of the wider economy through enhancing its overall level of productivity. This improvement in productivity in firms outside the aviation sector comes through two main channels: through the effects on domestic firms of increased access to foreign markets, and increased foreign competition in the home market, and through the freer movement of investment capital and workers between countries.

Improved connectivity gives Indian-based businesses greater access to foreign markets, encouraging exports, and at the same time increases competition and choice in the home market from foreign-based producers. In this way, improved connectivity encourages firms to specialise in areas where they possess a comparative advantage. Where firms enjoy a comparative advantage, international trade provides the opportunity to better exploit economies of scale, driving down their costs and prices and thereby benefiting domestic consumers in the process. Opening domestic markets to foreign competitors can also be an important driver behind reducing unit production costs, either by forcing domestic firms to adopt best international practices in production and management methods or by encouraging innovation. Competition can also benefit domestic customers by reducing the mark-up over cost that firms charge their customers, especially where domestic firms have hitherto enjoyed some shelter from competition.

Improved connectivity can also enhance an economy's performance by making it easier for firms to invest outside their home country, which is known as foreign direct investment (FDI). Most obviously, the link between connectivity and FDI may come about because foreign investment necessarily entails some movement of staff: whether to transfer technical know-how or management oversight. But increased connectivity also allows firms to exploit the speed and reliability of air transport to ship components between plants in distant locations, without the need to hold expensive stocks of inventory as a buffer. Less tangibly, but possibly just as important, improved connectivity may favour inward investment as increased passenger traffic and trade that accompanies improved connectivity can lead to a more favourable environment for foreign firms to operate in. The countries with higher connectivity (measured relative to their GDP), are in general more successful at attracting foreign direct investment.

The five largest airports in India – Indira Gandhi International, Chhatrapti Shivaji International, Chennai International, Bengaluru International and Kolkata International – handle over 77 million passengers a year. In total over 109 million passengers arrive or depart from

Indian airports each year16. Over 1.4 million tonnes of freight is handled annually.

The Aviation sector in India (comprising the airlines, the airports and ground-based infrastructure and the aerospace sector) directly employs 276,000 people locally, and supports through their supply chains a further 841,000 jobs. Examples of these supply-chain jobs include those in the distribution sector delivering aviation fuel; jobs in the catering sector and construction workers building or maintaining facilities at airports and those in firms that produce navigational and control equipment. A further 605,000 jobs are supported through the household spending of those employed by the sector and their supply chain.

The Aviation sector directly contributes around INR 147 billion to the Indian economy (GDP). The sector contributes indirectly another INR 107 billion through the output it supports down its supply chain. A further INR 77 billion comes from the spending of the employees of the airlines and their supply chains. Overall, the Aviation sector contributes over INR 330 billion to the economy (0.5% of GDP) and supports around 1.7 million jobs in India.

Indira Gandhi International Airport is India's principal hub airport. As a hub airport for intercontinental passenger traffic, Indira Gandhi can offer its Indian residents and businesses better access to more destinations, at a higher frequency and at lower priced fares. As discussed in Section 2 of this report, such network benefits enhance a country's connectivity, which in turn can feed through to the economy's overall levels of productivity and GDP. Air transport lies at the heart of global business and tourism. Through its speed, convenience and affordability, air transport has expanded the possibilities of world travel for tourists and business travellers alike, allowing an ever greater number of people to experience diversity of geography, climate, culture and markets.

Tourism, both for business and leisure purposes, makes a large contribution to the Indian economy, with foreign visitors spending just over INR 548 billion in the Indian economy each year18. Around 89% of these visitors arrive by air (Chart 3.4), so that foreign visitors who travel by air spend approximately INR488 billion. Oxford Economics estimates that in 2009 the travel and tourism industry directly employed 24.6 million people and supported indirectly through its supply chain a further 7.6 million jobs. A further 4.5 million people were supported through the household spending of those people directly and indirectly employed by the travel and tourism sector. Of these jobs, we estimate that 3.8 million (direct), 2.3 million (indirect) and 1.0 million (induced) jobs were supported through the spending of foreign visitors who travelled by air.

The travel and tourism industry directly contributed INR 1,177 billion to the Indian economy (GDP), INR 925 billion indirectly through the output it supports down its supply chain and a further INR 559 billion through the induced effects of consumer spending. When only considering the contribution linked to the spending of foreign visitors arriving by air on Indian produced goods and services, the sector contributes INR 181 billion directly to the Indian economy, INR 278 billion indirectly and a further INR 122 billion through induced effects [3]. As mentioned by the Minister for Civil Aviation on the occasion of Aviation Day, 'airline industry in India is undergoing a very challenging period because of high cost structure coupled with global economic slowdown.

Within India's civil aviation sector, pricing of ATF is determined by a small number of suppliers. Indian ATF consumers 'choice is restricted to four suppliers. Three suppliers are state owned oil companies that enjoy access to essential facilities within India's airports and maintain refinery capacity, resulting in market dominance.

The total cost of fuel does not just make it difficult for incumbent Indian airlines to grow; high fuel costs also make it hard for new air carrier service providers to enter India's civil aviation market. Before entering India's civil aviation market, a potential market entrant must consider the price of fuel, how the price of India's ATF moves, and the effect state and central government taxes will have on the firm's overall operational expenses. Additionally, the potential entrant firm needs to determine whether or not it can absorb such fuel expenses both in the short- and long-term. High fuel expenses prevent Indian airlines from buying more aircraft and servicing more routes, which in turn contributes to overall market growth. Currently, fuel expenses make up approximately 40% of India's operational expenses.

Nathan report mentioned, highly taxed fuel impedes the ability of India's international airports to compete and develop into international hubs for plane services such as maintenance, fuel and re-hauling. Due to the high cost of aviation turbine fuel, Indian airports lose this type of business to regional hubs such as Singapore, Kuala Lumpur and Bangkok,116 which in turn reduces the airports' ability to grow, improve existing infrastructure, and positively contribute to the overall growth of India's civil aviation sector [16].

High cost of fuel also hurt the consumers, because they lead to less choice of flights and higher airfares as airlines will attempt to pass on high fuel costs to passengers. Brazil's air carrier service providers faced similar issues with respect to paying for relatively expensive and highly taxed ATF. Brazil's cargo and passenger carriers spent between 37 % and 50% of their operational budgets on the cost of jet fuel,118 hurting their ability to compete with foreign airlines. Brazil like India, a crude oil producing country, had the prevailing ATF price about 14% higher than the rest of the region.

Minister for Civil Aviation on the occasion of Aviation Day also mentioned, 'I am sure, various initiatives the Civil Aviation Ministry has taken will have a positive impact on the growth and competitiveness of the airlines in India. There are still number of policy issues which have drawn my attention and we are in process of taking decisions on these issues to further the process of reforms. Technology up gradation in the field of air navigation is one of the most important areas for the overall efficiency and safety of entire Indian civil aviation industry. The creation of ANS Corporation from the existing AAI is one of the top most priorities of the Government so as to boost the pace of modernisation and up gradation of technology in the field of air navigation'[17].

IBEF website says to give a big boost to international air travel, the Government has taken substantial steps to liberalize and grant traffic rights to Indian carriers to fly to several new destinations across the globe. In order to ensure better advance planning on the part of airlines, the Ministry of Civil Aviation as a long term plan has already allocated the traffic rights to Indian carriers for next two years i.e. Summer-2013 and Winter-2013. The new traffic rights have opened up several new international sectors and increased the overall traffic entitlements of the airlines by approximately 60% over the existing traffic rights. Only in Gulf and South East Asian countries, there is an enhancement of approximately 81,000 seats per week in the entitlement of Indian carriers which is about 80% more than their present entitlements. Now with liberalised aircraft acquisition policy, I hope our airlines will be able to utilize all these bilateral rights bringing enormous benefits to the Indian public [2].

Another area which has given wings to the growth of Indian civil aviation is the privatization of four major airports under JV/PPP model and the policy of development of Greenfield airports which envisages synergy between the public and private sector. Keeping pace with the Government policy, the Airports Authority of India has also completed the expansion and up gradation of two metro airports at Kolkata and Chennai and has undertaken the development of 35 selected non-metro airports. The Government would like the AAI to run these airports including metro airports at Kolkata and Chennai by engaging professional airport operators on the management contract through a global competitive bidding process. Further accelerating the modernization and development process, Indian Government envisages an investment of US$ 12.1 billion at Indian airports under the 12th Five-Year Plan, of which a contribution of about US$ 9.3 billion is expected from the private sector.

The association of Private Airport Operators suggested that, Policy should be framed to make all strategically located Indian Airports as Hub and Spoke model to make them most efficient, cost effective, liable, safe, secure and comfortable air travel to passengers. There are substantial economic gains which can be derived from a Hub airport including improving employment opportunities [4].

The policy should be to have an integrated transport model connecting Seaport, Road and Rail Transport and to certain extent Public Road transport utilities to make hub-spoke model most efficient and cost effective by utilizing economies of both scale and scope and provide passengers and cargo seamless connection and more efficient services.

The policy needs to position India as a global hub by effectively utilizing world class airport infrastructure capacity to handle large movement of aircraft and augment trade and tourism opportunities and to ensure seamless transition for the passenger and the airline.

Civil Aviation market contributes significantly to the process of development of the country. It also contributes to GDP substantially. All this demonstrate the significant footprint the Civil Aviation sector has on the Indian economy. Considering the importance of this sector there should be an easy entry and exit policy for the Civil Aviation sector. The policy must encourage investment for both Indian and foreign investors. It must also ensure removal of all the bottlenecks for easy access.

2.4 Other views

The aviation sector burns about 5.8 per cent of total oil consumed in the world. Technology improvement and better load management among other factors caused ongoing improvement in energy efficiency. Regional econometric modelling showed that aviation fuel demand is inelastic to aviation fuel prices despite their inverse impacts on financial balances of individual airliners. The fuel demand is highly responsive to aviation traffic that in turn is mainly a function of economic growth. Elasticises of fuel demand and aviation traffic confirmed the continuation of the ongoing energy intensity decline in the aviation sector by all the regions of the world. He conclude that The behaviour of the aviation sector with regard to fuel demand, traffic growth, load factor, capacity expansion and many other related variables is mostly regional-oriented. In some regions, the domestic traffic aviation is maturing, while in the other regions it is expanding. Further study is required to fine-tune the data at the country level to come up with a more reliable aggregate data set for each region. The current paper thus has focused on the aviation fuel demand in India [8].

With the rising and falling of economies, whether in the Organization for Economic Cooperation and Development (OECD) countries or other developing countries, the aviation industry has been affected by multiple factors such as passenger traffic, freight traffic, airport capacities and oil prices. Aircraft manufacturers have worked on improving the engine efficiency of their newly built airplanes (e.g. Airbus's A-380 and Boeing's B-787), and many airports in the world have increased the number of their runways to face the increasing demand for air traffic in the world. In their paper Aviation fuel demand modelling in OECD and developing countries: impacts of fuel efficiency it says that aviation fuel demand is modelled in OECD North America, Europe and Pacific regions and some selected developing countries.

Price elasticity of fuel demand in all regions are low, while income elasticity are high. The elasticity of aviation fuel demand on passenger kilometre performed (PKP) is considerably low. One per cent increase in PKP leads to less than half a per cent increase in aviation fuel demand, confirming ongoing fuel efficiency in aviation industry. They also concluded that Aviation fuel in all OECD regions grows steady, but consumption of developing countries is expected to increase faster. The aviation fuel consumption in selected developing countries would surpass OECD Pacific soon. The consumption would surpass OECD Europe and OECD North America around 2025 and 2030, respectively [18].

The airline industry has recently experienced its most volatile period in the past 20 years. Propelled by expectations of ever-increasing demand for air transportation, passenger airlines expanded rapidly throughout the late 1990s. The growth was led by discount carriers that possessed distinct competitive advantages over their more established rivals. When the economy faltered in 2001, it became apparent that air carriers had expanded beyond sustainable levels. The September 11th attacks contributed to a further decline in the industry. Over the course of the next 5 years, airlines continued to struggle as fuel prices rose to historic highs. Even after passenger volume recovered, the airlines continued to shed jobs in an attempt to restructure and return to profitability. In early 2007 employment in air transportation reached a trough, and airlines returned to profitability, carrying record numbers of passengers. However, the recovery in airline employment would prove to be short lived. By 2008, the industry was once again losing jobs because of soaring fuel prices and a faltering national economy [19].

Oxford Economics study in India has described and quantified a number of channels through which aviation in India generates important economic benefits for its customers and the wider Indian economy. The study has also shown what a critical asset India’s air transport network is, to business and the wider economy. Connectivity between cities and markets boosts productivity and provides a key infrastructure on which modern globalized businesses depend. Many of these city-pair connections are dependent on hub airports through which to generate the traffic density necessary to sustain them. All airlines supplying services at Indian airports contribute to generating these wider economic benefits. These ‘supply-side’ benefits are hard to measure but are easily illustrated by the experience of the volcanic ash cloud, which closed much of European airspace for a week in early 2010. Travellers were stranded. Globalized supply chains and just-in-time manufacturing processes came to a halt. Aviation has a significant footprint in the Indian economy, supporting 0.5% of Indian GDP and 1,723,000 jobs or 0.4% of the Indian workforce. Including the sector’s contribution to the tourism industry, these figures rise to 1.5% of Indian GDP and 8.8 million jobs, or 1.8% of the workforce [3].

Ref. [5] worked on a model for the optimization of fuel consumption during the operations of civil aircrafts. Several parameters were identified which effect the aircraft fuel consumption during its operations from the literature. An informational framework was developed. It was evaluated, validated and refined. Average importance rating of decision variables was done. The unimportant variables were discarded and information refinement is done for the important and moderate variables. The information refinement is done by applying the Principal Component Analysis with the help of MS excels and a fuel optimization model was developed. Aviation model specific variables can be selectively simulated to obtain the fuel consumption optimization model for that particular product. In the paper they identified operational variables , 1.Fuel Weight, 2.Payload, 3.Cruise Speed, 4.Flight Profile, 5.Stage Length, 6.Altitude, 7.Aircraft takeoff weight, 8.Aircraft landing weight, 9. Extra Aircraft Weight as refined set of variable affecting the fuel consumption of aircrafts [5].

Nathan Economic Consulting India Pvt. Ltd., India, suggested that their report broadly analyzes India‘s civil aviation sector, while recognizing the necessity that deeper assessments of each sub-sector of India‘s civil aviation must be undertaken individually. They recommend creation of one single civil aviation policy. This civil aviation policy should aim to reduce artificial barriers to entry such as fleet and equity requirements. It should have clear delineation between regulatory authorities that oversee activities in this sector, which would result in clear and predictable regulatory outcomes. Furthermore, it should include a framework for monitoring anticompetitive pricing behaviour within the sector. Additionally, this policy should aim to create a more level competitive field between India‘s private, national and foreign carriers. It should also aim to introduce market mechanisms and incentives into the distribution of slots and dispersion of routes. Lastly, this policy should aim to attract greater private investment into India‘s airports and improve the competitiveness of the government procurement process within this sector [15].

What international air passenger travel will look like in five, ten or fifteen years and why? This requires answering two questions; what will be the principal determinants of the growth in international air travel, and what impact will each of these drivers have on the growth rate? An imbedded question is: does history have anything to teach us or are there new forces at work? Canvassing the current aviation trade press finds two schools of thought, one taking the position that this is a deep recession but a recession nonetheless and once world economies start recovering air traffic will go back to the typical growth of 4-5 percent annually. A second school is less sanguine, taking the position that it will not be business as usual when economies stop sinking and move to recovery. Any economic recovery is going to involve fundamental changes in institutions, rethinking policies regarding government participation in economies and changes in economic leadership in the world. There is also the hydra of protectionism, most prominent now in the US but certainly being practiced elsewhere, and what will happen to foreign ownership restrictions that, prior to 2009, were being seen as hurting rather than helping world airlines. All of this will change international aviation going forward [20].

Association of Private Airport Operators in a study suggested A well structured national aviation policy is need of the hour and should address the following: Address the discrepancies in the existing rules/acts within the Civil Aviation sector thereby removing scope for different interpretations. There is a need to re examine the regulations/rules of MoCA, AERA Act/OMDA/SSA etc. to have cohesiveness in interpretation and implementing the rules. Ensure setting up of an investor friendly Regulatory regime. Ensure all future airport projects under PPP model and to allow private participation in all the areas of Civil Aviation sector. Ensure financial viability of Airports – Promote non-aero revenue source. Ensure the freedom and flexibility of operation and management for private airport developers. Promote an integrated transport system in the country. No intervention from any agency like CAG audit or application of RTI rules to the PPP airports. A well structured policy for planned development of Airports, Cargo, Hub, MRO, Aerotropolis, R&D, General Aviation and Aviation University etc. Policy should formulate a progressive tariff regime of Dual Till in the Indian Airports Sector. Review of Bilateral Policy to minimize leakage of passengers from the catchment area of Indian Airports, granting infrastructure industry status to airports, fiscal benefits like tax exemption/tax holiday to airports, clear policy to facilitate private sector investment in airports and for Aerotropolis development [4].

3. Motivation of the study

The motivation of the study is drawn from the outlook shared by the Minister for Civil Aviation in India on the occasion of Aviation Day.

The first spur is the fact that, 'the countries airports would be handling 336 million domestic and 85 million international passengers with projected investment to the tune of US$ 120 billion by 2020.' Keeping pace with such a robust growth, the availability and positioning of aviation turbine fuel have to match. This would need proper assessment of the demand over the years.

The second point to note is that, 'aviation sector brings enormous benefits to communities and economies around the globe. It is a key enabler of economic growth, social development and tourism providing connectivity and access to markets globally. Air transport currently supports 56.6 million jobs and over US$2.2 trillion of Global GDP.' Aviation turbine fuel being one of the major inputs for the operation of the industry, a market driven assessment process is essential.

The third important aspect is that, 'The prospects and possibilities of growth of Indian aviation markets are huge. The gap between potential and current air travel penetration shows that India is presently at 0.04 air trips per capita per annum which is far behind developed countries like US and Australia (more than 2 air trips per capita per annum), China and Brazil (0.3 air trips per capita per annum). The Low ratio of per capita air trips in India suggests a huge potential for the air traffic growth considering a relatively higher trajectory of economic growth in the country coupled with necessary Government support.' To bridge the gap, requirement of aviation turbine fuel also have to match the time and quantity.

The fourth, being that, 'the cost of ATF constitutes the major component of the cost of operations of airlines in India. One of the important reasons of higher cost of ATF in India is the added burden of sales tax levied by the State Governments. To reduce this burden, the Government has decided to allow direct import of ATF by Indian carriers. It is understood that all major Indian airlines are exploring the possibilities of importing ATF. There are initial difficulties in putting the whole system in place for import of ATF in terms of sharing of on-site and off-site infrastructure for transport of ATF.' With increased demand, the petroleum industry has to evolve innovative process to offer aviation turbine fuel at an competitive price that supports such growth and also can sustain new entrants.

The final being the statement by the Defence Minister, that, 'the Indian aviation sector is growing at the fastest pace and will evolve into a major hub for aerospace operations and outsourcing in the coming years [17].

With the prospects of aviation industry poised for a major growth in India, timely availability of aviation turbine fuel at reasonable price and sufficient quantity will be a challenge to the petroleum supply chain. As the supply chain starts with the basic requirement of the customers, the assessment of future demand will be the key activity for smooth operation of the supply chain.

Thus, our objective in the paper is to develop a model for aviation turbine fuel demand estimation that will keep pace with the dynamic aviation business. The model is to incorporate factors like, economic activity of the country; situations of negative publicity; price of JET A-1, the fuel used as aviation turbine fuel; competition from the premium rail journey; promotions on tourism; cost of air freight; technological development in aircraft type and operation to name a few.

The transportation sector consumes about 50 per cent of the total world oil demand known as the major contributor to incremental oil demand. Oil demand in the transportation sector was 17 mb/d in 1971 and experienced an annual growth rate of 2.7 per cent over the period to 2006 to reach 43.7 mb/d. Aviation oil demand was 1.18 mb/d in 1971. It experienced an annual growth rate of 2.9 per cent, 0.2 per cent ahead of the transportation sector growth rate, reaching 4.9 mb/d in 2006.With this consumption level, the aviation sector is the second major consumer, with 11.2 per cent share in total oil demand in the transportation sector, which is second to road transportation with about 79 per cent share in 2006. The aviation sector burns about 5.8 per cent of total oil consumed in the world. [8].

In India, the transport sector consumed about 51 percent of the total oil demand during 2001-02. The consumption increased to 61 percent during 2011-12. In volume terms, from over 45 million metric tonne (MMT) in 2001-02, transport sector fuel consumption reached 85 MMT in 2011-12 with a cumulative annual growth rate (CAGR) of 6.4 percent. The growth in consumption of transport sector fuel over the years is shown in Figure 8.

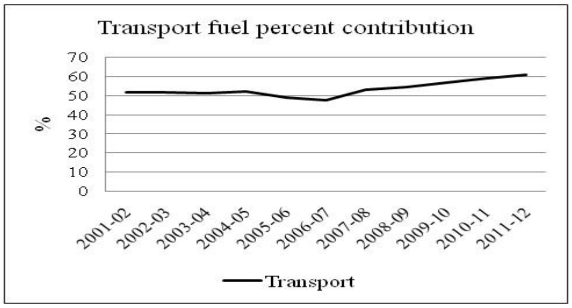

Figure 8. Transport fuel percentage over the years

When the CAGR of transport fuel consumption was 6.4 percent, the overall POL consumption grew by 4.7 percent. In volume terms POL consumption increase from 89 MMT in 2001-02, to 141 MMT in 2011-12.

Aviation turbine fuel contributed 3 percent of the total POL consumption in 2001-02, and increased to 4 percent in 2011-12. In volume terms, the consumption of Aviation Turbine fuel increase from over 2 MMT in 2001-02 to over 5 MMT in 2011-12. The aviation fuel contributes between 5 to 7 percent of the transport fuel consumption in India. Figure 9 shows the contribution of aviation turbine fuel over the years.

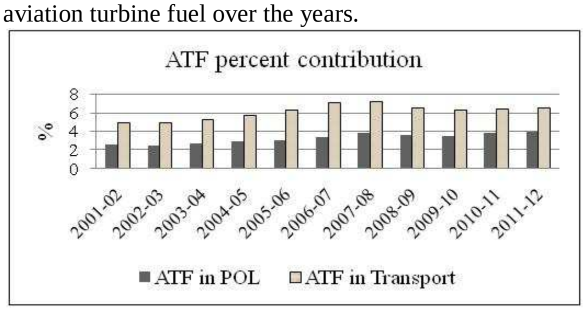

Figure 9. Aviation Turbine Fuel contribution in POL and transport fuel consumption

When the transport fuel CAGR was 6.4 percent, the aviation fuel consumption in the same period grew by 9.4 percent. In other words the growth of aviation turbine fuel was the maximum compared to transport fuel consumption and overall POL consumption during 2001-02 to 2011-12. In Table 7, the comparative growth is shown.

Table 7. Comparison of CAGR

	2001-02	2011-12	CAGR
ATF	2263	5535	9.4
Transport	45748	85208	6.4
POL	88992	140802	4.7

As described earlier the aviation sector in India is growing at a faster pace compared to any other sector. Though the CAGR over a decade was 9.4 percent, the year-on-year growth in Figure 10 shows a different trend.

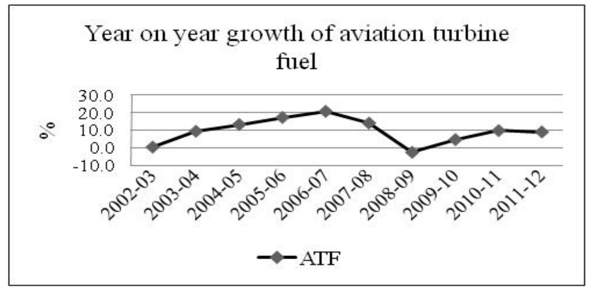

Figure 9. Year-on-year growth of aviation turbine fuel

The year-on-year (YOY) growth reached 20.7 percent in 2006-07 over 2005-06, from a mere 0.3 percent in 2002-03 over the previous year. Due to recession in 2007-08 in the international market and its impact being felt on the Indian economy, the growth slowed down to 14.1 percent in 2007-08 and further went to negative growth of minus 2.6 percent in 2008-09. Table 9 shows the steep de-growth over the two years between 2006-07 and 2008-09. The aviation business showed signs of recovery from 2009-10 that resulted in positive growth in aviation turbine fuel consumption. For the steep downturn from 2006-07 to 2008-09, the CAGR also got corrected accordingly. Figure 10 shows the variation in the CAGR with 2001-02 as base year.

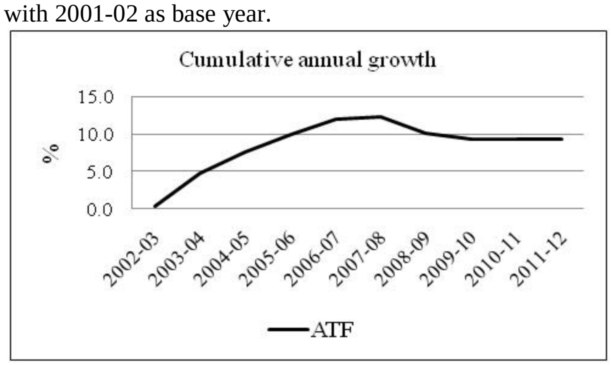

Figure 10: CAGR trend with 2001-02 as the base year

The demand elasticity of POL products in India remained the same at 0.49 in the X th and XI th five year plans. The transport fuel demand elasticity showed an increase from 0.06 to 1.13, while the aviation fuel demand elasticity decreased from 1.54 to 1.15. The reason being the effect of economic slowdown in the international market that the reduced the air traffic and cargo movement by this transportation mode. Table 8, 9 and 10 shows the details of the demand elasticity in the last two five year plans for POL products, Transport fuel and Aviation turbine fuel respectively.

Table 8. POL demand elasticity in India

Particulars	2002-06 X Plan	2007-11 XI Plan
POL demand growth	3.8	4.0
GDP growth	7.8	8.2
Demand Elasticity	0.49	0.49

Table 9. Transport fuel demand elasticity in India

Particulars	2002-06 X Plan	2007-11 XI Plan
Transport fuel demand growth	5.1	9.3
GDP growth	7.8	8.2
Transport fuel demand Elasticity	0.65	1.13

Table 10. Aviation fuel demand elasticity in India

Particulars	2002-06 X Plan	2007-11 XI Plan
Aviation fuel demand growth	12.0	9.4
GDP growth	7.8	8.2
Aviation fuel demand Elasticity	1.54	1.15

The above facts it is evident that the aviation sector is a growing sector and is affected by the overall economic environment of the country and the international market. It also shows that the aviation fuel demand elasticity is dependent on not merely the overall economic condition but other factors that are not apparently visible.

To overcome this, a survey was conducted to understand the underlying factors that affect the demand of aviation turbine fuel. For accessing the demand of aviation turbine fuel that is in line with the changes in the environment within and beyond the aviation sector, we should understand the process of influence and develop the model.

The process should start from understanding the industry attractiveness and the external environment through PESTLE analysis. With the insight of within and beyond the industry activities, a set of factors are listed that are validated through a survey. The survey results are subject to factor analysis for finalising some meaningful components or factors that are the underlying causes of the demand of aviation turbine fuel. With the identified factors, we will develop the model for aviation turbine fuel in India.

4 Methodology

4.1 Methods

The research methods followed were both primary and secondary. Under primary method, a survey was conducted to identify the factors affecting the demand of aviation transport petroleum fuel. With the help of a self designed questionnaire, primary data was collected from four hundred respondents. The respondents were from across the country, with wide ranging experience either in service or business. The reliability of questionnaire was tested through a pilot study. The responses were tabulated and statistically analyzed by SPSS software.

The questionnaire as a tool was used to identify the factors that affect the demand of aviation transport petroleum product. The choice covered the inputs from availability, quality, price, economic, technological, inter-fuel substitution and environmental aspects. After the responses were tabulated, it was subject to Kaiser-Meyer-Olkin measure of sampling adequacy (NSA) to determine the need to further reduce the factors for more practical and effective assessments. The sampling size of four hundred was found very adequate as a true representation of the population consisting of experienced citizens of India.

After the factors were reduced through factor analysis, the demand model was formulated through multiple regression. For multiple regression, secondary data was collected from a number of reliable government and private sources.

Ref. [21] identified that in order to have confidence that the survey results are representative, it is critically important that we have a large number of randomly selected participants in the survey group. For a 95% confidence level, which means 5% chance of sample results differing from the true population average, a good estimate of the margin of error or confidence interval is given by $1/\sqrt{N}$ where N is the number of participants or the sample size. With a sample size of four hundred, the margin of error fraction is 0.05 and percentage margin of error is 5%. This is narrow margin of error and survey of four hundred randomly selected participants is well accepted for having confidence in the results [21].

4.2 Process

The potential benefit of aviation fuel demand lies in the realm of decision making so as to exert control over environment and infrastructure capacity in the country.

Aviation fuel is a vital input to both passenger and freight mobility. The demand for it is growing from developing economies. This in turn places increasing demands on infrastructure, environment protection, technology and manpower. Accessing the consumption needs has thus become a significant element of the planning exercise in the petroleum sector.

Therefore, it is of great importance that the underlying factors are judiciously identified. If the basic factors become erroneous both infrastructure and capital investment will be imbalanced. This could affect the oil companies and the economy of the country.

There is an array of methods available today for demand forecasting. An appropriate method is to be chosen on the basis of availability of the data (frequency, cross section, time series, panel data, etc.) and the desired nature of the forecasts. In the past, linear extrapolations of historical energy consumption trends worked well. However with a changing lifestyle, structural breaks in the economy and the evolution of complex energy-economy linkages, it has become imperative to use other modelling techniques, which capture the effects of factors such as prices, income, population, inter-fuel substitution, technology and other economic, demographic, policy and technological variables.

The process of specifying a forecasting model involves (1) selecting the variables to be included, (2) selecting the form of the equation of relationship, and (3) estimating the values of the parameters in that equation. After the model is specified, (4) its performance characteristics should be verified or validated by comparison of its forecasts with historical data for the phenomenon it was designed to forecast.

Although the forecasting analyst might simply guess at the optimal form of the equation of relationship and the likely values of the parameters, both the equation form and the parameters values can usually be estimated more accurately with reference to historical data for the phenomenon. Thus, an historical data base is useful both to the specification and to the validation phases of model construction [22].

5. Modelling aviation fuel demand in India

5.1 Survey analysis

Barlett's test of Sphericity and Kaiser-Meyer-Olkin measure of sampling adequacy (MSA) for ATF was carried out. The Bartlett test of Sphericity compares the correlation matrix with a matrix of zero correlations, or the identity matrix, which consists of all zeros except the one's along the diagonal. From the test we are looking for a small p value indicating that it is highly unlikely for us to have obtained the observed correlation matrix from a population with zero correlation. The MSA does not produce a p value but we are aiming for a value between 0.5 to 0.8 [24].

Table 11. KMO and Bartlett's Test (Table 11)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.801
Bartlett's Test of Sphericity	Approx. Chi-Square	1023.151
	df	55
	Sig.	.000

The overall value of MSA in Table 11 above is 0.801 and is acceptable. The Barlett's test of Sphericity is highly significant with a 'p' value of less than 0.001 and indicated in the report as 0.000.

The above results indicate that a valid factor analysis can be performed.

The interpretation of the SPSS output for Aviation transport fuel is explained and factors identified based on Ref. [24] 'Marketing Research Text and Cases'.

The first step in interpreting the output is to look at the factors extracted, their Eigen values and their cumulative percentage of variance in (Table 12) in Annexure 1.

It is observed that the 'cumulative %' column under 'Total variance explained' table that the five (5) factors extracted together account for 69.728% of the total variance (information contained in the original eleven (11) variables). This is a pretty good bargain, because it is able to economize on the number of variables (from 11 the reduction is to 5 underlying factors), while about 30 percent of the information content is lost (70 percent retained by the 5 factors extracted out of the 11 original variables).
Now the second task which follows is that of interpreting what these 5 extracted factors represent. This can be accomplished by looking at Tables 13 in Annexure 2, the rotated factor or component matrices.

Looking at Table 2, the rotated factor matrix, we noticed that variable numbers 1, 6, and 8 have loading of 0.657, 0.738, and 0.727 on component 1 (we look down the component 1 column in Table 2 and look for high loadings closed to 1.00).

This suggests that component 1 is a combination of these three original variables. Therefore, there is no problem interpreting factor or component 1 as a combination of 'Price of JET A-1' (variable 1), 'Number of flights per day in an airport' (variable 6) and 'Type of aircrafts being operated in an airport' (variable 8).

The researcher's task is to find a suitable phrase, which captures essence of the original variables which continues to form the underlying concept of the 'Factor or Component'. In this case, the factor or component 1 could be identified with 'Price of JET A-1' as the other two are impacted by the variation of the price. So, for this analysis the factor 1 may be represented as 'Price of JET A-1' in subsequent steps.

To interpret factor or component 2, we look at Table 2, down the column for component 2 and find variable 3, variable 9, and variable 10 have high loadings of 0.746, 0.671, and 0.512 respectively. This indicates that factor 2 is a combination of these three variables

The loading on variable as in Table 2 for component 2 indicate the effect of economic factors on choice and decision of transport. This factor is best reflected by one of the economic indicators like the Gross Domestic Product of India or GDP at factor cost at constant price. For the analysis, factor 2 will be represented as 'GDP'.

Similarly, variable numbers 2, 5, and 7 have loading of 0.679, 0.630, and 0.710 on component 3. This suggests that component 3 is a combination of these three original variables. Therefore, the factor or component 3 is interpreted as 'Number of passengers travelling by air in an airport per month' (variable 7), as this has the highest loading and practical for data collection. However, from the original 'Number of passengers travelling by air in an airport per month' it is practical to use 'Number of passengers travelling by air per annum' to have an overall view of the total air traffic, that influences number of airlines operating and the cost of tickets. By not restricting the analysis to any specific airport the total view was looked into and the cumulative country aviation operation as a whole was considered, which will impact the demand of aviation fuel. The third factor was read in subsequent analysis as 'Number of Air passenger per year'.

Factor 4 and 5 was retained 'Average cost of air freight', and 'Situations of negative publicity like disease, war, terror' as both have high loadings of 0.841 and 0.943.

Average cost of air freight is a commercial decision of an airline and varies widely on negotiation and the business approach of the company. By business approach we mean the decision of the company to pursue business with aggressive, moderate or status-quo outlook for the financial year. These decisions are driven by other factors like what market share the airline is targeting for the year or whether the airline wants to focus on profit maximization. Clear data on such information is not published as it is commercially confidential in a competitive market. However, the outcomes of the decisions are seen through the revenue earning through freight. Such revenue earning through freight is a published data by all airlines and in DGCA website. To incorporate a major revenue source of freight as identified by the survey conducted the factor 4 as 'Operating revenue from freight', in Rs million was used. This data is readily available from the detailed financial results of schedule airlines during any financial year.

The situations of negative publicity like disease, war, terror affect the aviation business specifically in the international sector. It is rightly identified by the survey as an important factor in accessing the demand of aircraft operation and in turn the aviation fuel. However, there is no such represent able data to signify this. To overcome this, a scale of adversity is suggested. The scale reads from 10 meaning 'favorable positive publicity' to 100 indicating 'critical negative publicity' as shown in the Table 14 below.

Table 14. Publicity Index reference table

Scale	10	50	100
Meaning	Favorable positive publicity	No negative publicity	Critical negative publicity
	Highly positive	Normal	Highly negative

The score have to be applied on judgment only depending on the recent developments and its impact on the air travel. For example, with the news of H1N1 spreading across few areas of the country the scale of negative publicity may read as 60, while after Mumbai terror attack the scale will read 80. This is purely judgmental and can be accessed by a short close group opinion poll and applied. If an incident is purely incidental and will affect the business for a short period it is suggested to remain at level 50 considering the majority part of the year running smooth for the airline business. The last parameter, factor 5, identified by the survey as 'Situations of negative publicity like disease, war, terror' to be read as 'Publicity index' and can adopt a numerical value ranging from 10 to 100 preferably in whole number and multiples of 10.

So the final factors identified through factor analysis are 5 in number out of the 11 variables and they are used for further analysis in the following names and variable representation shown in Table 15.

Table 15. Final independent variables

	Factor Name	Combining original variable numbers
1	Price of JET A-1	1,6,8
2	GDP	3,9,10
3	Air passenger per year	2,5,7
4	Operating revenue from freight	Renamed 4
5	Publicity index	Renamed 11

All the five factors are meaningful and explain the major factors that influence demand of Aviation turbine fuel.

5.2 Model estimation

Looking at the correlation of all the variables with aviation transport fuel sales and each other, it is observed that all variables have high positive correlation with aviation turbine fuel historical sales.

The above shows that a fairly good set of independent variables namely, Price of JET A-1, GDP, Air passenger per year, Operating revenue from freight and Publicity Index, were chosen.

The SPSS correlation and regression output is explained on Marketing Research Text and Cases written by Rajendra Nargundkar.

The other point noted in the correlation table was that two independent variables are highly correlated with each other. Like Air passenger per year and GDP indicate that the variables are not independent of each other. Some independent variables were further eliminated by approaching the step wise process.

The results (output) of this step wise regression model are shown in Table 16 in Annexure 3. Column 3 of the table, titled 'B' lists all the coefficients for the model. Here, we used a model number 6. The parameters explaining the model number 6 are most suitable in this step.

First, let us look at the statistical significance of the model and the R^2 value. It is evident from the model summary in Table 17 in Annexure 4, that the R^2 is 0.998.

The analysis of variance table, Table 18, in Annexure 5, indicates the p-level to be 0.000. This indicates that the model is statistically significant at a confidence level of (1-0.000) x 100 or nearly 100%. The p-level indicates the significance of F value.

From Table 16 of 'Coefficients', we also note that t-tests for significance of individual independent variables indicate that the two identified variables are statistically significant in the model. In the model the independent variables 'Air passenger per year' and 'Price of JET A-1', have a significance of 0.000, 0.001 respectively.

The equation obtained is with the following coefficients,

a (intercept) = 1111.037

b1 = 0.046, b2 = 0.022

These values can be used to form a model, for ATF sales prediction,

ATF_TMT = 1111.037 + 0.046xPassengers + 0.022xPriceJet

From an identified 5 factors through factor analysis, by step wise regression we ended up with only 2 factors which can explain over 99.99 percent of the variance in the dependent variable as ATF sales.

The regression equation is judged for its usefulness based on,

1. The overall F- test for the model. In this case, it is significant at 99.99 percent confidence level. This indicates that the model is good overall. This shows up as a p-value of 0.000 on the ANOVA table (Table 18) in the regression output.
2. The variables in the model are good explanatory variables of the dependent as the individual t-test for each variable is significant and less than 0.05.
3. The R2 value 0.998 of the model tells us that 99.9 percent of the variation in the dependent variable is explained by all the independent variables in the model.

5.3 Validation of the model

The parameters that were valid in 2011-12 in relation to the ATF sales prediction were considered. An actual situation was used for validation of the model. In 2011-12 the relevant independent variables are shown in Table 19 below.

Table 19: Independent variables in 2011-12

Air passenger per year	Price of JET A-1 per KL	ATF Sale
Number ('000)	Rs/KL	TMT
75273	60390	5535

Using the model identified for ATF sale prediction,

ATF Sales = 1111.037 + 0.046x75273 + 0.022x60390

Predicted ATF Sales = 5902.18

Error = (5902.18 – 5535) / 5902.18 = 6.2%

Predicted value of ATF for year 2011-12 is 5902.18 as against actual observed value of 5535. The error in prediction is 6.2% over-estimated.

6. Conclusion

At the global level, the aviation sector is facing tight competition that has left the industry a narrow profit margin. Fuel and oil prices are forming a big portion of the expenditures especially with high oil prices. The oil and fuel prices for the airlines are out of their control. They are trying to reduce the impact of oil and fuel prices through hedging policies, improving the load factor, optimising the capacity and many other activities related to load and traffic management. In many markets where the traffic demand is inelastic or less elastic to fare prices, a portion of the spike in expenditures is transferred to the customers to reduce the impacts of external cost and to improve their financial position. Although oil and fuel prices are affecting the financial position of airlines, estimated fuel price elasticity showed that fuel price plays a modest role in aviation fuel demand.

To get an insight in the Indian aviation sector, eleven factors were considered as the underlying reasons of aviation turbine fuel demand. A survey was conducted to generate the factors from over four hundred respondents across the country on random basis. The survey response was subject to MSA test to ascertain the need for further refinement of the factors. The sampling adequacy was acceptable and factor analysis reduced the eleven factors to five components. The five components indicated the most prominent logical relations with aviation fuel demand like the Price of JET A-1, GDP, Air passenger per year, Operating revenue from freight, Publicity index. On model building, however only two factors were significant, mainly Air passenger per year and Price of JET A-1. The model was validated with the actual data for the year 2011-12 and was found to be very satisfactory. Thus, the objective of the paper to develop a model for aviation turbine fuel demand estimation that will keep pace with the dynamic aviation business with underlying factors causing the demand is satisfactorily fulfilled.

The factors will undergo change over the time due to inherent character and nature of the aviation business. The model also has to change accordingly. The paper was based on the concept that the dynamic nature of the aviation business needs to be captured in the demand estimation process of aviation turbine fuel. To achieve this, it is necessary to understand the industry attractiveness of the aviation business, PESTLE analysis to understand the environment beyond the aviation industry that will define the limitations of the business. A survey has to be conducted with the basic ideas generated through the PESTLE analysis and industry attractiveness to get the correct feedback for finalising the underlying factors. On identifying the factors through MSA test and factor analysis a model for the aviation fuel demand is to be developed. The efficacies need to be validated to use the model for a reasonable time frame.

The demand of aviation fuel in India is positive to number of passengers expected while negatively related to price. However the impact of passengers is more compared to negative effect of price increase. In other words if due to positive environmental effects like political stability, country image, decent growth in the economy attracts more passengers to air travel, the effect of price rise will be limited. Effective use of the newly constructed publicity index may be used as yard stick to assess passenger sentiments. The estimation model is dynamic in nature and will require revision over a period. The effects of all factors outlined are as important as the final construct. Though at this time the most prominent factors have been considered for assessing the demand, being dynamic in nature, at a different segment of time, there may be other factors that will be more prominent on the demand estimation construct. The construct can be made more elaborate through larger sample base and calls for further research. This is a scope that is left open to other researchers.

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Annexure 1

Table 12. Total Variance Explained

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.624	32.944	32.944	3.624	32.944	32.944	1.991	18.102	18.102
2	1.350	12.269	45.213	1.350	12.269	45.213	1.635	14.864	32.966
3	1.079	9.809	55.022	1.079	9.809	55.022	1.634	14.852	47.818
4	.868	7.893	62.915	.868	7.893	62.915	1.286	11.688	59.506
5	.749	6.813	69.728	.749	6.813	69.728	1.124	10.221	69.728
6	.730	6.635	76.362						
7	.644	5.856	82.219						
8	.589	5.359	87.577						
9	.517	4.702	92.279						
10	.469	4.267	96.546						
11	.380	3.454	100.000						
Extraction Method: Principal Component Analysis.									

Annexure 2

Table 13. Rotated Component Matrix (a)

Rotated Component Matrix[a]					
	Component				
	1	2	3	4	5
Price of JET A-1	.657		.310		
Average cost of minimum air ticket			.679		
Average cost of air conditioned (AC) 3 tier ticket in railway		.746		.405	
Average cost of air freight				.841	
Number of airlines operating in an airport	.446		.630		
Number of flights per day in an airport	.738				
Number of passengers travelling by air in an airport per month		.409	.710		
Type of aircrafts being operated in an airport	.727			.372	
Economic growth - Factors like Gross Domestic Product (GDP), Index of Industrial Production (IIP), Consumer price index (CPI) and per capita income		.671	.323		
Promotion on tourism		.512			.354
Situations of negative publicity like disease, war, terror					.943
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.					
a. Rotation converged in 12 iterations.					

Annexure 3

Table 16. Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	1317.087	89.655		14.691	.000
	Air passenger per year ('000)	.059	.002	.995	27.661	.000
2	(Constant)	1111.037	57.237		19.411	.000
	Air passenger per year ('000)	.046	.003	.780	17.891	.000
	Price of JET A-1/KL	.022	.004	.234	5.361	.001

a. Dependent Variable: ATF TMT

Annexure 4

Table 17. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
1	.995[a]	.990	.988	116.347	.990	765.134	1	8	.000
2	.999[b]	.998	.997	55.042	.008	28.744	1	7	.001

a. Predictors: (Constant), Air passenger per year ('000)

b. Predictors: (Constant), Air passenger per year ('000), Price of JET A-1/KL

Annexure 5

Table 18. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10357416.496	1	10357416.496	765.134	.000[b]
	Residual	108293.904	8	13536.738		
	Total	10465710.400	9			
2	Regression	10444502.720	2	5222251.360	1723.704	.000[c]
	Residual	21207.680	7	3029.669		
	Total	10465710.400	9			

a. Dependent Variable: ATF TMT

b. Predictors: (Constant), Air passenger per year ('000)

c. Predictors: (Constant), Air passenger per year ('000), Price of JET A-1/KL