TECHNOLOGY APPLICATION AND GROWTH STRATEGIES FOR SUSTAINABLE SUPPLY CHAIN CONTEMPLATION THROUGH STRATEGIC OUTSOURCING IN INDIAN AIRCRAFT INDUSTRY

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Abstract

India is fast becoming a major global aerospace market, supported by a combination of increasing defence expenditure budgets, a booming commercial aviation market, and rising technological and manufacturing capabilities among local companies with Government of India projecting around 500 brown-field and green-field airports by 2020. India has an inherent edge over several other nations because of higher skills and lower costs of production. By means of the collaborative supply chains with the aim of vendor satisfaction and monitoring from close corners in all the echelons of supply chains, Indian Aircraft Industries (IAI) is expecting to utilize all the opportunities to nurture in the direction of growth with present governments support of 'Make in India', combating all the problems with the use of new technology. The lessons learnt from world major's in Aviation Industry are helpful for IAI towards sustained growth with right inclusion of Original Equipment Manufacturers (OEMs) and other suppliers in their Supply Chain Management network with Strategic Outsourcing at its zenith. Information Technology use in the Supply Chain Echelons' to the maximum extent would be a great idea in reducing the costs, reducing the supply lead-times and using the systems for faster location, identification and transportation. Computing Everywhere, Treat the Issue, Not the Symptom, Smart Machines, Cloud/client Computing, and Risk-Based Security & Self-Protection are such technology initiatives, which were detailed in this paper.

Keywords: Growth prospects of Indian Aircraft Industries, collaborative supply chain performance and structuring, Original Equipment manufacturers, Strategic Outsourcing, *Computing Everywhere, Smart Machines, Cloud/client computing, and Risk-Based Security.*

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Introduction

"**T**he *Indian Aircraft Industry is one of the fastest-growing aerospace markets in the world with an expanding consumer base comprising airlines, businesses and high-net-worth individuals. The rapid growth of this industry has attracted major global aerospace companies to India. All segments in the aerospace industry, including civil and military aviation and space, are showing a significant level of growth*," ***analysts from Price Waterhouse Coopers***.

Growth prospects of Indian Aircraft Industries

India is fast becoming a major global aerospace market, aided by a combination of increasing defence expenditure budgets, a booming commercial aviation market, and rising technological and manufacturing capabilities among local companies.

Major Western aerospace firms desiderate to establish a presence in the country that is one of the largest markets for both civil and military aviation. In view of the stringent offset requirements in fulfilment of such contracts, the present government that is keen to create a manufacturing hub and indigenous firms with greater freedom to set up partnerships to participate in the sector, establishing a niche in the global supply chain along the way.

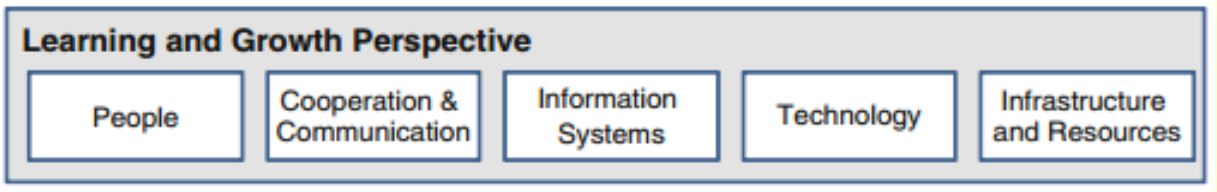

Figure 1: Learning and Growth Perspectives

Frost & Sullivan, a research firm, stated that since 2005 air traffic has grown by 18%, the cargo market has increased by 14% and overall passenger movement appreciated by 20%. Despite the downturn, international and domestic aircraft movements could grow by 13% and 14% respectively over the next seven years. Passenger growth is projected to be 20% domestically and 16% in the international segment, while cargo expansion of 12% and 10% is expected in the domestic and international markets. In 2015 when the same are looked at, the observations crossed marginally indicating higher growth than expected.

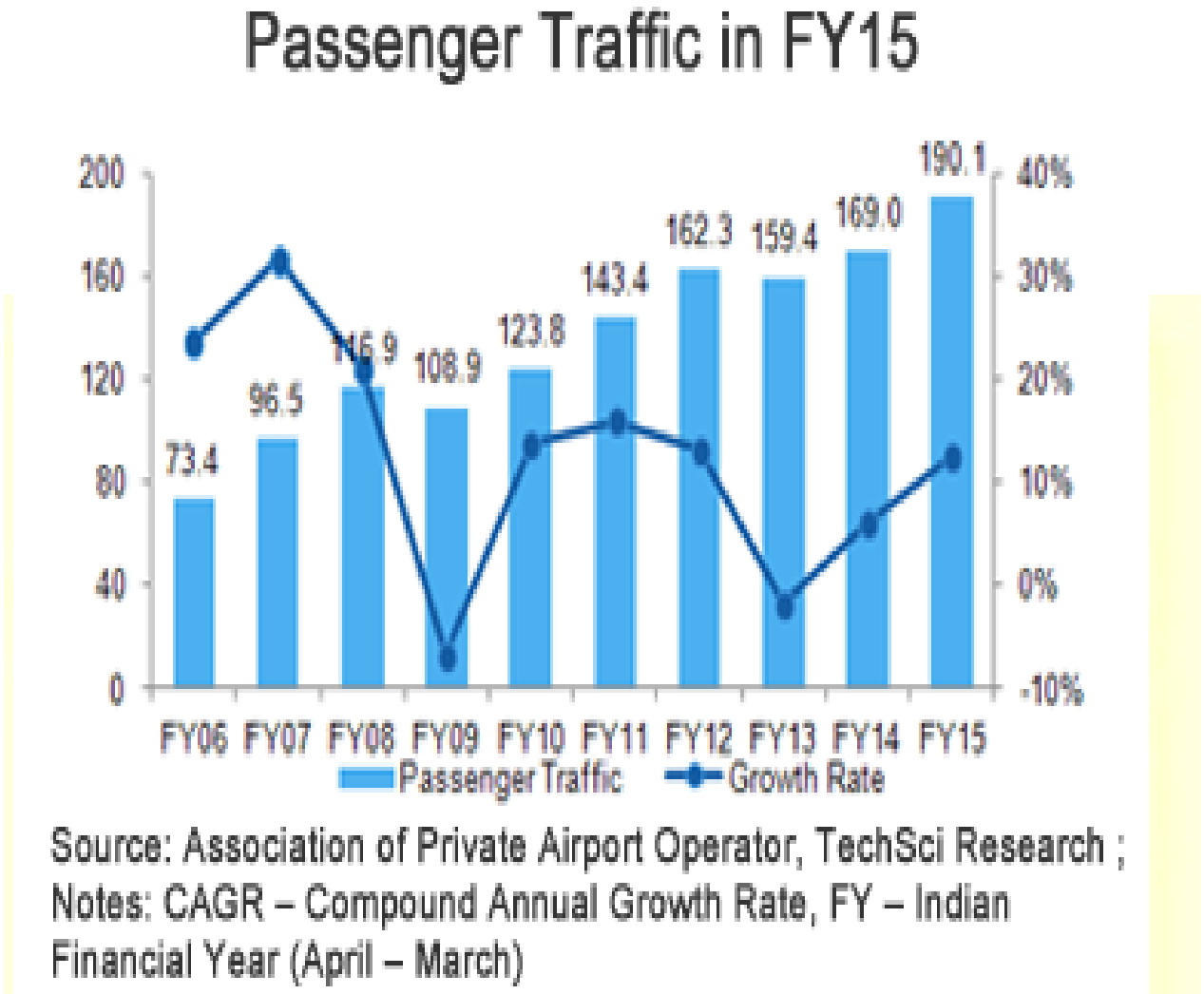

Figure 2: Passenger Traffic and Growth Rate

Figure 3: Investment Opportunities in Indian Aerospace Industry

Strong growth prospects Passenger traffic growth has grown at a CAGR of 16% in India over the past 10 years	**Aviation economics are not favorable in India** Higher taxes on ATF and airport charges continue to be key headwinds for the sector; besides higher cost base, airlines in India are also mandatorily required to fly on certain unviable routes
Relative underpenetrated market Penetration of air travel at <3% is significantly below benchmarks in other markets	**Inadequate Infrastructure** Development of airport infrastructure has not kept pace with demand, thereby resulting in delays and higher costs for airlines
An opportunity to create India as an hub An opportunity for foreign airlines to create India as their hub for international traffic between Europe and South East Asia; Additionally offer better connectivity within India with international destinations	**Poor financial health of most airlines** Intense competition, sharp fluctuation in ATF prices and high debt burden continue to weigh on the financial performance of Indian airlines; foreign exchange fluctuation and lack of adequate hedging mechanism (for fuel) have added to the woes
An opportunity to create India as an MRO centre Foreign airlines could also look at leveraging on India's low-cost arbitrage by setting up MRO facilities in India	**Highly competitive & Price Sensitive traveler base**
Low Valuations Market valuation of listed airlines in India has suffered due to poor performance	

Figure 4: Favourable & Unfavourable conditions for Focussing towards Growth

Commercial Aircraft Demand

Entering into production of commercial aircraft and Low Cost carriers, IAI is therefore intending to collaborate with major international manufacturers for component production as well as aircraft manufacturers in India. Such initiatives are based on expected growth in the world market. Boeing has projected a demand for 900-1,000 commercial aircraft worth $100 billion over the next 20 years. In the near term, the forecasts are that there will be $25 billion spent on commercial aircraft and $100 billion on defence until 2015, pointing to significant growth in terms of manufacturing.

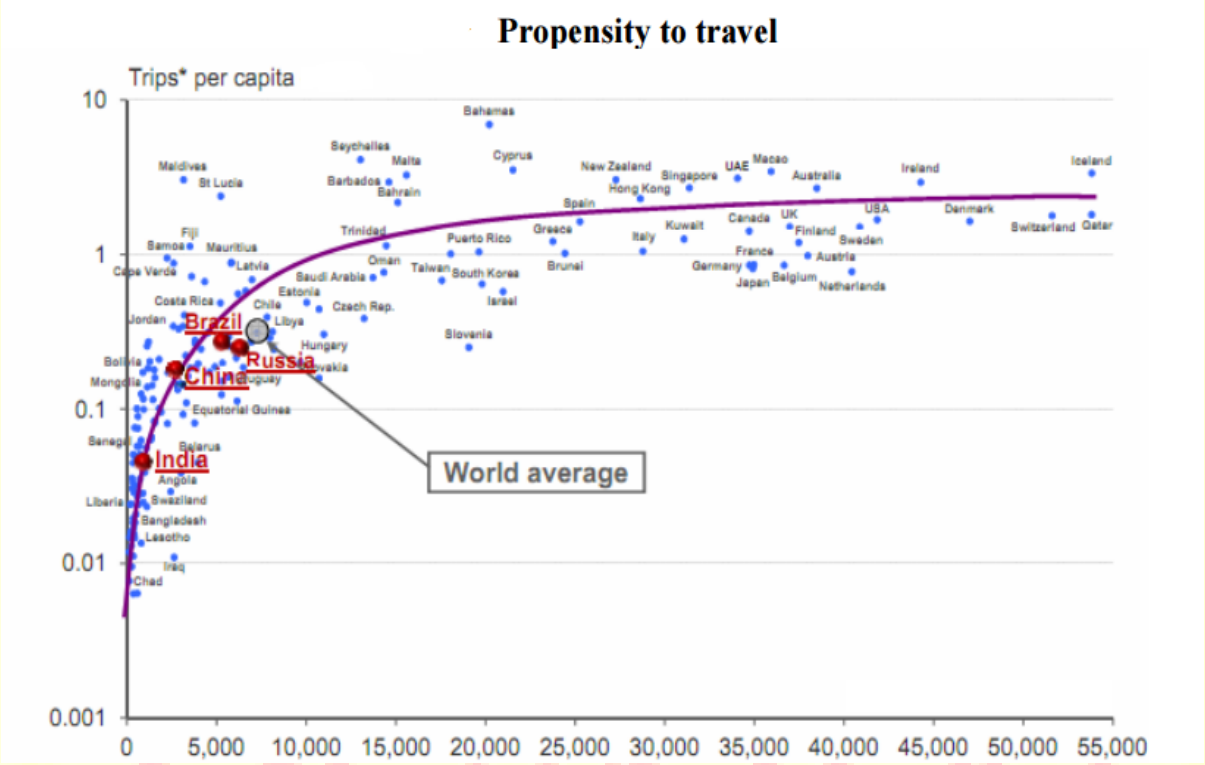

Figure 5: World Scenario – Propensity to Travel

Indian scenario shows higher growth, because apart from the business growth, there is governmental support together with India's advantages of relatively lower costs of manpower, the availability of talent, the information technology utilization capabilities the firms could offer, and the geographical advantage of spacing between the major markets in East Asia, the Middle East and Europe.

2. Literature Review

While studying the literature, it is primary for the researcher to know about the right definition of the subject's main constituent part. This understanding of definition would show the right path for understanding the total gamut.

Stock and Boyer (2009) defined SCM as "The management of a network of relationships within a firm and between interdependent organizations and business units consisting of material suppliers, purchasing, production facilities, logistics, marketing, and related systems that facilitate the forward and reverse flow of materials, services, finances and information from the original producer to final customer with the benefits of adding value, maximizing profitability through efficiencies, and achieving customer satisfaction".

Williams (2006) stated that long term objectives include improving efficiency and effectiveness of supply chain partners, improving market share and profits, and increasing customer satisfaction. Short term objectives of Supply Chain include increasing productivity, and reducing cycle time and inventories (Wisner & Tan, 2000).Several dimensions and practices of SCM were proposed by Wisner and Tan.

Cook and Heiser (2011) defined the following SCM practices: information sharing, long range relationships, and advanced planning techniques, leveraging the internet, and supply and distribution network structures. They found a positive relationship between SCM practices and organizational performance with the moderating effect of supply chain role.

Li et al. (2004) developed and validated five dimensions of Supply Chain Management (SCM) practices: supplier and customer relationships, level and quality of information sharing, and postponement. They found a positive effect of Supply Chain practices on competitive advantage and organizational performance.

Jabbour et al. (2011) identified and validated the following Supply Chain Management constructs: Supply Chain integration, information sharing, customer and supplier relationships, and postponement. Sezen (2008) investigated SCM in terms of the following aspects: Supply Chain integration, Supply Chain information sharing, and Supply Chain design. He found that

none of the three SCM practices affected flexibility performance, and only Supply Chain design affected output performance and resource performance.

Sundram et al. (2011) measured SCM using the following constructs: supplier and customer relationships, level and quality of information sharing, postponement, agreed goals and vision, and reward/risk sharing. They found that all SCM practices, except customer relationship, positively affected Supply Chain performance. Ibrahim and Ogunyemi (2012) investigated SCM in terms of supplier and customer partnerships, and level and quality of information sharing. They found that SCM practices were positively related to both Supply Chain performance and export performance.

Lee et al. (2007) measured SCM using the following practices: customer linkage, supplier linkage, and internal linkage. They found that internal integration is the most contributing practice to cost performance while integration with the supplier is the most important practice to Supply Chain reliable performance. Flynn et al. (2010) investigated the impact of Supply Chain integration on operational and business performance. They found that internal integration and customer integration were positively related to operational performance, while only internal integration was related to business performance. They also found that supplier integration was neither related to operational nor to business performance.

Based on this literature review, five Supply Chain Management Strategies as the most frequently used strategies in the Supply Chain literature: supplier integration, internal integration, customer integration, information sharing, and postponement can be clearly demarcated for technology application and sustainable strategy development.

Supplier Integration

Supplier integration is defined as "The long-term relationship between the organization and its suppliers. It is designed to leverage the strategic and operational capabilities of individual participating organizations to help them achieve significant ongoing benefits" (Li et al., 2004).

Supplier integration characterized by various aspects and activities such as information sharing, coordination, trust, shared technology, integrated processes, long-term contracts, assisting suppliers to improve production processes, fostering quality improvements, investing in supplier's assets, including suppliers in new product development, improving supplier's overall capabilities, risk and reward sharing, and shared gains from development efforts (Dyer et al., 1998; Echtelt et al., 2008). As such, integration results in improved decision making, enhanced knowledge sharing, aligned capabilities, built learning routines, and increased performance of Supply Chain partners (Echtelt et al., 2008).

Trust enhances the degree of commitment between the two parties, reduces transactional costs, improves cooperation, enhances the satisfaction of the two parties, decreases the formal contracts, and reduces conflicts (Sahay, 2003).

Internal Integration

Internal integration is defined as "the degree to which a manufacturer structures its own organizational strategies, practices and processes into collaborative, synchronized processes, in order to fulfill its customers' requirements and efficiently interact with its suppliers" (Flynn et al., 2010).

Internal integration is an essential practice that should be implemented prior to moving to achieve external integration (Vanichchinchai & Igel, 2009). Internal integration deals with integrating and linking information among different organizational departments, creating an easy access to inventory information, developing an easy accessed integrated database that encompasses main operational data, integrating production processes using advanced information systems, and linking production and marketing departments using computerized planning systems (Lee et al., 2007).

Customer Integration

Customer integration is defined as "demand management practices through long-term customer relationship, satisfaction improvement, and complaint management" (Tan et al., 1998). The

fundamental aspect of customer relationship is the focus on key customers to understand their needs and requirements and to satisfy them (Shethet al., 2000).

Customer integration includes different activities and practices such as integrated problem-solving initiatives, direct customer contacts, managing customer complaints, increasing customer satisfaction, and establishing long-range relations with customers (Boulding et al., 2005; Sousa, 2003; Tan et al., 1998).

Customer integration is expected to yield different benefits to organizations. Such benefits include the ability to differentiate products from competitors, increased market share and retention of profitable customers, improved customer loyalty, quickly resolving potential problems, shared knowledge and expertise concerning new technologies, deep understanding of customer needs, and rapid responses to customers (Magretta, 1998; Wasti & Jeffrey, 1999).

Information Sharing

Information sharing is defined as "The extent to which critical and proprietary information is communicated to one's supply chain partner" (Li et al., 2004). The advancements of information technology have greatly contributed to the evolution of sharing information throughout the SC.

Regular exchanges of information enables SC parties to perform as a single body (Stein & Sweat, 1998). Shared information has different kinds related to inventory, resources, products, demands, delays, and planning information (Sakka & Botta-Genoulaz, 2009). It may also include information about quality, logistics, customer and general market information, and design information (Singh, 2013). In order to yield best results, shared information has to be adequate, accurate, credible, and timely (Li et al., 2004). Information sharing affects performance in terms of improved customer responsiveness, decreased costs, enhanced service levels, and reduced levels of complexity (Zhao et al., 2002).

Postponement

Postponement is defined as "the practice of moving forward as far as possible one or more operations or activities to a later point in the supply chain" (Van Hoek et al., 1999).

Postponement will be the appropriate SC strategy in the following situations: costly and expensive products, short product life cycles, long delivery time, high demand variance, high degree of customization, innovative products, high variety of products with low volume, and low delivery shipments (Pagh & Cooper, 1998; Van Hoek, 2001).

Postponement brings several benefits to companies. It enables companies to control the risks related to product diversity and uncertain demand, increases flexibility, enables companies to keep their options open before the availability of sufficient information, reduces Supply Chain costs by keeping undifferentiated inventories, reduces levels of inventory, improves forecasting effectiveness, facilitates mass customization, and reduces production cycle times (Yang et al., 2005; Li et al., 2004).

Rob Kusiciel and Don Ratliff focus their attention on the key link in many of these supply chains: the trans-continental Outlook on the Logistics & Supply Chain Industry 2012 movement of freight by deep-sea container. They are very critical, from academic and business perspectives, of the deep-sea container system, arguing that the "spot market mentality" and widening boom-bust cycles are posing a major threat to the long-term growth of international trade. Kusiciel advocates a "paradigm shift" to container shipping services that are more contract based, customer-focused and consistent. Ratliff questions the wisdom of shipping lines investing in a new generation of even bigger vessels and argues that it reveals a "disconnect between the container shipping industry and its customers".

A restructuring of the deep-sea shipping market, along the lines proposed by Kusiciel and Ratliff, would yield environmental as well as economic benefits. The environmental, or more specifically carbon, impact of supply chains is the main focus of my own paper. It casts doubt on the feasibility and desirability of measuring the supply chain emissions of individual consumer products to permit their carbon labelling. It notes that much of the early enthusiasm for carbon labelling has waned, as major corporations such as Tesco and Wal-Mart have discovered just how complex, costly and time-consuming it is to carbon footprint at a product level.

The papers by Mohammed Sharaf and John Manners-Bell address two other critical aspects of supply chain management: information and communication technology (ICT) and skills. The paper by Sharaf illustrates how various forms of ICT have helped the port operator, DP World, to facilitate the movement of trade through its terminals and to increase labour productivity. He shows how even basic equipment, such as mobile phones, can be used to create new forms of "virtual supply chain" which are likely to be "transformational". It can, for example, enhance manpower planning, cutting the time required for a port operation by up to 30%.

Raising the productivity of the existing logistics workforce is not the only human resources' issue facing the sector. As Manners-Bell points out, logistics managers around the world are experiencing difficulty in recruiting new staff with the requisite skills. He reports the results of a global survey of 300 logistics executives, roughly two thirds of which claimed that they had a problem filling posts. They attributed this mainly to an inadequate supply of good candidates, low average wages and the industry's relatively poor profile as an employer.

India is currently suffering a shortage of logistics skills. This is partly due to the rapid growth in demand for logistics services discussed in the paper by Vineet Agarwal. The combined effects of economic and population growth is fuelling a 15-20% annual growth of the Indian logistics industry, which, among other effects, is placing a strain on the country's road and rail infrastructure. Agarwal argues that the country needs a National Logistics policy to support "focused investment in logistics infrastructure", greater coordination between transport modes and a concerted effort to develop people skills in supply chain functions.

The two concluding papers provide differing viewpoints on a topic which has generated a great deal of interest in recent years within our Council, across the World Economic Forum and in business and government circles worldwide: global supply chain risk. Jonathan Wright summarizes the main findings of the joint World Economic Forum/ Accenture study on this subject. Published in January 2012, it was based on "a multipronged initiative of surveys and executive interviews across industries and regions". Wright's paper highlights the need for better risk metrics, improved scenario planning, a greater willingness to collaborate and the

simplification and internationalization of "risk legislation". Businesses and governments are exhorted to adopt a new approach to supply chain risk that he calls "dynamic operations".

A generic approach such as this needs to be accompanied by more specific sets of measures targeted on particular supply chain threats. In her paper, Elizabeth Greig examines the scale of the threat posed by Somali pirates who, since 2008, have been violently attacking hundreds of merchant ships and have held over 3,500 seafarer's captive. She proposes that the numerous agencies dealing with this problem adopt a more "comprehensive approach", including stronger naval intervention, better regulation of the maritime security industry and joint efforts to find "alternative livelihoods for would-be pirates". Members of the Council have identified what they regard as some of the major challenges confronting the logistics industry and suggested ways of dealing with them. Although the report is problem-focused, the Council does not wish to present the industry in a negative light. On the contrary, the logistics industry is one of the main growth sectors in the global economy and is absolutely critical to the improvement of living standards around the world.

Supply Chain Performance

There is no consensus among researchers concerning the best measures of SC performance (Ibrahim & Ogunyemi, 2012; Flynn et al., 2010). Jeong and Hong (2007) measured SC performance in terms of delivery reliability, responsiveness, flexibility, cost, and efficiency. Sezen (2008) used flexibility, output, and resource performance to measure SC performance. Lee et al. (2007) measured SC performance using cost-containment and reliability measures.

Vanichchinchai and Igel (2009) used the variables of cost, flexibility, relationship, and responsiveness to measure SC performance. Ibrahim and Ogunyemi (2012) measured SC performance using SC flexibility and SC efficiency. Some authors used one construct to measure SC performance (i.e., Sundram et al., 2011; Gunasekaran et al., 2004; Elmuti, 2002). Efficiency and effectiveness aspects have been widely used in the literature to measure SC performance (Lee et al., 2007; Ibrahim & Ogunyemi, 2012; Tan et al., 1998; Li et al., 2006). Gunasekaran et al. (2004) argued that flexibility is the most important and critical variable to measure SC effectiveness.

From these references and the experience of the author in Indian Aircraft Industry paved the way to bring-out the required thoughtful analysis in this paper.

Review of Six Indian Organizations striving for growth

1. **Hindustan Aeronautics Limited**

Before 2000, state-owned firms such as Hindustan Aeronautics Limited and the other consortium public sector enterprises including ADA, NAL & ADE dominated the local market. These companies also helped the development of an indigenous aerospace industry by outsourcing much of their work to other firms in the country. As a result, private sector firms such as Larsen & Toubro, Mahindra & Mahindra and the Tata Group began to acquire the capabilities in the market as well understanding the growth possibilities and market benefits.

The doors inched open a little bit in 2001, when the government allowed 100% domestic private investment in the defence sector upon obtaining an industrial licence and foreign direct investment of up to 26% with conditions. The rules have been further relaxed in the defence sector, with the private sector now allowed to become Tier 1 suppliers in military contracts and giving foreign firms greater flexibility in their choice of local partners.

The maintenance, repair and overhaul market also grown in similar terms and can be stated that it is the major beneficiary, with the estimation that it will grow by 10% annually and reach $1.17 billion by 2015 and $2.6 billion by 2020. It is also estimated that the aerospace industry spends more annually on MRO than on manufacturing or research and development, and the rapid growth of India's airline industry means that demand is increasing.

“Indian labour costs are an advantage” says Frost & Sullivan, at $30-35 per man-hour. This compares with $55-60 in South-East Asia and Middle East and even higher in the USA and Europe. "India has the potential to service not just Indian aircraft, but also those from neighbouring regions," it adds.

The government has also said that aerospace will be one of the pillars of its attempt to boost India's manufacturing base. Several special economic zones dedicated to the aerospace industry are in the works, offering attractive tax and financial incentives for investors, although the economic downturn may have temporarily resulted in some of them being scaled back or delayed.

As manufacturing requires heavy investment in facilities, Hindustan Aeronautics Limited., (HAL) remains the leader in India with its 19 production units. It has manufactured 26 different types of aircraft, mostly military, through indigenous development and licence-production deals. HAL also supplies components for the major companies viz., Airbus A320 doors and Boeing 777 'flaperons'. "The composite 777 'flaperon' that HAL will produce represents a significant leap forward in technological capability, and supports Boeing's strategy to work in partnership with India's aerospace industry for the long term," says Boeing India president Dinesh Keskar. "We are delighted that our strengths in composites are getting more international recognition," says Soundara Rajan, director, corporate planning and marketing at the company. "Showcasing HAL's composite manufacturing capability on one of the world's premier long-haul commercial jets positions us for even greater opportunities at the forefront of technology." Many of the Indian organizations with foreign collaborations and 'vice versa' are also entering into the fray.

2. **TATAs**

Tata, an Indian conglomerate with a long history in the manufacturing segment, has plans to set up an aerospace production facility at its forthcoming special economic zone in Hyderabad. In January, Tata signed a contract with 'Agusta-Westland' to assemble the AW119 in India. Sikorsky and Tata agreed a deal in November to manufacture components in India, building on a June 2009 contract for Tata to assemble the Sikorsky S-92 helicopter cabins.

"Sikorsky's affiliation with Tata both strengthens our supply chain and extends our globalisation effort to establish significant operations in regions where the need for rotorcraft and support is great. India is certainly a key aerospace region, and we are thrilled to team with Tata and help serve and grow the business there," says Mick Maurer, senior vice-president of operations for Sikorsky.

Airbus Group SE, the European multinational aerospace and defence corporation, Toulouse, France, its defence and security division- EADS outsources $126 million worth of aero infrastructure and engine components each year to Indian vendors and expects that to rise to $1.3 billion annually by 2020. "As part of its industrial strategy, EADS is aiming to increase sourcing volumes in India either directly or in co-operation with Indian partners," says the European aerospace and defence conglomerate. "Establishing partnerships with Indian public and private sector organisations and direct investments are a key part of EADS's industrial strategy."

3. Airworks

Air Works in India would also like to take advantage and plans to invest $120 million over the next few years to expand its existing MRO facilities and set up new ones. It has also signed a lease agreement with another local firm, Taneja Aerospace, to use their huge land and five hangar spaces on a long-term basis. Apart from offering base maintenance, it plans to service engines and components. "We will need another $100 million and a strategic partner about a year-and-a-half down the line as we get into sophisticated engineering," says Fredrik Groth, chief executive of Air Works.

4. Eurocopter

EADS's helicopter subsidiary Eurocopter has also got longest partnerships with Indian Aircraft Industry. Since 1962, it has worked with HAL in India to manufacture more than 600 Alouette 3 and Lama (known as Cheetah and Chetak locally) helicopters. HAL also produces airframes for the Ecureuil/Fennec family of rotorcraft. The European firm also plans to set up pilot training facilities in India for the civil and military segments and plans to invest €7-8 billion ($9.5-11 billion) over the next 10 years.

"India has an inherent edge over several other nations because of higher skills and lower costs of production. This makes India an ideal partner for Eurocopter as we are in the process of diversifying our global supply chain across the world. Over the next few years our association with India can be expanded into momentous industrial partnerships and co-operation," says Eurocopter.

"We shall continually strive to expand our footprint in India. To ensure that our customers receive the best end-to-end support in the country, it requires investment. This investment will help us create the right infrastructure to support our overall goal with respect to India. It will also help us create a skilled labour force that will in turn help build India's domestic capability."

Indian software companies such as HCL, Infosys, Infotech, Tata Consultancy Services and Wipro have also been active in the aerospace industry for the last few years. Increasingly, they are benefiting from the engineering services' outsourcing programmes that will help India to evolve from IT and low-end business process outsourcing work to high-end design services. Overseas companies are viewing the Indian Aircraft Industries consortium as "long-term partners and not as mere suppliers/vendors".

5. Honeywell

Honeywell Aerospace, which provides integrated avionics, engines, systems and service products for the aerospace industry has already started their activities in India. This US Company has now established a design and development centre in India and has plans to expand in the coming years.

6. Airbus

In 2006, Airbus set up the Airbus Engineering Centre India in Bangalore where local engineers support develop capabilities in modelling and simulation, covering areas such as flight management systems and aerodynamics, to facilitate in the design and production of aircraft such as the A380 and the A350. It is also working with Indian IT firms such as CADES, HCL, Infosys, Quest, WIPRO and Mahindra to offer support across various aircraft programmes. IT and engineering majors are also now playing an important role in projects that involve a transfer of technology from the respective foreign counterparts that helped foster indigenous growth of the sector and the business models of these companies have also evolved from simple models to ones that are unique, innovative and that involve the sharing of risk in the global spectrum.

The newly-formed **C**onfederation of **I**ndia **I**ndustry's **N**ational **C**ommittee on **A**erospace (CIINCA), under the Chairmanship of R K Tyagi, Chairman, HAL, now providing new vistas for the aerospace sector. With the increasing focus on achieving self-reliance in defence, some of the key issues have been put forward and strategies for the future have been drawn in terms of import substitution, tax reduction/tax holiday, collaboration with foreign OEMs, developing supply chain, promoting Indian tier-1, tier-2 companies and SMEs through structured programmes.

Other growth prospects

- Five international airports (Delhi, Mumbai, Cochin, Hyderabad, Bengaluru) have been completed successfully under Public Private Partnership (PPP) mode. Now they are operating more number of flights to more countries.
- Greenfield airport at Navi Mumbai, Mopa (Goa) and few brown-field airports of Airports Authority of India (AAI) and 50 airports under the low-cost model are to getting developed all over the country.
- Indian aviation is experiencing dramatic growth across the board; from the emergence of Low Cost Carriers/new carriers to a growing middle-class ready to travel by air as well as growth in business and leisure travel.
- India's middle-income population is expected to increase from 160 Million in 2011 to 267 Million by 2016.
- Greater focus is in-terms of infrastructure development; increasing liberalisation – Open Sky Policy; AAI driving modernisation of airports, Air and Navigation Systems.
- Growth in aviation accentuating demand for MRO (maintenance, repair and overhaul) facilities.
- Large scale collaborations/Mergers & Acquisition deals – Etihad Airways & Jet Airways; Tata Group & Singapore Airlines, Tata Group & AirAsia etc showing the way of future growth.
- India plans to increase the number of operational airports to 250 by the year 2030.

The CIINCA aimed at creating a vibrant aerospace manufacturing and service sector in India through unity of efforts from not only government, PSUs but also private sector, multi-national companies and research organisations. The aim is to identify and attract potential suppliers, R&D

partners to boost indigenisation and import substitution along with outlining the path for the integration of SMEs into the Indian Aircraft Industry's supply chain. These thematic pillars - import substitution, R&D investment, labour cost advantage and skill development are the real solutions in order to sustain global competitiveness, creating an export ecosystem, developing MSMEs and boosting the brand "Make in India" are vital for the Indian Aircraft Industries Supply Chain Management System.

"The world is focused on Indian aviation – from manufacturers, tourism boards, airlines and global businesses to individual travellers, shippers and businessmen. If we can find common purpose among all stakeholders in Indian aviation, a bright future is at hand," said Mr. Tony Tyler, Director General and CEO, International Air Transport Association (IATA).

Market Size

Over the next five years, domestic and international passenger traffic are expected to increase at an annual average rate of 12 per cent and 8 per cent, respectively, while domestic and international cargo are estimated to rise at an average annual rate of 12 per cent and 10 per cent, respectively as per the growth indicators. The Key investments and developments in India's aviation industry indicating the possible market size are-

- Airbus, the world's leading aircraft maker, expects India's aviation industry to grow at over 10 per cent annually in the next decade, almost double the average growth rate of the global aviation industry.
- Eyeing large orders from Indian airlines, Airbus has committed to source products worth US$ 2 billion cumulatively over the next five years from India; the company plans to provide customised maintenance and other services closer to the base for all its airline customers in India.
- French drone-maker LH Aviation signed a Memorandum of Understanding (MoU) with India's OIS Advanced Technologies on June 19, 2015to manufacture tactical drones in India through an industrial license.
- Mahindra Group expanded its partnership with GE Aviation by signing an agreement to manufacture aero structures at the Group's new aerospace facility in Bengaluru.

- IndiGo plans to file documents for an initial public offering within the next two months to raise US$ 400 million by selling 10 per cent stake.
- SpiceJet plans to enter a deal with Boeing Co. and Airbus Group SE to buy 80-120 jet airplanes which would help to expand their fleet and rebuild its business..
- Air India, India's national airline, has started to shift its IT operations to cloud and is exploring the use of iPads for work, as it plans to upgrade its technology to maintain pace with the competition.
- The Airports Authority of India (AAI) and Kannur International Airport Ltd. (KIAL) signed a MoU for 26 per cent equity in the greenfield airport worth Rs 1,892 crore (US$ 295.62 million) being built at Mattannur in Kannur.
- Hindustan Aeronautics Ltd. (HAL) signed an agreement with French engine manufacturer Turbomeca for maintenance, repair and overhaul (MRO) of Shakti helicopter engine, which would power a fleet of 1,000 Indian military choppers over the next 10 years.

Government Initiatives

Government agencies project that around 500 brown-field and green-field airports would be required by 2020. The private sector is being encouraged to become actively involved in the construction of airports through different Public Private Partnership models, with substantial state support in terms of financing, concessional land allotment, tax holidays and other incentives. The states that are newly formed in India are also trying their best for their prosperity in-terms of inclusive growth.

Some major initiatives undertaken by the government are:

- Gujarat is expected to get a second international airport at Dholera. The state government has formed Dholera International Airport Co. Ltd. and is obtaining approvals from the union government.
- The Directorate General of Civil Aviation (DGCA) has given its approval to Air India's maintenance, repair and overhaul (MRO) unit.
- The Government of India has decided to award airports in Kolkata, Chennai, Jaipur and Ahmedabad on management contract. AAI has issued the 'Request for Qualification' document for these four airports.

- The Government of India plans to form a committee comprising bankers, aviation experts and technocrats to help turn around and privatise the national airline, Air India.
- The Government of India has approved a proposal to set up a second airport in the National Capital Region.
- The Government of India expects to finalise the new aviation policy and revised international flying norms for domestic carriers soon; the government may remove the '5/20' norms for domestic airlines in this new policy.

Indian Aircraft Industry, the consortium of all the Aircraft Industries in India, is a highly enthusiastic, motivated and knowledgeable dream organisation with expected extensive expertise in many areas of industries, business and technology aiming at Strategic Supply Chain Management to utilize the existing growth parameters at all levels. The knowledge and experience spans a broad range of vendor, partner and end-user companies and their delivery, service, management and use of IT for business advantage.

Supply Chain Network

SCM Network suggests a serial entity; the reality of the Indian Aircraft Industry is an increasingly complex network of relationships. With the structure of modern aerospace industry moving away from traditional vertical programmes to highly distributed, multinational and multi-stage operations, including production and the rapidly expanding aftermarket Maintenance, Repair and Overhaul, there are inevitably great challenges. With tier 1 and tier 2 suppliers are taking on more responsibility and Original Equipment Manufacturers (OEMs) are having less visibility and control over the supply chain than ever, IAI is planning to manage the difficulties and the intricacies of the aerospace supply chain through Strategic Supply Chain Management Decisions. IAI aimed at the best possible solution of stakeholders' improved collaboration, which can be facilitated through the usage of Automate Technologies in terms of Product Lifecycle Management and Technology based Mergers and Acquisitions.

Figure 6: Supply Chain Challenges

Facing up the realities

As per observations of Indian Aircraft Industry, both Boeing and Airbus have been victims of their supply chain complexities. The delivery of Boeing's 787 has famously been hit by numerous delays, the majority of these as a result of failures in the supply chain. Likewise, the arrival of Airbus' A380 - the world's biggest commercial aircraft to date - has been clouded by a series of problems, shunting back its delivery schedule dramatically. Once again, the flaw in the A380 program lay within the production process, in what Christian Streiff, Airbus CEO and President called the 'one weak link in the chain', namely the airplane's electronic harnesses.

The possible reasons are looked upon and found to be –

"Initially assigning its subcontractors to do more assembly themselves and deliver completed subsystems, Boeing intended to perform the final assembly of these component parts. However, some subcontractors encountered difficulty completing the extra work, because they could not procure the required parts; perform the sub- assembly on schedule, or both. As a result, Boeing was hit with serious delays. With hundreds of thousands of components coming together from

hundreds of multinational suppliers all for one single aircraft, the prevention of late delivery will be a central concern for supply chain managers.". With the collaborative supply chains with the aim of vendor satisfaction and monitoring from close corners in all the echelons of supply chains, IAI is expecting to combat such problems.

Today's Supply Chain

To limit the very real risk and very costly issue of late delivery, relationships throughout the supply network aspire towards greater operational transparency and visibility. If the relations with the 'Supply Chain Echelons' especially with the suppliers are not healthy and are not conducive enough the organizations need to face the risk of inefficient operations and conflicting demand for materials resulting in cost-creating excess inventory. Exacerbating the situation further is the industry's sluggishness to move away from a mass- manufacturing model , as goods are 'pushed' through manufacture to a production schedule that may or may not align with customers requirements at the time of delivery. The advent of a demand-led pull model is the right one to streamline the process and reduce the non-value adding margins, but its implementation calls for astute management in an industry governed by long lead times in the production of low volume but highly engineered deliverables.

The marked trend towards buyers' enforcing performance based contracts within the aerospace industry increases the pressure on stakeholders throughout the chain and would also affect the supplier's supplier. With large scale programs characterised by multi-year contracts, multifaceted compliance regulations as well as intricate supply networks, meeting the customer's demands can often prove difficult. For the supply chain to operate at its optimum efficiency there must be an alignment of objectives realised through intimate relationships between the different tiers.

The complex aerospace supply chain can often be improved by careful balancing of the interests of each individual stakeholder with those that are overarching and shared. Sharing risk information across the chain would be one such method of collaboration, combining the OEM's greater wealth of resources with the potential for an earlier response in the tier 1 and tier 2 stages of manufacture. Such integration would alleviate last minute pressure on the OEMS to struggling to produce deliverables to deadline, allowing problems to be identified and worked through at an

earlier stage.

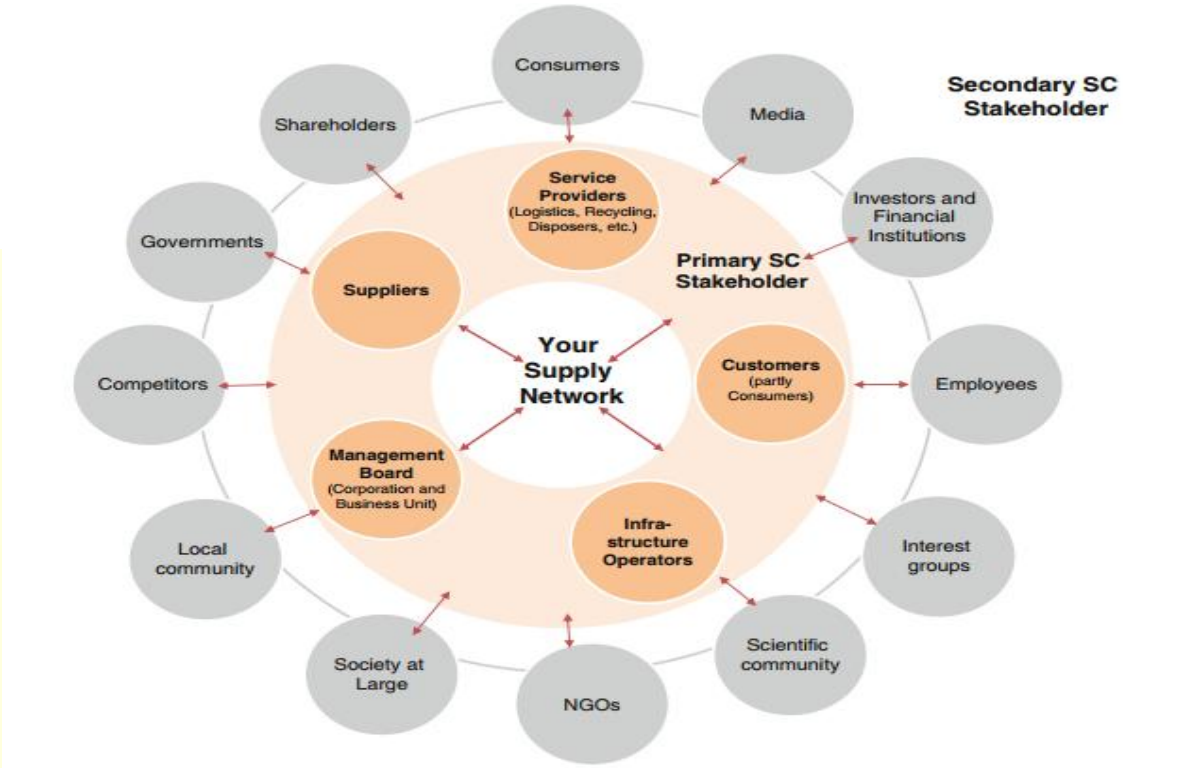

Figure 7: Supply Chain Stake holders

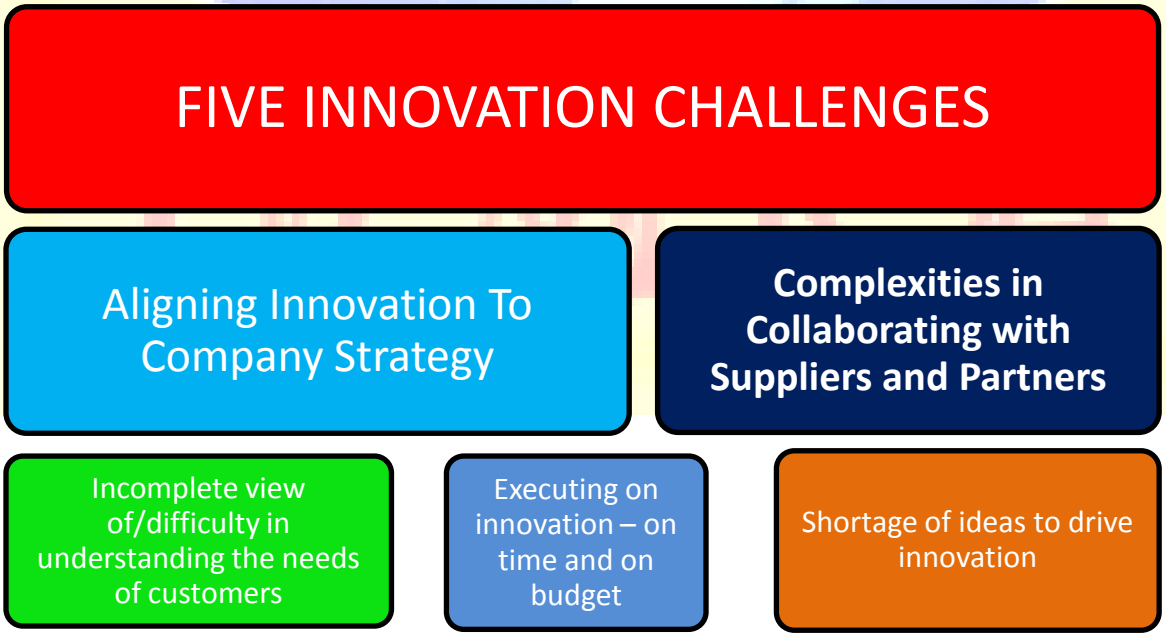

Figure 8: Supply Chain Innovation Challenges

Changing Scenarios

Certainly the changing world order is forcing a response from the OEMs, but 'when it comes to the latest technology', says Morris A Cohen, professor of operations and information management at Wharton Business School in the US, '**Boeing and Airbus** are very careful to outsource only certain parts of the manufacturing'. To retain their competitive advantage, Boeing, for example, keep their avionics and wing design in house, whilst benefiting from the clusters of competency in low cost locations such as Czech Republic, Mexico Indonesia, Malaysia, Tunisia and Morocco for manufacture and lower value-added services.

Protecting their high value knowledge and Intellectual Property (IP), the OEMs are securing their interests against reproduction, but many critics including labour organisations, are concerned that nations such as China (with its clear ambition to build a domestic industry) are absorbing aerospace technologies and production knowledge gleaned from such joint ventures. Such anxiety and the opportunity to capitalise on aftermarket part profit can engender a culture of IP hoarding in elements of the supply chain, creating an adverse effect on the chain's network of relationships.

Although the outsourcing of manufacture is the most visible manifestation of globalisation, OEMs are increasingly seeking engineering and R&D talent pools outside the traditional hotspots of the US and Europe. In the last twenty years the maturation of digital design tools and innovations in the broadband infrastructure has both amplified the potential for

outsourcing and offshore engineering. Boeing was one of the first OEMs to leverage these possibilities when, in 1993 it established a small technical centre in Moscow employing 10 engineers. Today Boeing employs nearly 2,000 engineers in its Engineering Design Centre there, a facility that produced approximately one-third of the structural drawings for the 747 model. Similar trajectories have been followed by Honeywell and GE, who both have set up large engineering centres in Bangalore, India. Off-shoring, outsourcing, supplier collaborations are thus emerged as success strategies. If the linking is viable among all the collaborators and suppliers, there is the opportunity for sustainable competitive advantage.

Competitive advantage

To understand the competitive advantage, here it is pertinent to mention about the "Five Forces" analysis of a company's competitive environment, developed by Michael Porter, which, still provides a useful tool to identify external competitive challenges and, in turn, potential strategies for competitive advantage. In Porter's framework, competitive advantage comes through being the lowest cost supplier, providing differentiated capabilities or focusing on a particular area of strength. But in today's environment, off-shoring, outsourcing and maintaining the supply chain relations to the level of supplier's supplier, the advantages can more readily and rapidly be matched by competitors through such means as common access to third-party logistics providers, advanced information and communication technology, advanced inventory and distribution centre technology with reduced entry barriers.

Developing a sustainable competitive advantage in various supply chains require innovative focus on creating value in the organization. A supply chain needs to be viewed as a "value chain," in which all participants are truly integrated and share a common vision of goals, processes and information sharing. The goal of all participants is to maximize value in the total supply chain and Aircraft Industries are focussing on this aspect with their collaborative partners all-over the world.

To achieve this transformation and firmly gain a significant competitive advantage requires a different way of thinking about various vendors, licensors, collaborators, sub-contractors 'supply chain performance and structuring' in a constructive way. The key is identified as value creation through total commitment to seamless value-focused supply chain performance. Value creation is feasible by achieving on-time deliveries and optimal inventory levels primarily with focus on collaborative relationship with suppliers, customers and other stakeholders. IAI is looking at continuous improvement and flexibility in Supply Chain to adapt to constant changes in the marketplace with identified six principles to accomplish the mission-

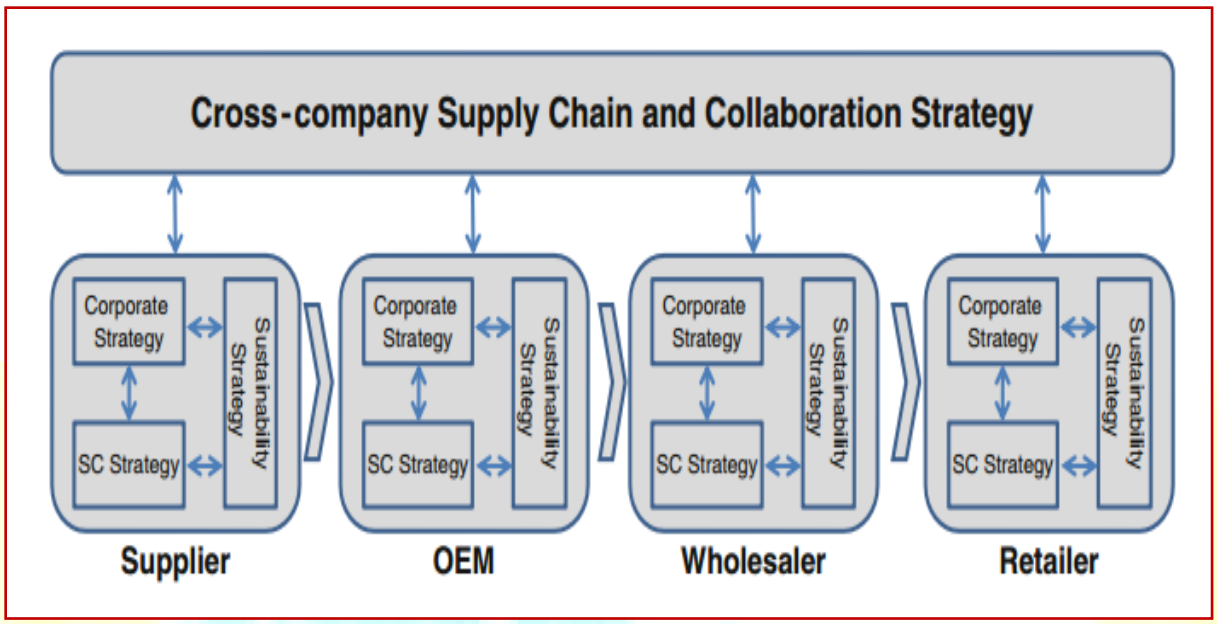

Figure 9: Cross-company Supply Chain Collaboration and Strategy

SIX PRINCIPLES

1. Collaborate, Don't Compete — A true value-oriented supply chain consists of an extensive network of integrated suppliers, suppliers' suppliers, internal supply chain participants and customers, all working together to maximize the value of the supply chain. When the relationship with suppliers is developed, it is the mirror image of setting up customer relationships. Each participant's success in Supply Chain and increases the value and will always have a positive impact on the performance of the industry in general and Indian Aircraft Industries in particular.

Partnership companies and Suppliers are the best source for new ideas on technology, process streamlining, inventory reduction and product design improvements. But making this work requires different methods of developing incentives and monitoring performance for partners. IAI's methodologies and approaches to have joint risk/reward sharing are interlaced in terms of Long Term Business Agreements.

2. Remember the Goal — Many strategic sourcing/supply chain organizations tend to get overwhelmed by the task at hand and lose sight of the bigger picture. This is a more significant tendency in organizations where people identify more with their function than with their company. A common trait of successful supply chain professionals is the recognition that,

ultimately, they are as responsible for selling product as any member of the sales force. In other words, cost savings aren't sought to meet some functional objective but rather to improve the competitiveness and profitability of the end product.

IAI noted that aligning goals with the company's overall direction has always been critical to the success of a supply chain. In the best circumstances, supply chains that have developed a competitive advantage actually work to create their company's vision and direction, not just respond to it.

3. Recognize the Complex, Manage the Simple — The buzz for many companies over the past few years has been about avoiding complexity. Unfortunately, the supply chain is not cooperating and, despite everyone's best efforts, the exact opposite is occurring. Global marketplaces, outsourcing of non-core activities, extended supply chains with multiple layers of suppliers, shorter lead-times/product lifecycles and so on are combining to increase the complexity of the business environment at an alarming rate. IAI identified the key as simplification and providing clarification at the instant by using new technology to the maximum extent. IAI is constantly working towards reducing the complexity by analysing the 'work-component' internally. IAI noted that this is the only possible counter to the growing complexity that is experienced externally.

While this seems like a basic concept, many of the issues faced by IAI viz., implementation of new enterprise resource planning (ERP) systems are the result of either relying solely on the technology to remove complexity (without addressing process complexity) or becoming enamoured with the capabilities of a system and actually adding nonessential elements to strategic sourcing/supply chain processes. Ultimately, redesigning supply chain processes and implementing technology should be about simplifying the way business is conducted, not about jumping on the newest technology bandwagon. A reasoned approach that focuses on simplifying the complex should be carried throughout the supply chain.

4. Treat the Issue, Not the Symptom — The supply chain can be analogous to the human body. Both are highly complex and provide a wide range of metrics that can be used to assess their

health. Doctors typically focus on a relatively small number of key metrics to guide their effort to find an appropriate course of action when a patient experiences ill health.

The key to the efficiency and effectiveness of the doctor's intervention is the ability to interpret those initial metrics and to quickly find the right combination of additional tests to complete the overall picture. Then, of course, the doctor has to draw accurate conclusions and predict the impact of various treatment options. The same process is being used with the IAI's supply chain.

A small set of key metrics are monitored on an ongoing basis to confirm the health of the supply chain. If the key metrics reveal an overt symptom of something gone awry, the supply chain professionals would analyze the key metrics, gather additional data and craft a response that gets at the underlying issues. IAI performs root-cause analysis as part of their operations and, consequently, frequently treat the issue and not symptoms.

5. Focus on Cost Drivers and Business Impacts —Understanding what makes up the costs of the supply chain is critical to obtaining value from strategic sourcing/supply chain activities. Creating a sustainable competitive advantage requires more than that. Costs are symptoms; cost drivers are the cause. Across the entire supply chain of IAI the supply chain professionals focus more on the issues/causes than just the cost difference between two possible solutions to a specific problem.

In addition, strategic sourcing and supply chain metrics in IAI are tied with economic/financial results. This is done through employing special financial analysts or work in concert with finance people by conducting regular financial reviews of various operations. Doing so makes it possible to become more accurate in predicting, and more confident in describing, the financial impact of strategic sourcing/supply chain decisions. IAI noted that the ability to link a supplier's cost driver with a business impact that affects the company's bottom line is a critical competency for its professionals in this arena.

6. Don't Waste an At-bat — If an idea is worth pursuing, it is worth pursuing to its full and natural conclusion. Opportunities to make a sustainable competitive impact are all too frequently

missed because strategic sourcing/supply chain personnel "drove one off the fence" and merely trotted down to first base, content that they had gotten a hit. To make a significant impact on the business, strategic sourcing and supply chain professionals of IAI appreciates that, over the course of a season, the difference between "hall of fame" and "journeymen" hitters is largely that the hall-of-famer is driven to excel on every swing.

IAI recognized that the hardest part of achieving a competitive advantage is sustaining it. There is always a new financial vehicle, software package, logistics platform, manufacturing expertise or product enhancement emerging somewhere in the world. The key is to build an atmosphere of constant improvement and not present competitive advantage as a *one-time revolution* but rather as a *continuing evolution*. At IAI the strategic sourcing/supply chain team continuously keep-on updating the emerging strategies and technologies and critically evaluate how any ideas can help create or sustain an advantage in the marketplace.

Collaboration, Visibility, Integration and Relationships

The network's complexity requires new thinking coupled with strategically applied technology to adapt and manage, driving improved efficiency into the supply chain. Many companies are already implementing supply chain improvement programmes, Airbus with their '**Power8 program**' is one such example. According to the press release of Airbus "**Power8** will enable Airbus to face the very substantial challenge of the US dollar weakness, increased competitive pressure, the financial burden related to the A380 delays as well as meet its other future investment needs. Power8 provides for strong cost-cutting measures, aims at transforming the Airbus business model and the development of a global network of partners. It will allow Airbus to devote its resources to core activities and eliminate inefficiencies within its current structure. The programme aims at the full industrial integration of Airbus by establishing a new industrial organization with transnational Centres of Excellence replacing the existing national structures. This transformation will happen progressively over several years and includes the further extension of Airbus& Apos; global footprint."

With many trying to save the costs in the downturn, the financial crisis makes stark the complications and flaws within the supply chains. But current dynamics also provide an

opportunity to get things right, cutting costs and improving business practice with focus on areas including supply chain and Lean initiatives. Enabling the three industry buzzwords of collaboration, visibility and integration, supply chain stakeholders can work together to try to ensure that there is no single point of failure. With added complexity there is an ever greater need to synchronise activities across a vast number of players.

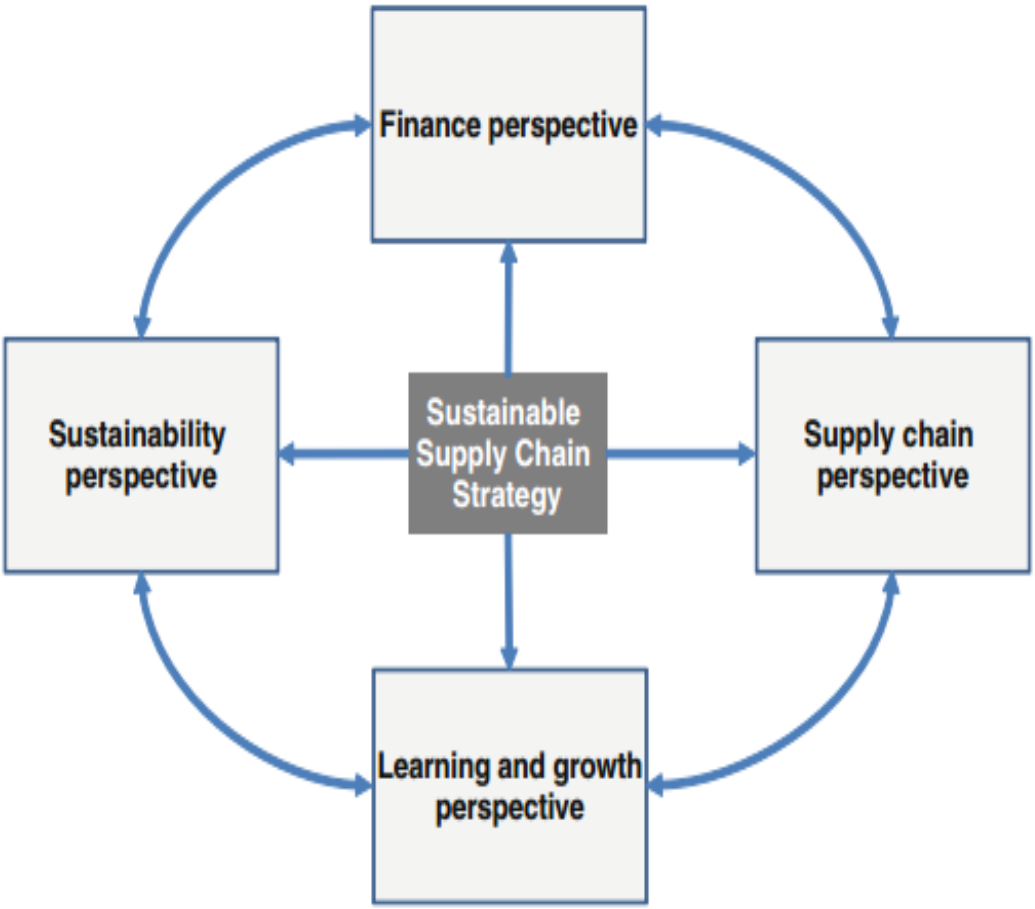

Figure 10: Sustainable Supply Chain Strategy

The OEMs and the majority of Tier 1 suppliers have enough liquidity to absorb the costs of implementing technologies such Product Lifecycle Management and Supply Chain Management systems. There will be always reluctance from smaller sub-contractors within the chain to adopt new systems which add some times extra overheads. If the value is absorbed across the main echelons of the supply chain such pinpricks can be avoided. Another limiting factor is of course the industry's reluctance to change; adopting seemingly expensive and time consuming 'manual'

collaboration strategies for little immediately apparent value-add.

Managing relationships

As a web of inextricably linked yet changing relationships, real time supply chain management can be seen as a corporate asset. As more responsibility has been delegated away from the OEMs, a direct result has been the increase of risk harboured in the lower tiers. The OEMs' rationalisation of the supply chains provides an ideal opportunity for the OEMs and their top tier suppliers to build on their 'existing relationships' 'consolidated ties' and can create more standardised processes. The relationships can be improved upon through mutual alignment of information, goals and shared risk mitigation using information technologies such as Product Life Cycle Management as the enabler. There is a general clause in contracts to typically impose liquidated damages or financial penalties for late delivery of goods. In similar lines there can also be a clause giving a special benefit to the supplier, an incentive scheme, to reward timely output. It is seen that IAI adopted such an approach to all members of its supply base, but streamlining, prioritising and nurturing of relationships has been shown to deliver a strong, sustainable and profitable network of partners to the benefit of the end user/customer.

Geopolitical concerns

The evolving nature of relationships in the aerospace industry increasingly calls for sensitive management of regional needs. This is aggravated by a large number of differences in international business practice, language and culture. Irrespective of the fact that the component parts are manufactured in various countries all over the world, the finished aircraft must meet the standards of any given customer's jurisdiction's complex regulatory requirements and quality control checks. The clearance from international supervising bodies' viz. Federal Aviation Administration (FAA), JAA, European Aviation Safety Agency (EASA) is a must with respect to safety of the passengers. In India, the clearance from DGCA, RCI, CEMILAC etc., are the appropriate authorities based on the type of product.

India amongst others is somewhat offset by stimulus packages in the US and France, successful management of supply chains could provide a sustainable way to maintain competitive advantage. Moreover, with evermore political rhetoric devoted to green issues, aircraft carriers

have been under huge pressure to reduce their carbon footprint. As the end customer of the supply chain, these concerns subsequently filter down to the IAI and their suppliers, who in turn face pressure to increase sustainability and 'green' their design and manufacturing processes.

Adding value to maintain competitive edge

Value engineering is another typical consideration in aerospace supply chain management. In the current economic climate, one challenge facing managers is to improve both real and perceived value of their products and services. To increase value added activity, significant focus is to be made on all the suppliers. In general the Aerospace supply chain can be likened to a complex geared system. All of the parts must operate in tandem with as little resistance as possible to operate effectively. The sheer scope of the interaction between the 'cogs' - each individual supply chain member - is such that all process areas rely or influence others to a greater or lesser extent. From the very beginning of the supply chain in the product design and development stage, incremental value can be delivered through effective collaboration between the OEM and its supply chain. Engineers from both parties can add transparency can help to reduce the development cycle and provide greater confidence and control over the quality of deliverables. In terms of the chain's management, it also signals a transparency and visibility from the earliest stages in the development process, allowing expectations and issues to be as aggregated and rationalised at the earliest possible opportunity.

When it comes to sourcing and procurement; communicating and collaborating with suppliers on sourcing processes and procedures can provide more effective workflows and insight in a number of key areas, including the enforcement of due diligence, the status of purchase orders as well as the significance of incoming shipments; these can form part of the information shared between the chain's members via digital 'dashboards' available with more advanced IT solutions. Managing schedules, subcontract deliverables and change can also be more efficiently co-ordinated. Logistics and transportation is another area that can see benefit through effective use of information technology. Working in tandem with logistics service providers, supply chain managers can establish greater transparency into the status and location of goods in transit, enabling real-time and accurate forecasting of delivery schedules; essential to the production and assembly of sophisticated and complex deliverables. The same principle works vice versa, as

providing suppliers with visibility into their customers' production schedules can help them plan to serve the OEMs production and shipment targets more effectively, thereby avoiding the shortages that can bring assembly or production to a grinding halt.

Whilst component shortages can often plague the OEMs timely delivery of aircraft, stockpiling and inventory holding are meaningful even though they are listed in the group of expensive overheads for the prime airframe manufacturers. In the long run these special exercises of stock-piling and inventory holding have been proved to be cost effective and meaningful. Increased supply chain collaboration coupled with the adoption of Lean manufacturing techniques enables top tier stakeholders to formulate aligned view of supply and demand with the supply chain. Improved long and short term forecast accuracy, better demand planning, enhanced finished goods management and improved customer services can all form part of the value add and are the means to improve the Supply Chain Relationships.

Maintenance, Repair and Overhaul (MRO) operations working with suppliers to manage critical parts and spares capacity can significantly improve the asset efficiency and utilisation. Indian Aircraft Industries could witness this and can be stated simply that once it hold 75% of the spare parts inventory in year 2000 and today they hold just 61% of the 48 billion dollar parts inventory in the MRO supply chain. Unscheduled maintenance, or a disruption in spares production schedules, for instance may result in an unexpected parts shortage. However, in an integrated, managed supply chain environment as spares or replacement information becomes available, divisions can adjust maintenance, service and sourcing accordingly.

Moving forward

In today's aerospace industry the challenge of delivering to-time and to-cost while co-ordinating complex network deliverables requires more than just capability or technical competence. Information Technology use in the Supply Chain Echelons' to the maximum extent would be a great idea in reducing the costs, reducing the supply lead-times and using the systems for faster location, identification and transportation. The TEN Technological trends in IT can be best utilized with total security to improve productivity in the Supply Chain.

Ten Information Technological Trends

IAI highlighted the top 10 information technology trends that will be strategic in maintaining better Supply Chain Relationships and progressing towards prosperity. IAI has defined the strategic technology trend as one with the potential for significant impact on the organization in the present situation. Factors that denote significant impact include a high potential for disruption to the business, end users or IT, the need for a major investment, or the risk of being late to adopt. These technologies are expected to impact the organization's long-term plans, programs and initiatives.

1. Computing Everywhere

As mobile devices continue to proliferate, IAI predicts an increased emphasis on serving the needs of the mobile user in diverse contexts and environments, as opposed to focusing on devices alone. Phones and wearable devices are now part of an expanded computing environment that includes such things as consumer electronics and connected screens in the workplace and public space. The messaging systems, stock identification and related communications by using 'WhatsApp' and communication in the echelons of Supply Chain would be of more meaningful and time saving. This will continue to raise significant management challenges for the organizations as they lose control of user endpoint devices but it is helpful in reducing the distances.

2. The Internet of Things

The combination of data streams and services created by digitizing everything creates four basic usage models — Manage, Monetize, Operate and Extend. These four basic models can be applied to any of the four "Internets." Organizations should not limit themselves to thinking that only the Internet of Things (IoT) (assets and machines) has the potential to leverage these four models. The pay-per-use model can be applied to parts/ assets (such as industrial equipment), services (such as pay-as-you-drive insurance), people (such as movers), places (such as parking spots) and systems (such as cloud services). All the supply chain members from all industries can leverage these four models.

3. 3D Printing

Worldwide shipments of 3D printers are expected to grow 98 percent in 2016, followed by a doubling of unit shipments in 2017. 3D printing will reach a tipping point over the next three years as the market for relatively low-cost 3D printing devices continues to grow rapidly and industrial use expands significantly. New industrial, biomedical and consumer applications will continue to demonstrate that 3D printing is a real, viable and cost-effective means to reduce costs through improved designs, streamlined prototyping and short-run manufacturing. Hence all the feasible areas need to be equipped with the specific facility for gaining the advantage.

4. Advanced, Pervasive and Invisible Analytics

Analytics will take centre stage as the volume of data generated by embedded systems increases and vast pools of structured and unstructured data inside and outside the enterprise are analyzed. Organizations need to manage how best to filter the huge amounts of data coming from the IoT, social media and wearable devices, and then deliver exactly the right information to the right person, at the right time in the Supply Chain. Analytics will become deeply, but invisibly embedded everywhere." Big data remains an important enabler for this trend but the focus needs to shift to thinking about big questions and big answers first and big data second — the value is in the answers, not the data.

5. Context-Rich Systems

Ubiquitous embedded intelligence combined with pervasive analytics will drive the development of systems that are alert to their surroundings and able to respond appropriately. Context-aware security is an early application of this new capability, but others will emerge. By understanding the context of a user request, applications can not only adjust their security response but also adjust how information is delivered to the user, greatly simplifying an increasingly complex computing world.

6. Smart Machines

Deep analytics applied to an understanding of context provide the preconditions for a world of smart machines. This foundation combines with advanced algorithms that allow systems to understand their environment, learn for themselves, and act autonomously. Prototype autonomous vehicles, advanced robots, virtual personal assistants and smart advisors already

exist and will evolve rapidly, ushering in a new age of machine helpers. The smart machine era will be the most disruptive in the history of IT.

7. Cloud/Client Computing

The convergence of cloud and mobile computing will continue to promote the growth of centrally coordinated applications that can be delivered to any device. Cloud is the new style of elastically scalable, self-service computing, and both internal applications and external applications will be built on this new style. While network and bandwidth costs may continue to favour apps that use the intelligence and storage of the client device effectively, coordination and management will be based in the cloud. In the near term, the focus for cloud/client will be on synchronizing content and application state across multiple devices and addressing application portability across devices. Over time, applications will evolve to support simultaneous use of multiple devices. The second-screen phenomenon today focuses on coordinating television viewing of a manufacturing or repair centre or part manufacture with use of a mobile device. In the future the enterprise applications alike will use multiple screens and exploit wearable's and other devices to deliver an enhanced expertise.

8. Software-Defined Applications and Infrastructure

Agile programming of everything from applications to basic infrastructure is essential to enable organizations to deliver the flexibility required to make the digital business work. Software-defined networking, storage, data centers and security are maturing. Cloud services are software-configurable through API calls, and applications, too, increasingly have rich APIs to access their function and content programmatically. To deal with the rapidly changing demands of digital business and scale systems up — or down — rapidly, computing has to move away from static to dynamic models. Rules, models and code that can dynamically assemble and configure all of the elements needed from the network through the application are needed.

9. Web-Scale IT

Web-scale IT is a pattern of global-class computing that delivers the capabilities of large cloud service providers within an enterprise IT setting. More organizations will begin thinking, acting and building applications and infrastructure like Web giants such as Amazon, Google and

Facebook. Web-scale IT does not happen immediately, but will evolve over time as commercial hardware platforms embrace the new models and cloud-optimized and software-defined approaches reach mainstream. The first step toward the Web-scale IT future for many organizations should be DevOps — bringing development and operations together in a coordinated way to drive rapid, continuous incremental development of applications and services.

10. Risk-Based Security and Self-Protection

All roads to the digital future lead through security. However, in a digital business world, security cannot be a roadblock that stops all progress. Organizations will increasingly recognize that it is not possible to provide a 100 percent secured environment. Once organizations acknowledge that, they can begin to apply more-**sophisticated** risk assessment and mitigation tools.

On the technical side, recognition that perimeter defence is inadequate and applications need to take a more active role in security gives rise to a new multifaceted approach. Security-aware application design, dynamic and static application security testing, and runtime application self-protection combined with active context-aware and adaptive access controls are all needed in today's dangerous digital world. This will lead to new models of building security directly into applications. Perimeters and firewalls are no longer enough; every app needs to be self-aware and self-protecting.

Road Ahead

India’s aviation industry is largely untapped with huge growth opportunities, considering that air transport is still expensive for majority of the country’s population, of which nearly 40 per cent is the upwardly mobile middle class. The industry stakeholders should engage and collaborate with policy makers to implement efficient and rational decisions that would boost India’s aviation industry. With the right policies and relentless focus on quality, cost and passenger interest, India would be well placed to achieve its vision of becoming the third-largest aviation market by 2020 and the largest by 2030.

There is significant potential to improve efficiency of operational practices in Aircraft Industry in India with the use of recent technological frame works in the total gamut of Aircraft Industry. This can be stated as the overall review of air traffic management, airport congestion, route optimization apart from Manufacture and Servicing of Aircraft and their Supply Chain management issues. Furthermore, a fragmented airspace is inefficient and automated technologies and procedures, based on satellite data-links as also proposed under Future Indian Air Navigation System (FIANS) Master Plan implementation needs to be expedited as a part of overall growth strategy.

Additionally, Knowledge accumulation and information diffusion in India has to be fostered among aviation stakeholders through collaborations and partnerships.

Finally, an integrated approach, which can be stated as the combination of 'supply side' comprising technology and operational practices, 'additional aspects' of business strategies and models, demand management, customer behaviour, air transport management, airport management, research management, and regional and industrial planning apart from Supply Chain Integration in Aircraft Manufacture and Maintenance.

Note: The Views and opinions expressed, conclusions drawn and critical analysis arrived at or any other ideas/ strategies in the above paper are of our own and do not reflect or represent the views of any of the organization.

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