Executive Summary

Survey of new industrial areas in India

Cross Functional Consulting Group

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NRI

Envision the value,
Empower the change

Executive Summary

Overview and Objective

Objectives

NEDO and **NRI** conducted a joint study on 4 technology areas – **Quantum Computing**, **Space & Aviation**, **Generative AI** and **Bio-manufacturing**. The study incorporates perspectives from key decision-makers and stakeholders across the Indian ecosystem in order to understand India's strength and opportunities. The study also presents **potential collaboration area between India and Japan** by assessing respective strength and weakness

Overview

Study Areas

A. Quantum Computing

B. Space & Aviation
   i. Space
   ii. Aviation

C. Generative AI

D. Bio Manufacturing
   i. Bio-Pharma
   ii. Bio-Fertilisers
   iii. Bio-Plastics

Aspects Studied

- Global and Indian Market Overview
- Indian Ecosystem - Players Participation
- Drivers and Challenges for the Technology
- Impact and Growth Potential

Technology Trends Analysis

Key Technology Trend: Specific technologies that are key contributors to the growth of the sector along with opportunities in Indo-Japan collaboration

Indian expert interviews: to identify key technology trends and to understand Indian landscape

Japanese expert interviews: to identify collaboration opportunity for Indian technologies

Evaluation of Tech Landscape

Indian Landscape:
- **Adoption Level**
- **Implementation Level**

Japanese Landscape:
- **Current Strengths**
- **Future Plans and Role of India in it**

Collaboration Clusters

- **Cluster 1:** Opportunity for Japanese players to leverage Indian expertise in Japan & India market & market entry opportunity for Japanese players
- **Cluster 2:** Opportunity for Japanese players to enter in Indian market (if available product) and co-develop products
- **Cluster 3:** Opportunity to collaborate with a university/long term collaboration for IP/human resource development
- **Cluster 4:** Help addressing the cause for low adoption and Opportunity for Japanese players to leverage Indian expertise in Japan market

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Executive Summary

A. Quantum Computing

⦿ High	○ Medium	△ Low

Study focus area: Across the value chain

Market size Global Market is around **USD 9.27 Bn** and expected to grow to **~USD 26.17 Bn by 2030**. India is expected to contribute **~USD 350 Mn.** by 2030

Key sectors **Energy, Chemicals, Healthcare and BFSI** are expected to be the top adopters of Quantum Computing by 2030

Growth Drivers	Challenges
• Start-ups in quantum computing	• Low enterprise adoption
• Collaboration between academia and industry	• Limited quantum simulators
• Growing awareness among key industry players	• Limited skilled resource

Key players (Non-Exhaustive)

Private org.	Startups	Research org.	Govt. org
HCL Technologies	BosonQ	C-DAC: Centre for Development of Advanced Computing	MeiTY: Ministry of Electronics and Information Technology
Infosys	Qkrishi		
Mphasis	QpiAI Tech	C-DOT: Centre for Development of Telematics	GKQCTP: Greater Karnavati Quantum Computing Technology Park
Tech Mahindra	Quanfluence		
…	…	…	..

Focus: Across the value chain except Quantum Comms.
Strength: Commercialisation and application solution
Weakness: Infrastructural support for software development

Key Technology Trend	Adoption	Implementation
Processors	△	△
Ion Traps	△	○
Photonics and Optics	○	○
Topological Qubits	△	△
Super-Conducting Qubits	⦿	○
Cryogenics	△	△
Annealing	○	△
Commercialisation	⦿	○

Cluster #	Tech Trends Identified for Indo-Japan Collaboration
1	• Super-Conducting Qubits • Commercialization
2	• Photonics & Optics • Annealing
3	• Processors • Qubit Technologies • Cryogenics
4	• Ion Traps

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Executive Summary

B. Space & Aviation | i. Aviation

⦿ High	○ Medium	△ Low

Study focus area: R&D and Sustainable Aviation Fuel

Market size

Global Market is at ~**USD 2.04 Bn.** and is expected grow to ~**USD 31.85 Bn**. India is currently at ~**USD 60 Mn.** and is expected to reach ~**USD 970 Mn. by 2030**

Key sectors

This sector is led by **commercial and military** applications with brands like **Mahindra, Tata** and **DRDO** etc. contributing significantly to this field

Growth Drivers	Challenges
• Passenger awareness regarding sustainability	• Lack of raw materials for Sustainable Aviation Fuel (SAF)
• Secure feedstock and readily available technology	• Procedural delays in approval for certification
• International Air Transport Authority (IATA) driving Sustainable Aviation	• Challenges in aircraft electrification

Key players (Non-Exhaustive)

Private org.	Startups	Research org.	Govt. org
Dynamatic Technologies	Biezel Green Energy	ADE: Aeronautical Development Establishment	ADA: Aeronautical Development
MAPL: Mahindra Aerospace Private	BON V Technology		
Praj Industries	Eplane company	GTRE: Gas Turbine Research Establishment	Bharat Petroleum
…	…	…	..

Focus: R&D and Sustainable Aviation Fuel

Strength: Strong availability of selected technologies for generating SAF

Weakness: R&D and raw material availability

Key Technology Trend	Adoption	Implementation
Hydrogen Propulsion	△	△
Electric Propulsion	○	△
Gas Turbine Engines	△	△
Solid State Batteries	△	△
Advanced Engines	△	○
Power to Liquid	○	⦿
Alcohol to Jet	○	○
High Efficiency Motors	△	△
Fischer Tropsch via Biomass	○	△
Hydrotreated Esters and Fatty Acids (HEFA)	⦿	△
Airplane design and structure	△	△
Composite Materials	△	△

Cluster #	Tech Trends Identified for Indo-Japan Collaboration
1	• Alcohol-to-Jet
2	• Advanced Engines • Power-to-Liquid • HEFA
3	• Hydrogen Propulsion • Electric Propulsion • Gas Turbine • SS Batteries • High-Efficiency Motors • Fischer Tropsch • Airplane Design and Structure • Composite Materials

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B. Space & Aviation | ii. Space

⦿ High	○ Medium	△ Low

Study focus area: Heavy & small launch vehicles and applications areas around remote sensing, GPS and satellite communications

Market size: Globally ~**USD 656 Bn.** overall, is expected to be ~**USD 1616 Bn.** by 2030. Indian market is about ~**USD 33 Bn.** currently and is expected to be ~**USD 354 Bn.** by 2030

Indian service market: Indian space launch service is expected to be ~**USD 270 Mn.** for commercial usage and ~**USD 1.50 Bn.** for government and military usage

Growth Drivers	Challenges
• Innovation and independence to private sector	• Limited independent launch solutions
• Growth in internet connectivity	• Limited conduct trial facilities
• Increase in application area	• Limited talent in space sector

Key players (Non-Exhaustive)

Private org.	Startups	Research org.	Govt. org
Ananth Technologies	AgniKul	IIST: Indian Institute of Space Science and Technology	ISRO: Indian Space Research Organisation
Centum Electronics Ltd.	Astrome Technologies		
Larsen & Toubro (L&T)	Bellatrix Aerospace	IITK: Indian Institute of Technology Kanpur	SAC: Satellite Applications Centre
…	…	…	..

Focus: Heavy and Small Launch Vehicles and Applications

Strength: Strong software and infrastructure

Weakness: Sensor for remote sensing, low participation from start-ups and private bodies

Key Technology Trend	Adoption	Implementation
Reusable Launch Vehicles	△	△
Remote Sensor Development	△	○
Advanced Engine Systems	○	○
Payload Management Systems	⦿	⦿
Launch Vehicles	⦿	⦿
3D Printed Launch Vehicles	△	△
Systems Automation	○	○
Advanced Materials	○	○
GPS Aided Navigation	○	⦿
Satellite Search and Rescue	○	⦿
Disaster Management Support	⦿	⦿

Cluster #	Tech Trends Identified for Indo-Japan Collaboration
1	• Remote Sensor Development • Advanced Engine Systems • Payload Management • Launch Vehicles • Systems Automation • Advanced Materials • GPS-Aided Navigation • Satellite aided search & rescue • Disaster management support
3	• Reusable Launch Vehicles • 3D Printed Launch Vehicles

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Executive Summary

C. Generative AI

⦿ High	○ Medium	△ Low

Study focus area: Across the value chain

Market size

Global Market at present is ~**USD 17 Bn.** and is expected to be ~**USD 109 Bn.** by 2030. India is currently contributing ~**USD 1.1 Bn.** and expected to be ~**USD 7.6 Bn** by 2030

Leading sectors

Leading industries that are expected to utilise GenAI technology- **IT&Telecom, BFSI, Healthcare, Automotive**

Growth Drivers	Challenges
• Lower cost of applications	• Limited data & governance framework
• Growing Internet economy	• Limited funding
• Increasing demand for IT clients	• Limited talent in AI research

Key players (Non-Exhaustive)

Private org.	Startups	Research org.	Govt. org
TCS	Beatoven.AI	IIT Bombay	MEITY
Tech Mahindra	Blend	IIT Delhi	
Wipro	Codemate	IIT Madras	
Reliance Jio	brahmGAN	IIT Guwahati	
…	…	…	

Focus: Gen AI value chain except training infrastructure

Strength: Creating application on Gen AI and LLMOPs (existing expertise)

Weakness: LLM (Large Language Model) research

Key Technology Trend	Adoption	Implementation
Ethical AI	△	○
RAG	△	⦿
Verticalisation	△	⦿
Multi modal models	○	△
Trust layer	△	△
Data localisation	△	○
Cloud integration	○	○
Generative design	△	△
Bots in workforce	△	△

Cluster #	Tech Trends Identified for Indo-Japan Collaboration
1	• Cloud integration
2	• Multi modal models
3	• Trust layer • Generative design • Bots in workforce
4	• Ethical AI • RAG • Verticalisation • Data localization

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D. Bio-manufacturing | i. Bio-Pharma

⦿ High	○ Medium	△ Low

Study focus area: Across the value chain

Market size: Globally the market is ~**USD 517 Bn.** and is expected to be ~**USD 652 Bn.** by 2027. Indian market is at ~**USD 24.8 Bn.** and is expected to be ~**USD 35.3 Bn.** by 2027

Growth rate: Indian pharma bio-manufacturing market is expected to grow at ~**13%** which is higher than the global average **of ~8%**

Growth Drivers	Challenges
• Rising chronic diseases	• Limited infrastructure
• Rising income & increased healthcare spending	• Quality concern, particularly for imports
• Govt. initiatives	• Raw material dependence

Key players (Non-Exhaustive)

Private org.	Startups	Research org.	Govt. org
Bharat serums & vaccines	Eyestem	ICMR (Indian Council of Medical Research)	BIRAC*
Biocon	ImmunoACT		BIBCOL (Bharat Immunological & Biological Corp)
Dr. Reddy's Lab	Zumutor	JNCASR (Jawaharlal Nehru center for advanced scientific research)	
Enzene biosciences	Bugworks		Hindustan Antibiotics Ltd
…	…	…	..

Focus Area: Across the value chain

Strength: Manufacturing and R&D is a strength to cater to local market

Weakness: Raw material supply is relatively a area of weakness due to dependence on foreign imports

Key Technology Trend	Adoption	Implementation
Genomics & personalized medicine	△	○
Cell and gene therapy	○	○
Bio-printing and tissue engineering	△	△
Immunotherapy	⦿	⦿
Monoclonal antibodies	⦿	⦿
mRNA	○	○
Continuous manufacturing	⦿	⦿

Cluster #	Tech Trends Identified for Indo-Japan Collaboration
1	• Cell & gene therapy • Immunotherapy advancements • Monoclonal antibodies • Continuous manufacturing
3	• Genomics and personalized medicine • Bio-printing and tissue engineering
4	• mRNA

*BIRAC - Biotechnology Industry Research Assistance Council

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D. Bio-manufacturing | ii. Bio-fertilisers

⦿ High	○ Medium	△ Low

Study focus area: Across the value chain

Market size Globally it is around ~**USD 8.8 Bn.** and is expected to be ~**USD 13.27 Bn.** by 2027; Indian market is at ~**USD 543 Mn.** and is expected to be ~**USD 838 Mn.** by 2027

Growth rate Indian bio-fertilizers market is expected to grow at ~**16%**, similar to the historical growth rate

Growth Drivers	Challenges
• Increased demand for organic produce	• High target specificity & cost
• Increasing awareness about farming practises	• Competition from chemical counterparts
• Govt. initiatives	• Low current awareness & usage

Key players (Non-Exhaustive)

Private org.	Startups	Research org.	Govt. org
Biostadt India	Cytolife agritech	Indian Council of Agricultural Research	BIRAC*
Coromandel International			Gujrat state fertilisers
IFFCO (Indian Farmers Fertilizer Cooperative Limited)	Samarth Biotech	Indian Agricultural Research Institute	NCOF (National Center for Organic Farming)
…	…	…	…

Focus area: Across the value chain

Strength: Manufacturing is a strength to cater to local market

Weakness: R&D and raw material supply are relatively areas of weakness

Key Technology Trend	Adoption	Implementation
Advanced formulations and strain improvements	△	⦿
Mixed inoculants	⦿	⦿
Biofilm fertilizers	○	△
Biostimulants & bio enhancers	⦿	⦿
Waste utilization	△	○
Smart delivery systems	○	○
Precision agriculture integration	○	○
Blockchain traceability	△	△

Cluster #	Tech Trends Identified for Indo-Japan Collaboration
1	• Mixed inoculants • Biostimulants & bio enhancers
2	• Biofilms fertilizers • Smart delivery systems
3	• Precision agriculture integration • Blockchain traceability
4	• Advanced formulations & strain improvements • Waste utilization

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D. Bio-manufacturing | iii. Bio-Plastics

⦿ High	○ Medium	△ Low

Study focus area: Across value chain

Growth Drivers	Challenges
• Increasing demand for bio-manufactured products	• Limited penetration in rural areas
• Abundance of biomass resources	• Higher cost and inferior properties than plastics
• Government initiatives	• Import of most of raw materials

Key players

Private org.	Startups	Research org.	Govt. org
Greendot Biopak	Symphony Polymers	Center of excellence in sustainable polymers - IIT Guwahati	BIRAC*
…	Zerocircle		
	Greendot		
	Resqpol	…	
	…		

Focus area: All across value chain
Strength: Manufacturing is current strength in India
Weakness: Raw material supply and R&D are current weakness

Key Technology Trend	Adoption	Implementation
Nanotech in bioplastics	△	○
Bioplastic films and coatings	○	⦿
3D printed bioplastics	○	⦿
Bio-based feed stock	△	⦿
Bioplastics recycling	△	⦿

Cluster #	Tech Trends Identified for Indo-Japan Collaboration
1	• Bioplastic films and coatings • 3D printed bioplastics
4	• Nanotech in bioplastics • Bio-based feed stocks • Bioplastics recycling

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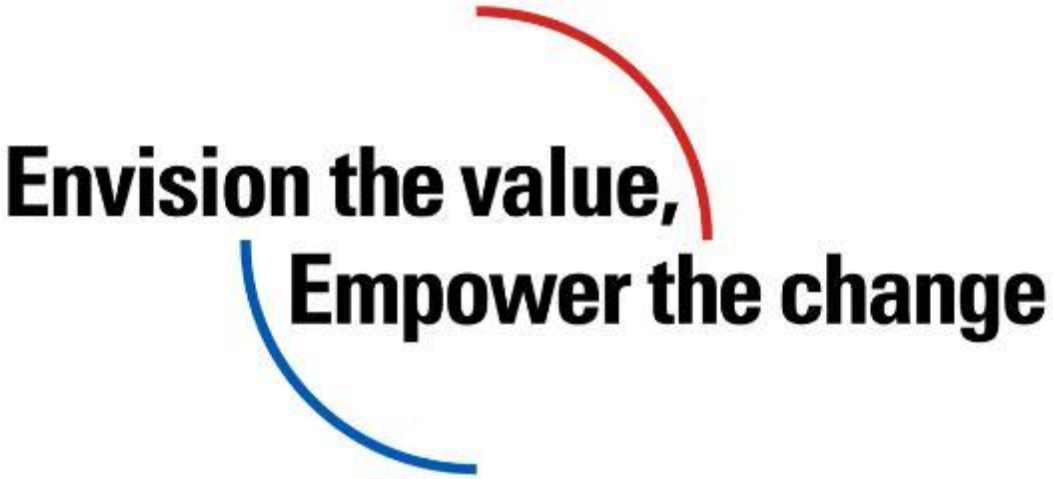
Envision the value,
Empower the change