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Science & Technology research for Industry Analysis in India: a Literature Review

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ABSTRACT: The paper aims to identify and explore the contributions to the literature available about trends in science and technology research in Indian industry at various levels. A deep search of literature was conceded out in an attempt to identify considerable works that have been published concerning various facets related to science and technology research in Indian industry. Varied search terms like "research", "research and research output", "science and technology research", "research collaboration", "industry analysis", "research in universities", "importance of science and technology", "issues in research", etc. were used for retrieving the literature from a range of online scholarly databases, search engines and allied web sources like ebsco, IBEF, etc. The deep scan of literature review reveals that a considerable amount of literature has been published related to science and technology research related to Indian industrial analysis. However, keeping in view vast advancements and innovations in science and technology, scholarly output is still in its emergent phase. It is apparent from the study of existing literature that there is still immense scope for advanced exploration on the topic and the study paves the way for the concerned organizations and institutions (like libraries, publishers and universities,) at national and international level to take substantial measures to boost research in the field of science and technology. This paper makes an endeavour to review the literature and provides a summary of emerging trends in science and technology research.

Keywords: Research, Industry analysis, Science and technology research, Collaborative research, University research, Research issues, Indian industry, Sciences.

I. INTRODUCTION

India ranks third among the most eye-catching investment destinations for modern technology transactions in the world. Modern India has had an intensive focus on science and technology, knowing that it is a key element of current economic growth. India is among the topmost countries in the world in the area of scientific research, positioned as one of the top five nations in the area of space exploration. India has much to be proud of last year; it became the first to reach Mars on its initial attempt. It boasts a thriving pharmaceutical industry that produces low-cost medications that are desperately needed by the developing world. In his first year in office, PM Modi launched an ambitious plan to make India a leader in solar power .The country has regularly undertaken space missions, including missions to the moon and the famed PSLV (Polar Satellite Launch Vehicle)...

Currently 27 satellites including 11 that facilitate to the country in communication network operational, establishing India's progress in the space technology domain. India is also likely to take a leading role in satellites launching for the SAARC nations; by offering its space facilities for use to other countries can give an opportunity to generating revenue.

But at the same time, such successes cannot hide the huge challenges facing this country of 1.3 billion people, which leads the world in tuberculosis incidence and maternal deaths, and lacks electricity for one-quarter of its citizens. India is expected to become the world's most populous nation within a generation, and it will require a robust science and technology sector to supply the needed energy, food, health care, jobs and growth. Yet researchers in India and abroad say that the country has a relatively weak foundation in science and engineering

Market size

India is among the world's top 10 nations in the number of scientific publications. Position-wise, it is ranked 17th in the number of citations received and 34th in the number of citations per paper across the field of science and technology (among nations publishing 50,000 or more papers). The country is ranked ninth globally in the number of scientific publications and 12th in the number of patents filed.

India's analytics industry is expected to touch US$ 16 billion by 2025 from the current US$ 2 billion, as per the National Association of Software and Services Companies (Nasscom).

With support from the government, considerable investment and development has incurred in different sectors such as agriculture, healthcare, space research, and nuclear power through scientific research. For instance, India is gradually becoming self-reliant in nuclear technology. Recently, the Kudankulam Nuclear Power Project Unit-1 (KKNPP 1) with 1,000 MW capacity was commissioned, while the Kudankulam Nuclear Power Project Unit-2 (KKNPP-2) with 1,000 MW capacity is under commissioning.

Recent developments

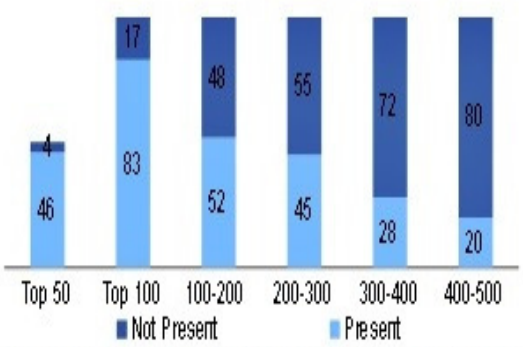
Some of the recent developments in the field of science and technology in India are as follows:

1. The Indian Space Research Organisation (ISRO) plans to launch 2 satellites in March and April 2017, which includes the satellite meant for the benefit of the South Asian Association for Regional Cooperation (SAARC) nations. ISRO also targets launch of second lunar mission Chandrayaan-2 in first quarter of 2018.
2. ISRO has launched a record high of 104 satellites in one go on a single rocket from Satish Dhawan Space Centre in Sriharikota, Andhra Pradesh.
3. ISRO has successfully placed remote sensing satellite RESOURCESAT-2A in orbit, to provide continuity to ISRO's three tier imaging data, which will be extremely useful for agricultural applications.
4. Magicbricks has launched India’s first real estate Experience Centre in Mumbai, which uses technologies such as virtual reality, augmented reality, and on-demand video-call to provide an intuitive experience in property purchase.
5. The Defense Research and Development Organisation (DRDO) has tied up with French engine maker Snecma to guide the Gas Turbine and Research Establishment (GTRE) to improve the performance of Kaveri engines being used in India’s indigenously developed Light Combat Aircraft (LCA) Tejas.
6. The Indian Space Research Organisation's (ISRO) Polar Satellite Launch Vehicle-C35 (PSLV-C35) has successfully placed eight different satellites in a single rocket mission, including SCATSAT-1 for weather related studies, five foreign satellites and two satellites from Indian academic institutes into orbit.
7. The Ministry of Environment, Forest and Climate Change (MoEFCC) has announced a research and development (R&D) initiative to develop next generation sustainable refrigerant technologies as alternatives to the currently used refrigerant gases like hydrofluorocarbons (HFCs), in order to mitigate its impact on the ozone layer and climate.
8. The Indian Space Research Organisation’s (ISRO) geosynchronous satellite launch vehicle-F05 (GSLV) successfully launched India's weather satellite INSAT-3DR into space, which will provide meteorological services and assist search and rescue operations of security agencies including all defence forces, the coast guard, and in shipping industry.
9. The Indian Space Research Organisation (ISRO) plans to partner with private firms to jointly build a navigation satellite that it would launch by March 2017, which would allow the space agency to free its resources to focus on research and deep space missions.
10. Indian Institute of Technology, Kharagpur (IIT-Kharagpur) and National Highways Authority of India (NHAI) have signed a memorandum of understanding (MoU) for research project to develop technology to construct maintenance free highways in India.
11. Intertek Group, a UK-based total quality assurance provider, has launched an Agricultural Technology (Agritech) laboratory in Hyderabad, which will perform high-tech Deoxyribonucleic Acid (DNA) analyses for the agri-biotech, plant seeds breeding, and plant seeds production industries.
12. The Indian Institute of Science (IISc) has discovered a breed of natural cures for cancer in Quercetin, a compound found in fruits and leaves, and plant VernoniaCondensata, which can significantly reduce the tumour size and increase the longevity of life.
13. The Indian Space Research Organisation (ISRO) has completed its mission of developing India's independent navigation system by launching Indian Regional Navigation Satellite System (IRNSS - 1G), the seventh and final navigation satellite, which will reduce the country's dependency on US Global Positioning System.
14. The Indian Space Research Organisation (ISRO) has signed a memorandum of

understanding (MoU) with the Airports Authority of India (AAI), aimed at providing space technology for construction of airports, which will help make flight operations safer and provide optimum utilisation of land.

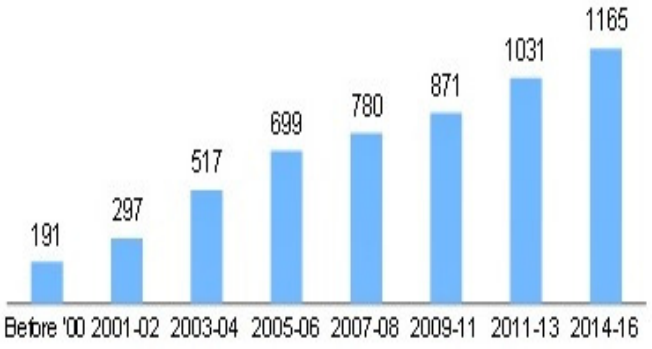
15. Indian and American delegations have discussed an arrangement for Space Situational Awareness (SSA), a programme for monitoring space environment and track potential hazards and security threats, and have set up a bilateral mechanism for sharing information for tracking movements of satellites, avoiding collisions and identifying potential threats to space and ground assets.
16. The Department of Space/ Indian Space Research Organisation (DOS/ISRO) and Kuwait Institute of Scientific Research (KISR) have signed a Memorandum of Understanding (MoU) on cooperation in the field of exploration and use of outer space.
17. The Indian Institute of Science (IISc), Bangalore has become the first Indian institution to enter the Top 100 universities ranking in engineering and technology.

Number of R&D Centres for Global 500 Companies, 2014



Source: FICCI, Department of Science & Technology, Zinnov, TechSci Research
Note: Figures mentioned are as per latest data available

Total Number of MNC R&D Centres in India



Source: FICCI, Department of Science & Technology, Zinnov, TechSci Research
Note: Figures mentioned are as per latest data available

Investment Scenario

1. Infosys Ltd has invested Rs 14.5 crore (Danish Krone 15.22 million) in a Danish artificial intelligence start-up called UNSILO, which specialises in advanced text analysis and has built a semantic search engine with best-in-class text intelligence.
2. NIDHI (National Initiative for Development and Harnessing Innovations), an umbrella program pioneered by the Department of Science & Technology (DST), has committed Rs 500 crore (US$ 75 million) to implement Prime Minister Narendra Modi's Startup India initiative, by providing technological solutions and nurturing ideas and innovations into successful startups.
3. InnoNano Research, a clean water technology company, has raised US$ 18 million from NanoHoldings, a US-based energy and water investment firm, which will be used to set up manufacturing facility, modern research laboratory and technology delivery offices across North America, Asia and Africa to make India an exporter of water technologies.
4. Ecoppia, an Israel-based developer of robotic cleaning technology for solar sites, has signed a deal with Sanmina Corporation, a US-based Original Equipment Manufacturer (OEM), to begin mass production of their E4 robots at a new facility near Chennai.
5. Saama Technologies Incorporation, the Big Data analytics solutions and services company, headquartered in the Silicon Valley, plans to invest US$ 2 million to create the largest pure play data science and analytics hub in India.
6. The Government aims to invest 2 per cent of the country's GDP on research and development (R&D) in its 12th Five-Year Plan period (2013–17). Accordingly, the Government has undertaken various measures for promoting growth of scientific research,

such as:Sustained increase in plan allocations for scientific departments

a. Setting up of new institutions for science education and research
b. Launch of new Science, Technology and Innovation Policy 2013
c. Creation of centres of excellence for research and facilities in emerging and frontline science and technology areas in academic and national institutes
d. Establishment of new and attractive fellowships
e. Strengthening infrastructure for R&D in universities
f. Encouraging public-private R&D partnerships
g. Recognition of R&D units
h. Fiscal incentives and support measures for enhancing industry participation in R&D

Government Initiatives

India and Israel have agreed to enhance the bilateral cooperation in science and technology in the next two years, under the aegis of the S&T agreement concluded in 1993, by providing US$ 1 million from each side to support new research and development (R&D) projects in the areas of big data analytics in healthcare and cyber security.

India has become an Associate Member State of the European Organisation for Nuclear Research (CERN), which will increase the collaboration between India and CERN's scientific and technological endeavours, and will increase participation of Indian physicists, software engineers and electronics hardware in global experiments.

Ms Nirmala Sitharaman, Minister of State with Independent Charge for the Ministry of Commerce & Industry, outlined plans of setting up a committee to examine and expeditiously implement measures to improve India's innovation landscape.

Dr Harsh Vardhan, Minister for Science and Technology and Earth Sciences, outlined Government of India's plans to pursue a green path to growth by doubling investment in clean energy research to US$ 145 million in the next five years from current investment of US$ 72 million.

The Department of Health Research (DHR), Ministry of Health and Family Welfare plans to set up a three-tier national network of Viral Research and Diagnostic Laboratories (VRDLs) under which 160 VRDLs will be set up with capability to handle around 30-35 viruses of public health importance.

The central government plans to soon institute a nation-wide consultation process with a view to develop the first publicly accessible Science and Technology policy. The policy 'Vision S&T 2020' would articulate the country's future towards self-reliance and technological independence in the 21st century.

The Union Cabinet gave "in principle" clearance for the location of a Laser Interferometer Gravitational-Wave Observatory (LIGO) facility in India which will be the third in the world and will be set up and managed by the IndIGO Consortium (Indian Initiative in Gravitational-wave Observations).

The Department of Biotechnology, Ministry of Science and Technology of the Government of India has become only the second country outside of Europe to join the European Molecular Biology Organisation (EMBO), which consists of 1,700 eminent scientists and 84 Nobel laureates, and aims to encourage research in the field of life sciences.

The National Highways Authority of India (NHAI) has signed a Memorandum of Understanding (MoU) with the National Remote Sensing Centre (NRSC) under Indian Space Research Organisation (ISRO) and North East Centre for Technology Application and Research (NECTAR) to use spatial technology such as satellite data to monitor and manage national highways.

National Council of Science Museums (NCSM), an autonomous organisation under the Union Ministry of Culture, is engaged in the establishment of Science Centres across the country. NCSM is developing a Science City at Guwahati, Assam, which would be handed over to the Government of Assam for future operations and maintenance. The organisation has received proposals from various state governments for setting up of such Science Cities. NCSM has undertaken the Science Centres/Cities projects in a phased manner depending on the availability of resources, project handling capacity of NCSM, and existing level of science centre activities in a particular state.

The Road Ahead

India is aggressively working towards establishing itself as a leader in industrialization and technological development. Significant developments in the nuclear energy sector are likely as India looks to expand its nuclear capacity. Moreover, nanotechnology is expected to transform the Indian pharmaceutical industry. The agriculture sector is also likely to undergo a major revamp, with the government investing heavily for the technology-driven Green Revolution. Also, several automobile manufacturers, from global majors such as Audi to Indian companies such as Maruti Suzuki and Mahindra & Mahindra, are exploring the possibilities of introducing driverless self-driven cars

for India. The Government of India, through the Science, Technology and Innovation (STI) Policy-2013, among other things, aspires to position India among the world's top five scientific powers.

India has a strong network of science & technology institutions and trained manpower. It has the third-largest scientific and technical manpower in the world with 162 universities awarding over 4,000 doctorates degrees and 35,000 post graduate degrees annually.

India is among the top-ranking countries in the field of basic research and ranks 12th in terms of the number of patents filed. India also ranks ninth globally in terms of the number of scientific publications.India has been strengthening its position in research through investment. India's R&D globalisation and services market is expected to reach US$ 38 billion by 2020. More than one-third of the top 1,000 global R&D spenders have centres in India. Going forward, India's investment in R&D sector is expected to rise from 0.8 per cent of Gross Domestic Product (GDP) to reach 2.4 per cent of GDP in 2034.

In recent years, the Government of India has implemented several fellowship schemes to nurture human capacity for advanced research in the country. The Government is also providing continued policy support in the form of Science, Technology & Innovation Policy 2013 and the Twelfth Five Year Plan (2012–17). Through Science, Technology and Innovation policy, the Government promotes mechanisms for nurturing technology business incubators and science led entrepreneurship. The Ministry of Earth Sciences, Government of India and Japan Agency for Marine-Earth Science and Technology (JAMSTEC) have signed a Memorandum of Understanding (MoU) for advancement of academic research in the field of Earth Sciences.

Furthermore, 2010–2020 has been declared the 'Decade of Innovation' to stimulate innovations and produce solutions for societal needs such as healthcare, energy, infrastructure, water and transportation.

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