Transforming Innovative Research into a Profitable Technology

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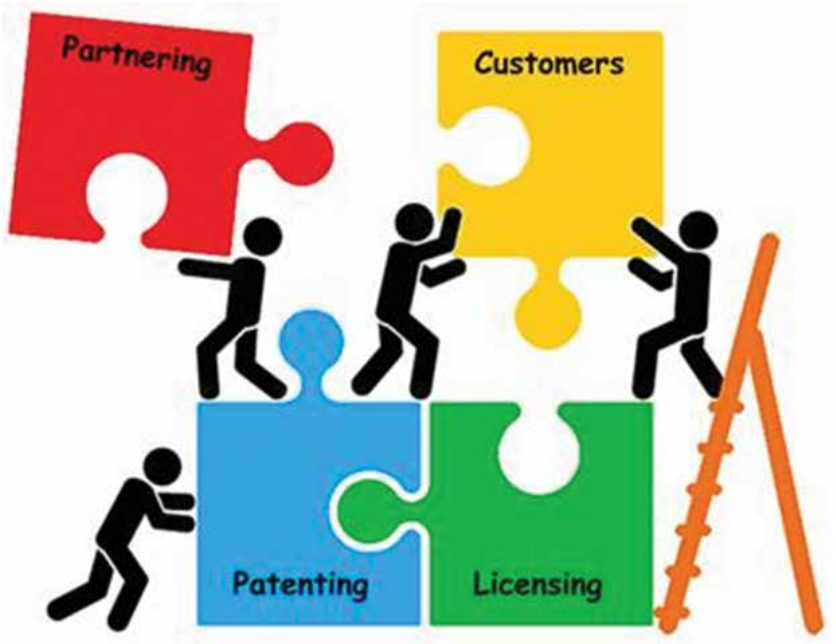
Innovation is always explored by academic scholars and organisations to identify its factors, features and often ends in producing unharmonious results. This article advocates research on innovation by systematically developing a structure of the innovation process. The conceptual progress, generation and implementation processes, experiences, and influences of innovation on organisations have been explained thoroughly in this article. Previous research work has been aligned with either one of the two components of the innovation process. However, this article deliberates each and every part of the innovation process to combine them in a single framework and discusses their contribution in generating diversified outputs. By developing an understanding of innovation as a process, this article aims to complement existing models of innovation to further extend and advance theory and research on the innovation process and outcome in organisations.

India's contribution to the total global research and development expenditure is about 2.8 per cent. In terms of its own GDP, in the past decade, India has nearly spent a consistent 0.6-0.7 per cent on research and development. This is in stark comparison to the United State of America's 2.8 per cent and Korea's 4.2 per cent. India has focused on the latter end of the TRL (Technology Readiness Level) scale. This is evident from a blooming startup ecosystem. It has still not been able to galvanise its S&T ecosystem to produce game-changing deep-tech technologies like the ARPANET or to take a more recent example, the language translation AI systems of the Chinese Baidu. One sector where India has done well is biotechnology. An indirect indicator of this is the world's largest vaccine manufacturer, the Serum Institute of India, which is based in Pune.

A key component for any nation's science and technology strategy is how it promotes technology transfer like it is done in other developed countries. So, to promote technology transfer, India can adopt numerous strategies that are used by these developed countries. In fact, India is already applying a few to varying degrees of success. The accelerating spread at which new technologies are coming up in a competitive environment world-wide, it makes it imperative that new ideas and technologies are



Pictorial representation of the Technology Commercialisation Puzzle

identified at their source in the scientific world, carried forward by technological innovation and piloted into commercial production.

Challenges in innovation and translating laboratory science to the market

In India, there is an urgent need to put systems and measures in place for efficient transfer of technology from the laboratory to the market and commercialise this technology. This would be the first step in harnessing the technology developed in our laboratories for the benefit of the larger economy. By offering products and services based on technological innovations, businesses can gain a long-term competitive edge, and, technology can provide the key to solving wide-ranging grassroots problems in India. In such a scenario, where the majority of the country's R&D activities are done by public research organisations, which are removed from the commercial arms of the economy, the need to translate that research into commercial products and services becomes imperative. The need to have mechanisms, policies and people who will facilitate effective technology commercialisation cannot be overlooked. Some of the challenges in innovation and translating laboratory science to the market are:

- **Mindset of researchers:** One of the main challenges research institutes face in translating laboratory science to products and services is the mindset of the researchers and scientists. Most scientists in India (or for that matter in most parts of the world) value blue-sky research over application-oriented research and are interested in publishing papers in a respected journal instead of patenting and commercialising their work.
- **Disconnect from societal problems:** Researchers, being away from the markets and the industry, do not work on social problems. Therefore, problems do not come to the notice of the scientists working in research institutions.
- **Finding the right people for technology commercialisation:** There is a huge gap in the demand and supply of professionals, to support commercialisation of technology. There is a big need / demand for professionals who have the right orientation and possess a problem solving approach such as IP lawyers, legal service providers in tech transfer, business plan writing, advisors in company formation, and other allied services.
- **Finding the money:** The next big challenge is finding the resources to showcase the developed technologies and once successful, finding seed funding for these technology startups.

Global best practices in technology development and commercialisation

While synergy between science and technology development is the first requisite to achieve success in commercialisation of technology in hi-tech areas, the second requisite is an organic

linkage between the laboratory developing the technology and industry acceptance. Technology transfer from public funded research institutions to industry happens in various ways. The research organisations have a special cell or department for liaison with the industry.

Germany's Fraunhofer model

Research institutes in Germany are categorised into institutes pursuing pure basic research, applied research, and solving challenges. The Helmholtz Association is Germany's largest scientific organisation. Helmholtz works with long-term goals in six fields of research – energy, earth and environment, health, aeronautics, space and transport, and matter.

Fraunhofer Society, founded in 1949, undertakes applied research that drives economic development and works for the wider benefit of society. With its clearly defined mission of application-oriented research and its focus on key technologies of relevance for the future, Fraunhofer society plays an important role in the German innovation process. At present a total of 72 institutes and research units operate under the umbrella of Fraunhofer-Gesellschaft. Each institute specialises in a particular field, cultivates its own market presence and manages its own budget. They are organised into eight Fraunhofer groups. Each group is devoted to a specific area of technology, thus bringing together institutes working in similar areas and thereby leading to increased collaboration and market presence.

The annual research budget of Fraunhofer-Gesellschaft amounted to 2.6 billion euros in 2018. Of this, 2.2 billion euros was generated through contract research. Around 70 per cent of the contract research revenue was obtained from contracts with the industry and from publicly financed researched projects. German federal and state governments funded around 30 per cent in the form of base funding in the ratio of 9:1. Accounting for about 85 per cent of business volume, contract research is the mainstay of Fraunhofer's business activities. Contract research includes research conducted on behalf of the industry, publicly funded projects and pre-competitive research finance with base funding. New project groups and research institutions generally receive funding from respective state governments for an initial period of five years.

Over the years, Fraunhofer-Gesellschaft has been a very successful model. One of the key features of this model is that these institutes generate maximum revenue themselves in the form of contract research and intellectual property rights (IPR). This leads to a constant partnership with the industries and the market and thus results in technology transfer from the laboratory to the market.

In India, the following practice of technology commercialisation based on the Fraunhofer model could be utilised.

- Create a new powerful autonomous society / institute / company with complete focus on applied research and development (technology from concept to commercialisation).
- Decide area of focus based on immediate and near-future needs of the Indian society. Create specialised scientific R&D institutes across India under this society.
- Set-up groups or alliances for collaboration of these institutes working in similar areas.
- Focus revenue models on profit generation through contract research with companies / industries and public institutions, and IPR.
- Have successful competent scientists, entrepreneurs, industrialists on board. Hire the best scientists, engineering and medical graduates from India and abroad.

Technical University Munich (TUM) model of Europe

TUM is among Europe's top university. TUM encourages the culture of entrepreneurship among its students, scholars, professors and alumni. One of the major objectives of TUM is to transform the findings of its top researchers into sustainable profits for the society. TUM has

undertaken a series of reforms since 1998 to transform itself into an entrepreneurial university.

Entrepreneurial spirit: TUM supports university graduates / researchers who have promising ideas for high-tech startups. It also provides advice on setting up a new company and prepares entrepreneurs for the challenges of the market.

Technology transfer: TUM actively markets the inventions of its researchers and students in various high-tech sectors. Each year, TUM concludes more than 6,000 cooperation agreements with the industry.

Entrepreneurial university: A strong sense of entrepreneurship is firmly embedded into TUM's culture.

The TUM Office for Research and Innovation (TUM ForTe) is the first point of contact and the central coordinating body for any form of cooperation between the business and research sectors, research funding support and technology transfer at TUM. It provides the following crucial support to budding entrepreneurs in the campus:

Startup advising team: Provides advice to scientists, researchers and students who want to start a business on an idea or technology they have developed.

Financing team: Helps to provide funding through application for various funding projects.

Patents and licensing team: Supports all TUM members who intend to apply for a patent to protect an interesting idea, a project under development or a finished product. The services include:

- Comprehensive advice on IPR
- Assessment of inventions to determine their patentability and industrial applicability
- Filing of a patent application and asserting patent rights
- Commercialisation of ideas and innovations

With its clear aim of applied research to solve major challenges faced by the society, it encourages entrepreneurship culture in its campus. A separate department / office has been set-up for technology transfer. This provides several services to the entrepreneurs within the campus, and acts as a starting point of contact for industrial partners. The following practice of TUM could be used for technology development and commercialisation in India.

- Redefine itself as an entrepreneurial university with an aim to provide technological solutions for immediate and near-future challenges facing the Indian society.
- Orient their R&D towards applied research and development of technologies from concept to commercialisation.
- Have a dedicated department with competent professionals providing services to entrepreneurs for technology commercialisation.
- Increase collaborations with industries in India and abroad. Provide solutions to industrial problems through R&D and generate revenue through contract research.
- Encourage entrepreneurship culture among scientists, researchers and students at the institute.

Good practices of technology commercialisation in India

After Independence, the Government established large public funded R&D institutions in the country. Prominent among them were the institutions established under the Council of Scientific and Industrial Research (CSIR) across the country for carrying out research activities aimed at solving the burning issues of the nascent manufacturing industries, both public and private in various sectors. In the subsequent years, a large repository of knowledge and innovations emanating from these R&D institutions required an organisational set-up to transfer them to the industry. Over the years, the Government established several organisations and agencies to address transfer of knowledge and innovations from public funded research organisations to the industry. Some of the prominent technology transfer

organisations established in the country along with their roles and achievements are briefly described below:

National Research Development Corporation (NRDC)

NRDC was established in 1953 by the Government of India, with the primary objective to promote, develop and commercialise the technologies / know-how / inventions / patents / processes emanating from various national R&D institutions / universities. It is presently working under the administrative control of the Department of Scientific & Industrial Research, Ministry of Science & Technology, Government of India.

During the past six decades of its existence and in pursuance of its corporate goals, NRDC has forged strong links with the scientific and industrial community in India and abroad. It has developed a wide network of research institutions, academia and industry and made formal arrangements with them for the commercialisation of know-how developed in their laboratories. It is now recognised as a large repository of a wide range of technologies spread over almost all areas of industries, viz. agriculture and agro-processing, chemicals including pesticides, drugs and pharmaceuticals, bio-technology, metallurgy, electronics and instrumentation, building materials, mechanical, electrical and electronics, etc.

Since its establishment in 1953, NRDC has concluded more than 5,000 license agreements for the licensing of indigenously developed technologies to the Indian industries. This activity has facilitated the establishment of a large number of small and medium scale industries in the country. Besides being the torch bearer in the field of technology transfer, NRDC also undertakes a number of activities under its structured promotional programme for encouragement and advancement of research, promotion of inventions and innovations such as meritorious inventions awards, techno-commercial support, technical and financial assistance for IPR protection, value addition services and support for further development of technologies and much more.

NRDC has also successfully exported technologies and services to both the developed as well as the developing countries. NRDC is recognised, particularly in the developing countries, as the source of reliable appropriate technology, machines and services, which are typically suitable for these countries.

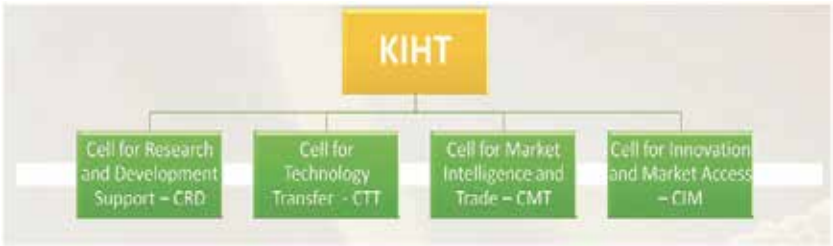
Kalam Institute of Health Technology (KIHT)

Kalam Institute of Health Technology (KIHT) is a Government of India (GoI) project that was founded in 2017 with the support of Department of Biotechnology (DBT). KIHT provides the much-needed back-end support of the Make in India initiative for medical devices in the country. KIHT was notified as the Project Analysis Unit for all health technology projects in the country by the office of the Principal Scientific Advisor (PSA) in June 2018. The main objectives of KIHT are:

- Identification of key technology gaps, which could be identified for supporting the Department of Biotechnology to provide support for R&D for focused development of medical technologies; and
- Undertaking technology transfer of available technologies from the academia and research institutes to the industry.

The PSA to the GoI acts as the President of the Society and the Governing Council is headed by the Secretary, DBT, GoI. The Governing Body has a mix of representatives from the government, technical experts, academicians and medical device industry.

- Cell for Research and Development Support (CRD) facilitates focused and target-oriented R&D by institutions based on market and industrial demands.
- Cell for Technology Transfer (CTT) facilitates technology transfer of innovations from academia, research institutes, innovators, startups, etc. to the manufacturing industry through e-auction.
- Cell for Market Intelligence



KIHT has formed four cells for smooth and efficient functioning of the institution.

and Trade (CMT) analyses data related to international trade, FDIs, and mergers and acquisitions (M&A).

- Cell for Innovation & Market Access (CIM) provides services for health technology assessment (HTA), knowledge for Indian manufacturers in consonance with the regulations worldwide.

Office of Technology Transfer @ C-CAMP

Findings from research laboratories often remain within the confines of publications and it is important to enable the findings to impact society in positive ways. By harnessing inventions that have commercial and societal value, securing their intellectual potential and disseminating them through chosen development partners who can make them commercially viable, the Office of Technology Transfer (OTT) aims to contribute to regional economic development, generate revenue-streams for inventors and their institutions and promote economic well-being of the masses.

OTT at C-CAMP (Centre for Cellular and Molecular Platforms, Bengaluru) established with the support of the National Biopharma Mission has a mandate to move innovations and discoveries from laboratories to the marketplace for greater societal benefit. OTT bridges the research community with industry and startups through strategic evaluation, protection and licensing of innovations so as to enable excellent science and entrepreneurship to complement each other.

Services offered includes patentability assessment, drafting and filing patent applications, prior art search, patent mapping, freedom to operate analysis, out-licensing invention, technology sourcing, in-licensing, technology transfer, collaboration with academic labs for PoC/validations or scale-up, linkages with other OTTs for joint licensing of technologies, etc.

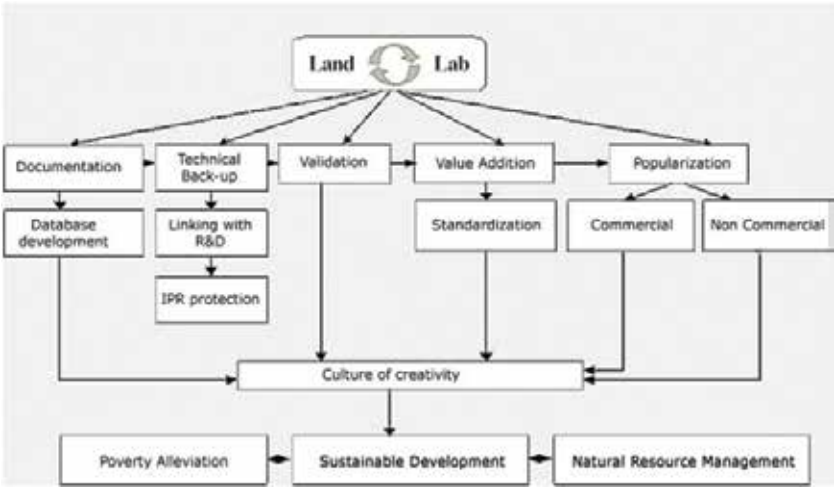
Other Indian Technology Commercialisation Organisations (TCO)

- Antrix of Indian Space Research Organisation (ISRO)
- Technology Licensing Cell (TLC) of Bhabha Atomic Research Centre
- Biotech Consortium India Limited (BCIL).
- C-Tech of Defence Research and Development Organisation (DRDO)
- Centre for Scientific and Industrial Consultancy (CSIC) of Indian Institute of Science
- Foundation for Innovation and Technology Transfer (FITT) of Indian Institute of Technology, Delhi
- Industrial Research & Consultancy Centre (IRCC) of Indian Institute of Technology, Bombay
- Sponsored Research and Industrial Consultancy (SRIC) of Indian Institute Technology, Kharagpur

Mechanism of technology transfer: A case study

Usually all the incoming technologies undergo a preliminary evaluation at the TCOs by the in-house engineers. Entrepreneurs are provided information on the availability of knowledge for commercial exploitation through advertisements, publications and get-togethers. Recently, the TCOs started a knowledge management scheme in which all technology inflows are screened by experts in the area and value addition is made for better package deals.

Value addition in the technology developed by the TCOs: The commercialisation of unproven lab scale technologies involves high risk. Therefore, entrepreneurs are generally not keen on undertaking a venture



Mechanism for technology commercialisation

based on such technologies. The TCOs, therefore, undertook several programmes to promote these indigenous technologies. Many such technologies have been developed through support from the corporation either through equity participation or developmental loans or grants. This calls for proper evaluation of the technologies assigned to the organisation and value addition to make a complete technology package for the entrepreneur / industry so that setting up a commercial plant becomes easier and the chances of success become high.

Market surveys: This is the key factor in getting an advantage over competitors in the market. The survey provides important information required to identify and analyse the market need, size and competition. Industry analysis and business research is helpful in making a decision to launch new products in the market. To make the technology package complete, the organisation carries out not only in-house market survey studies but also engages outside consultants.

Actual transfer of technology: This takes place after a legal agreement is executed by the client and TCOs. This agreement supports certain initial payment and also royalty at a fixed percentage of sales value for a specified period. It also provides for mutual exchange of information during the tenure of the agreement thus making available to the licensee any improvements in the technology during the contract period.

The technologies available with the TCOs for commercial exploitation cover a wide range of sectors, which includes drugs and pharmaceuticals, machinery, pesticides and herbicides, plasticisers, resins, electrochemical products and metallurgy, paints and varnishes, leather chemicals and auxiliaries, food technology, electrical, electronics and instruments, building materials, glass and ceramics, agro-based products, etc.

Trends in technology transfer: These disciplines have been passing through a cycle. Mechanical technology was appropriate for a decade in the 1950s and chemical discipline technologies in the 1960s. Later, it was import substitution and reverse engineering till the economic liberalisation in the 1990s. At present, life science and biotechnology related technologies are prominent. Some successful technologies from the 1960s onward are Amul baby food, pesticides, surgical sutures, drugs, cinema arc carbon, blood bags, heart valve, etc. Now some of the successful technologies are vaccines for cattle, biotechnology based drugs, etc.

In short, technology transfer and the commercialisation process of the Indian system is that the S&T ecosystem can develop and adhere to the following SoPs to standardise the transfer of technology from the laboratory to the market in a systematic and efficient manner. The SoPs are:

- Making a formal offer for entering into a Memorandum of Agreement (MoA) with the R&D organization for transfer of technology.
- Signing of the MoA with the R&D organisation after getting the MoA approved from both parties.
- Details of each technology are provided by the R&D organization in the technology acquisition format.
- Assessment of the technology for its commercial potential

and suggesting measures for taking suitable IP protection.

- Conducting market survey and / market analysis of the process / product for its techno-economic feasibility / viability, basic engineering design package.
- Preparing tech profiles on each technology assigned giving non-critical information for publication and communicating with the target industries.
- Inviting prospective industries / licensees for discussion on licensing the technology, and scientists / researchers from R&D organisations who are also involved in this discussion.
- Finalising technology transfer terms and conditions in consultation with the R&D organisation (inventor), approved by the respective organisations.
- Bidding or auction of the technology.
- The normal terms and conditions for licensing technologies can be as follows:
    - Lump sum premium (upfront technology fee paid by industry before release of know-how)
    - Recurring royalty (%) on ex-factory sales
    - Period of license
    - Nature of license (Exclusive / non-exclusive / limited exclusive)
    - Formally offering the technology to industry / licensee and communicating transfer terms and conditions
- Requesting the R&D organisation to provide demonstration and training of the process and release the technical know-how document to the industry / licensee.
- Demonstrating know-how to the industry / licensee by the R&D organisation on as-is-where-is basis
- Providing data on plant layout, specification of plant, machinery, chemicals, suppliers, etc.
- Providing data dossier pertaining to tests and trials.
- Providing details on the requirement of manpower and utilities, and the techno-economics of production at the scale developed, etc.
- Providing details on hazard management, pollution control, mandatory clearances, etc.
- Disbursing the share of lump sum premium and royalties for various technologies remitted by industries / licensees to the R&D organisation.
- Handing over the know-how documents after the release of technology i.e., training and demonstration of the workability of the technology to the licensee by the R&D organisation
- Review of payment of annuities for maintenance of the patents for technologies assigned and commercialised.

Strategies to promote development of technologies

To promote the development of indigenous innovative products and technologies in India, it is important to carry out the following measures.

Support to inventors: The S&T ecosystem will have to stimulate the spirit of inventiveness and innovation not only among scientific and technical personnel and industrial workers but also amongst craftsmen, artisans and the emerging youth in the community. The following incentives can help harness their creative talent for the benefit of the nation.

- Prize awards for meritorious inventions
- Assistance for patenting inventive ideas of R&D organisations and universities both in India and abroad
- Assistance to inventors to commercialise their patented inventions
- Cash awards under various categories and certificates to inventors by way of recognition of meritorious work. The awards can be announced every year for meritorious inventions. We can also help inventors in arranging the commercial exploitation of their patented inventions.

Reaching out to rural India

Rural India with its urgent

need for technological inputs provides a vast market for new agricultural processes and services. The S&T ecosystem will need to promote technologies that are particularly suited to the local needs. Examples of these include, the agro-waste utilisation paint derived from the latex of Euphorbia plants, the mud block making machine, the use of blue-green algae for nitrogen fixation and farm soil enrichment, etc. Efforts are being made to provide safe drinking water, low cost housing, sanitation, better agricultural implements and post-harvest technologies, solar pumps, heaters, solar cookers and solar dryers, cement from paddy husk ash and employment by utilising farm waste. The S&T ecosystem should explore opportunities to supplement these efforts. It can also set-up rural technology demonstration-cum-training centres in various parts of the country to give hands-on training and demonstrations to artisans and technicians living in rural areas.

The sourcing of technologies

India has an extensive network of about 2500 R&D institutions. They are mostly government supported. These institutions cover virtually every branch of research and technology ranging from paleobotany to space exploration. The institutions in this network are the primary sources of marketable technologies. In pursuance of its goals, the S&T ecosystem should forge links with and between the scientific and industrial communities in India and abroad. It should have formal arrangements with many of the major R&D organisations in the country for the commercialisation of know-how developed in their laboratories. It should also continue efforts in strengthening the industry-academia partnerships of various organisations and academic institutions from India and abroad, and for propagation of the country's technological capabilities in wide-ranging sectors and applications. In short, the S&T ecosystem can act as a window for:

- Information on the latest technologies developed around the world, particularly in India
- An objective assessment of the commercial potential of inventions
- National and international patenting
- Identification of potential manufacturers
- Negotiation of licensing agreements
- Legal back-up for royalty collection
- Share in license income and other unexpected gains
- IPR consultancy to firms, R&D institute, etc.
- Awarding meritorious inventions

Disseminating information about Indian innovation and technologies

As a service organisation, the S&T ecosystem will need to constantly endeavour to encourage inventive talent in the country. It will also need to promote development and utilisation of the results of indigenous research to accelerate the technological and economic self-reliance of the nation. To achieve this, it will need to bring out publications to promote the technologies by disseminating information through them. These will include but not be limited to:

- Science, technology and innovation magazines providing information on the latest trends in science and technology to entrepreneurs, scientists, technologists, industrialists, inventors, students and the public.
- Publications brought out periodically, containing lists of available classified processes based on the various disciplines of technology.
- Pamphlets and booklets brought out on selected and successful technologies from time-to-time.

To create awareness on the range of technologies and services that are available in India, the members of the S&T ecosystem will have to keep themselves abreast by participating in exhibitions, seminars, workshops and entrepreneurship development programmes, both in India and abroad.

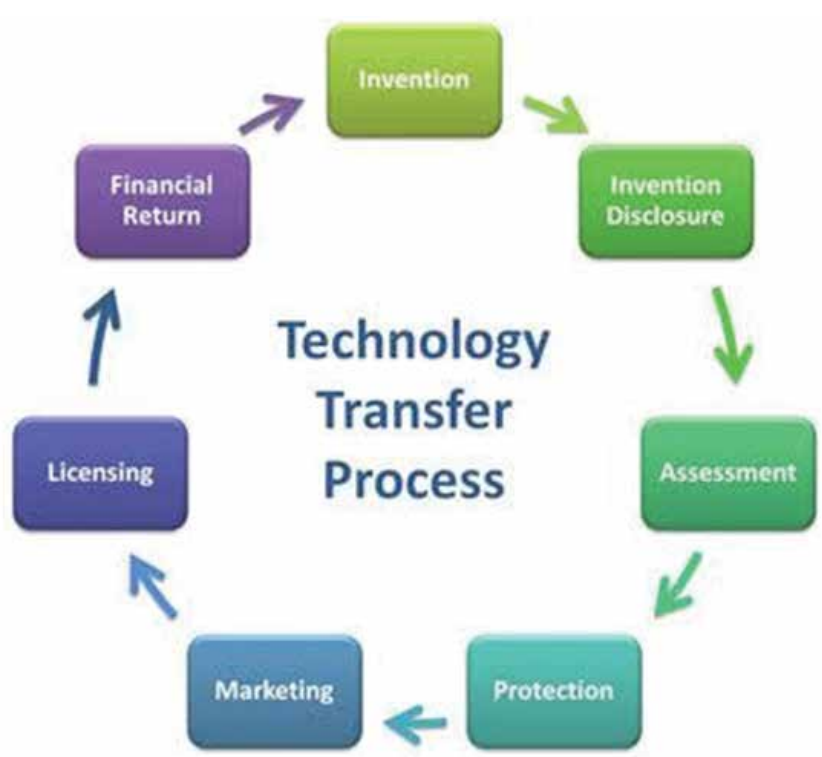
Strategies to commercialise technologies

To promote the products and technologies targeted for commercialisation, the S&T ecosystem needs to engage in the following activities.

- Providing grants to R&D laboratories for development of technologies and setting up pilot plants to validate or scale-up laboratory processes prior to commercialisation.
- Promoting and commercialising inventions by awarding meritorious inventions, assisting innovators and inventors in patenting and commercialising their inventions and popularising science highlighting inventions by publishing them in various magazines.
- Promoting and developing grassroots and rural technologies in line with the current priorities of DST, DBT, CSIR, ICAR labs, etc. by identifying, proving and demonstrating selected rural and grassroots technologies, and assisting in commercialisation of selected rural and household technologies.
- Promoting export of technologies by projecting India as a source of technology, preparing publicity material giving information about the technologies suitable for export, preparing feasibility reports and basic engineering design packages for information on technology transfer, organising training programmes related to technology development and transfer, participating in exhibitions, publishing periodicals, arranging audio-visuals to popularise indigenous technologies, both at home and abroad.
- Technical evaluation of the innovations / technologies.
- Participating in equity of early stage ventures.
- Providing IPR consultancy to R&D institutes and corporates.
- Facilitating export of Indian technologies / know-how and services.
- Executing turnkey projects abroad based on indigenous technologies.
- Value-adding technologies in terms of market survey, basic engineering design, etc.
- Licensing of technologies to companies and end user organisations.

The following best practices could also be adopted by India to encourage the R&D institutions for development of industry-ready technologies.

- Encouraging and incentivising Indian institutions to acquire and maintain an active relationship with international organisations like WIPO, IEEE, etc. to indirectly keep them in the loop of the latest R&D efforts.
- Forming a strong link between the private and public sector that can drive transfer of developed technologies to the industries in India, and



compete with, and perhaps even buy out foreign rivals, thereby pushing for reverse engineering of foreign technologies.

- Attracting diaspora talent back is a viable indirect measure to bring back research and development capabilities into the country from developed nations. Converting 'brain drain' to 'brain circulation', as is done by China, which allows for easy movement of its own skilled labour and remittance of money across its borders.
- Incentivising foreign R&D organisations to set-up centres in India by providing them with R&D tax credits. This could be a methodology worth pursuing to attract foreign technology in India. With such set-ups in India hiring and training local talent, foreign technologies and practices would invariably sweep into the nation. India can also consider deploying government schemes and subsidies in specific sectors to encourage small businesses to import and absorb foreign technologies.
- Formulate policy measures, which push global companies to transfer technology for hi-tech purchases and build local manufacturing capabilities and intellectual property. For example, the Ministry of Defence is already doing this. It has an offset policy for all capital purchases made from a foreign buyer, who are contractually obligated to offset around 30 per cent of the acquisitions cost in terms of transfer of technology or indigenous manufacture of components.
- Treaties like the India US Defense Tech Transfer Pact signed in 2019 are more direct measures for technology transfer into India. Other examples of this include the tech transfer component built in the purchase of tanks from Russia as well as tech transfer agreements with Malaysia for the oil palm industry.
- Last but not the least, FDI is a powerful, if not overused tool for attracting technology transfer into the country. The noteworthy sectors for this instrument are software development, auto design and pharmaceuticals.

Major recommendations for technology development and commercialisation

The S&T ecosystem should work towards encouragement and advancement of research, promotion of inventions and innovations, techno-commercial support, assistance for IPR protection, value addition services and support for further development of technologies and much more. It should also work on exporting technologies and services to both developed as well as the developing countries to be recognised as the source of reliable appropriate technology, machines, and services. Some policy suggestions for encouraging R&D laboratories to proactively transform innovative research into a profitable technology are:

- Mapping research outcomes from R&D projects supported by various R&D institutions / departments and making efforts to translate their research outcomes into technologies / products.
- R&D ministries / departments supporting projects in TRL 4 and 5 (project from prototype to product development), which is the valley of death for technology commercialisation process in addition to the projects at TRL 1-3 and TRL 6-7.
- Setting up value addition centres across the country to make the products emanating from R&D institutions marketable. These should have scientists with a marketing / business background.
- Establishing a national technology portal make all the technology developed in the country available on the same platform. This will make it easy for ministries / entrepreneurs to take their technologies to the market.
- Encouraging the mobility of scientists to industry and vice versa for short durations so that action linkages between academia / research institutions and industries can be developed to take the product from the laboratory to the market.
- Technology to be developed should be demand driven and should provide low-cost

solutions to the existing public problems.

- Developing an ecosystem that supports startups in making business plans, getting connected to the right mentors, rising business, etc.
- Facilitating entrepreneurs to collaborate with local researchers, educators and industry leaders to achieve new levels of competitiveness.
- Creating a new powerful autonomous society / company to focus on technology from concept to commercialisation.
- There should be a clear distinction between applied research and pure fundamental research so that applied research institutions totally focus on providing technology solutions to innovative challenges being faced by the society.

Conclusion

To pursue the dreams of making India the 'Innovative Capital of the World', the enterprise needs to realign itself and develop and commercialise the technologies, processes, etc. emanating from the various national R&D institutions / universities. India's scientific community has to forge strong links with the scientific and industrial community in India and abroad and develop a wide network of research institutions, academia and industry for the commercialisation of know-how developed in R&D laboratories. They have to get recognised as a large repository of a wide range of technologies spread over almost all areas of industries, viz. agriculture and agro-processing, chemicals including pesticides, drugs and pharmaceuticals, biotechnology, metallurgy, electronics and instrumentation, building materials, mechanical, electrical and electronics, etc. It will happen by licensing the indigenous technology to entrepreneurs, startups, MSMEs, etc. and helping them to establish a large number of small and medium scale industries.

Promoting closer links between universities of countries and encouraging collaborative research will invariably lead to an inward flow of technology. The concept of 'sister universities' may also be applied to connect institutes, which share research goals and priorities. An extension of this measure is also fostering a strong link between the industry of a nation and foreign universities and vice versa.

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