FLCTD

Promoting Innovation and Deployment of Low Carbon Technologies

(UNIDO-BEE-GEF PROJECT)

Facility For Low Carbon Technology Deployment

ANNEXURE II

DST-CENTRE FOR POLICY RESEARCH
PANJAB UNIVERSITY CHANDIGARH

DST- Centre for Policy Research Panjab University, Chandigarh

Annexure II (a)
INDIA

India

A. Innovation Profiling

- India is a diverse country with diverse actors and attributes associated with its innovation ecosystem. As per the Global Innovation Report 2022, India ranks 40th among the 132 economies worldwide. Among the lower-middle-income economies category, India ranks at the top among 36. India outperforms these 36 lower-middle-income countries in all the GII Pillars, such as Institutions, Human Capital and Research, Infrastructure, Market Sophistication, Business Sophistication, Knowledge and Technology Outputs, and Creative Outputs. India also ranks 1st in the geographical category of Central and Southern Asia and outperforms the regional average of all GII Pillars in this specific region. India performed above expectations in comparison to its level of development. In addition, India performs well in its innovation outputs compared to the level of innovation investments made in the country.
- In terms of key indicators defining the STI ecosystem of the country, India's positioning as per the NSTMIS Report is as follows
  - India's GERD as a percentage of GDP has remained stagnant at 0.7% in the past decade. In contrast, most developed countries contribute more than 2% of their GDP to R&D, which is one of the key factors in spurring innovation in the country.
  - Most developed and innovation-backed countries have more than 2% of GERD, and more than 60% of the R&D expenditure (More than 70% for the USA, Japan, S. Korea, and China) is borne by the private sector. Whereas in India, more than 50% of R&D expenditure is borne by the government, including the higher education sector. The low participation of the private sector in GERD is one of the critical challenges in developing the Indian STI ecosystem
  - India's scientific output in publication has shown a rising trend for the past decade, with a growth rate in scientific publication of 8.4% against the world average of 1.9% (as per Scopus). India is in 9th position in the world in resident patent filing activity

B. Innovation Actors

B.1. Government System

- The government of India has 52 ministries and two independent departments. It has six scientific line ministries and departments that administer Science and Technology, leading to innovation in the country. These are:
  1. Ministry of Science and Technology [comprising of the Department of Science and Technology (DST), the Department of Biotechnology (DBT), and the Department of Scientific and Industrial Research (DSIR), including the Council of Scientific and Industrial Research (CSIR)]
  2. Ministry of Earth Sciences (MoES),
  3. Ministry of Electronicsand Information Technology (MeitY),
  4. Department of Space (DoS),
  5. Department of Telecommunications (DoT),
  6. Department of Posts and Department of Atomic Energy (DAE)

  The other ministries are known as socio-economic ministries and directly/indirectly have an S&T component.
- As per the government data, 93% of the R&D expenditure by the Central government is incurred by 12 scientific agencies, as follows:
  1. Defense Research and Development Organisation (DRDO): 31.6%
  2. Department of Space (DOS): 19%
  3. Indian Council of Agricultural Research (ICAR): 11.1%
  4. Department of Atomic Energy (DAE): 10.8%
  5. Council for Scientific and Industrial Research (CSIR): 9.5%
  6. Department of Science and Technology (DST): 7.3%
  7. Department of Biotechnology (DBT): 3.7%
  8. Indian Council of Medical Research (ICMR): 3.1%
  9. Ministry of Earth Sciences (MoES): 2.3%
  10. Ministry of Electronics and Information Technology (MEITY): 0.8%
  11. Ministry of Environment, Forest and Climate Change (MoEFCC): 0.5%
  12. Ministry of New and Renewable Energy (MNRE): 0

The government has taken significant steps in supporting science and technology and promoting innovation in the country. The various ministries and departments have undertakennational missions and initiatives to spur innovation in the country as described in Table 1.
Some of the key programmes to support innovation in the country are presented in the table below.

Table 1: Key government programmes for stimulating innovation in the country

S. No.	Ministry/Department	Initiatives/Programmes
1.	Office of Principal Scientific Adviser to Government of India	• National Missions under PM-STIAC to promote innovation in 9 thematic fronts that include quantum frontier, artificial intelligence, waste to wealth, electric vehicles, deep ocean exploration, natural biodiversity, bioscience for human health, natural language translation, AGNII (Accelerating growth ofNew India's Innovations) City based Science and Technology clusters to strengthen S&T-led innovation growth in specified regions
2.	Department of Science and Technology, GoI	• Technology Development and Transfer programme to support R&D for innovative technologies and promote advanced technologies' technological application. There are sub-programmes to support innovation across different thematicsectors. Some of the key sub-programmes are : ○ NIDHI-DST Technology Platform for Electric Mobility(TPEM) ○ Device Development Programme (DDP) ○ Waste Management Technologies (WMT) ○ Advanced Manufacturing Technologies (AMT) ○ Biomedical Device and Technology DevelopmentProgramme (BDTD) • The National Science & Technology Entrepreneurship Development Board (NSTEDB) supports programmes for science, technology and innovation-led entrepreneurship in the country. It has the initiative 'National Initiative for Developing and Harnessing Innovations (NIDHI)' to support entrepreneurship and innovation in the country in line with the national priorities and goals. • Women-centric programmes through Women Scientist Schemes A, B and C to support women innovators across different sectors • To spur the innovation ecosystem, DST has three missions implemented, which are as follows: ○ Technology Mission Programme on Water and CleanEnergy ○ Nano Science & Technology Mission ○ National Super Computing Mission
3.	Department of Biotechnology,GoI	• DBT, GoI has set up the Biotechnology Industry Research Assistance Council (BIRAC) as a not-for-profit, Section 8, Schedule B, Public Sector Enterprise to support research, development and innovation in the biotech sector. It provides support right from ideation to the commercialization of research ideas. It also empowers biotech enterprises to address national needs and priorities by undertaking strategic research and innovation. • Biotech Clusters are established across India to support research and innovation in the biotechnology sector
4.	Department of Scientific and Industrial Research, including the Council of Scientific and Industrial Research, GoI	• DSIR programmes such as the Industrial Research and Development Promotion Programme, Patent Acquisition and Collaborative Research and Technology Development Programme, promoting innovations in individuals, startups, and MSMEs are vital programmes to promote innovation. • CSIR, comprising 38 national research laboratories, three innovation complexes, five units and 39 outreach centres, is significantly contributing to the national innovation ecosystem. Amongst various schemes, CSIR's New Millennium Indian Technology Leadership Initiative (NMITLI) is directly catalyzing innovations in PPP mode.

5.	Ministry of Earth Sciences(MOES), GoI	The MOES has dedicated schemes with an aim to support research, development and innovations. These schemes are placed with the following subject domains: • Atmospheric, Climate Science and Services • Ocean—Services, Modelling, Application, Resources andTechnology • Polar Science and Cryosphere Research (PACER) • Seismology and Geosciences • Deep Ocean Mission
6.	Ministry of Electronics and Information Technology (MeitY), GoI	MeitY has a dedicated division to support 'R&D' and 'Startup, Innovation & IPR Division'. It has several schemes to support innovation, such as the Technology Incubation and Development of Entrepreneurs programme, MeitY Startup Hub, Startup Accelerator Programmes, Scheme for Accelerating Startups around Post COVID Technology Opportunities, etc.
7.	Department of Atomic Energy (DAE) ,GoI	DAE has set up R&D units to promote research and innovation. These units are the Bhabha Atomic Research Centre, Indira Gandhi Centre for Atomic Research, Raja Ramanna Centre for Advanced Technology, Variable Energy Cyclotron Centre, Atomic Minerals Directorate for Exploration and Research, and the Global Centre for Nuclear Energy Partnership. These organizations play a key role in bringing innovations in the strategic sector in line with national priorities and goals.
8.	Department of Space (DoS)	DoS, through the Indian Space Research Organization, is promoting research and innovation to develop space technologies that are of immense utility to industries and the masses as a whole. ISRO, through Atal tinkering labs, fellowships and grants, is supporting innovation in the space sector.
9.	Defence Research andDevelopment Organisation, (DRDO), GoI	DRDO has led to the formulation of technology clusters, laboratories, corporate clusters and directorates that are dealing with innovation-related activities. DRDO has also established "Defence Innovation Organisation (DIO) " as a "not-for-profit Section 8 Company" under the Companies Act 2013 to promote innovations in the defence sector. It has launched Innovation for Defence Excellence (iDEX) to foster innovation and technology development in the Defence sector and encourage R&D institutes, academia, industries, start-ups and even individual innovators to engage with each other for indigenous technologydevelopment.
10.	Indian Council of Agricultural Research (ICAR), GoI	ICAR is an autonomous organization of the Ministry of Agriculture and Farmers Welfare, GoI and comprises 111 ICAR institutes and 71 agriculture universities supporting knowledge generation, research and innovation in the agriculture sector.
11.	Indian Council of Medical Research (ICMR), GoI	ICMR is the apex body formed under the Ministry of Health & FamilyWelfare with a mandate of formulation, coordination and promotion of biomedical research. It provides grants, fellowships and innovation funds in the biomedical research field.
12.	Others	Some of the key programmes initiated by other ministries and departments supporting innovation are as follows: • Startup India • Make in India • Atal Innovation Mission • India Innovation Initiative

- On an **international front**, the International S&T Division of DST, GoI, has the primary mandate of 'negotiating, concluding and implementing Science, Technology and Innovation (STI) Agreements between India and other countries. The division carries out the responsibility by closely aligning with the Ministry of External Affairs and Indian missions abroad, concerned government agencies, industry associations and STI stakeholders from academic and research institutes.
- The Office of Principal Scientific Adviser jointly leads the policy framework for STI in the country to the Government of India and the Department of Science and Technology, Government of India. India has four science policies rolled out, which are as follows:
  - Scientific Policy Resolution (SPR 1958) to foster, promote and sustain" the "cultivation of science and scientific research in all its aspects".
  - Technology Policy Statement 1983 (SPR 1958) emphasised the need for technological competence and self-reliance.
  - Science and Technology Policy 2003 (STP 2003) sought to "integrate programmes of socio-economic sectors with the national R&D system and create a national innovation system".
  - Science Technology Innovation Policy 2013 (STIP 2013) "Science, Technology and Innovation to focus on faster, sustainable and inclusive development of the people". It was in 2013 that the government focused on integrating science and technology with innovation to spur innovation in the country and create value out of science and technology.
- Several government-mediated incentives have been rolled out to stimulateinnovation in the system, which are as follows:
  - **Financial Incentives:** GoI has a broad spectrum of programmes, schemes and initiatives that provide financial support in the form of grants, fellowships, loans, and equity to stakeholders of the system to pursue innovation. Some of the key programmes are listed in the above table.
  - **Awards:** The government has various award systems to honour researchers, scientists, and entrepreneurs who have contributed to science, technology and innovation, such as the Shanti Swarup Bhatnagar Prize for Science and Technology, amongst the most prestigious STI awards.
  - **R&D Tax Incentives:** The following fiscal incentives are available for the industries recognised by the Department of Scientific and Industrial Research (DSIR), GoI.
  - 100% super deduction of in-house R&D expenditure, including capital expenditure (other than in respect of land and buildings)

    1. A deduction of 100% applies to specified payments made to a scientific research company or association, university or college, or other institution for scientific and statistical research.
    2. Production-linked incentives schemes for various sectors
    3. Capex—Tax incentives for expenditure incurred on agriculture extension projects
    4. Patent box regime: The royalty income of an Indian resident that owns a patent that was developed and registered in India may be taxed at a rate of 10%.

B.2. Education and Research System

India is the third largest education ecosystem in the world. It has a vast network of educational and research institutes in the country. The Indian higher education system comprises more than 1000 universities and nearly 42000 colleges under the ambit of the Ministry of Education. The Higher Education system is the leading knowledge provider for the innovation system. The higher education system is categorised as:

- **Central Universities** are established through an Act of Parliament and funded by the union government (central government). There are 40 central universities in India.
- **State Universities** are established under the State Legislature Act and primarily funded by the State Government. There are in total 460 State Universities in India.
- **Private universities** are also established under the Act of the State Legislature. There are in total 430 State private universities in India.
- **Deemed Universities** are institutes that perform well and are regarded as having an equal standing to universities established by the central government.There are, in total, 127 deemed universities in India.
- **Institutes of National Importance** are the institutions established to deliver well-trained manpower and are funded by the central government. It included eminent institutions like the Indian Institutes of Technology (IITs), National Institutes of Technology (NITs), Indian Institute of Management (IIMs) and others. There are, in total, 161 INIs established in India.

These higher education networks run courses under the category Science, Technology, Engineering, Management (STEM) courses and non-STEM courses that comprise Arts, Business Management, Commerce, Humanities and Social Affairs. Both streamslead to knowledge generation in the country. Other than the higher education institutes in the country, India has a wide network of research institutes that act as a second arm for producing scientific knowledge in the country. The major scientific agencies in the country have set up dedicated research institutes nationwide. There are, in total, 619 research institutes established by the central government scientific agencies, which the Central government supports. Further, there are State R&D institutions comprising Agriculture institutes, State Government R&D institutes and Research Stations. There are 1054 R&D institutes under the State Sector. Higher education and research institutes are the major knowledge drivers in thecountry. They have set up a strong national research and innovation foundation. They have contributed to knowledge generation through publications, intellectual property and technologies. The Ministry of Education has initiated the Atal Ranking of Institutions on Innovation Achievements to rank HEIs based on their performance in Innovation and Entrepreneurship. The usual system of accreditation of HEIs was carried out through NAAC, which pays limited attention to aspects related to innovation and entrepreneurship. The top 10 HEIs as per ARIIA ranking are presented below.

Table 2: Top 10 HEIs as per ARIIA Ranking, 2021

Top 10 Institutes of National Importance and Central Universities	
1.	Indian Institute of Technology Madras
2.	Indian Institute of Technology Bombay
3.	Indian Institute of Technology Delhi
4.	Indian Institute of Technology Kanpur
5.	Indian Institute of Technology Roorkee
6.	Indian Institute of Science
7.	Indian Institute of Technology Hyderabad
8.	Indian Institute of Technology Kharagpur
9.	National Institute of Technology Calicut
10.	Motilal Nehru National Institute of Technology
Top 10 Universities and Deemed Universities (Government institutes, technical institutes and government aided institutes)	
1.	Panjab University
2.	Delhi Technological University
3.	Netaji Subhas University of Technology
4.	Chaudhary Charan Singh Haryana Agricultural University
5.	Avinashilingam Institute for Home Science and Higher Education for Women
6.	Institute Of Chemical Technology
7.	Gujarat Technological University
8.	Savitribai Phule Pune University
9.	Gujarat University
10.	Periyar University
Top 10 universities and deemed to be universities (or technical institutes) (privately or self-financed)	
1.	Kalinga Institute of Industrial Technology Khordha
2.	Chitkara University
3.	Lovely Professional University
4.	S.R.M. Institute of Science And Technology
5.	Pandit Deendayal Petroleum University
6.	Kalasalingam Academy of Research And Education
7.	Chandigarh University
8.	Vellore Institute of Technology
9.	Amity University
10.	Symbiosis International

B.3. Company System

The industrial sector in the country comprises mainly private industrial set-ups comprising big corporates, Medium and Small Enterprises, and Startups and unicorns. Private industry in research and innovation comprises Government (DSIR) recognised in-house R&D units of private companies, Scientific and Industrial Research Organizations (SIROs), and industries performing research and innovation but not recognised by DSIR. In total, 5636 private industries are contributing to R&D in the country. The top 10 R&D investing companies in India are as describing in Figure 1_India.

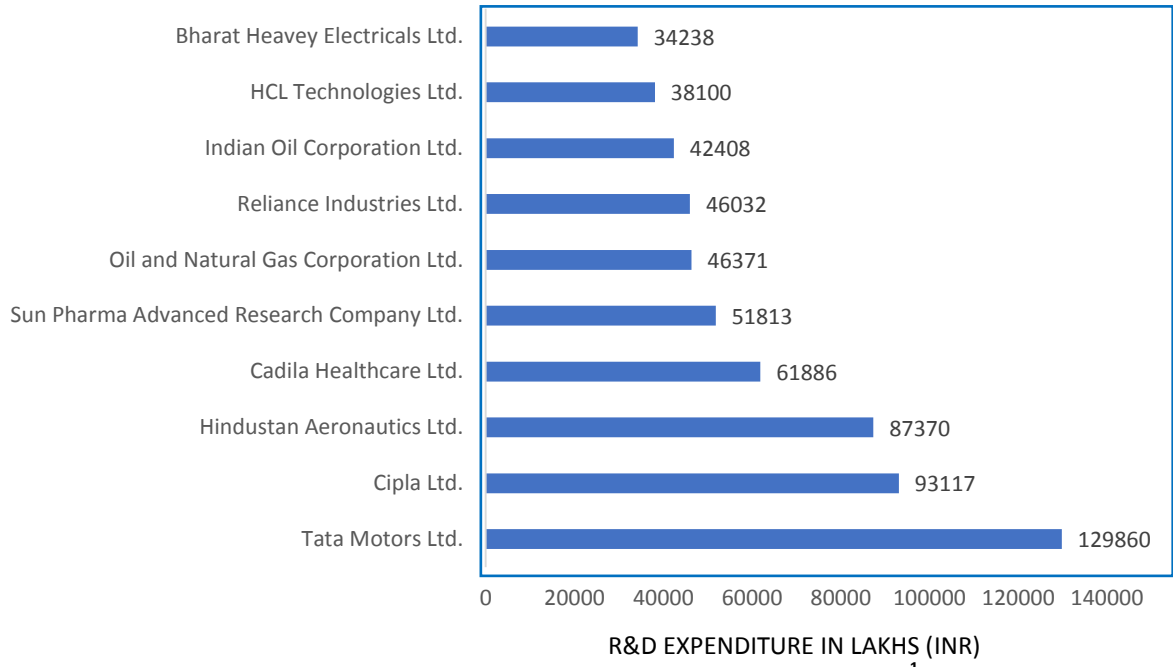

Figure 1_India: Top 10 R&D Investing companies in India[1]

The government has also set up public sector undertakings in the country, categorised as Central Public Sector undertaking (PSU) and State PSU. There are, in total, 142 PSUs set up in the country, which the government supports.

Industries are collaborating with knowledge generators to translate knowledge to the market. Industries have set up cooperative labs for the same. Industries also provide research and innovation support to academic and research institutes through corporate social responsibility (CSR). Startups are coming up as one of the major drivers of research and innovation in the country. India is the third largest startup ecosystem in the world and has showcased nearly 12-15% of annual growth.

Many multinational companies in India are setting up their R&D centres. MNC giants such as Google, IBM, Microsoft, and Walmart, to name a few, have established their R&D Centresacross the country. The government of India has initiated a plan to attract MNCs' R&D for national needs and priorities. For the same, a policy framework for incorporating Foreign Direct Investment (FDI) to enhance national R&D and innovation intensity is in process.

[1] Source DSIR Annual Report 2020-21

B.4. Intermediaries System

A network of enablers is established in the country to enable and facilitate the knowledge transfer from knowledge generators to knowledge consumers. Many educational and research institute-based enabling mechanisms supported by the public sector or the institute itself have been established. Prominent enablers in the Indian STI ecosystem are listed in the table 3 below.

Table 3: Prominent enablers in the Indian STI ecosystem

Sr. No.	Enabler/Facilitator	Brief Details
1.	City-based Science and Technology Cluster	O/o PSA has supported the establishment of six city-based S&T Clusters in six regions in the country. These clusters are working with a mandate to foster linkages between academic and research institutes with other stakeholders like ministries, industry, MSMEs, startups, etc., to stimulate knowledge generation and its application. These six clusters are o Jodhpur City Knowledge and Innovation Cluster (JCKIC) o Pune Knowledge Cluster (PKC) o Research and Innovation Circle of Hyderabad (RICH) o Delhi Research Implementation and Innovation (DRIIV) o Bhubaneswar City Knowledge Innovation Cluster (BCKIC) o Bengaluru S&T (BeST) cluster
2.	Incubators and Accelerators	A number of incubators and accelerators are set up in academic institutes, research institutes, private organisations and as standalone entities to provide incubation support to the flourishing ideas of entrepreneurs. Many incubatorsare supported by the public sector, such as incubators and technology parks by DST, GoI through its key initiative 'National Science and Technology Entrepreneurship Development Board (NSTEDB)'; Incubation centres by DBT, GoI; incubators set up by MeitY;
3.	Research parks/knowledge parks	There are knowledge and research parks established in various parts of India to strengthen innovation culture by promoting the commercialisation of research and technologies. Many government agencies are promoting the setting up of such parks in different parts of India. For example, DBT and GoI have set up biotech knowledge parks and incubators across the country to spur biotech research and innovation and its application in the market. These parks also facilitate the commercialisation of technologies and new/joint ventures in that particular region. MeitY has set up Software Technology Parks of India (STPI) in India to support technological growth in the software and the Internet of Things (IoT) domain.
4.	Technology Transfer Offices	Many academic and research institutes have established dedicated technology transfer offices to promote knowledge transfer from academia and research institutes to the market. BIRAC, GoI has established TTOs in different institutes to provide enabling mechanisms for technology transfer from academic and research institutes to the market. There are seven TTOs set up in public and private sector entities by BIRAC to support knowledge transfer and assist Intellectual Property management, acquisition and adaptation of technologies. Many of the institutes have set up entities that facilitate knowledge transfer. In some institutes, these entities are called Business Management Units, IP Cells, Industry-Academia cells, Industrial Research Consultancy cells/units, etc.

5.	Others	Many public and private sector organisations have come forward to set up an enabling ecosystem for STI in the country; the prominent examples are highlighted below: • The Ministry of Education has created the MHRD Innovation Cell (MIC) to spur a culture of innovation and motivate students to cultivate new ideas and develop innovative technologies. The Ministry of Education has also supported the development of the Institution Innovation Councils in various regions to support local institutions in scouting ideas and providing pre-incubation support. • The Department for Promotion of Industry and Internal Trade (DPIIT) under the Ministry of Commerce and Industry has established the "Cell for IPR Promotion and Management" (CIPAM) for the promotion, creation and commercialisation of IP assets in the country. CIPAM, through its various programmes and initiatives, is providing support for IP awareness and management in the country. • DST, GoI has created 'Technology Enabling Centres (TEC)' in different academic institutes to provide an enabling ecosystem for developing and transferring technologies to the market. DST is also creating 'Technology Innovation Hubs' in various educational and research institutes to support developing technologies in new and emerging areas. • To provide enabling support for startups, the government has launched the 'Startup Initiative', which is managed by a dedicated Startup India Team under the ambit of the Department for Industrial Policy and Promotion (DPIIT). • The government has also launched the 'Digital India' program, which is acting as a significant platform for people to display their talent and share ideas on the spectrum of topics. This is boosting innovation across the sectors.

India's innovation system also comprises the informal sector as grassroots innovators and traditional knowledge practitioners in the country. The knowledge carried out by the commonpeople and skills embedded in various communities, groups, etc., contribute to the innovation system. The National Innovation Foundation (NIF) mainly supports and documents informal innovations in India. It is reported that NIF has documented nearly three hundred thousand ideas,innovations and traditional practices that fall under informal innovation. These innovations are developed by common people for their self-use or societal use at the regional/local level without any intention of seeking profits. These are generally termed grassroots innovations/frugal innovations/inclusive innovations.

B.5. Innovation System Interconnectedness

Most university-industry linkages are successfully implemented in the academic sector through premier institutes such as IITs, the Indian Institute of Sciences (IISc) and some other universities and autonomous institutes. Amongst the research institutes, CSIR established research institutes with a mandate to undertake industry-relevant research and provide research assistance to industries for their R&D problems. These research institutes have developed mechanisms for industry connect by organising industry conferences, undertaking plenary talks, displaying technologies through technical exhibitions, business-to-businessmeetings, undertaking round table discussions on select themes, undertaking fast-track commercialisation projects, etc. As highlighted in the NIS map of India, the interconnectedness can be understood by the linkages between various actors.

- The government that comprises central and state governments is the major propellerof innovation in the country. The government formulates the legal, regulatory and policyframework for the innovation that is applied to all the STI actors comprising knowledge generators, Enablers and knowledge consumers. The maximum contribution to building the innovation funding landscape and infrastructure is through the government sector.
- The government also stimulates the incentivisation for R&D and innovation through different mechanisms that mainly comprise tax incentivisation and financial support. The government has a strong interconnectedness with the knowledge generators by providing resource support (educational system, research institutes, public sector undertaking, startups and informal sector). There are linkages between knowledge generators in the form of knowledge support and resource sharing. The in-house R&D units that generate knowledge are recognized by the government, upon which these units become eligible for various incentives.
- The knowledge consumers have set up linkages with the knowledge generators to acquire knowledge and transfer it into marketable product/technology. The enablers such as industry-academia cells, technology transfer offices, innovation hubs, etc., play significant roles in linking knowledge generators and knowledge consumers. Knowledge consumers are also interconnected with the government and academic and research institutes in terms of providing financial contributions through CSR, philanthropic support, angel investment etc.

Keeping in mind the need to promote collaborative culture in the country, the government is implementing various support programmes to pursue collaborative research between public and private partners, a few of them are listed below

- International S&T Cooperation Division of DST: Promotes innovation and commercial R&D via I-A applied R&D projects/Public Private Partnerships (PPP) under the Global Innovation and Technology Alliance (GITA) platform for facilitating tech. development and transfer in association with partner countries.
- Promoting Innovations in Individuals, Start-ups and MSMEs (PRISM) of the Department of Scientific and Industrial Research (DSIR)
- New Millennium Indian Technology Leadership Initiative' (NMITLI) of the Council of Scientific and Industrial Research (CSIR)
- Small Business Innovation Research Initiative (SBIRI) and Biotechnology Industry Partnership Programme (BIPP) of the Biotechnology Industry Research Assistance Council (BIRAC)

Following is an indicative list of institutional mechanisms set up to promote collaborative research and innovation in the country

- Global Innovation and Technology Alliance (GITA)
- Indian Institutes of Information Technology (IIITs) [Ministry of Education]
- Invest India (DPIIT + FICCI + State Govt.) [Department for Promotion of Industry and Internal Trade, Ministry of Commerce and Industry]
- Telecom Centres of Excellence (TCOEs) [Ministry of Electronics and InformationTechnology]
- General Motors-IIT-Kharagpur Collaborative Research Laboratory on Electronics, Controls and Software
- Wipro GE Healthcare and IISc Bangalore partnered with Healthcare InnovationLab etc.
- The Tata Infotech Laboratory at IIT-Bombay
- Research platforms to support collaborative research
- Textile Research Associations (TRA) [Ministry of Textiles]
- Automotive Research Association of India (ARAI), Pune [affiliated to the Ministry of Heavy Industries and Public Enterprises, Government of India]

C. Technology Transfer Ecosystem of India

In the Indian Scenario, patenting and technology/IP commercialisation are gaining momentum. Post-COVID, with a push of 'Atmanirbhar Bharat Abhiyan,' India has seen indigenous technology development and commercialisation. However, academia-industry linkages for knowledge commercialisation are pretty limited and effectively exist mainly in premier institutes like IITs. Academics in India are more oriented towards publication rather than commercialising innovative ideas (Ravi and Janodia, 2022). There is a need to develop adequate mechanisms for knowledge transfer from academia to the industry through national policies and models for converting research output for market benefit(Nandagopal, 2013).

Along with that, Indian Knowledge generators that mainly comprise HEIs and NRLs should focus on (Ravi and Janodia, 2021):

- Leveraging scientific expertise to undertake interdisciplinary research to generaterevenue
- Focusing on the commercial utility of research
- Develop mechanisms for collaborating with the industry

The foundation for promoting creativity and innovation was laid down by the Indian Patent Act of 1970. The act boosted the development of indigenous technology and licensing them out, especially from the NRLs. However, India needs to succeed in generating revenue from the patents/IP. Indian science policies such as Technology Policy Statement 1983, Science and Technology Policy 2003, and Science, Technology and Innovation Policy 2013 have emphasised creating mechanisms for technology commercialisation. In 2008, the push for the commercialisation of academic research was attempted through the introduction of The Protection and Utilization of Public Funded Intellectual Property Bill (PFIP) in line with the US Bayh Dole Act which aimed to provide incentives to the inventors for the commercialisation of their IP. However, the proposed bill did not see the light of legislation (Srivastava & Chandra, 2012). Despite the policy push and attempts, the Indian technology transfer ecosystem is still nascent due to inadequate policy implementation, under-developed industry-academia linkages, minimal industry collaborations, absence of any specific technology commercialisation model (Ravi and Janodia, 2022).

As IP awareness and promotion have increased since 2000, technology transfer is also practised. Many institutes are developing dedicated IPR policies for their institute, focusing on technology licensing and transfer (Ravi and Janodia, 2022).

1. Many government departments and funding agencies have prepared a compendium of technologies for technology commercialisation. For example, the Directorate of Industry was established by Defence Research and Development Organization (DRDO), Ministry of Defence that has responsibility for technology transfer as per the set guidelines and procedures of the technologies developed at DRDO institutes.
2. The Indian Space Research Organization (ISRO) have set up a commercial arm, Antrix and New Space India Limited, to assist public-private partnership and technology transfer in the space sector.
3. DSIR, GoI has also established the National Research Development Corporation established by DSIR in 1953 as a Section 8 Company under the Companies Act 2013 to develop, promote and commercialise technologies/inventions/know-hows/patents etc. from national research laboratories in India.
4. BIRAC, GoI has established an in-house IP and Technology Management cell that facilitates IP and Technology Transfer management. The cell provides financial and mentoring assistance for IP and technology transfer to Academia, SMEs, Startups and the Biotech industry. BIRAC has also set up 'IP and Tech Management Law Clinic Connect'to assist academia and research institutes, startups and companies with IP filling, licensing and commercialisation. CSIR, GoI has established a technology portal named 'CSIR India Technology Showcase' that showcase technology compendium that comprises technologies that are ready for technology transfer and technologies that are successfully commercialised. The portal spans over 25 sectors, over 900 technologies, and 3200 patents (active), which CSIR NRLs develop.

Many government schemes are also available to support academia and industry financially to aid the technology transfer process. Some of the key programmes/schemes are listed below:

- Promoting Academic Research Conversion to Enterprise (PACE) and ProductCommercialization Program Fund (PCP Fund) by BIRAC, GoI
- Promoting Innovations in individuals, Start-ups and MSMEs (PRISM) and international Technology Transfer Programme (ITTP) by DSIR, GoI
- Technology Development Programmes (TDP) by DST, GoI
- Fast Track Translation (FTT) / Fast Track Commercialisation (FTC) project scheme byCSIR, GoI
- AGNIi initiative by O/oPSA, GoI

Some **State governments** are also coming up with support mechanisms for technology transfer. One such model example is from the State of Kerala, which has set up a Technology Transfer Scheme under Kerala Startup Mission. Through this scheme, startups procure technology licenses from the national research institutes to commercialise their technology/products, and technology fees and other expenses will be reimbursed.
Chhattisgarh has come up with a Technology Transfer scheme that benefits local tribes, women and other beneficiaries by providing assistance mechanisms for the transfer of existing technologies within the State / outside the State or through the innovation of new technologies.

At the institute level, many higher educational institutes and national research laboratories have created dedicated units/cells to support sponsored research and industrial consultancy, IP management, industry linkages, etc., supporting technology transfer. At the same time, some institutes and laboratories have set up dedicated Technology Transfer Offices (TTOs) or Technology Commercialization Entities (TCEs). Funding agencies are also providing institutional support for forming such entities, for example, the establishment of Technology Enabling Centres by DST, GoI. TEC is established to support the ecosystem for technology development and commercialisation from academia to the market. Such kinds of Centres are established in various academic institutes with the following objectives.

- Technology mining at academic and research institutes
- Technology assessment as per the MSME requirements
- Evaluation of technology maturity for the further scope
- Market assessment of the technologies
- Technology transfer from academia to industry

There are several TECs established across the country (e.g., TEC in Panjab University, Chandigarh; Tezpur University, Assam; Amity University, Noida; Amrita Vishwa Vidyapeetham, Kerala; KIIT, Bhubaneswar). On the other hand, BIRAC, GoI has createdseven TTOs in various institutes with the following objectives.

- Supporting technology transfer by the acquisition of professionals with experience and knowledge in technology transfer
- Assisting in technology adaptation and technology acquisition
- Awareness of IP creation and management
  The creation of facilitative and enabling mechanisms has made efforts to attract industries to academic knowledge and create platforms for academic research to work on research projects as per industry needs and demands. Various industry associations, such as the Confederation of Indian Industry (CII) and the Federation of Indian Chambers of Commerce and Industry (FICCI), support technology commercialisation from academia to industry. One such programme jointly launched by FICCI and DST is the **India Innovation Growth Programme** to support technology development and commercialisation. FICCI has also joined hands with the Technology Development Board and USAID to facilitate the percolation of innovation to the market by creating support mechanisms for technology commercialisation through the Millennium Alliance (MA) initiative. DRDO and FICCI have supported defence technology transfer through the DRDO-FICCI Accelerated Technology Assessment and Commercialization ATAC Program.

- Many other regional industrial associations also promote technology transfer from the academic sector to the industry sector, mainly to MSMEs. CII, in collaboration with DPIIT and the Indian Patent Office, is facilitating championing of IP rights and technology commercialisation through 'National IP awards'.
- CII supports technology development and commercialisation process through various platforms such as the Global Innovation and Technology Alliance (GITA)- A not-for-profit society (under establishment) jointly promoted by CII and DST; establishment of Technology Exports Development Organisations (TEDO) in collaboration with DSIR to support transfer technical know-how to industry to enhance their competitiveness; implementing scheme such as India Innovation Initiative (i3) in collaboration with DST to take innovation to the market for the awardee innovators.

Many **international organisations** are also providing support for strengthening the technology transfer ecosystem in the country. One example is UNIDO's FLCTD project, launched in 2016 to promote and facilitate low-carbon technology deployment and scale-up in India. Bill & Melinda Gates Foundation has created the platform 'Innovative Technology Solutions' to identify emerging technologies in global health and support their deployment and commercialisation.

International organisations such as the

- Indo-French Centre for Promotion of Advanced Research (IFCPAR / CEFIPRA), Indo-German Science & Technology Centre (IGSTC) and Indo-US Science & Technology Forum (IUSSTF) are also supporting collaborative research and technology development, deployment and commercialisation in the country under bilateral agreements.
- World Intellectual Property Organisation has also created the 'Technology and Innovation Support Center (TISC)' to support technology development and deployment in the country. WIPO has set up 12 such TISC in India.

Annexure II (b)
SWITZERLAND

Switzerland

A. Innovation Profiling

Switzerland is the most innovative country globally and ranks 1st amongst the 132 economies worldwide on the Global Innovation Index (GII), 2022, and has held this position since 2011. Switzerland is a developed country with a high per capita income. In geographical terms, Switzerland is located in Europe, is known for the highest number of Nobel Prizes per capita, and possesses a strong network of industry and academia.

According to the GII Report 2022, Switzerland performs better in terms of innovation outputs (ranks 1st) than the innovation inputs (ranks 3rd, a measure of the factors that lead to and facilitate innovation, such as Infrastructure, institution, business, human capital, and research, and market sophistication). Switzerland performs best and ranks 1st globally in terms of creative outputs and knowledge and technology outputs, contributing as one of the significant outputs for innovation. Its weakest performance is in Market sophistication (rank 8th) and Business sophistication (rank 7th).

Switzerland's institutions performed great and ranked 2nd place, while Infrastructure and Human capital and research ranked 4th, respectively. Switzerland devotes over 3% of its GDP to R&D. According to the OECD 2022 report, the Gross Expenditure on R&D (GERD) made by Switzerland has increased significantly from 2015 to 2019, as shown in Figure 1_Swiss below. The private sector contributes almost two-thirds of R&D expenditures.

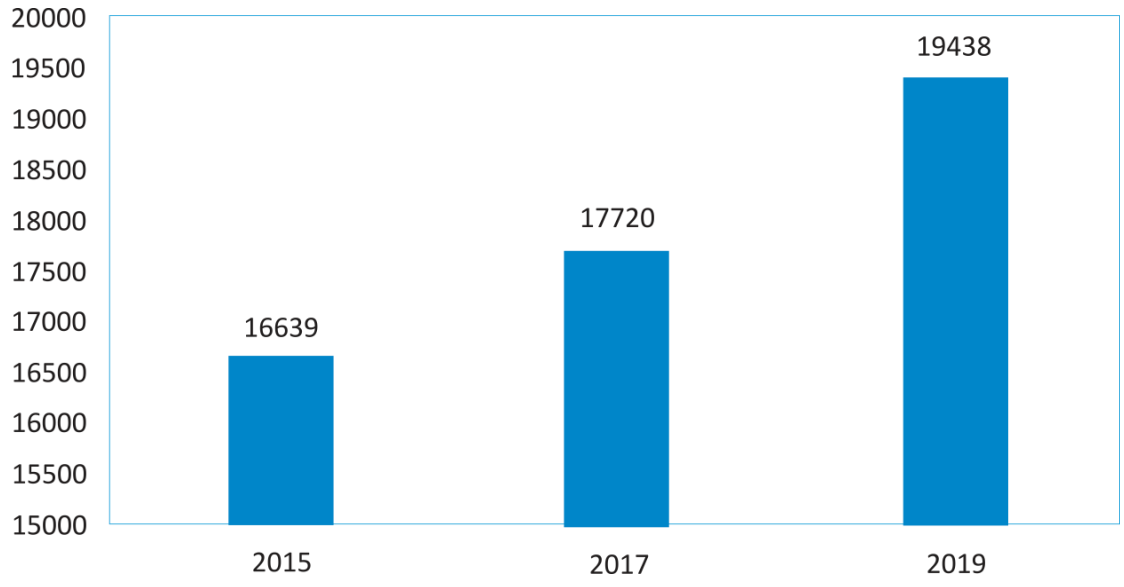

Figure 1_Swiss: Gross Expenditure on R&D by Switzerland in a million USD[2]

* Data not available for the year 2016, 2018, and 2020.

[2]Source: OECD, 2022

Figure 2_Swiss below shows Switzerland's contribution to GERD as a percentage of GDP by the government and private sectors. It is emphasised that the business sector is the most significant contributor and that its annual contribution to GERD as a percentage of GDP is rising every year. The analysis from 2015 to 2019 is depicted in figure 3_Swiss; it is highlighted that the business sector is the largest source of funding for GERD, followed by the government, the higher education sector, and private non-profit organisations.

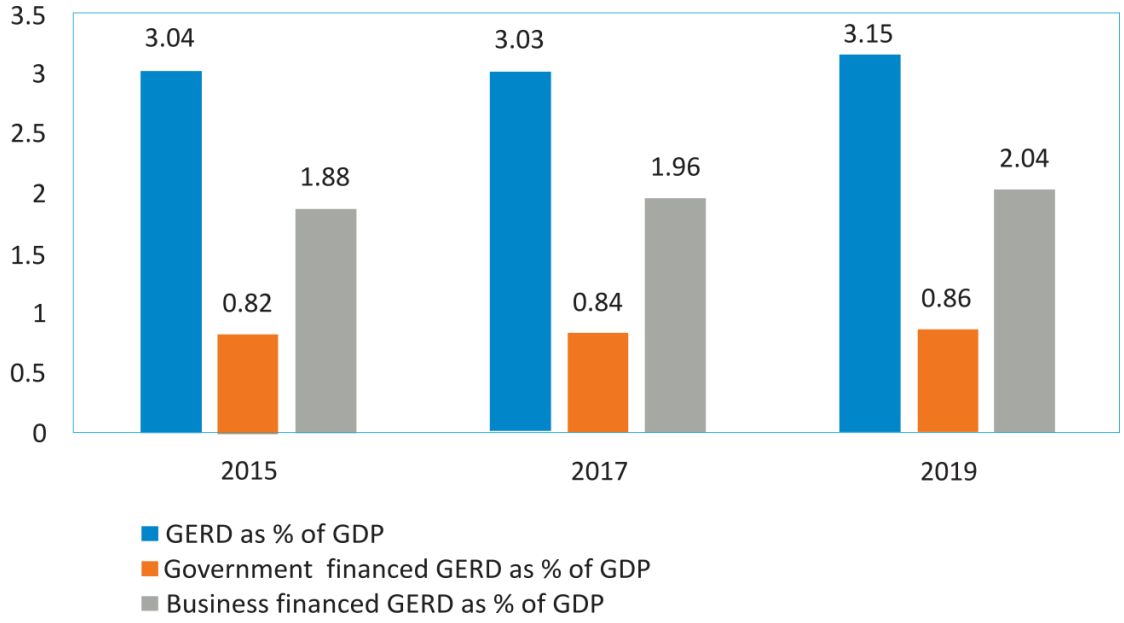

Figure 2_Swiss: Gross Expenditure on R&D (GERD) as % of Gross Domestic Product (GDP)[3]

* Data not available for the year 2016, 2018, and 2020.

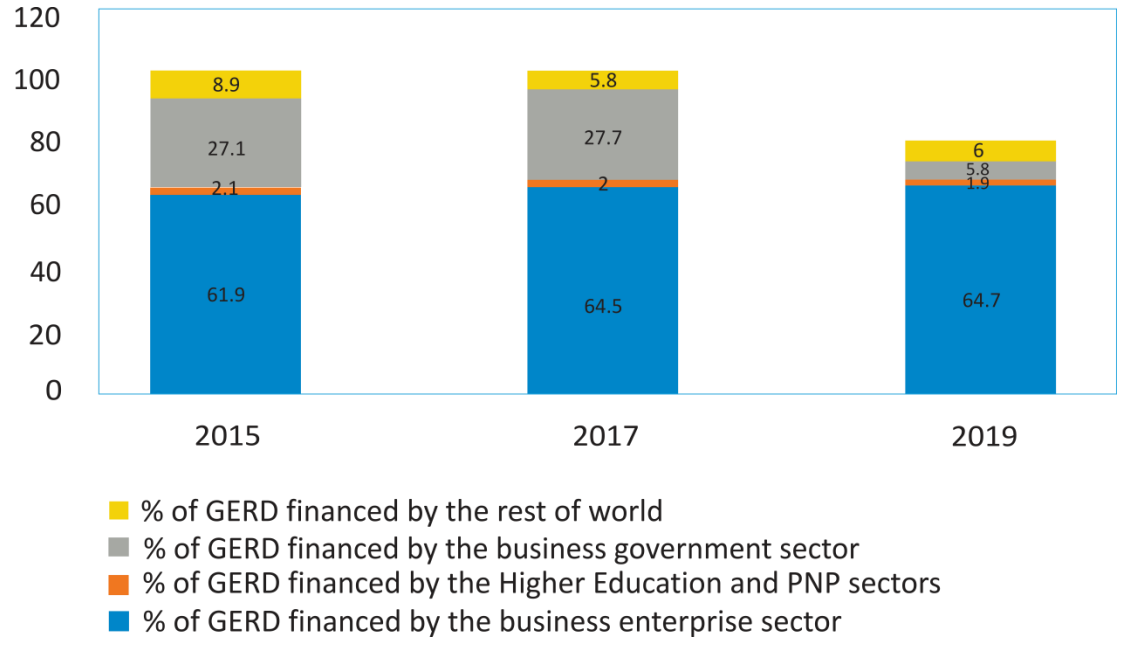

Figure 3_Swiss: The percentage of Gross Expenditure on R&D (GERD) financed by different Sectors[3]

* Data not available for the year 2016, 2018, and 2020.

[3] **Source: OECD, 2022**

B. Innovation Actors

B.1.Government System

In Switzerland, the highest authority of governance is the Federal Council. It comprises seven members elected through the Federal Assembly. The Federal Council supported its activities through the seven Federal Departments, and each councillor heads one of the departments. **The Federal Department of Economic Affairs, Education, and Research (EAER)** is one of the seven departments responsible for dealing with education, research, and innovation matters.

The research and innovation ecosystem of Switzerland is primarily governed by two governmental organizations, and both of them are under EAER. The two organizations are

1. **Swiss Innovation Agency, Innosuisse**: It is one of the administrative offices and a public law institution with an independent legal entity. Innosuisse is a Swiss statutory body that took over the Commission for Technology and Innovation (CTI) in 2017. It is one of the administrative offices and a public law institution with an independent legal entity. Innosuisse aims to boost the innovation ecosystem in the country by linking the Academic institutes with the industries to promote/enhance the commercialization of the technologies. It was set up as a separate legal entity under public law to support the Science and Technology activities in the country. The Innosuisse is vital in boosting R&D in Switzerland by providing advisory services, targeted funding, and bringing together academia and industry. Innosuisse specifically caters to technology enhancements and TT activities in the industry and academia. Innosuisse funds half of the project if an innovator works with a Swiss institute. The major initiatives and programmes of Innosuisse for promoting Private and Public Partnership (PPP) in R&D are presented in Table 1.

Table 1: Innovation Programmes of Innosuisse

Sr. No.	Programme	Brief about programme
1.	Energy Funding Programme	Innosuisse administers this programme, the Swiss Federal Office of Energy (SFOE), and the Swiss National Science Foundation (SNSF). This program aims to discover solutions to the energy challenges outlined in "Energy Strategy 2050."
2.	BRIDGE Programme	The initiative was launched in 2016 jointly by Innosuisse and the Swiss National Science Foundation. The programme aims to maximise research discoveries' monetary and societal potential. The programme assists scientists/researchers who see application potential in their work but require additional work to achieve their vision.
3.	National Thematic Networks (NTNs)	The first NTNs were established in 2013 jointly by Innosuisse to identify industrial collaborators for developing innovations. NTNs assist in identifying industrial collaborators for innovation projects, and in exchange, industrial members of these networks pay membership fees allocated to innovation projects.
4.	Specialized Thematic Events	Innosuisse, in collaboration with the business sector, organises specialised thematic events. These events facilitate cooperation between industry and academia on innovative topics. Innosuisse provides 50% financial assistance for organising such events in either academia or industry.
5.	Thematic Platforms	Thematic platforms are primarily selected trade events with readily identifiable themes. Essential features of these platforms include the ability to engage in face-to-face conversations about various innovations. This facilitates the development of contacts and allows SMEs to discuss their primary innovative and administrative challenges.
6.	Advisory Services-Innovation Mentors (IMs)	The innovation mentors excel in both the business and research fields. They advise businesses on Swiss and European Union funding programmes/schemes, particularly SMEs. Free innovation mentoring is available to SMEs. This innovation mentoring supports translating innovative ideas, finding research institutes where the same concept can be worked upon, and eligible companies to apply for Federal funding.

7.	Innovation cheques	Innosuisse initiated this programme in 2009; approximately 120 cheques have been awarded annually since then. This provision is for small and medium-sized enterprises new to innovation and research initiatives. These innovation cheques (15,000 CHF) help the SMEs utilize the R&D services from public research partners.
8.	Supporting Joint Innovative Projects	Innosuisse supports innovation projects conducted by SMEs in collaboration with any public research institution or organisation. Innosuisse provides funding support to the SME and research institute in the form of salary, material costs, and administrative contributions for the research partner. Innosuisse has a basic structure for supporting innovative projects in Energy & Environment, Engineering, Information and Communication Technology, Life Sciences, Social Sciences, and Business Management. The following criteria are used to select innovation projects for financial support: ● The social impact of the project's results. ● The project's associated value creation. ● The market impact and sustainability of an innovative initiative. ● The degree to which the project is innovative. ● Landscape quality of the project. ● Competencies of those involved in the project. In addition to assisting SMEs with innovation projects, Innosuisse encourages startups and individual entrepreneurs to present innovative concepts.

2. **State Secretariat for Education, Research and Innovation (SERI)**: It is the Federal Office for education, research, and innovation policy. It is the Federal Office for Research and Innovation Policy. The Swiss Federal Department has set up SERI to promote education, research and innovation both on the national and international front. SERI establishes Swiss Innovation Parks Swissnex Networks and runs other initiatives to promote R&D and innovation at the national and international levels. To promote international cooperation for research and innovation, SERI has also been a member of Multilateral Cooperation Programmes and Instruments.

Under this, the following are the initiatives that strongly promote Public Private Partnerships (PPP) for R&D in collaboration with other European countries to strengthen the innovation ecosystem and support knowledge exchange.

- **EUREKA Initiative:** EUREKA is a strategic industrial initiative promoting cross-border cooperation for market-oriented R&D. This initiative comprises nearly 40 European countries and three associated nations: Canada, South Africa, and South Korea. Under this initiative, higher educational institutes, research institutions and the private sector (Companies, SMEs) work together to bring innovations to the market. The private sector provides most of the funding (around 70%) for the research projects under the EUREKA initiative.
- **EUROSTARS:** This initiative is a part of the EUREKA framework. Under this initiative, Swiss companies can collaborate with European research teams in R&D. International funding is provided to SMEs, with 10% of their turnover attributed to research and development. The Swiss government covers the total grant share of the projects undertaken by the Swiss partners.

- **Joint Technology Initiatives:** SERI promotes joint technology initiatives based on PPP between businesses and the European Union. The initiatives undertaken are as follows:
    - Innovative Medicines Initiative 2 (IMI2)
    - Fuel Cell and Hydrogen (FCH2) Initiative
    - Clean Sky 2 (CS2) Initiative
    - Shift to Rail (S2R) Initiative
    - SESAR Initiative
    - Bio-Based Industries (BBI) Initiative

Enhancing S&T competitiveness through numerous Acts/laws/policies, Switzerland has enacted stringent legislative standards for Innovation. Following are the various Acts and laws for the regulation of innovation in Switzerland:

- The Federal Act on the Promotion of Research and Innovation (RIPA) generally regulates the tasks and structure of federal support for research and innovation at both national and international levels. RIPA also sets out the tasks, procedures and responsibilities of funding institutions.
- The Swiss law (Article 332 Swiss Code of Obligations) dictates that inventions and designs that an employee produces while performing his/her duties and fulfilling his/her contractual obligations belong to the employer, not the employee.
- Switzerland's intellectual property protection processes are simple and efficient. Companies in Switzerland have easy access to IP specialists (e.g. patent attorneys). The multilingual nature of Switzerland also makes it easier to operate across national borders, for example, in the EU region.
- The Federal Constitution guarantees freedom of research for individuals and institutions (Art. 20 FC; Schweizer, 2011). However, it also requires legislators to set limits on research. For example, Article 120 of the Federal Constitution states that human beings and their environment shall be protected against the misuse of gene technology.
- In Switzerland there are no legal restrictions on the transfer of intellectual property (sales, licensing, franchising, security rights, etc.). Regarding the transfer of intellectual property rights, Switzerland generally allows for the free transfer of IP through sales, licensing agreements, franchising arrangements, security rights, and other similar mechanisms. This means that the Swiss government imposes no specific legal restrictions on these types of transfers.

These legislative instruments have been crucial in fostering innovation and facilitating technology transfer. Being both stable and liberal, the Swiss legal system provides substantial protection for intellectual property and a high level of investment security for R&D activities.
The following government-mediated incentives have been implemented to promote innovation in the country, which are open-ended and may get amended from time to time:

1. **R&D Super Deduction:** R&D super deduction at the cantonal level (A canton is the administrative division of a country; 26 cantons of Switzerland are the member states of the Swiss Confederation) applies as from 1 January 2020 at the discretion of the individual cantons. The super deduction is not limited to particular industries; the incentive benefits taxpaying entities incurring R&D expenditure in the country resident in a canton that offers an R&D super deduction. The R&D super deduction allows for a 150% deduction (instead of 100%) of qualifying R&D expenses incurred. For super deduction R&D activities, qualifying R&D includes scientific research (including basic research and applied sciences) and knowledge-based innovation, i.e., developing new products, procedures, and services. The maximum benefits available to large and SME enterprises include a 150% deduction for qualifying R&D expenses incurred in Switzerland, subject to an overall full deduction of 70% of taxable profit.
2. **Patent Box:** A patent box that is based on the Organization for Economic Cooperation and Development (OECD) modified nexus approach and regulations provides for a special deduction for innovative companies amounting to a maximum of 90% of revenues from patents and comparable rights that are based on qualifying expenditure for research and development. The maximum benefits available to large and SME enterprises include tax relief of up to 90% of the patent income, subject to an overall full deduction of 70% of taxable profit. The patent box regime applies to tax-paying entities with qualifying IP assets, including patents and patent equivalent rights (Swiss & foreign).

3. **Increased tax breaks for R&D expenditure**: Also, cantons can optionally grant a maximum of 50% reduction for research and development expenditure. Innovative large companies, as well as SMEs, can benefit from this relief. The maximum tax relief must not exceed 70% of profits, but the cantons can set a lower relief limit.
4. **Credits for preliminary studies- Innovation cheque:** The cheque funds preliminary studies, such as concept developments, preparatory work for innovation projects, or analyses of technology transfer potential.
5. **European Commission initiatives:**
    a. Eurostars 2 Support for SMEs
    b. Cross-border innovation projects (EUREKA)
    c. European projects in the field of electronics (ECSEL)

B.2. Education and Research Institutes

The academic sector of Swiss is globally recognized because of its high academic standards, well-acknowledged innovators and flexible academic programme that facilitates students. The Swiss higher education institution (HEI) system comprises of.

1. 02 federal institutes of technology (one in Zurich and the other in Lausanne) under Federal authority.
2. 10 cantonal universities (Cantonal universities are operated and managed by individual cantons).
3. 07 universities of applied sciences and universities under cantonal authority.

Federal institutes of technology and cantonal universities mainly pursue fundamental research and research-based teaching. In contrast, universities of applied sciences focus more on research and development (R&D).

Switzerland Innovation's network of ecosystems facilitates collaboration between academic partners and industry, allowing universities and innovative companies to use their respective competencies to develop commercially viable products and services. As an important centre of research, Switzerland attracts highly qualified foreign researchers. Several internationally important institutions are based in Switzerland, For example, the European Organization for Nuclear Research CERN, the Paul Scherrer Institute (PSI) and the Swiss Center for Electronics and Microtechnology (CSEM). Private research centres, such as the multiple Nobel Prize-winning IBM Research Laboratory, Google's European Research Center (its most prominent research location outside the USA) and the Disney Research Lab, are all in Switzerland.

The top 10 innovation-backed universities in Switzerland are as follows:

1. Swiss Federal Institute of Technology Zurich (ETH Zurich)
2. Ecole Polytechnique Federale de Lausanne (EPFL)
3. University of Zurich
4. University of Lausanne
5. University of Basel
6. Universita della Svizzera Italiana (USI)
7. University of Bern
8. University of Geneva
9. University of Fribourg
10. Dalle Molle Institute for Artificial Intelligence Research

Research and Innovation (R&I) culture of Swiss has the backing of its distinguished academia system. Academic research institutes and research laboratories have played a significant role in Switzerland's educational system in developing the requisite skill set in the areas of research and innovation. Top 7 innovation ranked federal research laboratories of Switzerland are listed below.

1. IDIAP Research Institute
2. Swiss Federal Laboratories for Materials Science and Technology
3. Swiss Tropical and Public Health Institute
4. Paul Scherrer Institute
5. Swiss Federal Institute of Aquatic Science and Technology
6. European Organization for Nuclear Research
7. Swiss Federal Institute for Forest, Snow and Landscape Research

Switzerland's academic universities/institutes and research laboratories have developed robust connections with the industrial sector. They are heavily engaged in collaborative R&D due to government regulations & legislative norms, and the private sector effectively commercialises a significant portion of the country's knowledge and technologies.

B.3. Industry System

Industry in Switzerland has taken the lead in numerous R&D and innovation-related initiatives, making business R&D one of the most influential actors in the Swiss innovation ecosystem. The top 10 R&D Investing companies in Switzerland are as follows.

1. Roche Holding AG (Health Sector)
2. Novartis AG (Healthcare)
3. Nestle (Food & beverages)
4. Syngenta AG (Agribusiness & Chemical)
5. ABB Ltd. (Electrical Equipment sector)
6. Garmin Ltd. (Tech Hardware & Semiconductors)
7. Alcon AG (Healthcare Sector)
8. Liebherr International (Heavy machinery & Domestic appliances)
9. Givaudan SA (Flavours & Fragrances)
10. TE Connectivity (Electronics - Connectors and Sensors)

The industrial community of Swiss is leading the R& D culture at the global level. As per a business review held internationally by accounting and consulting firm Ernst & Young (EY), Swiss companies spend approximately 6.6% of their revenue on research and development, compared to the global average of 3.8%.

B.4. Intermediary System

Switzerland has developed a robust environment conducive to innovation, as evidenced by the following examples:

Swiss Innovation Park: Swiss Innovation Park was established by SERI in 2016. The Swiss Innovation Park aims to develop private R&D activities and investments in the country. These parks provide space (land and floor) and expertise from the nearby educational and research institutes for the national and international R&D players. These Innovation Parks were established under the legal framework of RIPA and approved by the Swiss Federal government. According to the act, the funds for the activities of the innovation parks would be provided by SERI, and these activities would be collectively decided by the public and private sectors. The Innovation Park has been centred at the hub site of 2 Federal institutes at Lausanne and Zurich and three network centres at Biel, Northwest Switzerland and Aargau. The support services provided by these Innovation parks are Advisory Services, Networking, Organizing Events and Workshops, and Collaboration with Universities and Research institutes.

The Innovation Parks are

1. Park INNOVAARE (Aargau)
2. Switzerland Innovation Park Basel
3. Switzerland Innovation Park Biel/Bienne
4. Switzerland Innovation Park Network West EPFL
5. Switzerland Innovation Park Zurich

Swissnex Network: The Swissnex Network was established by SERI with the vision and mandate to implement international cooperation policy in education and research. The global network connects Switzerland to the rest of the world regarding teaching, research, and innovation. The mission is to support its collaborators' outreach and active participation in the international exchange of ideas, knowledge, and talent. In partnership with over 20 selected countries worldwide, Switzerland has developed innovation policies with the aim of:

1. Knowledge exchange and promote the visibility of research organizations, higher educational institutes, and the private sector (start-ups, SMEs, etc.).
2. Create a strong network for strengthening the innovation ecosystem with the public and private sectors engaged with partner countries.
3. R & I-related advocacy and related opportunities at various levels.
4. Outreach of HEI, start-ups and other innovation-driven collaborators.
5. Inspiring new ideas by promoting knowledge exchange.

The major drivers/initiatives under Swissnex to strengthen the innovation ecosystem and promote knowledge exchange and Public-Private Partnership between the partner countries are as follows.

1. **Swissnex India** Swiss Federal government in partnership with India starts programmes/initiatives to promote PPP are: Corporate Innovation Programme that connects Industry Players by providing expertise for knowledge and technology transfer.
2. **Swissnex Brazil** Swiss Federal government in partnership with Brazil started a programme/initiative to strengthen the innovation ecosystem and promote PPP. Academia-Industry Training Programme to Brazilian and Swiss researchers to interact and collaborate with the industry players.
3. **Swissnex Boston** that supports connecting corporate programme to connect the Swiss corporate and innovation agencies with the key innovation players in Boston.
4. **Swissnex San Francisco** has **a connecting corporates network that hosts a diverse community** of universities, research institutes, corporations, start-ups, designers, and individual artists to build a corporate platform for innovations in Silicon Valley.

Biotech Hubs: Switzerland is widely considered a global leader in the biotechnology industry and is home to some of the world's most innovative biotech hubs. The development of networks that are fuelled by prestigious educational institutions, as well as highly specialised businesses and new ventures, is the most crucial aspect in achieving success. The Swiss biotechnology industry brought in about CHF 4.8 billion in revenue in 2019, demonstrating that it remains an attractive target for fresh financing and investments.

Tech Hubs: In Switzerland, there is a geographical distribution of technology centres and heterogeneity in terms of the technologies that each hub focuses on. The cantons of Vaud, Lausanne, and Zurich are the most important regions to study to comprehend how the Swiss technology ecosystem functions. Startups in Switzerland's Vaud region provide a supportive and robust ecosystem. The region is home to over 15 per cent of all new businesses launched in Switzerland and attracts over 2/3rd of the total worth of startups in the country. Lausanne and its universities are perceived as critical drivers of energy and health tech innovation. The convergence of government, business people, and venture capitalists is one of the most notable characteristics of the ecosystem in Zurich. This convergence is one of the main reasons the ecosystem is so thriving.

C. Technology Transfer Ecosystem of Switzerland

The Federal Government has played a vital role in stimulating the technology transfer ecosystem through various organisations such as

- **Swiss National Science Foundation (SNSF) and the Swiss Innovation Agency (Innosuisse**) support research and innovation in Switzerland. Both institutions evaluate and choose research initiatives through a competitive process. The SNSF in Switzerland supports scientific research. It places particular emphasis on the advancement of youthful scientists. In contrast, Innosuisse is the federal institution that supports research-based innovation and promotes knowledge transmission between public research institutes and industry. Additionally, Innosuisse supports scientific startup companies.
- **Swiss Innovation Parks** contribute significantly in fostering knowledge and technology transfer (TT) in Switzerland. The Swiss Innovation Park is a public-private partnership that is funded and managed by the Confederation and cantons, the scientific community, and the private sector. There are two hub locations, one near the ETH Zurich and the other near the EPF Lausanne. There are also three other sites devoted to science and business that are joined together within the same network. Also, most cantons and many urban areas in Switzerland have technoparks where knowledge and technology transfer occur.
- **swiTT (Swiss Technology Transfer) Association**: Swiss universities and academic research institutes developed a professional framework to support cooperation with the private sector and the commercialisation of technologies. swiTT recognises “Technology Transfer” as converting scientific research into applied use. This transfer is carried out within the framework of successful cooperation with external research partners, protecting intellectual property, licensing such intellectual property rights to existing companies or new enterprises, or similar transfer processes.
- **Swiss Network for Innovation (SNI)**: In late 1999, SNI came into force with a vision catered by the State Secretary for Science and Research. The foundation aims to support tertiary education organisations in their tech transfer activities. All cantonal universities (Cantonal universities are operated and managed by individual cantons e.g. the University of Bern, University of Geneva, University of Fribourg etc.), the Federal institutes of technology, the universities of applied sciences, other research institutes, and private companies are members of the network.
- **Unitectra** is the technology transfer (TT) organisation of the Universities of Basel, Bern and Zurich. It supports scientists/researchers collaborating with private industry and other public or private research institutions. The transfer of research results or knowledge into new products and services is fostered in collaboration with the scientists. The technology/knowledge transfer occurs either in partnership with established companies or by creating new spin-off companies. Unitectra also provides services to scientists/researchers positioned at different hospitals and research institutions that are associated with the three universities. The primary services provided by Unitectra include:
    a. Technologies/knowledge commercialization of the research results, commercialization strategy, and search for suitable commercial partners.
    b. IPRs management and protection of rights held within.
    c. Catering new spin-off at the initial stage.
    d. Capacity building in the TT domain.
    e. Nodal of contact for TT to the private sector
- **Swiss educational institutes and universities**: Swiss higher education institutions are involved in knowledge and technology transfer and providing services to third parties. All Swiss higher education institutions are part of international networks, vital for Swiss research and innovation. Knowledge and technologies are being transferred between Swiss HEI, research institutes, and private sector companies in Switzerland. Swiss universities of applied sciences, which work intensively with Swiss SMEs, are the higher education institutions most actively involved in knowledge and Technology transfer, followed by ETH Domain (ETH Domain comprises the two Federal Institutes of Technology, i.e. ETH Zurich and EPFL Lausanne) institutions.

Major intermediary organisations (e.g. public funding agencies, Knowledge and tech Transfer agencies) have stronger internal ties to higher education institutions or research institutes. The majority Swiss institutions of higher education have TTOs, and they identify and evaluate research findings (invented technologies) with economic potential and collaborate with researchers/inventors to develop a strategy for technology transfer.The Federal control institutes, i.e., two institutes of technology under the Federal system, one in Zurich and the other in Lausanne and research organisations have their TTOs within the institution, and all technology transfer-related activities and licensing activities are performed there only. Cantonal universities have a variety of institutional solutions available. They have dedicated organisations whose ownership rests with the Universities in Bern and Zurich.

- The Federal Act on the Promotion of Research and Innovation (RIPA) regulates the tasks and structure of federal support for research and innovation at both national and international levels. RIPA also sets out the tasks, procedures and responsibilities of funding institutions. Laws & acts explicitly designed to promote innovation and technology transfer. Public financing of research and innovation is primarily the federal government's responsibility. The Act encloses the aim of Confederation that leads
    1. To motivate science R&D and science-based STI developments.
    2. Caters the study and make the most of the innovative outcome.
    3. Networking between stakeholders: Academia and industry.
    4. Availability of funding opportunities with proper utilization.

Technology Transfer Offices (TTOs) have been established in most Swiss agencies that further support technology transfer activities at various institutional levels to promote and support knowledge and technology transfer. Most Swiss higher institutions have TTOs and generally deal with intellectual Property (IP) management for their home institution and several other institutions. TTOs are involved in a broad range of technology transfer activities, of which negotiating research agreements are most common and licensing is the least common. A few of the prominent TTOs in Switzerland's institutions are presented in Table 2.

Table 2: Key TTOs in the Switzerland

Institutions (Universities and Research Institutes)	TTO Name
Ecole Polytechnique Fédéral Lausanne (EPFL) - Federal Institute of Technology	EPFL-TTO
Eidgenössische Technische Hochschule (ETH) Zürich - Federal Institute of Technology	ETH-Transfer
University of Basel/ University of Bern/ University of Zurich	Unitectra
University of Lausanne/ University Hospital of Lausanne (CHUV)	PACTT - Joint technology transfer office of the University of Lausanne and University Hospital of Lausanne
University of Geneva	Unitec
Swiss Federal Institute for Materials Science and Technology (Empa)	Empa-Eawag TT-Office
Paul Scherrer Institute (PSI)	PSI TT-Office
University of Fribourg	Tech Transfer Fribourg
University of Applied Sciences Zurich	Ressort F&E
University of Applied Sciences Northwestern Switzerland	TTO

D. Snapshot of Good Practices in Technology Transfer

Reference from overall technology transfer ecosystem in Switzerland and TT Ecosystem at Swiss Federal Institute of Technology at Zurich, ETH Zurich, Switzerland (Highest performer in technology transfer in Switzerland) &swiTT (Swiss Technology Transfer) Association.
Good Practices in Technology Transfer in Switzerland. Table 3 lists the good Technology Transfer practices in Switzerland.

Table 3: Good Technology Transfer practices in Switzerland

Attributes	Inputs from Swiss Tech transfer system
1. Governance Practices	
Legislature and Policy Inputs: ● National level (National impetus on TT through Act/Law/Policy/Guidelines) ● Institute level (Designing flexible institute policies on TT)	• The **Federal Act on the Promotion of Research and Innovation (RIPA)** depicts the prime protocols and acts that rules the TT ecosystem of the nation. • Most of the Swiss HEI and R&D organisations have developed technology transfer guidelines and policies per the legislation's mandate under the Federal Assembly of the Swiss Confederation.
Governance Model: Setting up a dedicated entity for TT (technology transfer) and sufficient resources devoted to technology transfer by the institute with flexible and efficient institute administrators	• At the national level, academic research institutes and universities in Switzerland collaborated to create a professional organisation known as the **swiTT (Swiss Technology Transfer) Association.** swiTT encourages collaborative efforts with the private sector and the business development of new technologies. • Another national agency, **Swiss Innovation Parks,** is crucial to the country's efforts to spread new ideas and technologies. • Most of the research institutes and higher education universities and laboratories have developed technology transfer entities in their institutes. For example: • **Unitectra** ETH Transfer
2. Organizational and Managerial Practices	
Organization Culture: • Impetus from the top leadership and organisational objectives focus on technology transfer • Organizational standards for promoting technology transfer • Technology transfer is considered a source of revenue (via royalties, licensing fees; sponsored research agreements)	**swiTT is the Swiss Technology Transfer (TT) Association** has • Dedicated TT professionals that extend TT activities for HEI in the public, medical, and NGOs to the private sector. • Provides a forum for exchanging best practices in technology transfer proposals and experiences. • Through professional development, the organization's members promote advancement towards the technology transfer area.
TTO's managerial Position: **Team leader:** A position to manage and lead the overall functioning of the TTO.	**ETH has** • Head of ETH transfer, Equity Management • Head of group • Deputy head of the group, Spin-off licenses and Spin-off label • Marketing and Business Development Administrator • Senior Consultant Patents and Licensing • Technology Manager

Dedicated Team with the following set of expertise: • Financial and market analysis • IP protection and management • Communication • Licensing	• According to the **swiTT**, the public research organisations in Switzerland have staff members who are engaged as full-time equivalents (FTE) specifically for technology transfer activity inside the organisation or institute. The following are some of the areas in which the full-time workforce specialises: ○ IP protection and management ○ IP and technology licensing ○ Management of the research contract ○ Administration activities ○ Drafting and negotiation of research/cooperation agreements ○ Management of patent portfolio ○ Coaching of start-ups Numerous TTOs in Switzerland have partnered with external patent firms and business incubators to outsource IP protection and start-up administration and mentoring, respectively. • Center for Technology Transfer and Enterprise Creation (CTTEC) lead the technology transfer and university entrepreneurship support.
3. Financial Sourcing and Administration Practices	
Financing Sources: • Dedicated financial resources should be allocated to the TTO • Different routes for financial support should be explored by the TTO, such as venture and angel funds; CSR; Alumni funds etc.	• Universities and other research organisations are enthusiastic about collaborating with private businesses, and they encourage and assist their employees in this endeavour. • The TTOs are eligible for a fair financial share of the profits made by the collaboration partner. • Share comes from the industry value of its innovation. • Share of stakeholders is taken care of.
Financial governance: Regular audits (focus on technical audits)	• Specific financial governance practices and audit requirements can vary among different TTOs in Switzerland. Each TTO may have its policies, procedures, and compliance standards. • Audits play a crucial role in assessing the financial governance of TTOs. While financial audits are standard, technical audits focusing on the technology transfer process may also be conducted. These audits help identify areas for improvement, evaluate compliance, and provide assurance regarding the accuracy and reliability of financial information.
4. Functional Practices	
Safeguard the organisational intellectual property: The organisation should have a balanced approach towards exercising IP rights; they should be more open to licensing the technology rather than blocking it in IP form.	• Universities and research institutes in Switzerland recognise the importance of IP protection and the use of resultant IPRs of research for industry capitalization in the future. • In addition to research and education, **ETH Zurich** caters to industry interconnect to flourish innovation ecosystem to accelerate the profits of the Swiss economy and stimulate a constant source of income for R&D. • Employees and researchers of ETH Zurich can directly contact ETH transfer to obtain protection for intellectual property (IP).

Knowledge enhancement in getting overview of HEI, Industry and related science advocacy. • Technology assessment exercise • Technology Readiness Levels (TRLs) • Technology valuation • Commercial potential exercise • Technical specificities • IP ownership (type of IP licensing) • Negotiate Licensing agreements • Market the IP to private firms	As per the swiTT Annual Survey, 2022 the TTOs established at universities and public research organizations undertake: • Research collaborations with innovation actors (manage contracts for the same). • IP protection and management • IP commercialization • Evaluation of commercialization potential • Few TTOs also provide mentoring for start-ups based on the knowledge and intellectual property generated by host organisations. The majority of university TTOs deal with the administration and commercialization of intellectual property (IP), which includes assessing the commercialization potential of products, protecting and managing IP, and licencing or selling IP to industrial partners.
5. Output /Reporting Practices	
Documented Output of TTO: • Licences; Royalties; Patents; sponsored research agreements; start-up companies; invention disclosures; Students; informal transfer of know-how; Product development; Economic development • Dedicated website/portal to display information • Updating the website/portal User-friendly portal to make matchmaking.	**swiTT** maintains a database of technology and licensing opportunities from public research and education institutions. • The swiTT website covers all the required details and catalogues the tech transfer system with an effective data structure in pictorial form. • User-friendly portal exists to scout the technologies (https://switt.ch/swiss-technology-transfer).
Reporting in Annual Reports released by TTO: • Average Annual Licensing agreement • Average Annual Licensing Revenue	The data is presented annually through reports such as the swiTT Report 2022 (Swiss Technology Transfer Report 2022), a survey of TTO activities at higher education and research institutes in Switzerland.
6. Linkages and Network-Oriented Practices	
Effective interface/portal /technology display /exhibitions	Each consortium for technology transfer, institute, and university has created effective website portals/tabs showcasing the developed and transferable technologies.
Types of **relationship/networks** • Informal networks • TTO act as a platform to connect scientist and industry • Dissemination of information from private firms to academicians. • Outreach activities • Agreement relationships **Network building:** Effective communication with stakeholders across the system and forging alliances between scientists and industry Linkages pre TT • Industry-academia connect • Entrepreneurship-scientist connect	The greatest asset of the ecosystem for technology transfer is its network-centric approach to knowledge and technology transfer, as well as its connections. **swiTT** facilitates and strengthens cooperation as well as technology flow to and forth between industry and research organization of Swiss in public domain. Additionally, under the RIPA Act, the Confederation aims to 'Ensure the cooperation between research bodies (i.e. The research institute and private sector)'.

Technology exhibitions and technology demonstrations Linkages post-TT ● Scientist/researcher continues involvement with the firm ● Faculty member/scientist serve as a technical advisor or on board of directors for the firm (especially in case of start-ups)	
7. Incentivising Practices	
Motivate scientists/ faculty/ researchers to develop technology and undertake the TT process ● Royalty distribution formula (typically ranging from 25% to 50%) ● Awards (recognition within the scientific community) ● Promotional incentives	The annual survey is conducted, and institutes with superior technology transfer are acknowledged and financially rewarded for their achievements...
Motivating industries to collaborate with academia and research institutes for TT ● Financial and technical gain to the industry ● Utilization of CSR funding for R&D	Industries are self-motivated and recognise the importance of knowledge sharing, collaborative research and innovation, and the active dissemination of technology via academic and research institutions.

E. Case Study

Swiss Federal Institute of Technology Zurich (ETH Zurich)

- **Tech Transfer Office (TTO):** ETH Zurich has established a dedicated office, '**ETH transfer**', at the Swiss Federal Institute of Technology Zurich. TTO cater for the ETH community in the domain of TT, such as agreements signed with private sector Patent-related works.
- **Governance and administration:** ETH Transfer works under the leadership of the vice president of Knowledge Transfer and Corporate Relations.
- **Activities:** The office is responsible for negotiating licensing agreements and supporting ETH's patenting and licensing activities**.**
    - ETH transfer supports the researchers of ETH Zurich with topics related to research agreements with third parties and also obtains permission from the Vice-President for joint research projects and opens funds with the Finance Desk.
    - ETH Transfer at ETH Zurich supports and takes activities from technology assessment to technology valuation and IP management and carrying out market scouting and licensing negotiation through specified licensing agreements.
    - The office safeguards and monitors ETH discoveries/technologies, research, and inventions following the required Federal Technology Transfer Act and related acts/laws.
    - Office supports the ETH Zürich community in protecting their IP rights and sealing their agreements with the private sector.
    - ETH transfer caters for innovators in terms of valuation and proprietary rights.
    - Innovation protection through patents is of prime importance.
    - Any Startups related to ETH Zurich may apply for the ETH Spin-label. Additionally, ETH transfer regulates and is responsible for licensing contract negotiations.
    - ETH Transfer also manages the Office of Knowledge Transfer and Corporate Relations that facilitates and manages:
        i. Research collaborations and partnerships with industry, governmental agencies, non-profits, and other academic institutions
        ii. Protection and licensing of intellectual property
        iii. Support for entrepreneurs at ETH and interaction with ETH entrepreneurs
        iv. Exchange of ETH researchers with industry, policymakers, and the public administration.

  Similarly, there are many other remarkable success stories related to technology transfer in Switzerland.
- **Team:** The office has a dedicated team that oversees IP management and licensing, concentrating on royalty/equity share management disbursement. The primary responsibilities of the team include:
    - Controlling licensing contracts and research contracts.
    - Protects patents, licences, and software licences.
    - Management of spin-offs, Pioneer Fellowship, Venture Program & Strategies Team.
- **The Venture Programs & Strategies Team within ETH transfer** is a temporarily formed unit for 2-3 years to address the relevant tactical queries about value creation, start-up support, pioneer fellowship program and the ETH incubator development. The goal of the Venture Programs & Strategies Team within ETH transfer is:
    1. Value creation strategy
    2. Revising the equity and licensing policy
    3. Revising the spin-off guidelines
- **Venture strategy**
    - Developing various support programs for ETH start-ups
    - Developing a funding strategy for these support programs
    - Pioneer fellowship program
    - Streamlining the pioneer fellowship acceptance and jury process
    - Revising the PF guidelines and various documents and templates

- ETH incubator strategy
- Developing the business plan for a true ETH Incubator

- **Recognition:**

The Spark Award: The Spark awards are presented by ETH Zurich to the most promising inventions of the past year which have also resulted in a high quality, strong patent. Originality of the invention, patent quality and market potential are considered while making the selection.

Annexure II(C)
UNITED STATES OF AMERICA

United States of America (USA)

A. Innovation Profiling

The United States of America (U.S.A.) has a robust legislative framework for promoting innovation and technology transfer. It has been among the pioneers in cutting-edge science, innovation, and technology for decades. The United States ranks 2nd among the 132 economies worldwide in the Global Innovation Index (GII), 2022. According to the GII report 2022, the United States performs better in terms of innovation inputs (2nd place; a measurement of the factors that contribute to and facilitate innovation, such as infrastructure, institutions, human capital, research, business and market sophistication). In terms of innovation outputs, it ranks 5th place.

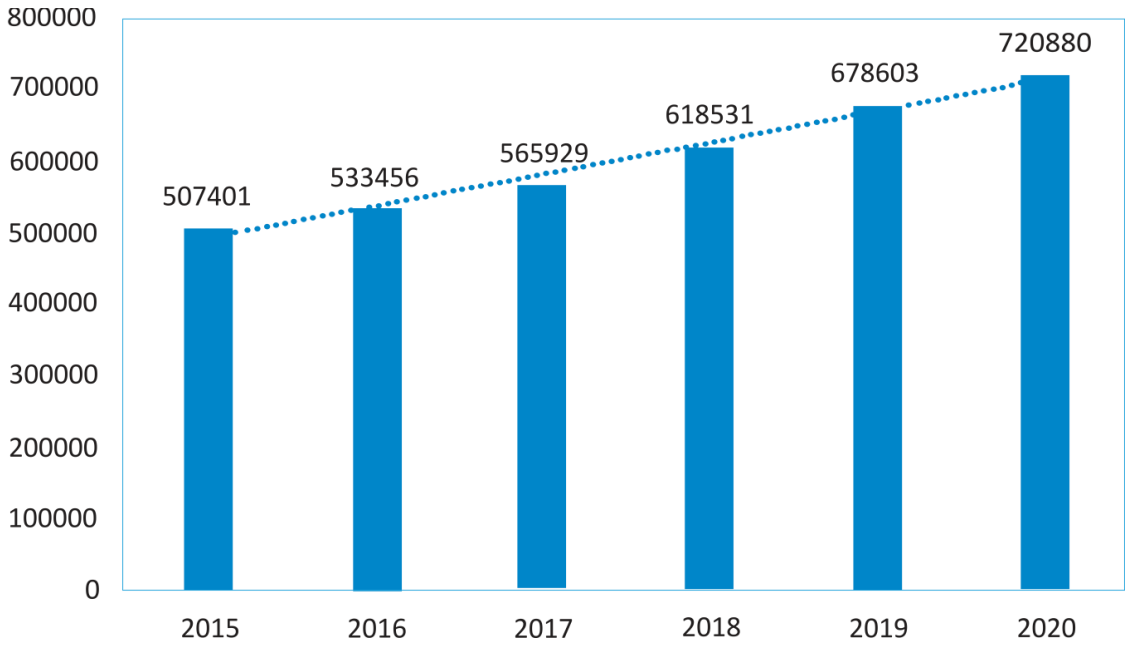

Figure 1_USA: Gross Expenditure on R&D by USA[4]

From an analysis of 2015 to 2020, it is evident that the business sector is the most significant contributor to GERD in financing and performing R&D, followed by the government, the higher education sector, and private non-profit organisations (Figures 1_USA and 2_USA). USA is ranked 1st globally in terms of market sophistication, which contributes as one of the significant inputs for innovation. The United States has 9.9 total researchers per 1000 employees in full-time equivalent mode. The United States' aggregate expenditure on R&D at current prices adjusted for purchasing power parity increased by 42% between 2015 and 2020 (Figure 1_USA).

[4] **Source: OECD, 2022**

The USA contributes more than 2% of its Gross Domestic Product (GDP) to Gross Expenditure to R&D (GERD) (Figure 2_USA).

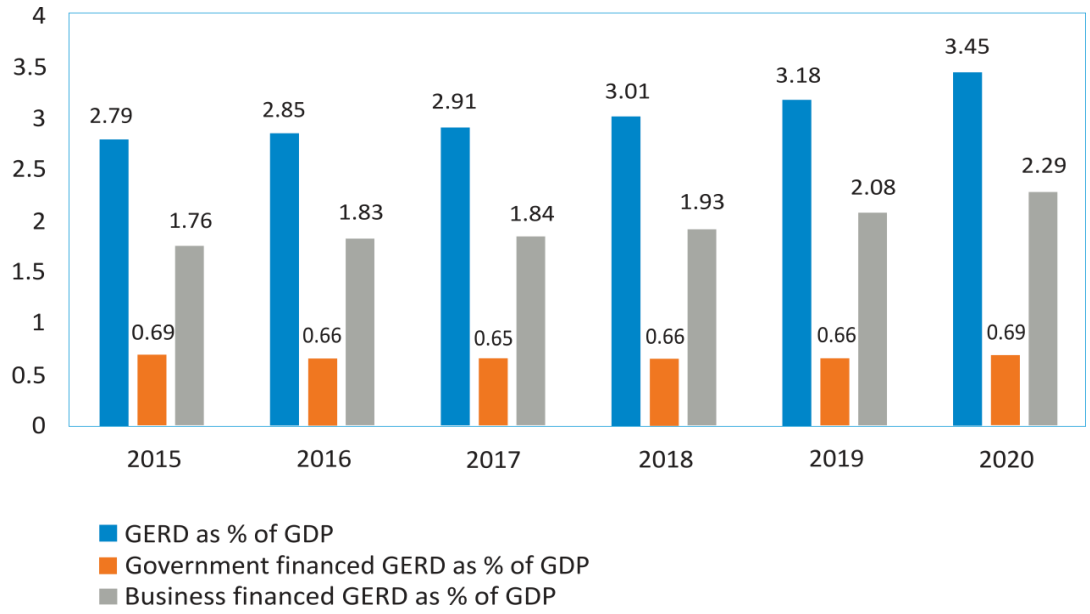

Figure 2_USA: Gross Expenditure on R&D (GERD) as % of Gross Domestic Product (GDP), OECD Publishing, Paris[5]

On the other hand, the USA has demonstrated increased innovation outputs as per the innovation investments made in the country (Figure 3_USA). The innovation ecosystem of the USA lies on three key innovation pillars comprising the federal government system, the business environment, and the education and research ecosystem. The USA has set up a solid regulatory and business environment that is pushing innovation in the country.

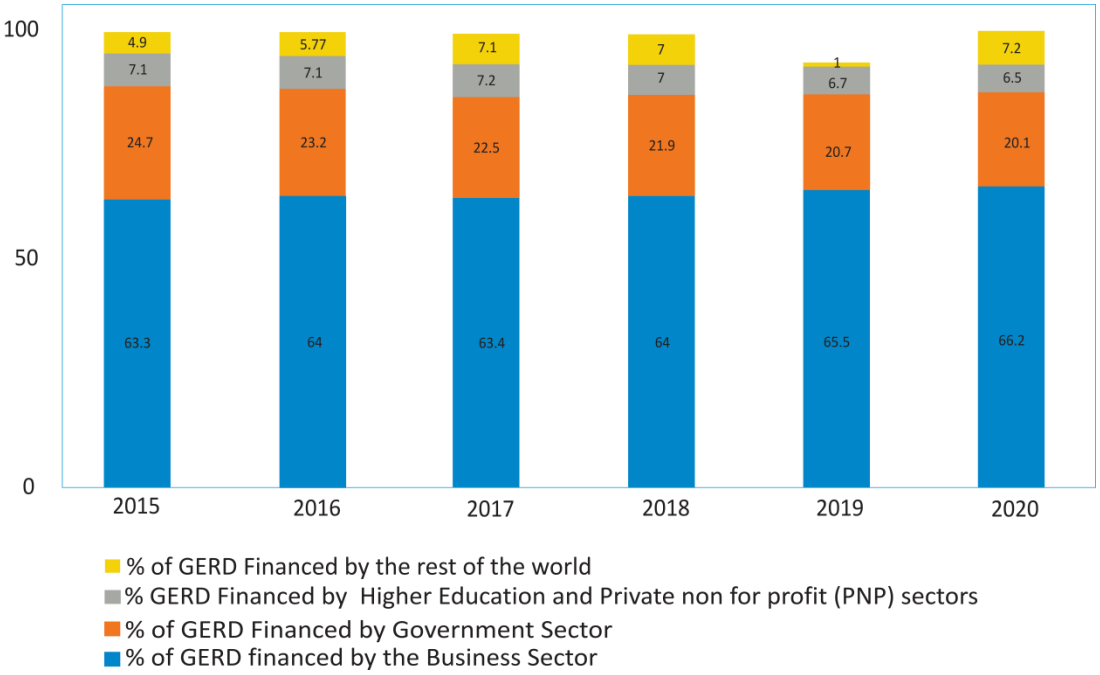

Figure 3_USA: Percentage of Gross Expenditure on R&D (GERD) financed by Sectors, OECD Publishing, Paris[6]

[5] **Source: OECD, 2022**
[6] **Source: OECD, 2022**

B. Innovation Actors

B.1. Government System

The United States Federal Government has established key offices to provide innovation policy and regulatory environment support to pursue innovation in the country. The key offices are as follows:

- **Office of Science and Technology Policy (OSTP)**: It is one of the foremost scientific bodies in the United States. It develops and implements national science and technology policy and determines the budgets of various funding agencies. OSTP regulates a variety of initiatives, programmes, projects, and activities that result in advancements in science, innovation, and technology.

- **President's Council of Advisors on Science and Technology (PCAST)** is an autonomous Federal Advisory Committee comprising members from various domains, including business, academia, and the non-profit sector, with diverse perspectives and skills. The PCAST provides advice to the President based on substantial evidence on science, technology, innovation policy, and scientific and technological information issues.

- **National Science and Technology Council (NTSC)**: The specialist Cabinet-level Council established on Nov 23, 1993, presents recommendations on the subjects associated with innovation. It intends to regulate science and technology policy among the many Federal research and development bodies. The NSTC is responsible for the following activities:
  - To coordinate the development of S&T policy.
  - To guarantee that decisions regarding science and technology policies and programmes align with the President's policy priorities.
  - To ensure the President's science and technology policy strategy is implemented throughout the Federal Government.
  - To ensure that S&T are considered in the development and implementation of Federal policies and programmes.
- **National Science Foundation (NSF)**, an autonomous agency of the United States government, is another body that deals with innovation. The NSF's mission is to promote fundamental research as well as education in all sectors of science and engineering, except medicine. The primary responsibilities include fostering the advancement of scientific research, enhancing national health, prosperity, and welfare, and ensuring the country's safety and security. The NSF grants funding for research projects and cutting-edge infrastructure and creates educational opportunities offering new skills for science and engineering students. The agency provides funding for research in traditional academic fields; however, in addition to this, it also assists with cutting-edge ideas, creative collaborations, and countless projects in the sphere of innovation and S&T.
- **Funding:** The majority of federal funding comes from agencies with specific missions, such as the Department of Defence, the Department of Energy, the Department of Health and Human Services (HHS), the United States Department of Agriculture (USDA), and the National Aeronautics and Space Administration (NASA). In 2018, HHS, which includes the National Institutes of Health (NIH), contributed more than half (or $22.9 billion) of the federal government's funding for academic research. Academic research that is federally supported is dominated by the life sciences, which also significantly contributes to formal technology transfer. The US federal government comprises more than 20 departments and independent federal agencies that support and invest in R&D. The funding is dependent on the mission of each department and agency and the scope of R&D in the same.

- **Innovation support:** The USA has several programmes to support and promote innovation in the country. The key government programmes for innovation are described in Table 4. These programmes are designed per national priorities and stimulate businesses to come forward and contribute to the national innovation ecosystem. Small Business Innovation Research (SBIR) Programme and Small Business Technology Transfer (STTR) Programme are prominent examples of government support for innovation in the private sector. Many other countries replicate these programmes to promote innovation.

Table 4: The key government programmes for innovation

Sr. no.	Innovation Programmes	Brief details
1.	Industry/University Cooperative Research Centres (I/UCRC) Programme Promoted and backed by NSF	The program was established in 1980 to develop and foster collaborations amongst the academia, government and industry. One of the programme's objectives is to expand the innovation capacity of the US competitive workforce through partnerships b/n industry and universities.
2.	The National Network for Manufacturing Innovation (NNMI) Programme, also called as ''Manufacturing USA,'' Supported by PCAST	Programme launched in 2011 to develop and commercialise manufacturing technologies through Public Private Partnerships (PPP) between the Federal government, Industries and Universities of the USA. The program provides enhanced and high-end infrastructure required for academia and industry to work together to resolve problems pertinent to the industry.
3.	Grant Opportunities for Academic Liaison with Industry (GOALI) Programme Supported by NSF	Initiated in 1995, the programme aims to promote University-Industry partnerships by providing funding/fellowship support to U-I linkages. It was designed to find newer solutions, discover novel approaches to generic issues, and evolve U-I joint educational programmes.
4.	Small Business Innovation Research (SBIR) Programme Program led by SBA (Small Business Administration), Office of Investment & Innovation (OII) and currently administered by 11 Federal Agencies.	The Small Business Innovation Development Act of 1982 established the programme in 1982. The initiative was to invigorate technical revolutionary innovation amongst the private sector, especially small businesses. The programme also aimed to motivate small enterprises and industries to innovate, market their research, and bolster the US economy.
5.	Small Business Technology Transfer (STTR) Programme Governed by SBA (Small Business Administration), Presently implemented by five Federal Agencies (DoD, DoE, NASA, NIH, NSF).	As a consequence of the Small Business Research & Development Enhancement Act of 1992, the programme was initiated in 1992. The main aim of the initiative is to diminish the gap b/n elementary science and conversion of its results into commercial entities. Constitutionally, this programme is intended to foster collaboration between innovative Small Business Concerns (SBCs) and research institutions.

- **Legislative norms:** The USA has established strong legislative norms for Innovation through various Acts/laws/policies. To maintain competitiveness and establish a hospitable environment for bringing ideas to market, science and technological research must be governed by policies, laws, and acts. Administrative regulation ensures equitable "ground rules" for all innovative economic actors. These legislative instruments/acts/laws have played an essential role in stimulating innovation and promoting technology transfer. The list of legislative instruments that have played a significant role are described in Table 5:

Table 5: Legislative instruments to promote innovation and technology transfer

S. No.	Legislative instruments	Brief details
1.	Stevenson-Wydler Technology Innovation Act, 1980	It is the first statute the US federal government enacted that requires federal laboratories to actively engage in technology transfer by allocating budgetary resources for such operations. According to the law, each government laboratory must set up an "Office of Research and Technology Applications" to facilitate technology transfer.
2.	The Bayh-Dole Act or Patent and Trademark Law Amendments Act, 1980	The act passed in 1980, aimed to provide incentives for the commercial exploitation of research outcomes from federally funded initiatives. The Bayh-Dole Act allows institutions to own patents developed with federal funding and grant industry collaborators licence rights. The act significantly increased patenting, licensing, entrepreneurship, and startup activity at these host institutions and universities.
3.	Federal Technology Transfer Act (FTTA), 1986	The act was introduced as an amendment to the 1980 Stevenson-Wydler Act, emphasising industry access to federally funded technologies developed in federal laboratories. This resulted in the establishment of the 'Federal Laboratory Consortium for Technology Transfer'. It encouraged federal laboratories and non-federal stakeholders to negotiate Cooperative Research and Development Agreements (CRADAs) as formal agreements.
4.	National Technology Transfer and Advancement Act, 1995	Modifying the Stevenson-Wydler Act of 1980 ensures that enough intellectual property will be transferred through CRADAs, making them a more appealing instrument for industry. It also led to the development cooperative technology standards for entering into such agreements.

- **Government Incentivization for Innovation**: The government has various innovation incentives to motivate faculty/scientists/researchers/businesses to develop and commercialise technologies at the institutional & industrial level. On the other hand, incentivisation mechanisms also attract the industry to take up technologies developed by academic and research institutes.

Types of Innovation Incentives

- **Federal grants**: The US federal government offers more than 900 programmes that provide grants for a variety of purposes, including (i) promoting and supporting trade and business; (ii) improving diet and nutrition, health, and environmental standards; (iii) improving and supporting agriculture and agricultural operations; (iv) improving energy resources; (v) promoting employment and workforce management; and (vi) fostering and/or undertaking science and technology.
- **R&D tax incentives**: A non-refundable research tax credit in the US can be used to lower income taxes. The research tax credit is calculated as a percentage of qualifying research expenditures above a certain threshold.
- **Targeted Research Credits:** Some other research credits are available that are aimed at funding particular kinds of research, such as the following: (i) a 20% credit for expenditures made to energy research consortia; (ii) a 20% credit for payments made to basic research conducted by academic

institutions and research organisations; and (iii) a 25% research credit for clinical testing related to orphan medicines (offering a credit equal to 25% of the funds utilised for clinical research) for tax years.

- **Small Businesses and Startups**: In order to pay less in payroll taxes for tax years beginning after December 31, 2015, eligible small businesses can use research credits.

B.2. Education and Research Institutes

- USA has the most prominent educational ecosystem in the world, and American schools and institutes are well known for providing high-quality education through a balanced, tried-and-tested curriculum. More than 4000 academic and 260 research institutes are in the USA.

  The top innovation-backed universities are as follows:

  1. Harvard University
  2. Massachusetts Institute of Technology
  3. Stanford University
  4. University of California, Berkeley
  5. University of California, San Diego
  6. Cornell University
  7. Johns Hopkins University
  8. University of Washington
  9. Northwestern University, Evanston
  10. Toyota Technological Institute at Chicago

- US government, departments, and independent agencies have set up nearly 300 scientific research and innovation laboratories. Federal laboratories can be accessed from the National Centre of Biotechnology Information (NCBI) website. Office of National Laboratories has been established to coordinate research and development activities among the federal laboratories and present a coordinated and collaborative network of federal laboratories.

  The top 10 innovation-ranked federal research laboratories of the US are listed below:

  1. Joint BioEnergy Institute
  2. National Center for Biotechnology Information
  3. Centre for Biologics Evaluation and Research
  4. Lawrence Berkeley National Laboratory
  5. Doe Joint Genome Institute
  6. National Renewable Energy Laboratory;
  7. National Institute of Standards and Technology
  8. Sandia National Laboratories, California
  9. Argonne National Laboratory
  10. Joint Quantum Institute

In the US system, academic and research laboratories are recognised as the centre for entrepreneurship, innovation, and research, where human capital is developed globally. Academic institutes and research laboratories have developed close relationships with businesses and are primarily engaged in cooperative research and development. The United States has developed robust interconnections with the private sector, which is propelled by the government's legal standards, and much of the generated knowledge is successfully commercialised by the private sector.

B.3. Industry System

Industry has led numerous R&D and innovation initiatives, making business R&D one of the most influential actors in the US innovation ecosystem. Nearly two-thirds of U.S. business R&D is contributed by manufacturing sector industries, with the remaining one-third by non-manufacturing sector industries.

The top 10 R&D Investing companies in the USA are as follows:

1. Alphabet (ICT Services Sector)
2. Microsoft (ICT Services Sector)
3. Apple (ICT Producers Sector)
4. Facebook (ICT Services Sector)
5. Intel Corp (ICT Producers Sector)
6. Johnson & Johnson (Health Sector)
7. Bristol-Myers Squibb (Health Industries)
8. Merck Us (Health Industries)
9. Pfizer (Health Industries)
10. Ford Motor (Automobiles & other transport)

B.4. Intermediary System

The United States has created a robust environment conducive to innovation, as illustrated by the following examples:

- **Intermediaries to support technology transfer activities**: The federal laboratories and universities have set up technology Transfer Offices/Technology Licensing Offices undertaking IP management and technology transfer.
- **State-level Innovation Development Centres**: Such Centres are set up by the government or academia with government funding in universities to support regional innovation ecosystems. One such example is the establishment of the College of Nanoscale Science and Engineering (CNSE) at the University of Albany to serve as a catalyst for regional innovation in nanoscience and engineering.
- **Translational Research Centre**: these are also established at the regional level to support translational research ecosystems and promote the conversion of academic and research knowledge into marketable technologies applicable to society. These centres are driven by the government (federal and State). One such example is the creation of the National Additive Manufacturing Innovation Institute (NAMII) to promote manufacturing innovation. It is a public-private partnership involving Ohio-based manufacturing companies, universities, non-profit organisations, and community colleges.
- **Corporate Research labs:** established by private firms in universities to build the innovation and technology space where academic expertise can be utilised for the research and innovation agenda of private firms.
- **Corporate Alliances:** established in universities in partnership with corporate firms and not for profit organisations to bridge academic knowledge translation with the market. Example, corporate alliances established in University of Pennsylvania to undertake multi topic research and avail funding support to pursue specific projects.

Regional Innovation Clusters: Innovation clusters are established in various geographical regions that have concentrated knowledge generators and knowledge consumers. These clusters are acting as hubs consisting of small and large businesses, suppliers, knowledge institutions, and other organisations to drive innovation in the region. Example: Acendian LLC (Set up to promote domain pharmaceutical supply chain); AgLaunch Initiative - Mid-South Delta Ag Innovation Cluster in the domain agriculture; Great Plains Technology and Manufacturing Cluster in the domain manufacturing technology amongst the other key clusters.

- **Incubators and Accelerators:** Wide network of incubators and accelerators have been established by public and private sectors, for example Incubators Y Combinator and TechStars, to support early-stage startups and entrepreneurs by providing training, mentoring and funding support.

There are other actors that exist in the US innovation ecosystem across federal laboratories, universities and independent existing that play a facilitative role in strengthening the innovation ecosystem. For example, the Clean Energy Institute at the University of Washington (https://www.cei.washington.edu/). The institute was established in 2013 with funding support from Washington to “accelerate the adoption of a scalable and equitable clean energy future that will improve the health and economy of our state, nation, and world.”

B.5. Innovation linkages

USA demonstrates strong interlinkages between the innovation actors, mainly between government, industry and academia, along with intermediary organisations facilitating such linkages. The figure below highlights the innovation governance in the USA.

- The government that provides the country's legislative and administrative framework for innovation.
- Innovation is mainly performed by the industrial sector (majorly), and the research and education sector, and both these sectors are supported and facilitated by the government sector.
- Facilitation is provided by the network of intermediaries that comprise regional chambers/intermediaries and national academies, national institutes, innovation clusters and private foundations, as highlighted in the figure below.
- The industrial, research and education institutes have developed linkages that have led to collaborative research and innovation.
- The infrastructure support to pursue innovation in the country is provided under the legislative and administrative norms set by the government and is facilitated by the contribution from banks and venture capitalists.

C. Technology Transfer Ecosystem of USA

The federal government has significantly contributed to the technology transfer ecosystem through several laws and regulations that were created mainly to encourage the technology transfer of federally supported research, projects, and innovations. In the US context, formal and informal technology transfer is undertaken.

- **Formal technology transfer** is initiated with federal funding support for R&D that results in discovery/invention that has commercial potential. The scientist or faculty member conducts research and development and then files an invention report or disclosure to set the groundwork for Invention's IP protection or Intellectual Property Rights (IPR). The IP protection further leads to the licensing of the invention to commercial entities of the startups or any other organisation to create a product. In return, universities/laboratories receive financial rewards or incentives through equity, royalties, and income from licensing.
- **Informal Technology transfer** is undertaken by forming engagements with the industry that can lead to joint venture formation, partnerships, cooperative agreements, sponsored research, etc.

Technology Transfer Ecosystem in Federal Laboratory
The federal system has established various vehicles for building a technology transfer ecosystem of federal laboratories, which are as follows:

- **Technology Transfer Offices (TTO)** are set up in most federal agencies, supporting technology transfer activities in their respective federal laboratories. For example, the National Institute of Health (NIH), a federal agency, has a dedicated 'Technology Transfer and Intellectual Property Office' that manages patent portfolios and undertakes licensing agreements. In another example, the Office of Science of the Department of Energy has established the Office of Technology Transitions (OTT) along with the Technology Transfer Policy Board to provide support and to ensure that the federal laboratories undertake robust technology transfer activities. The Chief Technology Officer heads the office. The other Federal agency, 'The Centers for Disease Control and Prevention', has set up TTO and partners with other government agencies, academia, industry, and non-profit organisations to transfer CDC technologies.

- **Federal Laboratory Consortium (FLC)** for technology transfer has been formally created that comprises a network of nearly 300 federal laboratories, research centres and agencies for fostering technology transfer and adapting best practices to translate technology from lab to market. It has undertaken various instruments for spurring technology transfer such as FLC awards, FLC planner, Labs in Action programme, etc. FLC also provides training and education to the tech transfer professionals, focusing on educating them with commercialization strategies.

- Setting up **Innovation Corps** to assist scientists in focusing on fundamentals related to commercialization and technology transfer. Such Innovation Corps have been established by federal organisations like the National Science Foundation (NSF) and the Department of Energy (DOE) to accelerate the process of technology transfer.

- Introducing programmes like '**Entrepreneur in Residence'** that provide mentorship to researchers/scientists on technology commercialization of new technologies.

- **Creation of Technology Transfer Coordinators (TTCs**) by agencies which are stationed in various geographical regions and undertake activities such as planning, coordinating, evaluating and administrating technology transfer activities. USDA's Agricultural Research Service (ARS) has placed 7 TTCs stationed in different geographical locations across the country. Till date USDA has taken this initiative while other funding agencies are in process of creating such TTCs.

- **Adoption and wide promotion of Federal R&D programmes such as SBIR and STTR** that provides support to industry for technology/knowledge transfer from the federal laboratories. The role of SBIR and STTR is further strengthened by SBIR/STTR Reauthorization Act, 2011 and corresponding SBA policy memorandums.

Federal agencies have come together to set up 'Interagency Workgroup on Technology Transfer' that works for developing reports and evaluation of R&D commercialization through metrics and means to quantify technology transfer impact. These vehicles have been contributing to formal and non-formal ways of technology transfer facilitating partnerships between federal government agencies and the non-governmental organisations and other entities. The federal agencies take up through their respective offices process the patent applications and undertake Cooperative Research and Development Agreements (CRADAs) for knowledge transfer, focusing on knowledge ownership and licensing rights.

Technology Transfer ecosystem in universities

Most of the universities have set up technology transfer offices and developed ways for undertaking strategic partnerships and collaborations for knowledge sharing and transfer. As per the report entitled Research to Renewal: Advancing University Tech Transfer released by *Heartlandforward.Org* in 2022, a comparative analysis of the technology transfer undertaken by universities is carried out. The top 25 universities in terms of technology transfer are highlighted in the USA map below.

The Carnegie Mellon University (CMU) in Pittsburgh, Pennsylvania, is the topmost ranked in technology transfer in the USA. The university has shown exceptional technology development, demonstration and commercialization in fields focusing on computer science, engineering, and other interdisciplinary areas. The University of Florida ranks second, Columbia University ranks third, Stanford University ranks fourth, and Harvard University ranks fifth.

The key attributes of the technology transfer ecosystem in universities are highlighted below:

- All the top 25 universities in technology transfer have long-established Technology Transfer or Technology Licensing Offices. The institutes have made technology transfer the key priority of the organisation. These offices are working as an interface between knowledge producers and knowledge consumers. However, it was observed that these offices have different governance structures in terms of:
  - Levels of autonomy
  - Reporting relationships
  - Resource Commitment
- Almost all the universities and their formal mechanisms have established informal channels to collaborate with the local/regional firms to form partnerships and collaborations that lead to technology transfer, student/faculty exchange and long-term collaborations. The universities have introduced graduate programmes in partnership with the industry (local) to promote employment and initiate the technology transfer process.

- These TT offices receive federal funding specifically for formal technology transfer. Universities have also established Innovation Corps under funding from the National Science Foundation to engage researchers and faculty with technology commercialisation activities.
- In addition to the dedicated policies for intellectual property and technology transfer as per the mandate highlighted by the Bayh Dole Act. Universities have also established incubators, accelerators and other facilitating entities that directly and indirectly play a role in technology transfer. These entities help build the entrepreneurial ecosystem and facilitate knowledge transfer from the academic setting.

D. Snapshot of Good Practices in Technology Transfer

Reference from overall technology transfer ecosystem in USA Table 6 lists the good Technology Transfer practices in the USA.

Table 6: Good Technology Transfer practices in USA

Attributes	USA
1. Governance Practices	
Legislature and Policy Inputs: ● National level (National impetus on TT through Act/Law/Policy/Guidelines) ● Institute level (Designing flexible institute policies on TT)	The legislative framework for promoting technology transfer (and bringing required impetus to technology transfer). The key legislative norms that stimulated technology transfer in the country are as follows: • Stevenson-Wydler Technology Innovation Act of 1980; • Bayh-Dole Act of 1980 - 35 USC 200; • Federal Technology Transfer Act (FTTA) of 1986 - 15 USC 3710; • The National Competitiveness Technology Transfer Act , 1989 As mandated by the Office of Science and Technology Policy of the White House, most of the nation's institutes, including federal laboratories and universities, have developed technology transfer policies and guidelines. A Green Book has been developed by Federal Laboratory Consortium for the Federal Technology Transfer Legislation and Policy that provides policy guidelines for technology transfer. USA has also developed dedicated **'metrics of commercialization'** and critical indicators and sub-indicators to evaluate technology transfer carried out in the country through research universities and national laboratories.
Governance Model: Setting up a dedicated entity for TT (technology transfer) and sufficient resources devoted to technology transfer by the institute with flexible and efficient institute administrators.	Dedicated entities established for technology transfer at the national level and institute level. Most universities have created their own Technology Transfer Offices (TTOs) with different structures based on centralised or decentralised approaches. After the Bayh–Dole Act was enacted in 1980, numerous US universities and institutes channelled their innovation dissemination endeavours through a centralised KTO. While many of the top 25 universities for tech transfer have TTOs that have been around for a long time, some institutions have built successful initiatives more recently by making tech transfer a priority and picking up lessons from their experienced counterparts.

<table>
<tr><th colspan="2">2. Organisational and Managerial Practices</th></tr>
<tr><td>Organization Culture:
Impetus from the top leadership and organisational objectives focus on technology transfer
Organisational standards for promoting technology transfer
Technology transfer is considered as a source of revenue (via royalties; licensing fees; sponsored research agreements)
Organisation passionate to removing regulatory and informal obstacles that slow down TT</td><td rowspan="2">There are two fundamental models for administering licensing offices: centralization and decentralisation. The conventional structural system, in which a TTO is formed at the central level of the university, is now being supplemented by decentralised TTOs at the level of research groups and departments in many universities.</td></tr>
<tr><td>Managerial Position in TTO: Team leader and managerial position has to be there to lead the overall functioning of the TTO
Dedicated Team with following set of expertise:
Financial and market analysis
IP protection and management
Communication
Licensing</td></tr>
<tr><td colspan="2">3. Financial Sourcing and Administration Practices</td></tr>
<tr><td>Financing Sources:
Dedicated financial resources should be allocated to the TTO
Different routes for financial support should be explored by the TTO, such as venture and angel funds; CSR; Alumni funds etc.</td><td>Dedicated financial resources are allocated to TTOs in the USA. For example, the University of California, Office of Technology Transfer: The University of California system has a dedicated TTO that receives financial support from the university. This allows them to have a team of experienced professionals who manage the technology transfer activities across the various campuses and assist in commercializing innovations developed by faculty and researchers. On the other hand, the National Institute of Health (NIH) has its own TTO called the Office of Technology Transfer (OTT). The NIH budget funds the OTT and receives dedicated financial resources to manage the technology transfer activities of the NIH's research institutes and centres.</td></tr>
<tr><td>Financial governance:
Regular audits (focus on technical audits)</td><td>Financial governance and regular audits are essential to managing a USA Technology Transfer Office (TTO). In comparison, the specific audit practices may vary across institutions, including financial reporting, internal controls, compliance and risk management, technical audits, etc.</td></tr>
<tr><td colspan="2">4. Functional Practices</td></tr>
<tr><td>Safeguard the organisational intellectual property:
The organisation should be less aggressive in exercising IP rights and more open to licensing the technology rather than blocking it in IP form.</td><td>The Bayh-Dole Act supported that, too, in favour of inventors to pursue licensing for their protected IP or filed IP.</td></tr>
</table>

Market the IP to private firms.	This is the most prevalent practice in the US ecosystem, where linkages between industry and academia are pretty productive as knowledge gets transferred from academia to industry, and TTOs play a significant role.
University, corporate, or scientific norms and environment comprehension ● Technology assessment exercise ● Technology Readiness Levels (TRLs) ● Technology valuation	There are dedicated standard operating procedures and protocols allocated for this. There are advanced management services for skilling TTO professionals, such as AUTM certificate in Technology Transfer.
Commercial potential exercise	This forms the basis of technology licensing, where TTOs carry out the market potential commercial utility and valuation.
Negotiate Licensing agreements: ● Royalties/equity ● Technical specificities ● IP ownership (type of IP licensing)	This is a crucial activity and functional practice of TTOs, as highlighted in the case studies.
5. Output /Reporting Practices	
Documented Output of TTO: Licences; Royalties; Patents; Sponsored ; Research Agreements; Startups; Invention Disclosures; Researchers/Students; Informal Knowledge Transfer; Product Development; Economic Development Dedicated website/portal to display information ● Updating the website/portal ● User-friendly portal to make matchmaking	TTOs report their outcomes in their reports. In addition, survey is carried out by AUTM that specifically culminate the inputs and output related data from TTOs, review it and releases specific rankings and performance of the TTOs.
Reporting in Annual Reports released by TTO: ● Average Annual Licensing agreement ● Average Annual Licensing Revenue	TTOs have diverse reporting relationships, degrees of autonomy, and resource commitments. For instance, some offices report directly to the university's chancellor. A few TTOs are autonomous organisations, such as the WARF.
6. Linkages and Network- Oriented Practices	
Bridging Mechanisms: Effective interface/portal /technology display /exhibitions Types of relationship/networks ● Personal associations ● TTO as a facilitator of scientific-business relationships ● Knowledge transfer from business to academics ● TT-related conferences/expos/town hall meetings ● contractual arrangements	A diversified portfolio is a more reliable long-term investment strategy than focusing on achieving a single major success. Effective technology transfer partners are corporations licencing technologies while sponsoring additional research, employing graduates, and utilising university expertise.
Network building: Effective communication with stakeholders across the system and forging alliances between scientists and industry	TTOs engage in outreach activities to raise awareness about technology transfer and the value of intellectual property. They educate faculty, researchers, and students on intellectual property rights, technology transfer processes, and commercialization opportunities.
Linkages pre- TT ● Industry-academia connect ● Entrepreneurship-scientist connect ● Technology exhibitions and technology demonstrations	Many universities have Innovation Corps (I-Corps™) programmes supported by NSF (National Science Foundation) that encourage researchers to engage in commercialization.

Linkages post TT ● Scientist/researcher continues involvement with the firm ● Faculty member/scientist serve as a technical advisor or on board of directors for the firm (especially in case of start-ups)	TTOs foster collaborations and partnerships between academic researchers and industry. They facilitate research agreements, sponsored projects, and collaborations between industry partners and faculty members or research teams both pre TT and post TT.
7. Incentivising Practices	
Motivate scientists/faculty/researchers to develop technology and undertake TT process ● Royalty distribution formula (typically ranging from 25% to 50%) ● Awards (recognition within the scientific community) ● Promotional incentives	Increased royalty shares, counting tech transfer participation in tenure and promotion decisions, Technology Transfer awards for academics are some examples of the many ways American colleges have experimented with incentivizing academics to participate in technology transfer.
Motivating industries to collaborate with academia and research institutes for TT ● Financial and technical gain to industry ● Utilisation of CSR funding for R&D	Industries heavily invest in research and innovation in USA. They are self-motivated to uptake the knowledge produced in the country, hence quite keen to take up the technology transfer and prioritize access to the expertise and talent, risk mitigation, dedicated government funds for technology uptake and access to the innovation pool.

E. Case Study

A. Technology Transfer Ecosystem at the National Institute of Health (NIH)

NIH has established a dedicated 'Office of Technology Transfer (OTT)'. Which is created under the division of Technology Transfer and Innovation Policy, Office of Science Policy, NIH

- The office provides support for patenting and licensing activities for NIH and associated laboratories
- Functions: It safeguards, monitors, and identifies NIH discoveries and inventions per the required Federal Technology Transfer Act and related statutes.
- Team: The office has a dedicated team that manages and oversees IP management and licensing, emphasising the distribution of royalty shares and enforcement of IP rights and licensing agreements.
- Types of licences undertaken:
    - License for Commercial Evaluation
    - License for Internal Commercial Use
    - Non-exclusive License for Patents
    - Exclusive License for Patents
- NIH has dedicated Technology Development Coordinators (TDCs) and Licensing and Patenting Managers (LPMs) to [provide advisory and assistive roles in the technology transfer process right from 1st phase to the end phase. They review the employee invention reports and manage the IP protection and prosecution as and when required. These coordinators and license managers take charge of licensing negotiation CRADA and other related agreements.
- NIH has developed a dedicated policy for technology transfer that focuses on Policy for Public Health Services (PHS) agencies to undertake and coordinate the Technology Transfer activities; Patent filing, reporting of employee inventions; licensing procedures; documenting and signing of CRADAs; designing model agreements; disbursement of royalties and its administration; methods for technology transfer award system etc.
- Filing of Patent Applications for PHS Inventions; PHS Policy/guidelines for Submitting Employee Inventions; Regulations for Management of Communications During Patent Prosecution Between NIH OTT and Technology Development Coordinators; PHS Licensing Guidelines and Policies; Policy and Protocols for PHS Cooperative Research and Development Agreements; model agreements; Handling and Distribution of Royalties; Policy and Guidelines for PHS Technology Transfer Awards, etc.
- **It has developed dedicated resources for undertaking licensing agreements and partnerships: Forms and agreements along with the Inventor resource created and inventor showcase.**
- **NIH OTT has also dedicated Royalty Coordinator for the inventors to make sure that the inventors get the best deal for the royalty share.**
- From a marketing point of view, NIH publishes quarterly NIH Technology Transfer Community Newsletter through OTT Marketing Group.
- For evaluation of the OTT and the technology transfer ecosystem in NIH, there are commonly tracked Metrics prepared at the NIH OTT.

B. **Technology Transfer Ecosystem at Carnegie Mellon University (CMU)**

The mission of the University is Transfer intellectual products to society. A Highest-scoring university in technology transfer that developed a formal process of technology transfer in 1993 and during this time only the CMU region was witnessing an industrial restructuring. The entrepreneurship ecosystem developed by the university has contributed to the industrial strengthening of the region. CMU has the following entities that contribute to the technology transfer:

- **Centre for Technology Transfer and Enterprise Creation (CTTEC)**[7] that contributes to technology transfer in the university. It manages the IP portfolio of the university and also provides assistance for license agreements and material/data transfer agreements and formation of new entities.
- **Governance**: Established by the university, internally managed and funded to carry out technology transfer. Working in alignment with the University mandate to support technology transfer of university technology to the society.
- **Team**: Team comprising 13 members and have lead roles and managerial roles in intellectual property and technology licensing and business management. There are dedicated licensing managers for departments to facilitate technology transfer as per IP policy and technology transfer guidelines.
- Capacity: To build the capacity, it has collaborated with AUTM to implement Online Professional Development in technology commercialization space and has developed AUTM CME Education portal for the same. It has also created a CTTEC fellow programme inviting graduate students to take formal training in commercialising academic knowledge/technology. The fellows work part-time, evaluate technology produced for its economic and market feasibility, and assist in the technology transfer process from evaluation to negotiation and licensing.
- Activities undertaken: IP Asset management; Funding; Marketing; Networking; License negotiation; Evaluation; Company formation and Enterprise creation service
- Process: It has dedicated **Internal Disclosure Forms, third-party forms and sample agreements such as** Biological Material Transfer Agreements, Materials Transfer and Evaluation Agreement, Inter-Institutional Agreement, Confidentiality Agreement, Spin-off License Template, 3rd party License Template etc. The following steps are taken for technology transfer at the Centre: Disclosure Evaluation, Market Strategy License Negotiation, and Enterprise Creation
- **Outcome**: From 2018 to 2022, CTTEC has contributed to the development of 44 spin-off companies, 1049 licences and other agreements; 90.5 million USD income from licensing.

The other entities that contribute to the technology transfer ecosystem:

- **The Swartz Centre for Entrepreneurship**: This has contributed to the entrepreneurship support to the startups and new ideas generated by the faculty members, researchers and students
- **Centre for Business Engagement** that facilitates sponsored research and consultancy projects. Many private firms, such as Apple, have developed **co-creation labs** in the Innovation Centre building of the university that has evolved the university as the **Tech Campus** of the region.

[7] *Centre for Technology Transfer and Enterprise Creation (CTTEC)*

Annexure II (d)
GERMANY

Germany

A. Innovation Profiling

Germany's innovation ecosystem dates back to the 19th century. It has been ranked 8th among the 132 economies featured in the GII 2022. According to the GII Report 2022, Germany performs well in innovation outputs, ranked 7th. It is ranked 12th in terms of innovation inputs. It has a positive relationship between innovation and the country's development and has showcased effective translation of investments made in creation to innovation outputs. It is the 5th largest R&D investing country in the world, with 3% of GERD contribution from its GDP. On observing the sector-wise contribution of the public and private sectors in R&D, the private sector is the most significant GERD contributor in terms of financing R&D and performing R&D, as highlighted in the subsequent figures. Germany is third globally in global corporate R&D investments.

As highlighted in Figure 1_Germany below, Germany has demonstrated an increase in its R&D investments from 2015 to 2020. As per the OECD 2022 report, gross Expenditure on R&D (GERD) made by the country has shown significant growth in the last five years but at a slow trajectory. The percentage growth in GERD from 2015 to 2020 is more than 26% (Figure 2_Germany).

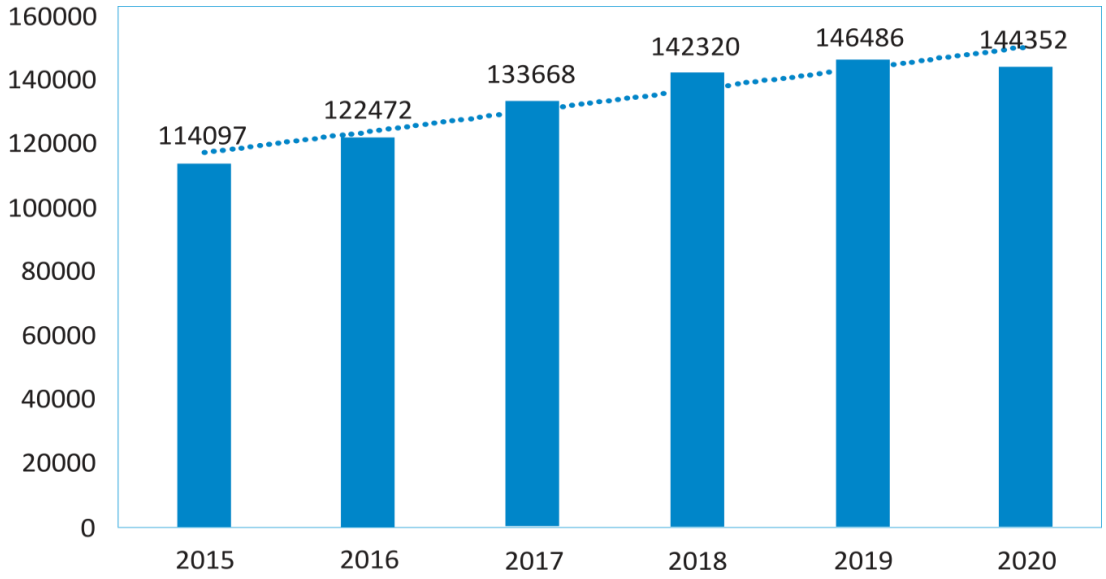

Figure 1_Germany: Gross Expenditure on R&D by Germany[8]

[8] Source: OECD, 2022

In Figure 3_Germany, the analysis from 2015 to 2020 in terms of GERD financed by different sectors indicates that the business sector in the country generates the most funding for GERD, followed by the government, sources from the rest of the world, educational sector, and private non-for-profit organisations.

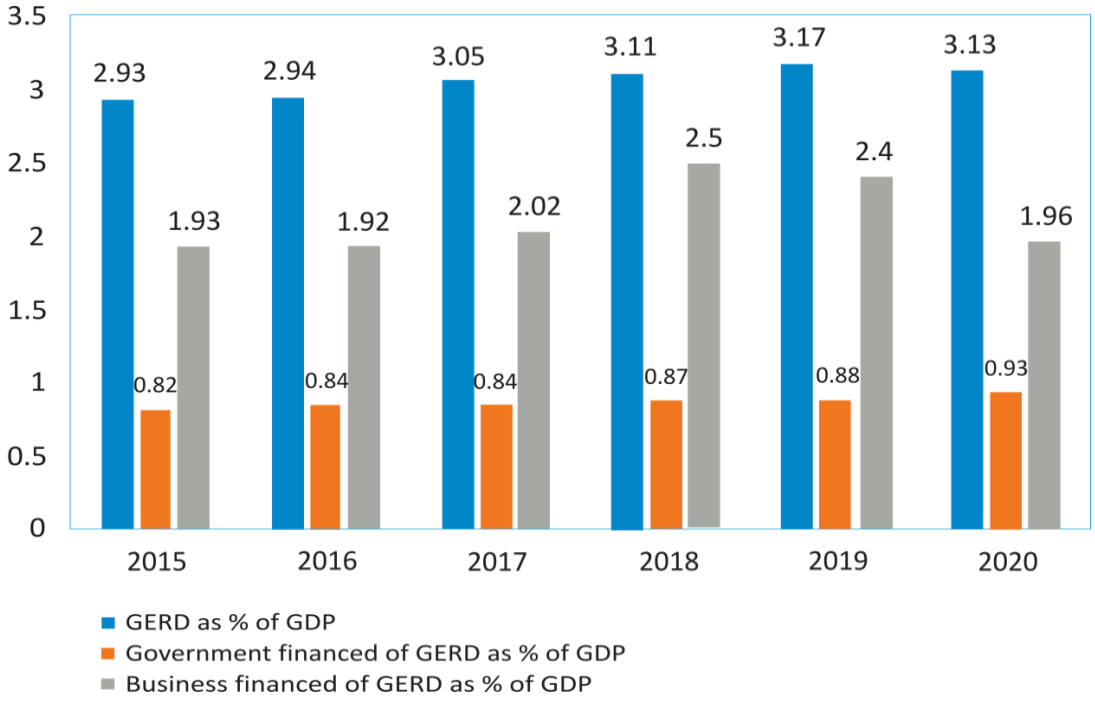

Figure 2_Germany: Gross Expenditure on R&D (GERD) as % of Gross Domestic Product (GDP)[9]

Germany has highlighted its strength in terms of innovation output by developing technical expertise, especially in engineering, sustainable environments and digital transitions domain.

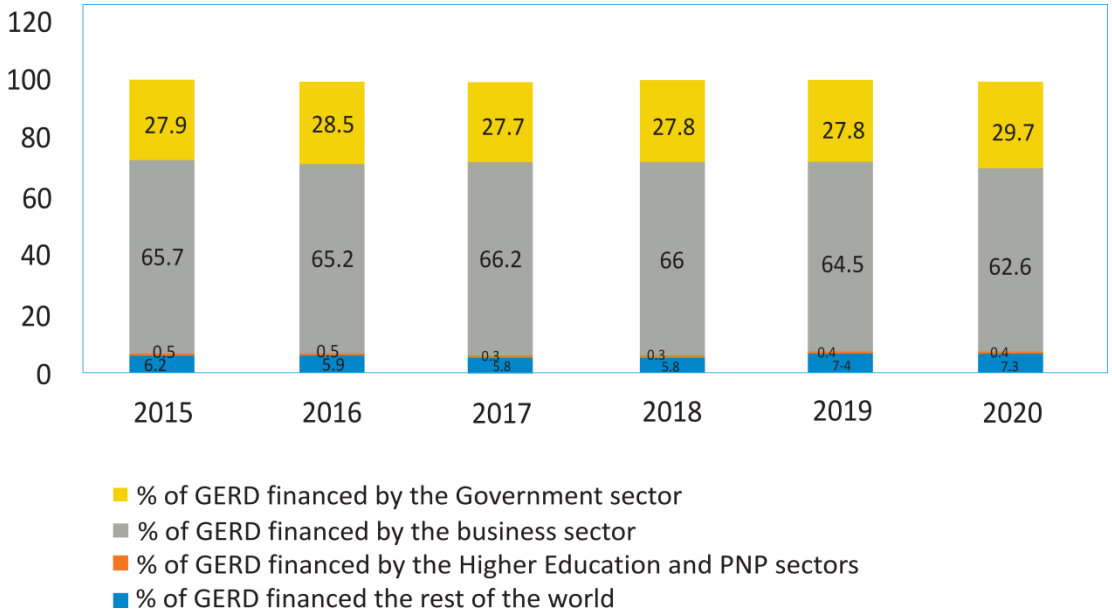

Figure 3_Germany: Percentage of Gross Expenditure on R&D (GERD) financed by different Sectors[10]

[9] Source: OECD, 2022
[10] Source: OECD, 2022

B. Innovation Actors

B.1. Government System

The German government has established several important offices, societies, and organizations to regulate and support science and technology and promote innovation in the country. The government's innovation policies and laws/regulations provide support to enhance innovations in the country. Two ministries primarily carry out STI governance:

- Federal Ministry for Economic Affairs and Climate Action (BMWK): promotes linkages between innovation systems and actors
- Federal Ministry for Education and Research (BMBF): promotes innovation activities

To promote education and research, both federal and state governments play a crucial role; while a significant proportion of research support is received from the federal government, governance is carried out by the state-specific government. **To assist SMEs and innovation, the Federal government and BMWK have a wide range of policy tools and programmes that support applied R&D. Starting from the knowledge/idea to a marketable product, the Federal government runs various programmes to support researchers/scientists.**

"From the Idea to Market Success" and related programmes: The "From the Idea to Market Success" programme is a high-level effort meant to highlight the significance of small and medium-sized enterprises (SMEs) in the innovation system and the country's economic competitiveness. BMWK's primary innovation policy instruments are encapsulated in its "From the idea to market success" strategy for the SME sector.

Four distinct families of programmes address unique problems encountered by businesses, as they innovate, are as follow:

- **Business start-up programmes:** The primary objective of the "Business start-ups" family of programmes is to provide assistance to new businesses at the preliminary stages of the innovation process. This will be accomplished, in part, by addressing the problem of inadequate finance for pre-commercial innovations and business concepts. The following is a list of some of the many schemes that are available to support new businesses and researchers in their early stages of development:

    - **Science-based start-ups – Existenzgründungenaus der Wissenschaft (EXIST):** One of the oldest and most accomplished programmes to foster an entrepreneurial ecosystem in academic and research institutions. The programme assists academic and research professionals in launching their technology-oriented businesses.
    - **ZuschussfürWagniskapital (INVEST):** Established in 2013, the programme provides financial support to young companies seeking venture capital funds. The programme is unique in terms of providing nearly 900 million euros in the form of risk capital. It also funds several tech-based startups with an acquisition grant of almost EUR500,000 year.
    - **High-Tech Gründerfonds (HTGF):** This initiative was established in 2013 and supports technology startups. The platform comprises investment managers that manage private and public funding for the startups.
    - **Coparion VC fund:** The fund worth 275 million euros is provided collectively by KfW Capital, the European Recovery Programme (ERP) Special Fund and the European Investment Bank and also includes equity support to startups and small enterprises younger than ten years of establishment.
    - **Start-up Competition for Digital Innovations:** This programme has been conducted every six months for supporting ICT startups. In each round, up to six startup ideas will receive venture funding of EUR 32,000, and up to fifteen other ideas will receive cash prizes of EUR 7,000.

- **Competence programmes:** These programmes provide funding and consulting services to digital startups and play an essential role in enhancing digital competencies. **The key initiatives taken are as follows:**
  - Go-inno and Go-digital provide consulting and management services to digital businesses.
  - Mittelstand 4.0 Kompetenzzentren (competence centres) have been established in Germany since 2015 as a theme-specific and regional service for small and medium enterprises.
  - IT Security in Business provides services associated with IT security to startups and small and medium enterprises and increases awareness about the same.
  - The Initiatives such as Go Cluster and Digital Hub initiatives are acting as innovation-backed regional clusters for providing digital transition and associated services in the region to their industries and startups.
  - German Accelerator was also established to provide national and international support to German startups to expand their global businesses. Such accelerators are set up in US cities and Asian cities.

- **Precompetitive programmes:** These programmes support the collaborative R&D of SMEs and various industrial research institutes in the country. These programmes also provide tech commercialisation support. The key initiatives in this programme family are as follows:
  - IndustrielleGemeinschaftsforschung (IGF) with a funding support of nearly 200 million euros for undertaking joint R&D projects in which 30% of research is performed by the industrial research institute, 55% by the academic institute and 15% by the public research institute.
  - INNO-KOM is an initiative to promote the regional economy by supporting not-for-profit industrial research institutes with nearly 75 million euros in annual investments.
  - WIPANO initiative provides Knowledge, Technology Development and Transfer support to universities and research institutes by assisting them in IP protection and commercialising their R&D results right from the early stage with annual investment support of 26 million euros.

- **Closeness to the market:** The "Closeness to the market" is the fourth programme family programme. The key initiative under this is the Innovation Programme for Business Models and Pioneer Solutions [InnovationsprogrammfürGeschäftsmodelle und Pionierlösungen (IGP)], a new pilot programme introduced in 2019, which provides financial support to the non-technical innovations made in the digital service sector.
  - **ZentralesInnovationsprogrammfür den Mittelstand (ZIM):** Since 2008, when ZIM was introduced as a merger of several earlier programmes, it has been run by BMWK. ZIM, which emphasizes collaboration and networking efforts aimed at SMEs' innovative performance in all technologies and sectors, is the main instrument of open assistance for SME R&D operations.
  - **Support for cluster initiatives:** BMBF has a history of supporting large, scientifically grounded clusters, like those in biotechnology. 15 Clusters of Excellence are supported along with their partners through the "Leading-Edge Cluster Competition" (2007–17) and is currently managing the "Clusters 4 Future" competition. BMWK has supported the "go-cluster" scheme since 2012, paying for technical services and guidance rather than R&D. These programmes are supplemented by several regional cluster plans.
  - **Support for science and technology-based start-ups:** Many resources are available to support startups accredited by BMWK, BMBF, and State governments. By providing funding for both R&D and validation projects, the "Validation of the Technological and Societal Innovation Potential of Scientific Research (VIP+)" and "Research at Universities of Applied Science" programmes support universities in developing ideas to prototypes and ultimately to the product ready to be launched in the market. Young businesses, especially start-ups, are supported by the BMBF initiative "StartUpSecure" as they create innovative IT security concepts.
  - **Industry 4.0:** BMWK is investing roughly EUR 100 million for R&D for innovation through the two funding initiatives "AutonomikfürIndustrie 4.0" and "Smart Service Welt." The BMWK and BMBF ministries and a committee of prominent personalities from business and academia oversee the platform.
  - **Zukunftsfonds (Future Fund):** The Future Fund strives to broaden the federal support architecture (both qualitatively and quantitatively), focusing on the financing alternatives accessible to startups. The government provides EUR 10 billion to the Future Fund, contributed by BMWK, KfW and ERP special fund.

Government-mediated incentives for innovation are as follows:

- **R&D tax credit:** Germany provides a research allowance that allows companies to claim 25% of their R&D costs involved in research personnel and 65% of the extramural costs for R&D undertaken as R&D contracts. This policy instrument was introduced in 2020.
- **Funding for thematic programmes**: Germany has allocated substantial funds to specific technology domains of current and future significance to sustainability and digital transitions. These programmes include electronics, microelectronics, high-performance computation, advanced information and communications, and quantum technologies. There are several programmes for internalising research, especially under the European Union framework. Organizations such as BMBF, BMWK and the European Molecular Biology Laboratory (EMBL) are supporting international R&D partnerships at a broader scale.

The regulatory framework for innovation (Law/Policies):
Germany has a sound policy and legislative framework for supporting research and innovation in the country. It has launched various policy initiatives such as High-Tech Strategy 2025, Research and Development (R&D) Tax Incentives, and Industry 4.0, among others to promote innovation and technology advancements.

- The overall barriers to entrepreneurship in Germany are pretty low compared to other countries. For example, Germany has a *one-in-one-out* rule for offsetting old regulation in place of new regulation, which has simplified regulatory rules related to business. In 2015, Germany introduced a dedicated law, "Bureaucracy Reduction and Better Regulation", to reduce bureaucratic hindrances in firms functioning in German government bodies and organizations.
- Germany has also introduced the Employee Invention Act, under which patent exploitation firms connected with the Technology Allianz were set up in laboratories to speed up technology commercialisation. The Employee Invention Act in Germany governs the rights and obligations of employees and employers regarding inventions made by employees during their employment. It aims to balance the interests of inventors and employers while promoting innovation and technology transfer.

B.2. Education and Research Institutes
Germany has over 1,000 public funded research organization and 400 academic institutes performing fundamental and applied research. The research institutes work under the following larger set of organizations, which are represented all across the country:

- Fraunhofer Society: comprised of 76 research institutes all across Germany focusing on applied research.
- Helmholtz Association: comprising 18 German research centres providing research infrastructure for the innovation ecosystem in the country.
- Leibniz Association: is an umbrella organization for over 97 research institutes working in the country's socio-economic challenges.
- Max Planck Society: 86 institutes focusing on basic and advanced research.

All four organizations operate autonomously while receiving funding from the government. They are regarded as self-governing public research organisations that further support a pool of institutes under each of them.

The top 10 innovation-backed universities in Germany are as follows:

1. Mannheim University of Applied Sciences, Mannheim, Germany
2. Technical University of Munich, Munich, Germany
3. Friedrich–Alexander - University of Erlangen–Nuremberg, Germany
4. Hannover Medical School (Medizinische Hochschule Hannover)
5. Hochschule Bonn-Rhein-Sieg University of Applied Sciences
6. University of Ulm, Baden-Württemberg, Germany
7. Ruprecht Karl University of Heidelberg, Germany

8. Albert Ludwig University of Freiburg, Breisgau, Germany
9. Ludwig Maximilian University of Munich, Germany
10. Dresden University of Technology, Dresden, Germany

The top 10 innovation-ranked federal research laboratories of Germany are listed below:

1. Max Planck Institute for Informatics, Saarbrücken, Germany
2. Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute, Berlin, Germany
3. European Molecular Biology Laboratory, Heidelberg, Germany
4. European Molecular Biology Organization (EMBO), Heidelberg, Germany
5. Helmholtz Association of German Research Centres, Bonn, Germany
6. Max Planck Institute for Intelligent Systems, Stuttgart, Germany
7. Leibniz - Research Institute for Molecular Pharmacology, Berlin, Germany
8. Fraunhofer Institute for Molecular Biology and Applied Ecology, Schmallenberg, Germany
9. Max Planck Institute of Biochemistry, Planegg, Germany
10. German Cancer Research Center (DeutschesKrebsforschungszentrum, DKFZ), Heidelberg, Germany

B.3. Industry System

Germany has established various Industrial co-operative research institutes and play significant role in knowledge transfer and translation. These institutes fall under two umbrella organizations as:

- **German Federation of Industrial Research Associations (AiF), an industry initiative founded in** 1954 to support R&D activities of SMEs. It is a 100-member organization focusing on subject-specific research in the country and linking SMEs with the same promote branch-specific R&D supporting innovation activities by SMEs.
- **Deutsche Industrieforschungsgemeinschaft Konrad Zuse [Zuse Association (ZA)],** founded in 2015, supports industry-relevant R&D and contract R&D with SMEs.

Table 7 lists the Top 10 R&D Investing companies in Germany as follows:

Table 7: Top 10 R&D Investing companiesin Germany

Sr. No.	Company	Sector
1.	Volkswagen AG	Automobiles & other transport
2.	Mercedes-Benz Group AG (former Daimler AG)	Automobiles & other transport
3.	BMW	Automobiles & other transport
4.	Robert Bosch	Automobiles & other transport
5.	Bayer	Health industries
6.	SAP	ICT services
7.	Siemens	ICT Producers
8.	Boehringer Sohn	Health industries
9.	Continental	Automobiles & other transport
10.	Merck De	Health industries

B.4. Intermediary System

Intermediary organisations are an essential part of the German Innovation system and provide linkage to industries, academia and SMEs with other research partners. The triple helix model of Germany (Mittelstand model) facilitated SMEs' networking and connections with other innovation actors. The key intermediary organisations are listed below:

- **Research campuses** which are set up as Public-Private Partnership entities to support long-term and large-scale industry-academia collaborations on dedicated thematic areas. The key focus areas are in energy systems, disease and other production-oriented technologies. Nine such research campuses have been established with world-class research infrastructure and act as one single platform for research to develop technology in close alliance with industry and SMEs. The funding of research campuses comes from BMBF and the industry pitch for the additional funds.
- **Start-ups from Science (Existenzgründungenaus der Wissenschaft), EXIST)** The Federal Ministry of Economic Affairs and Energy (BMWi) and the European Social Fund (ESF) jointly implemented the

program. This initiative supports universities in developing entrepreneurial and technology transfer cultures.

- **Zentrales Innovations programmeMittelstand (ZIM;http://www.zim-bmwi.de/zim-overview), a Central Innovation Programme for SMEs** to support market-oriented services to SMEs and promoting linkages of innovation actors with SMEs for technology-oriented solutions and seeking financial support from various government organisations.
- **Validation of Technological and Social Innovative Potential of Scientific Research (Validierung des Innovations PotenzialSwissenSchaftlicherForschung) VIP+:** This programme was started in May 2010 by BMWi to shorten the path of research results/technologies from the research lab to the markets. To increase the significant innovation, the bridge between research and the application of research findings needs to be strengthened. The primary core element covered under the programme is to provide funding at the early, high-risk phase of the validation process. The essential characteristic of the VIP+ is its outlook on deployment in the form of a commodity and service or concept. Also, the projects should build on research results and develop them further in the direction of application. Industry collaborations are excluded, but openness in commercialisation is required, i.e. projects should be funded early where there is no R&D cooperation with industry.
- **Helmholtz Association:** The Helmholtz Association comprises Germany's 18 "big science" institutes, which are significant in employment terms and tend to rely on large research infrastructures. Approximately one-third of the funding for individual Helmholtz Centers that does not come directly from government sources includes support from both the public and private sectors and the European Union (EU). Despite focusing on different technological fields, the research centres are united by a commitment to pursuing long-term objectives that benefit society.
- **Max Planck Society**: The MaxPlanck Society for the Advancement of Science was founded in 1948 as an independent, not-for-profit research organisation. The Max Planck Society is governed by its members, who may include paying, scientific, ex-official or honorary members. The common goal of the various Max Planck Society research institutes in the natural sciences, life sciences, and the humanities is to perform basic research in the interests of the general public. The primary goal of the Max Planck Society is to support fundamental research in the natural, life and social sciences, the arts and humanities in its 86 Max Planck Institutes.
- **Fraunhofer Society:** The Fraunhofer Society of Germany supports collaborative applied research between private and public enterprises. The society was established in March 1949 with an aim and effort to strengthen the post-war faltering German economy by steadily translating basic research conducted in the universities and research organisations through networking and partnerships with industries and SMEs. The society is funded and governed by BMBF. The Fraunhofer's funding is generated from various sources, including Federal, state, and European Union public funding, contract research fee from public organisations and industry, and from IP licensing. According to the Fraunhofer Annual Report 2021, the Fraunhofer Society generates nearly EUR 2.9 billion annually. Out of which EUR 2.5 billion are generated through contract research. Industry contracts and publicly funded research projects account for around two-thirds of that.
- **Leibniz Association:** It comprises more than 90 institutes under the Leibniz Science Association, initiated in 1977 and funded by the Federal Government. Their two leading roles are to conduct their inquiries and to provide supporting services, which can include advice on knowledge transfer and the use of equipment, to other researchers and research institutes. The Leibniz Association has five sections, or groups of institutes, specializing in Economics, social and spatial research, Humanities and education research, environmental sciences, Life sciences, Mathematics, natural sciences and engineering.

C. Technology Transfer Ecosystem of Germany

Germany has several programmes and initiatives supporting R&D, innovation and technology transfer. Continuous efforts are to introduce new policy instruments for enhancing technology development and commercialisation in the country. To enhance the technology transfer ecosystem in the country, Germany has introduced the concept of **Innovative Universities called Innovative Hochschule** with the following attributes:

- The Innovative Hochschule is dedicated to working on innovations, bridging the gap between higher education institutes and companies, and addressing social innovations to bridge the gap between science and society.
- To strengthen HEIs' role in the regional innovation system through strengthening networking, workshops, and conferences, including companies and municipal representatives.
- It also provides financial support to technology transfer in HEIs and the formal and informal structures required for IP ownership, university management and technology transfer.

Germany has also established the German Agency for Transfer and Innovation (DATI) formulated as a part of a coalition agreement. The government coalition recently announced the creation of a "German Agency for Transfer and Innovation" (DATI), which is documented in the coalition agreement. The agency DATI was established in March 2022 per the white paper published by the German Federal Ministry for Education and Research (BMBF). The Modal for DATI has been adopted from the model of regional innovation clusters in the UK, and the agency is supposed to work in tandem with the existing programs and strengthen synergies. The Innovative Hochschule and DATI collaborate to bring ideas, and research results more quickly into implementation.

Along with this are the significant societies and associations already in place in the German technology generation and commercialisation ecosystem. The funding mechanism has been depicted along with the centres/institutes established under the ambit of the entities. The prominent entities that are pioneers in the funding of R&D and support for technology transfer are as follows:

- **Universities of Technology** are technical universities (Technische Universitäten). There are 20 such technical universities set up and work primarily for knowledge transfer, focusing on applied engineering. These universities collaborate closely with the private sector to accelerate the knowledge transfer. These institutes have professors who require industrial experience and are equipped for research translation.
- **Universities of Applied Sciences** are created in Germany to accelerate the applied sciences domain and play a significant role in knowledge transfer. These universities undertake the applied research in line with the business sector priorities and provide sector-specific skills. These applied Science universities are established in areas of engineering, management, and information technology skills. The graduates from these universities get acclimatized to the industry set-up right after graduation and take up industrial research work that further culminates as their employee enrolment in the industries.
- **Helmholtz Association of German Research Centres** are working with a mandate to address grand science challenges associated with society and industry. The association plays a significant role in the German knowledge transfer system and has dedicated research institutes for technology transfer. The association's funding is majorly contributed from the industry or business sector, which is nearly 70%.

The research institutions and PROs (Helmholtz Association, Max Planck Society, Fraunhofer Society and Leibniz Association) are leading for technology transfer in Germany, assisting industries and taking the onus of financial risk associated with developing new technologies. Next to USA and Japan, Germany receives the highest third-party funding for research from the industry and business sector. The growing expenditure from the industry on R&D and the availability of high-tech Startups has contributed to the success in technology transfer in the country. There are TTOs in Universities and PRO, including commercial arms and independent public and private technology transfer agencies.

Channels of knowledge/technology transfer in TTOs and private agencies in Germany:
TTOs of research institutes and public research organisations (PROs) facilitate knowledge exchange. These technology transfer offices promote and facilitate technology transfer through various channels. Both formal and informal channels for science-industry transfer of knowledge exist.

Formal channels of TT include the following:

- Collaborative research by jointly carrying out research projects between academia/scientists and industry
- Contract research from the industry side to academic and research institutes for specific technology and knowledge intervention.
- Academic consultancy
- Intellectual property transactions
- Research mobility
- Academic spin-offs
- Labour mobility from industry to academia and vice versa

An informal channel of science-industry knowledge transfer includes:

- Join publications
- Research and innovation networking of innovation actors
- Sharing of research infrastructure
- Joint courses and dedicated courses for industry professionals

The following modalities have been established in Germany to facilitate the technology transfer process:

- Setting the TTOs in Universities and PRO
- Establishment of commercial arms for example, TU Dresden, HU Berlin, MPI) and other public and private technology transfer agencies
- Setting up incubators and science parks
- Germany has also set up Public funded patent marketing agencies for marketing of IP generated in universities and research institutes
- Several chambers of commerce and cluster management units have been set up
- The Establishment of Ascenion GmbH is mandated to evaluate IP and lead subsequent IP exploitation.

D. Snapshot of Good Practices in Technology Transfer

Reference from overall technology transfer ecosystem in Germany and TT Ecosystem at German HELMHOLTZ ASSOCIATION (Highest performer in technology transfer in Germany) and Fraunhofer Society. Table 8 lists the Good Technology Transfer practices in Germany.

Table 8: Good Technology Transfer Practices in Germany

Attributes	Inputs from German tech transfer system
1. Governance Practices	
Legislature and Policy Inputs: • National level (National impetus on TT through Act/Law/Policy/Guidelines) • Institute level (Designing flexible institute policies on TT)	Germany has enacted the Employee Invention Act (Gesetzüber Arbeitnehmererfindungen). Under this Act, Patent Exploitation Agencies were established in universities, further connected with Technology Allianz to facilitate technology transfer. They follow the Innovation Policy and guidelines for Knowledge and Technology Transfer.
Governance Model: Setting up a dedicated entity for TT (technology transfer) and sufficient resources devoted to technology transfer by the institute with flexible and efficient institute administrators	• Establishment of Federal Technology Transfer Entity: Germany is on its way to establishing a national entity, 'The German Agency for Transfer and Innovation,' to support and facilitate technology transfer of technologies developed by universities and research institutes. • In 2019, the German government created a federal technology transfer entity called SPRIND with support from BMBF and BMW to accelerate technology translation. Unfortunately, it was not successful and ran into bureaucratic hurdles and got closed. Therefore, in the new model, the focus is on developing a balanced approach for funding risky technologies and, at the same time, following public money spending rules. Hence, the Government is open to looking for alternative methods. This highlights the need for government flexibility in strengthening technology transfer ecosystems through federal entities. • Technologie Allianz and patent exploitation agencies for universities form technology transfer platforms. There are other large non-university research institutions that have established technology transfer entities, such as : ○ TT entity at Helmholtz Association ○ Max Planck Innovation, Max Planck Institutes ○ Leibniz Transfer, Leibniz Institutes. ○ Fraunhofer Gesellschaft (society with its 72 institutes) has developed the Central Exploitation Department that manages IP and licensing. • The government (Ministry of Economics and Technology has set up 'SIGNO' for the valuation and exploitation of IP and provides funds for patent exploitation agencies of the universities.

2. Organizational and Managerial Practices	
Organization Culture: ● Impetus from the top leadership and organisational objectives focus on technology transfer ● Organizational standards for promoting technology transfer ● Technology transfer is considered a source of revenue (via royalties, licensing fees; sponsored research agreements) ● Organization working to eliminate cultural and informal barriers that impede the TT process.	HELMHOLTZ ASSOCIATION has established its dedicated Tech transfer units across research centres as an independent entity with a mandate from the association to create profit from the knowledge and technology generated as part of its mission to "Create wealth for society and industry through knowledge transfer and innovation."
Managerial Position in TTO: The team leader and managerial position have to be there to lead the overall functioning of the TTO.	Almost all the TTOs have a leader/manager to run the TTO functions. The Helmholtz Association's transfer offices have two working groups: a Working Group on Technology Transfer and Intellectual Property that has a chair and team and another Knowledge Transfer Working Group that has a chairman and team.
Dedicated Team with the following set of expertise: ● Financial and market analysis ● IP protection and management ● Communication ● Licensing	The tech transfer units established in Helmholtz Centres have developed their professional team to undertake IP and technology management, spin-off creation and promote cooperation with various stakeholders. More than 100 experts are working in these tech transfer units. Center for Technology Transfer and Enterprise Creation (CTTEC) leads the technology transfer and university entrepreneurship support.
3. Financial Sourcing and Administration Practices	
Financing Sources: ● Dedicated financial resources should be allocated to the TTO ● Different routes for financial support should be explored by the TTO, such as venture and angel funds, CSR, Alumni funds, etc.	The government is providing financial support in spurring the transfer of technologies from the lab to the market. The Federal Ministry for Economic Affairs is providing funding for research and innovation projects to be taken up by companies in Germany. Example of key programmes: ● Transfer initiative ● Central Innovation Programme for SMEs (ZIM) ● Innovation Vouchers ● Proof-of -Concept-Funding (VIP) Institute-specific programmes are also made available, for example: ● Helmholtz Enterprise Fund ● Helmholtz Validation Fund
Financial governance: ● Regular audits (focus on technical audits)	TTOs adhere to financial regulations and guidelines applicable to their operations. This includes compliance with accounting standards, tax regulations, funding agency requirements, and other relevant financial regulations. Compliance ensures that the TTO operates within the legal and regulatory framework and meets the reporting obligations.

<table>
<tr><th colspan="2">4. Functional Practices</th></tr>
<tr><td>Safeguard the organisational intellectual property: the organisation should have a balanced approach towards exercising IP rights; they should be more open to licensing the technology rather than blocking it in IP form.</td><td>Technology transfer focusing area mainly by exploiting:
Contract research
Strategic collaboration with innovation actors
Open Innovation</td></tr>
<tr><td>Understanding regarding university, corporate or scientific norms and environment
Technology assessment exercise
Technology Readiness Levels (TRLs)
Technology valuation
Commercial potential exercise
Technical specificities
IP ownership (type of IP licensing)
Negotiate Licensing agreements
Market the IP to private firms</td><td>Example: The Max Planck Society undertakes the following activities on priority:
Assessment of the invention
IP protection
Marketing of IP assets
Communicating with Industry
Assist inventors in formulating their companies out if the research undertaken</td></tr>
<tr><th colspan="2">5. Output /Reporting Practices</th></tr>
<tr><td>Documented Output of TTO: Licences; Royalties; Patents; sponsored research agreements; start-up companies; invention disclosures; Students; informal transfer of know-how; Product development; Economic development
Dedicated website/portal to display information
Updating the website/portal
User-friendly portal to make matchmaking</td><td>Each TTO in universities and public research organizations, Technology Alliance and Independent tech transfer units set upon by research associations have developed websites and annually showcase the IP and technology transfer details.</td></tr>
<tr><td>Reporting in Annual Reports released by TTO:
Average Annual Licensing agreement
Average Annual Licensing Revenue</td><td>This is the mandatory clause for reporting R&D inputs and outputs generated through Germany's R&D and innovation policy.</td></tr>
<tr><th colspan="2">6. Linkages and Network-Oriented Practices</th></tr>
<tr><td>Effective interface/portal /technology display /exhibitions</td><td>The technology transfer ecosystem’s primary strength is linkages and its network-oriented approach to knowledge and technology transfer.</td></tr>
<tr><td>Types of relationship/networks
Personal relationships
TTO as a facilitator of relationships between scientists and firms
Knowledge transfer from industry to faculty members
Conference/expo/town hall meetings on TT issues
Contractual relationships
Network building: Effective communication with stakeholders across the system and forging alliances between scientists and industry
Linkages pre TT
Industry-academia connect
Entrepreneurship-scientist connect
Technology exhibitions and technology demonstrations</td><td>The TTOs established in Germany, especially in universities linked through Technology Allianz and independent units set up by research institutes/associations focus on networking through the following means:
Formation of sector-specific technology groups/network working groups
Workshops and thematic interactions with Industry
Open Innovation Workshop
Partnering events and showcase events
The other facilitators of the ecosystem also play an essential role in facilitating the technology process. Such facilitators in Germany that play an essential role are as follows:
Common Labs
Commercial arms
Incubator on campus
Research Centres, e.g. Helmholtz research centres.</td></tr>
</table>

Linkages post-TT ● Scientist/researcher continues involvement with the firm ● Faculty member/scientist serve as a technical advisor or on the board of directors for the firm (especially in case of start-ups)	• Technologie Allianz is a German network of patent marketing and tech transfer agencies.
7. Incentivising Practices	
Motivate scientists/ faculty/ researchers to develop technology and undertake the TT process ● Royalty distribution formula (typically ranging from 25% to 50%) ● Awards (recognition within the scientific community) ● Promotional incentives	In case of German Universities: Patenting as one criterion for faculty promotion and selection for tenure.
Motivating industries to collaborate with academia and research institutes for TT ● Financial and technical gain to the industry ● Utilization of CSR funding for R&D	Incentives are available for companies on public procurement of technologies, such as introducing the 'Centre of Excellence awards' through the Centre of Excellence for Innovative Procurement (KOINNO).

E. Case Study

Technology Transfer Ecosystem at Fraunhofer Society

Fraunhofer Center for International Management and Knowledge Economy (IMW)

Technology Transfer Office: The Fraunhofer Center has established a dedicated "Knowledge and Technology Transfer Division" office at the Fraunhofer Center for International Management and Knowledge Economy IMW. The office is mandated to support innovation, innovative competitiveness, innovation value chain and tech transfer.

Governance and administration: It is not a legally independent unit and follows the governance model of Fraunhofer society. However, the organisation provides a high degree of independence for its functioning.

Funding: About 70% of the Fraunhofer Society's revenue comes from deals with businesses or specific government initiatives. The remaining 30% of the budget is utilized to fund preparatory research and is sourced in a ratio of 9:1 from federal and state government grants.

Activities:

- Evaluation of technologies for their commercial applicability
- Assessment of the technologies in terms of their technology readiness levels
- To facilitate the supply of knowledge with the demand for knowledge
- To facilitate researchers for technology development and commercialisation
- Availability of technical services required
- Licensing negotiations
- Patenting and IP management services

Team:

The office has a dedicated team that manages and oversees all aspects related to technology transfer, innovation funding, innovation acceptance, intellectual property management, and licensing with a focus on the distribution of royalty/equity share management. The team comprises Unit-Head, Deputy Unit-Head, Research fellows, and Associated Researchers.

The primary responsibilities of the team include:

- Evaluation of the socio-economic spheres technology assessment.
- Technology valuation
- Generates finances for technology transfer through crowdsourcing and crowdfunding.
- Implementation of crowdfunding, crowdsourcing, and future cooperation with the industry
- Protects patents, licences, and software licences.

Research Units: Three research units under the office form the scientific basis described as follows:

1. **Innovation Financing Unit** that deals with financial management, including generating resources from crowdsourcing and crowdfunding.
2. **Innovation Acceptance Unit** that deals with the customers and end users to understand their requirements and do the match-making exercise.
3. **Professionalizing Knowledge Transfer Processes Unit** that evaluates and accesses the technology, negotiates the licensing terms, creates a future sight for the technology and undertakes cooperation management and project communication.

Together, these research groups form a TTO that promotes efficient technology transfer. By assessing the technology or innovation and translating it into solutions, they can grasp the usage requirements of their present and potential clients. They also carry out socio-economic evaluations on applying new technologies and social innovations.

Annexure II (e)
SOUTH KOREA

South Korea

A. Innovation Profiling

The Republic of Korea (South Korea or S. Korea) has advanced from a manufacturing economy to the most intensive knowledge economy. The systematic investment in R&D and the sound legislative environment have been the critical factors in transitioning the country from innovation followers to innovation leadership. As per the GII (Global Innovation Index) 2022, S. Korea is the 6th most innovative country among the 132 economies globally. South Korea ranks 4th in innovation outputs and 16th in innovation inputs. Regarding the innovation outputs, S. Korea has demonstrated high performance, especially in patenting. It has the most patent applications (National and Patent Cooperation Treaty) in the world compared to its GDP. It accounts for 7% of the global patent filings. The top technology focus areas are digital communication, electrical machinery, apparatus, energy, and computer technology.

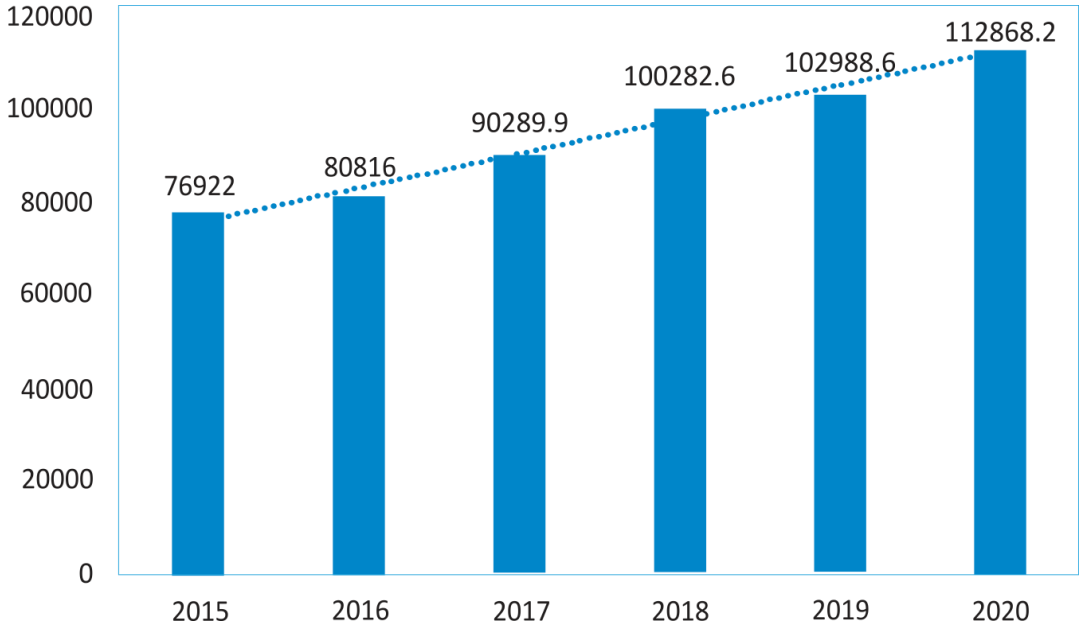

Figure 1_ South Korea: Gross Expenditure on R&D at current price at PPP by South Korea.[11]

As shown in Figure 1_South Korea, from 2015 to 2020, saw a 46% increase in R&D investments, contributing to over 4% of its GDP to GERD. Further, the private sector is one of the significant contributors to financing and performing R&D in the country, accounting for more than 70% of the total contribution, as shown in the subsequent figures. The corporate R&D sector also contributes significantly to academic R&D and has developed strong linkages with academia and the government sector for R&D and innovation activities.

[11] Source: OECD, 2022

The percentage of GERD that the business sector contributes to GDP has been steadily increasing, while the rate that the government contributes has remained practically unchanged since 2015. (Figure 2_ South Korea).

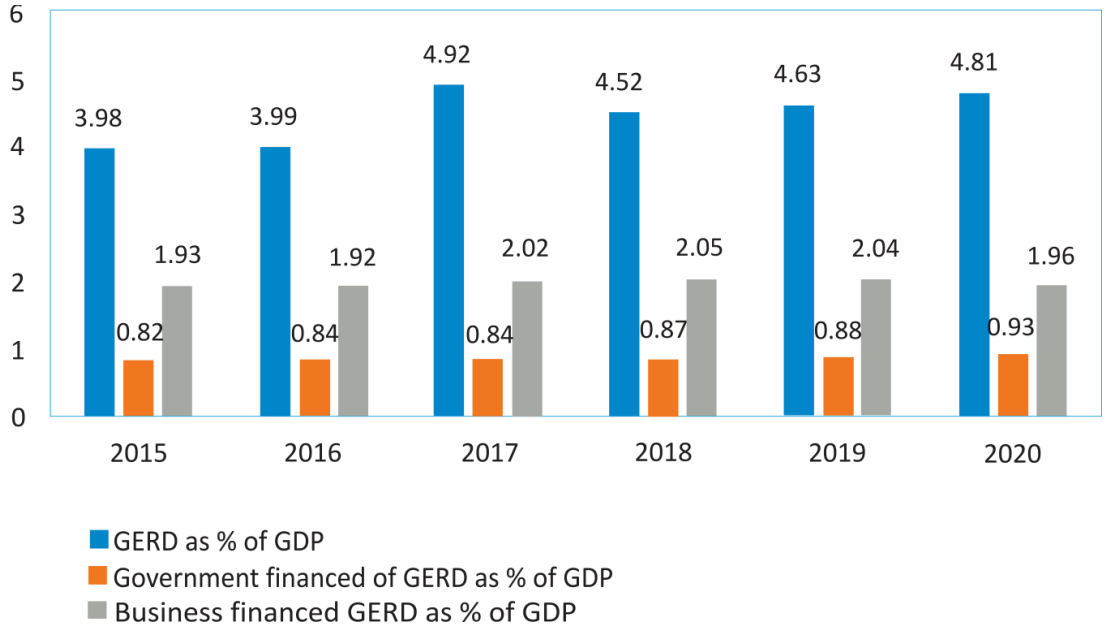

Figure 2_ South Korea: Gross Expenditure on R&D (GERD) as % of Gross Domestic Product[12]

[12] Source: OECD, 2022

The business sector has financed and performed most significantly in GERD from 2015 to 2020, followed by the “government”, “higher education sector”, and “private non-for-profit organizations” (Figure 3_ South Korea) The top technologies emphasized in S. Korea are digital communication, electrical machinery, apparatus, energy, and computer technology. The innovation system consists of crucial actors, including universities, research institutions, businesses, and government agencies, working collaboratively to foster innovation and technological advancements for societal and economic benefit. The interactions between these actors enable the creation, diffusion, and commercialization of new knowledge and technologies.

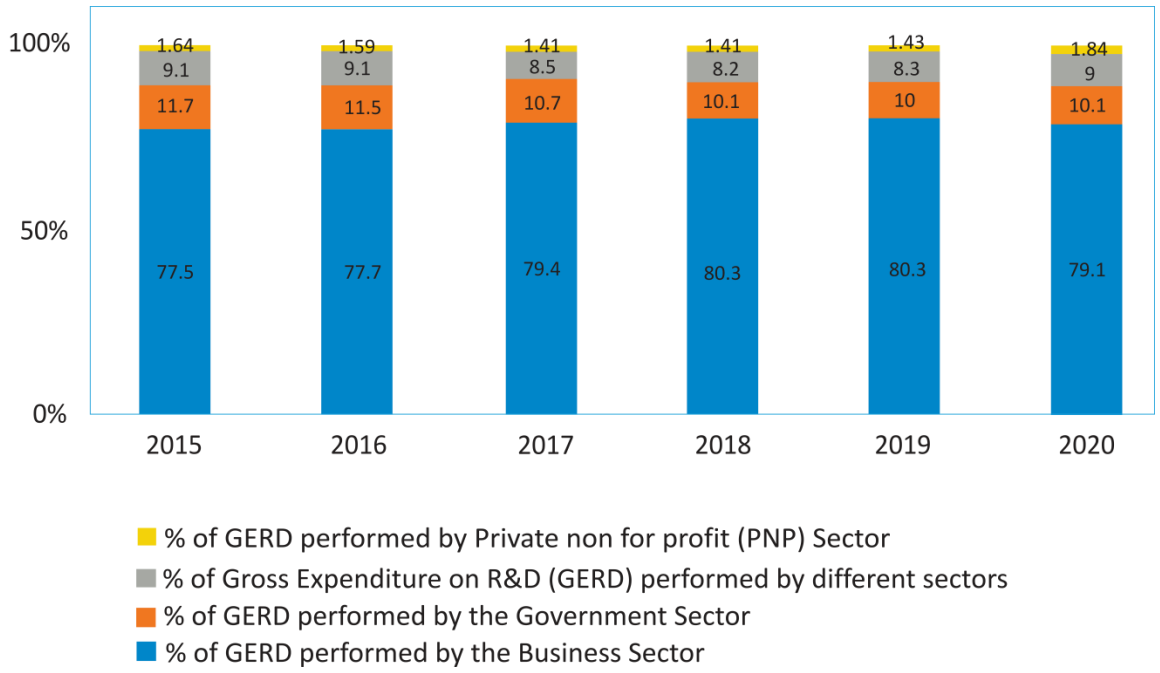

Figure 3_ South Korea 14: Percentage of Gross Expenditure on R&D (GERD) financed by[13]

B. Innovation Actors

B.1. Government System

The education, science, R&D and innovation ecosystem is highly organized and governed by different ministries and other umbrella organizations. Ministries such as the “Ministry of Trade, Industry and Energy (MOTIE)”; “Ministry of Science and ICT (MSIT)” and “Ministry of Education (MOE)” contribute to research and innovation. The key ministries and their role in S&T advancement are as follows:

- MSIT, the primary ministry that governs S&T, is advocating for the "K-Network 2030 Strategy." With the help of public-private partnerships, the MSIT encourages Korean businesses to invest in cutting-edge networking technologies like 6G, open Radio Access Networks, and satellites to increase their global market share and position themselves for the coming shift to cloud and software-centric network paradigms.
- The Ministry of SMEs and Startups, established in 2017, systematically monitors the continuation and expansion of various startup support programs.
- The “Ministry of Education, Science, and Technology (MEST)” plays a central role in coordinating the incorporation of education, science, and technology human resources for national development.
- The Ministry of Knowledge Economy (MKE) mission is strengthening the nation's knowledge-based innovation capacities.

In 2017 the Ministry of SMEs and Startups was established to encourage entrepreneurship nationally. Followings are some of the Umbrella Organization under it:

[13] Source: OECD, 2022

- **Science and Technology Innovation Office:** The Science and Technology Innovation Office of South Korea, also known as the STIO, is an organization that plays a crucial role in promoting and supporting scientific and technological innovation in the country. The STIO operates under the Ministry of Science and ICT (Information and Communication Technology) of South Korea.

- **National Research Council for Science and Technology (NSTC):** NSTC is the leading umbrella organization. Through policy planning, innovation in research management & evaluation, audit planning, project management, human resource development, and international cooperation, it establishes a research strategy/implementation system for government-funded research institutes to ensure a proactive response to rapidly changing times and technology. NSTC promotes 25 government-funded S&T research institutes. These institutions work in several fields.

- **Korea Institute of S&T Evaluation and Planning (KISTEP):** KISTEP is a leading think tank for invention, promoting S&T culture. Its primary focus areas are forecasting scientific and technological future outlooks, supporting the establishment of national S&T policies, performing technological assessment & technology assessment, and creating a benchmark for a national-level S&T system.

- **The National Research Foundation (NRF):** NRF was created in 2009 by merging three different organizations - the Korea Science and Engineering Foundation, Korea Research Foundation, and Korea Foundation for International Cooperation of Science and Technology - under the Act on National Research Foundation of Korea (Act No. 9518). As a specialized organization in research management in South Korea, the NRF is responsible for organizing, evaluating, and monitoring all academic and R&D projects conducted by universities, research institutes, and businesses in engineering, social sciences, and humanities.

- **The Korean Institute for Advancement of Technology (KIAT): KIAT** was established in May 2009 to promote innovation in industrial technology and various projects necessary for industrial technology innovation and developing related policies. It works under the Ministry of Trade, Industry and Energy (MOTIE). Its major tasks include the transfer and commercialization of industrial technology. It provides thoroughly specialized support so industries can actively address future challenges such as the fourth industrial revolution, digital transformation, and global carbon-neutral response.

- **The Korea Institute of Energy Technology Evaluation and Planning (KETEP): KETEP** was created under Article 13 of the Energy Act (Legislation No. 11713). Its primary responsibilities include investigating energy demand, analyzing and forecasting energy technology trends, collecting and analyzing energy-related information and data, supporting the development of energy technology policies, establishing long-term plans for energy technology businesses, evaluating and managing energy technology businesses, promoting the achievements of energy technology businesses, managing expenses related to energy technology, supporting the human resource department, and facilitating international joint research and cooperation. KETEP operates under the Energy Technology Division of the Ministry of Trade, Industry, and Energy.

Legislative Framework for Innovation (Laws/Acts/Policies): As listed in Table 9, the Korean government is a big promoter of industrially relevant and collaborative research activities. To uphold its stance towards collaborative and industrially relevant R&D, the government has introduced and enforced several 'Acts & Laws', recognized as the backbone of a robust system comprising various programs and schemes introduced for promoting industry-oriented R&D.

Table 9: List of Korea's Acts and Laws for promoting R&D and technology commercialization.

Sr. No.	Legislative Instruments	Brief Details
1.	"Act on Fostering and Supporting Women Scientists and Technicians [Enforcement Date 23. Mar, 2013.] [Act No.11713, 23. Mar, 2013., Amendment by Other Act]"	"The purpose of this Act is to contribute to the reinforcement of the capacities of women for science and technology and the development of national science and technology by devising policies to foster women in science, engineering, and technology, to make practical use of their abilities, and to support them, by extending assistance helping them to display their talents and abilities sufficiently."
2.	"Act on the Acquisition, Management and Utilization of Bio-Resources for Research [Enforcement Date 23. Mar, 2013.] [Act No.11713, 23. Mar, 2013, Amendment by Other Act]".	"The purpose of this Act is to ensure the efficient acquisition and systematic management of bio-resources for research that will lead to the sustainable utilization thereof as well as to build infrastructure for the development of biotechnology, thereby contributing to the enhancement of the quality of life of citizens and the development of the national economy".
3.	"Act on the Promotion and Management of Non-Destructive Testing Technology [Enforcement Date 23. Mar 2013.] [Act No.11690, 23. Mar 2013, Amendment by Other Act]".	"The purpose of this Act is to contribute to the safety of people by facilitating the promotion, research and development of non-destructive testing technologies, thus enhancing technical competitiveness and by increasing the safety of articles to be inspected through effective use of non-destructive testing technologies for industrial activities.
4.	"Act on the Support of Industrial Technology Research Cooperatives [Enforcement Date 23. Mar, 2013.] [Act No.11690, 23. Mar, 2013. Amendment by Other Act]".	"The purpose of this Act is to contribute to the development of the national economy through the advancement of industrial technology by prescribing matters necessary to incorporate and foster industrial technology research cooperatives to implement research and development of industrial technology and to introduce, disseminate, etc. collaboratively advanced technology, and by supporting such matters. "
5.	"Act on the Support of Industrial Technology Research Cooperatives [Enforcement Date 23. Mar, 2013.] [Act No.11690, 23. Mar, 2013., Amendment by Other Act] "	"The purpose of this Act is to contribute to the development of the national economy through the advancement of industrial technology by prescribing matters necessary to incorporate and foster industrial technology research cooperatives to implement research and development of industrial technology and to introduce, disseminate, etc. collaboratively advanced technology, and by supporting such matters. "
6.	"Astronomy and Space Act [Enforcement Date 23. Mar, 2013.] [Act No.11690, 23. Mar, 2013. Amendment by Other Act]".	"The purpose of this Act is, by providing for basic matters concerning the astronomical work, to prescribe the standardized calendar of the State, promote research on astronomy and space, and further contribute to disseminating the relevant knowledge."

7.	“Biotechnology Support Act [Enforcement Date 23. Mar, 2013.] [Act No.11683, 23. Mar, 2013. Partial Amendment]”.	“The purpose of this Act is to develop and support biotechnology more efficiently by laying the foundation of biotechnology research and to contribute to the sound progress of the national economy by facilitating the industrialization of the technology.”
8.	“Brain Research Promotion Act [Enforcement Date 23. Mar, 2013.] [Act No.11680, 23. Mar, 2013. Partial Amendment]”.	“The purpose of this Act is to efficiently foster and develop brain research through promoting its foundation and facilitating commercialization of its development technology, thereby contributing to national welfare improvement and national economy development.”
9.	“Cooperative Research and Development Promotion Act [Enforcement Date 23. Mar, 2013.] [Act No.11690, 23. Mar, 2013., Amendment by Other Act] ”	“The purpose of this Act is to contribute to the promotion of scientific and technological innovations and the national economy by prescribing matters for promoting cooperative research and development among universities, enterprises, research institutes, and foreign organizations related to research and development to facilitate the efficient use of research and development resources, and enhancing the possibilities of successful research and development.”
10.	“CT on the Promotion of Nanotechnology [Enforcement Date 23. Mar, 2013.] [Act No.11713, 23. Mar, 2013. Amendment by Other Act]”.	“The purpose of this Act is to contribute to innovations in science and technology and the development of the national economy by promoting the systematic fostering and development of nanotechnology and by creating nanotechnology research infrastructure.”
11.	“Nuclear Energy Promotion Act [Enforcement Date 23. Mar, 2013.] [Act No.11714, 23. Mar, 2013., Partial Amendment] ”	“The purpose of this Act is to provide for matters concerning the research, development, production and use of nuclear energy (hereinafter referred to as "use of nuclear energy") to contribute to enhancing people's lifestyles and welfare by facilitating the advancement of academic research and industrial development.”
12.	“Presidential Advisory Council on Education, Science and Technology Act [Enforcement Date 23. Mar, 2013.] [Act No.11678, 23. Mar, 2013. Partial Amendment]”.	“The purpose of this Act is to establish the Presidential Advisory Council for Science and Technology as an advisory organization under Article 127 (3) of the Constitution of the Republic of Korea to provide advice to the President on technical innovation, etc. and to prescribe matters necessary for the organization, functions, etc. ”
13.	“Special Act on the Designation and Support of High-Tech Medical Complexes [Enforcement Date 23. Mar, 2013.] [Act No.11690, 23. Mar, 2013. Amendment by Other Act]”.	“The purpose of this Act is to develop high-tech medical complexes into the global hub for research and development of medical services and contribute to the growth of the domestic medical industry by facilitating the active research and development of medical services and the commercialization of achievements from research with cooperation between enterprises, universities, research institutes, and medical institutions through the designation of, and support to, the high-tech medical complexes. ”
14.	“Korea Scientists and Engineers Mutual-Aid Association Act [Enforcement Date 05. Apr, 2013.] [Act No.11720, 05. Apr, 2013. Partial Amendment]”.	“The purpose of this Act is to establish an efficient mutual aid system for scientists and engineers through establishing the Korea Scientists and Engineers Mutual-Aid Association, thereby seeking the stabilization of scientists and engineers' livelihood and promotion of their welfare and contributing to activation of scientific and technological activities and enhancing national competitiveness.”

15.	"Support of Specific Research Institutes Act [Enforcement Date 15. Oct, 2014.] [Act No.12765, 15. Oct, 2014. Partial Amendment]".	"The purpose of this Act is to prescribe matters necessary for the protection and fostering of research institutes contributed to by the Government for the development of science, technology, industry and economy."
16.	"Framework Act on Science and Technology [Enforcement Date 30. Dec, 2014.] [Act No.12869, 30. Dec, 2014., Partial Amendment] "	"The purpose of this Act is to contribute to the national economic development, and further to the elevation of quality of national life and the development of human society by creating the basis for the development of science and technology, innovating science and technology, and strengthening the national competitiveness."
17.	"Act on the Establishment, Operation, and Fostering of Government-Funded Science and Technology Research Institutes, Etc. [Enforcement Date 30. Dec, 2014.] [Act No.12870, 30. Dec, 2014. Partial Amendment]".	"The purpose of this Act is to seek the establishment of an effective national innovation system for science and technology and the business rationalization of management and development of Government-funded research institutes specializing in science and technology by providing for fundamentals regarding the establishment, support, fostering, systematic management, and responsible operation of Government-funded research institutes specializing in science and technology."
18.	"Act on the Performance Evaluation and Management of National Research and Development Projects etc. [Enforcement Date 01. Jul, 2015.] [Act No.12871, 30. Dec, 2014. Partial Amendment]".	"The purpose of this Act is to enhance the efficiency and accountability of investment in research and development by evaluating the activities of research and development in the field of science and technology promoted by the Government after emphasizing performance and by efficiently managing and utilizing research outcomes."
19.	"Act on the Establishment of Safe Laboratory Environment [Enforcement Date 01. Jul, 2015.] [Act No.12873, 30. Dec, 2014., Partial Amendment] "	"The purpose of this Act is to manage research resources efficiently and thereby to contribute to the revitalization of scientific and technical research and development activities by ensuring the safety of laboratories in the fields of science and technology established in a university, research institute, etc. and ensuring proper compensation for damage caused by a laboratory accident."
20.	"Basic Research Promotion and Technology Development Support Act [Enforcement Date 12. Sep, 2015.] [Act No.13211, 11. Mar, 2015., Partial Amendment] "	"The purpose of this Act is to contribute to the strengthening of national competitiveness in science and technology and the economic and social development by supporting and nurturing basic research, encouraging research and development of core technologies, facilitating the accumulation of capabilities for creative research, and training excellent human resources for science and technology."
21.	"Fusion Energy Development Promotion Act [Enforcement Date 23. Sep, 2015.] [Act No.13346, 22. Jun, 2015. Partial Amendment]".	"The purpose of this Act is to contribute to the development of the national economy and promote the welfare of the people by facilitating research and development of fusion energy, establishing the infrastructure necessary for the generation and peaceful use of fusion energy, and promoting relevant technologies and industries."

22.	"Professional Engineers Act [Enforcement Date 01. Dec, 2015.] [Act No.13514, 01. Dec, 2015. Partial Amendment]".	"The purpose of this Act is to encourage the utilization of professional engineers in the fields of industrial technology by prescribing matters concerning the management of professional engineers and performance of their duties, thereby contributing to the promotion of science and technology and to the development of the national economy.
23.	"Space Development Promotion Act [Enforcement Date 21. Jul, 2015.] [Act No.13009, 20. Jan, 2015. Partial Amendment]".	"The purpose of this Act is to facilitate the peaceful use and scientific exploration of outer space and to contribute to national security, the sound growth of the national economy, and the betterment of citizens' lives by systematically promoting the development of outer space and by efficiently using and managing space objects."
24.	"Special Act on Promotion of Special Research and Development Zones [Enforcement Date 28. Sep, 2015.] [Act No.13231, 27. Mar, 2015. Partial Amendment]".	"The purpose of this Act is to promote special research and development zones, thereby accelerating the research and development by colleges, research institutes and companies in the regions, invigorate cooperation and support the commercialization of outcomes from the research and development as well as business start-ups, contributing to technological innovation and economic development of the Republic of Korea."
25.	"Special Act on Support of Scientists and Engineers For Strengthening National Science and Technology Competitiveness [Enforcement Date 12. Sep, 2015.] [Act No.13209, 11. Mar, 2015. Partial Amendment]".	"The purpose of this act is to contribute to the improvement of national competitiveness and to the development of the national economy by facilitating the utilization of scientists and engineers and providing them with better treatment upon nurturing talented scientists and engineers. "
26.	"Special Act on Establishment of and Support for International Science and Business Belt [Enforcement Date 28. Jul, 2016.] [Act No.13854, 27. Jan, 2016. Amendment by Other Act]".	"The purpose of this Act is to promote the enhancement of national competitiveness by establishing a basic research environment of a global standard and by preparing the foundation for the convergence of basic research and business through the development and support of an international science and business belt."

Government incentives for promoting innovation:

South Korea provides a general tax credit for R&D expenditures and a separate credit for acquiring R&D equipment. Suppose a business falls into the category of a Small and Medium-sized Enterprise (SME), a medium-sized enterprise (MSE), or a large enterprise (LE). In that case, it receives incentives for R&D according to the scale of the business.

Types of Innovation Incentives

Companies having annual sales income between Korean Republic Won (KRW) 40,000,000 to KRW 150,000,000 are considered SMEs and are liable to the grouping of the firm. Such a company's assets are valued at less than KRW 500 billion.

Small and medium-sized enterprises (SMEs) can claim a tax credit that's equal to either (i) 50 per cent of their R&D expenditure for the current year that exceeds the average R&D expenditure of the previous four years

- 25 per cent of their present session R&D expenditure, whichever is greater
- SMEs can also receive a tax credit equivalent to 10% of the purchase price of specific intellectual property (IP) purchased from a Korean party on or before December 31, 2021 (subject to a cap of 10% of the corporate income tax amount).
- Furthermore, an SME that develops and transfers or leases IP to a Korean party can avail of a patent box that provides a tax exemption for 50% of the corporate income tax on capital gains arising from the

transfer or 25% of the corporate income tax on rental income.

- In addition to a general tax credit for R&D spending, South Korea also provides a credit for purchasing R&D equipment.
- Financial support for the patent application fee
- Recommendation of Patented Products of Good Quality for Government Procurement
- Dispatch patent management advisors to universities and public research institutions
- Award for excellent innovation

Medium-sized enterprise (MSE)

The one whose average three-year sales revenue is less than KRW 500 billion. If a medium-sized enterprise spends more on R&D this year than it did on average the year before, it can claim a tax credit equal to the greater of (i) 40% of the difference or (ii) 8% of the total R&D spending this year.

The research and development (R&D) incentive varies in size depending on whether the research company is a SME, MSE or LE [2 million USD in 2011(20 thousand max. per application)]. Good inventions are recommended to the central government, local governments and state-run agencies. Recommended patented goods can receive preferential treatment in government procurement. 50 SMEs are nominated for their excellent inventions twice a year. The nominees receive a government award. Winners can display their inventions in a free booth at an invention exhibition.

A large enterprise (LE) is a business that is neither a SME nor a medium-sized business.

- Large companies are entitled to a tax credit that is greater than 25% of the current year R&D expenditure exceeding the average R&D expenditure for the previous four years or 50% of the R&D expense ratio (i.e., current R&D expense divided by sales revenue) of the current year R&D expenditure, capped at 2% of the current year R&D expenditure.
- Under the **New Growth Engine Industry or Original Source Technology Programs**, a more significant R&D tax credit is computed for medium- and large-sized businesses based on qualified expenditure. The maximum rate is 30% on the Korean Securities Dealers Automated Quotations (KOSDAQ) market].
- Large companies can claim a tax credit of 5% of the purchase price (capped at 10% of corporate income tax) if they buy a specific IP from a Korean SME before 31 December 2021.
- Large companies receive 1% of their R&D equipment investments, medium-sized companies 3%, and SMEs 7%. R&D expenses include machinery, facilities, tools, office machines, telecommunications instruments, testing machines, optical instruments, etc. Government-subsidized R&D is not eligible for the tax credit.

Government key innovation programs: The major programs/schemes and initiatives that have been undertaken for promoting R&D, especially under PPP mode, are listed in Table 10:

Table 10: National R&D Programs to Boost Public-Private Partnership

Sr. No.	National R&D Program	Brief Detail
1.	Korea Small Business Innovation Research (KOSBIR) Program	To create innovation-based growth of SMEs, the Korean government introduced the KOSBIR program based on the USA's highly successful 'Small Business Innovation Research" (SBIR) program. This initiative was presented in 1998 and referenced in Article 13 of the 'SME Technology Innovation Promotion Act'. Later, it was made permanent by revising the 'SME Technology Innovation Promotion Act' (August 2013). Three per cent of the R&D budget was set aside for implementing the KOSBIR program for supporting innovative practices of SMEs in 1998, which was enhanced to 5% from 2000 onwards. According to the latest available report, 19 organisations are participating in KOSBIR.

2.	Industrial Complex Cluster Program	The ICCP was implemented in 2005 as a part of the "National Balanced Development Policy" (NBDP) of 2004. The program was initiated with an aim: to bring transformation in factor-driven-production-centred industrial complexes into the knowledge-based growth of the industrial clusters. This program has promoted virtual networks of enterprises academic and research institutes. Through the formation of clusters, the Korean government has focused on enhancing the industrial competitiveness of local industries by promoting the exchange of knowledge and innovation.
3.	Accelerator Investment-driven Tech Incubator Program for Start-ups/Tech Incubator Program for Start-ups (TIPS)	TIPS Korea is an accelerator/investment-driven tech incubator program for Korean start-ups. The program provides enough support to a start-up to match a successful venture, helping newly formed companies establish a global base. It nurtures start-ups that are focused on ground-breaking technologies.
4.	Centers of Excellence	In 1990, the Centre of Excellence was established in various parts of the country by a non-profit organization, the “Korea Science and Engineering Foundation” (KOSEF)” to foster research linkages between industries and universities. In 2009, KOSEF merged with the Korea Research Foundation and the “Korea Foundation for International Cooperation of Science and Technology (KICOS)” to form the National Research Foundation of Korea. The major programs covered under the scheme of Centre of Excellence (CoEs) are the “Science Research Centre (SRC) Program”, the “Engineering Research Centre (ERC) Program”, the “Regional Research Centre (RRC) Program”, and “Medical Research Centre (MRC) program”.

Other than the above-mentioned National R&D programs (Table 11), additional programs implemented by NRF have significantly enhanced the STI ecosystem of the country.

Table 11: National Programs to Support Research and Development

Sr. No.	Name of Program	Brief Details
Category 1	**Individual Research**	
1.	Young Researcher Program	Contribute to the advancement and growth of research while cultivating the fundamental research capacity of researchers through individual research grants. **Sectoral Approach:** Multidisciplinary Science and Technology themes Qualification: Designation: Faculty position in an academic institution; Age <39 Years Abstract: Encourage innovative studies and expand the knowledge base to develop exceptional scientists. Period: 1 - 5 years Yearly Expenditure: ~ KRW 100,000,000/-
2.	Mid-Career Researcher Program	Contribute to the advancement and growth of research while cultivating the fundamental research capacity of researchers through individual research grants. **Sectoral Approach:** Multidisciplinary Science and Technology themes Qualification: Designation: Faculty position in an academic institution Yearly Expenditure: ~ KRW 200,000,000/-

3.	Research Leader Program	**Sectoral Approach:** Multidisciplinary Science and Technology themes Qualification: Designation: Faculty position in an academic institution Abstract: Create worldwide academic experts by supporting outstanding scientists' deep investigations to build autonomous technological advances and innovative technologies. Period: Either nine years (3+3+3) or five years (3+2) Yearly Expenditure: ~ KRW 800,000,000/-
4.	Bridging Research Program	**Sectoral Approach:** Multidisciplinary Science and Technology themes Qualification: Designation: Faculty position in an academic institution Abstract: Help brilliant scientists restart their research after a break. Period: 1 year Yearly Expenditure: ~KRW 30/50,000,000/-
5.	General Research Program	Provide broad support for basic research in Science and Engineering disciplines by individuals to transform and expand the research base and strengthen Korea's nationwide scientific capacity. **Sectoral Approach:** Multidisciplinary Science and Technology themes Qualification: Designation: Faculty position in an academic institution Abstract: Grants for scientific projects Period: 1-3 years Yearly Expenditure: ~ KRW 50,000,000/-
6.	Beginning Independent Researcher Program	Contribute to the advancement and growth of research while cultivating the fundamental research capacity of researchers through individual research grants. **Sectoral Approach:** Multidisciplinary Science and Technology themes Qualification: Designation: Faculty position in an academic institution; Age: <39 Years Abstract: Enhance options for research for talented young investigators and promote preliminary study success. Period: 1–3 years Yearly Expenditure: ~KRW 30,000,000/-
7.	Research Staff Program	Part-time Science and Engineering faculty in educational institutions working primarily for scientific research should be allowed to conduct innovative and challenging investigations without fear of rejection. This would provide them with stable and independent research support and encourage them to enhance their academic potential. **Sectoral Approach:** Multidisciplinary Science and Engineering themes Qualification: Only for Part-time faculty in academic institutions Abstract: Grants for scientific projects Period: 1-3 years Yearly Expenditure: ~KRW 10,000,000/- to 50,000,000/- million
8.	Research Program for Overlooked Areas	Preserving the diversity and balance of fundamental studies and naturalists in various fields. **Sectoral Approach:** Multidisciplinary Science and Engineering themes Qualification: Researcher Scholars Abstract: Grants for scientific projects Period: 1–10 years Yearly Expenditure: ~KRW 10,000,000/- to 100,000,000/-
9.	Regional Researcher Program	Strengthen localised Science and Technology research resources while offering support for developing exceptional researchers. **Sectoral Approach:** Multidisciplinary Science and Engineering themes Qualification: Designation: Faculty position in local, regional educational institutions Abstract: Grants for scientific projects Period: 1-10 years Yearly Expenditure: ~KRW 10,000,000/- to 50,000,000/-

Category 2	Group Research	
10.	Science Research Center (SRC)	Promote the worldwide competency of primary research fields and enhance Korea's readiness for fundamental research by recognising and encouraging creative and competent research groups. Promote collaborative studies to produce innovative, convergence-focused scholars for future generations and aid in establishing top-notch jobs for aspiring scholars. **Sectoral Approach:** Science themes Qualification: A group of ten to fifteen scholars working at higher education institutions Abstract: Foster great research groups in diverse scientific domains to create new ideas and solve scientific problems to strengthen Korea's fundamental research capabilities. Period: Up to 7 years Yearly Expenditure: ~KRW 1,560,000,000/-
11.	Engineering Research Center (ERC)	**Sectoral Approach:** Engineering themes Qualification: A group of ten to fifteen scholars working at higher education institutions Abstract: Create exceptional studies in engineering to encourage fundamental research that may be utilised to create and innovate and serve as a focus for enterprise-university partnerships. Period: Up to 7 years Yearly Expenditure: ~KRW 2,000,000,000/-
12.	Medical Research Center (MRC)	**Sectoral Approach:** Elementary medicinal discipline Qualification: A group of ten to fifteen scholars working at higher education institutions Abstract: Nurture fundamental medical, dentistry, and Oriental medicine schools to identify life-threatening phenomena and disease processes and increase Korea's physiological and wellness study capabilities. Period: Up to 7 years Yearly Expenditure: ~KRW 1,400,000,000/-
13.	Convergence Research Center (CRC)	**Sectoral Approach:** Convergence Qualification: A group of ten to fifteen scholars working at higher education institutions Abstract: Foster multidisciplinary confluence studies to develop world-class expertise and innovative solutions for social problems and demands from the public. Period: Up to 7 years Yearly Expenditure: ~KRW 2,000,000,000/-
14.	Regional Leading Research Center (RLRC)	**Sectoral Approach:** Specific to local issues Qualification: A group of ten to fifteen scholars working at higher education institutions Abstract: Establish local fundamental research centres to combine and characterise local research capabilities to equalise fundamental research advancement. Period: Up to 7 years Expenditure: ~KRW 1,500,000,000/-
15.	Basic Research Laboratory	Establish and promote modest research groups as complementary academic foundations in particular subject areas. **Sectoral Approach:** Multidisciplinary Science and Technology themes Qualification: Group of three to five Professor level experts in the Science and Engineering domain. Abstract: Encourage modest groups of researchers connecting private and public research to revitalise collaborative research. Period: 3 years Annual Expenditure: ~KRW 500,000,000

Category 3	**Infrastructure Building**	
16.	Research Facility Establishment Program	Encourage a fundamental framework for research centred on institutions and strengthen research administration. Strengthen the collaborative utilisation of instruments by building and administering scientific instruments at every organisation, and enhance the character of the premises for fundamental studies at educational institutions. **Sectoral Approach:** Multidisciplinary Science and Engineering themes Qualification: Depends on the infrastructure of higher educational institution Abstract: Assist with instrumentation for research integration and R&D costs. Period: 6 years (3+3) Yearly Expenditure: ~KRW 300,000,000–600,000,000/-
17.	Priority Research Institute Program	Establish university-affiliated centres for study to serve as academic hubs, encouraging them to specialise and assist in discovering and developing promising young scientists. **Sectoral Approach:** Multidisciplinary Science and Engineering themes Qualification: Scientific hubs at higher education institutions Abstract: Grants for scientific projects Period: 9 years (3+3+3) Yearly Expenditure: ~KRW 700,000,000/- to 1,100,000,000/-
Category 4	**Fostering the Next Generation of Researchers**	
18.	Post-Doctoral Domestic and Overseas Training	To ensure scientific consistency and independence, offer post-doctoral S&E scientists with instruction from domestic and international institutions. **Sectoral Approach:** Multidisciplinary Science and Engineering themes Qualification: Citizens of S. Korea gained PhD degree not before the last seven years International scientists obtained Ph. D. degrees from S. Korea not before the last seven years. Period: (For National) 1–3 years (1+1+1); (For International) 1 year Yearly Expenditure: ~KRW 45,000,000/-
19.	Presidential Post-Doctoral Fellowship	Help talented post-doctoral scientists become distinguished scientists and academic instructors. **Sectoral Approach:** Multidisciplinary Science and Engineering themes Qualification: Scientist gained PhD degree not before the last five years Age: <39 Year Abstract: Funding for training Period: 5 years (3+2) Yearly Expenditure: ~KRW 130,000,000/-
20.	Research Subsidies for Ph.D. Candidates	Support Ph.D. applicants' innovative doctoral thesis study proposals. **Sectoral Approach:** Multidisciplinary Science and Engineering themes Qualification: Scholars pursuing Ph.D. Abstract: Grant for training outlays Period: 2 years (1+1) Yearly Expenditure: ~KRW 20,000,000/-

* approximation based on the exchange rate of 1 USD = 1,100 KRW[14]

[14] Source: NRF-National Research foundation of Korea, 2022

B.2. Educational and Research System

- In 2022, S. Korea had 202 universities and 134 community colleges. S. Korean expenditures on R&D reached approximately 60 trillion won in 2020. Approximately 13.5 trillion won and 20 trillion won were allocated to basic and applied research, respectively.
- South Korea's federal research laboratories drive innovation and technology transfer (TT). These labs conduct cutting-edge research in fields such as biotechnology, nanotechnology, and artificial intelligence, which leads to the development of new products and services. They also collaborate with private companies to commercialize their research and bring new technologies to market. Federal research labs contribute significantly to South Korea's economic growth and competitiveness in the global marketplace through their efforts.

The top innovation-backed universities are as follows:

1. Seoul National University, Seoul
2. Yonsei University, Seoul
3. Korea Advanced Institute of Science and Technology, Daejeon
4. Korea University, Seoul
5. Sungkyunkwan University, Seoul
6. Hanyang University, Seoul
7. Kyung Hee University, Seoul
8. Samsung Advanced Institute Technology, Gyeonggi-do
9. Pohang University of Science and Technology, Pohang
10. Kyungpook National University, Daegu

In S. Korea, collaborative research and development projects for advancing technology research laboratories play an essential role in guiding the direction of the projects. The equitable distribution of the outcome of joint R&D carried out by federal research laboratories is encouraged by various government initiatives.

The top 10 innovation-ranked federal research laboratories of S. Korea are listed below:

1. Institute for Basic Science, Daejeon
2. Korea Institute of Oriental Medicine, Daejeon
3. Korea Research Institute of Bioscience and Biotechnology, Daejeon
4. National Institute of Animal Science, Jeollabuk-do
5. Rural Development Administration, Jeollabuk-do
6. Animal and Plant Quarantine Agency, Gyeongsangbuk-do
7. Korea Institute of Science and Technology, Seoul
8. Korea Food Research Institute, Jeollabuk-do
9. Korea Institute for Advanced Study, Seoul
10. Korea Research Institute of Chemical Technology, Daejeon

- Academic institutions and research labs have established strong connections with the commercial sector, emphasizing collaborative research and development. World-wide cooperative research is encouraged through the “Global Research Laboratory program” by bringing Korean and foreign labs at the same pace.
- Scientific and technological research activities prioritize achieving government objectives, interdisciplinary integration, teamwork involving students and facilities from different universities, and patent production.
- Educational and academic activities prioritize the quantity and quality of publications, academic conferences, developing educational programs, dissertations, post-doctoral research, and involving undergraduate and graduate students.

B.3. Industry System

S. Korea is an innovation leader due to systemic reforms for stimulating industrial participation in the innovation ecosystem through robust investments. Korean enterprises swiftly transitioned into heavy-chemical businesses and technologically driven industries due to an increase in research skills. Various programs in S. Korea were implemented to promote private sector participation in R&D. Details of such programs are mentioned in Table 12.

Table 12: Projects implemented in S. Korea for promoting private sector participation in R&D

Sr. No.	Initiative/project	Brief Details
1.	Creation of the Korean Industrial Research Council	Aimed at strengthening the capabilities of TLOs and also support Programs on IP management and TT. The council works to spread the research outcomes of the universities and the government-funded TLOs.
2.	Creation of Daedok Science Town	Daedok Science Town (Daedok Innopolis, since 2005) was created to drive national competitiveness in technology and prosperity by facilitating collaborations between universities, businesses and research organisations. It has around 30 government research institutes (GRIs), 42 private research institutes, five universities, eight support agencies, over 400 corporate R&D centres and more than 1200 high-technology companies (SMEs). Daedeok Innopolis is supported by the investments of central and local governments. Various constituents of the Science Town are - ● Industry - Daedeok Innopolis has good quality R&D functions, and the innovative technologies developed there find worldwide applications. At Daedeok, not only does the high-tech company develop their technologies, but start-ups also find a place to contribute their entrepreneurial skills. ● Academia - Daedeok Innopolis has around 15% of the PhD level engineering and science researchers in Korea, indicating that it has excellent R&D capability in Korea. Daedeok, therefore, plays a significant role in producing world-class leaders. ● Research - Technology creativity is due to qualified manpower, which has proven innovation records in IT, aerospace engineering, etc.
3.	Creation of Private Universities	Private universities make up a large section of Korea's educational institutions.
4.	Korean Small-Medium Business Administration	The administration started an initiative named 'Small & Medium Business Technology Innovation Development' to support SMEs in S. Korea. Under this initiative, the government supports SMEs collaborating with universities and research institutes to resolve industrial problems. The initiative promotes the formation of a consortium of industry and academic/research institutes working on common technical issues. This consortium is supported by the central government (50%), local government (25%), and SMEs (25%).

The top 3 R&D Investing companies in S. Korea are as follows:

- Samsung Electronics, South Korea
- LG Electronics, South Korea
- Hyundai Motor Co, South Korea

The top 10 companies as per the Fortune 500 (2020) list are as follows:

- Samsung Electronics
- Hyundai Motor
- SK Holdings
- POSCO
- LG Electronics
- Korea Electric Power Corporation
- Kia Motors

- Hanwha
- Hyundai Mobis
- KB Financial Group

Industries are also actively engaging themselves in the startup ecosystem of the country.

B.4. Intermediary System

S. Korea has built a variety of intermediaries that support R&D operations to strengthen the country's innovation ecosystem. They are listed below:

- **Chaebols:** In 2011, the government created the Pangyo Techno Valley industrial complex outside Seoul to boost high-tech company growth. 2013, the "Creative Economy" Program was launched, spending around USD 2 billion annually for five years. The administration supports these initiatives and proposed a USD 9 billion startup fund in 2018.

Many intermediaries are set up to enhance the startup ecosystem in S. Korea. The key examples are presented below:

- **K-Startup Grand Challenge (KSGC):** It supports international startups in Korea. The Gangnam-based 3-month accelerated Program has many mentors from Google for Entrepreneurs. Samsung, Hyundai, and LG provide mentorship, and Google Korea's Startup Campus offers free office space.
- **D.CAMP:** It is a foreigner-friendly, non-profit startup community ecosystem that supports fledgling entrepreneurs. They have co-working spaces, lounges, lecture rooms, event halls, and offices for promising early-stage enterprises. Companies here survive better than average, and most alumni get funding.
- **Seoul Global Startup Center:** A 2016 startup incubator helps overseas entrepreneurs in Seoul. Rehoboth, a 20-year-old Korean company incubator, runs the project with Seoul Metropolitan Government support. The Seoul Global Startup Center provides services to help overseas entrepreneurs launch and run enterprises in Korea.
- **SparkLabs:** It is a global accelerator that invests in and mentors seed-to-early-stage entrepreneurs looking to develop globally. Consumer Internet, Enterprise Software, Online Gaming, Mobile, E-Commerce, Digital Media, and Healthcare startups are their emphasis. The three-month Program provides cash, office space, and access to entrepreneurs, venture capitalists, angel investors, and executives.
- **N15:** A pioneering Korean hardware accelerator finds, grows, and invests in hardware startups and helps them expand globally by offering intensive legal and business assistance.
- **DreamPlus:** Hanwha Group's ICT accelerator helps enterprises expand into Asian markets. The accelerator builds Asian ecosystems.
- **Google Campus Seoul offers** mentorship, networking, and free cloud services. The first Asian Google Campus opened in Gangnam in 2015.
- **HeyGround:** Startups with social impact work at HeyGround. HeyGround is a stylish co-working place in trendy Seongsu with quirky cafes and eateries. They rent desks and workspaces and arrange impactful events. Members can use the picture studio, concierge, and community spaces.

B.5. Innovation Linkages

- To develop a stringent National Innovation System (NIS), the triple helix model was used to establish a strong linkage between industry-university-government to enhance the country's social and economic progress and knowledge industrialization.
- The country has a well-developed system of knowledge sharing, with close collaborations between firms, universities, and research institutes. This has allowed for the efficient transfer of ideas and knowledge, facilitating the development of new technologies and products.
- The government has been vital in promoting innovation and technology development, supporting firms and research institutes through various initiatives and funding programs. At the same time, private

firms have collaborated actively with universities and research institutes to develop new technologies and products.

- S. Korea's National System of Innovation comprises several key components and linkages. These include the interaction and collaboration between actors within the system, such as firms and institutions. Linkages between different types of participants, formal and informal, are also important. In addition, innovation system-level support is critical in supporting the creation and strengthening of South Korea's innovation ecosystem.

S. Korea emphasises worldwide collaboration via global collaborative research programmes, outreach programmes, technological partnerships, scientist exchange programmes, and research statistics sharing to enhance innovation and R&D.

C. Technology Transfer Ecosystem of South Korea

According to the "Technology Transfer Promotion Act [Article 2(2)]" of S. Korea, TT refers to transferring a technology from its owner to another. Knowledge, capital goods with integrated technologies, and intellectual property rights, including patent designs, utility models, configuration designs, and software, may be transmitted by licensing, technical advice, cooperative research, joint investment, or merger and acquisition.
'MOTIE', 'MSIP', and 'KIPO' launched multiple programs to foster TT and commercialization. MOTIE's initiatives sought to facilitate TT and transactions by assisting market-dominating technologies, distinguishing between autonomous and collaborative.

- Technology Transfer Office (TTO), endorsing IP professionals and cultivating TT and commercialization specialists.
- **MOTIE's** commercialization-associated technology development initiative helped enterprises with t promotional activities, consultancy, and accreditation.
- **MSIP's programmes** bridged the disparities between academic institutions and businesses, provided training and education to build TT specialists, and supported technology commercialization through upgrade TT projects.
- **KIPO's** priority in 2015 was recognizing market-oriented technologies, assisting them with commercialization, and linking inventors, TT and IP experts.
- **Leading TLO Program:** As a subprogram of the Connect Korea Programme, the Leading TLO Programme was created to designate 18 universities and ten national institutes with exceptional TLOs. The leading selection indicators were technology-producing capacity as measured by the calibre of researchers, the number of R&D funds, the performance of patents, and the revenue from TT. In addition, the standard of competence of TLO personnel and the quality of the university's regulations and system for technology commercialization were evaluated to assess the capability of TT.
- **Facilitating Technology Commercialization:** It was intended to encourage patent filing both domestically and internationally, to delegate patent counsellors to university TLOs, and to support international trade in technology with a total of 11 million dollars.
- **Regional Technology Commercialization Program:** It started bridging technology providers with industries and finance organizations. Korea has numerous regional TT Centres and Regional Environment Technology centres.

Transform government R&D initiatives into an industry-leading R&BD system. Establish university-based investment management companies as LLCs (Limited Liability Companies) and allow each university to manage its own LLC independently. Assist universities in raising funds for intellectual property, purchasing patents from external sources with these funds, and recreating patent packages with high-added value.

Numerous programmes provide guidance, instruction, advisory services, specialist introductions, and technology collaboration between universities and businesses to build infrastructure.

To uphold its stance towards collaborative and industrially relevant R&D, the government has introduced and enforced several 'Acts & Laws', recognized as the backbone of a robust system comprising various programs and schemes for promoting industry-oriented R&D in S. Korea.

The Korean government has also established various offices for building a TT ecosystem, which are as follows:

- **Technology Management Offices (TMO):** A TMO is tasked with implementing the organization's long-term strategy and vision by leading large-scale, complicated activities. Various TMOs are set up in universities, public R&D institutions, techno-park, etc.
- **Technology Licensing Offices (TLO):** The TT and Commercialization Promotion Act defines the TLO's function as follows: Works about invention, patents, including application, registration, maintenance, and use, allocation of income including royalties, etc., generated through knowledge transfer and commercialization, promotion of the transfer and commercialization of technologies and technical information support for industry.
- **Offline IP-Mart:** These were created to encourage selling patented products and technologies through exhibition centres, a consultation room for patent transfer, and an IP library.

Legislative framework for technology transfer

S. Korea's impressive technological advancements have made it a leader in many industries. However, the country's success is attributed to its innovation and robust legislative framework for TT. S. Korea has implemented several laws and policies to facilitate technology transfer between research institutions, businesses, and industries. This framework has played a crucial role in promoting technological innovation and growth in the country. Below Table 13 comprises details of such acts/laws.

Table 13: Acts and laws established in S. Korea for strengthening the TT ecosystem

S. No.	Acts/Laws	Details
1.	"Technology Transfer and Commercialization Promotion Act (Wholly Amended by Act No. 8108, Dec. 28, 2006, Act No. 14839, Jul. 26, 2017)".	This act aims to enhance the technical competitiveness of all industries by formulating and implementing policies appropriate for facilitating the transfer of technologies developed by public research institutes to the private sector for commercialization and to contribute to the growth of the national economy.
2.	"The Invention Promotion Act (amended in 2006)"	"The purpose of this Act is to enhance the technical competitiveness of industries and to contribute to the development of the national economy by encouraging invention and facilitating the prompt and efficient securing of rights to inventions and the commercialization thereof."
3.	"The Industry Education Enhancement and Industry-Academia—Research Cooperation Promotion Act (amended in 2003)"	The purpose of this act is to contribute to the development of communities and the state by training creative industrial human resources to meet the needs of the industrial world, by setting up an efficient research and development system, and by developing, spreading, diffusing, and commercializing new knowledge and technologies necessary for the growth of industries based on the linkage between education and research through the promotion of industrial education and the acceleration of industry-academia-research cooperation.
4.	"Industrial Technology Innovation Promotion Act [This Article Wholly Amended on Jan. 30, 2009]"	The purpose of this act is to promote the sustainable development of the national economy and the improvement of national living standards by fostering innovation and developing infrastructure for innovation in industrial technology to strengthen industrial competitiveness and enhance national capabilities for innovation.

Linkages and Network-Oriented Practices: South Korea has a well-developed ecosystem for TT, with national-level and institute-level organizations involved in promoting and facilitating technology transfer from research institutions to industry. Here are some examples of national-level organizations:

- **Korea Invention Promotion Association (KIPA):** KIPA is a government-funded organization that supports the commercialization of innovative technologies by providing patent services, licensing support, and other related services to various public and private universities, R&D institutions, etc. KIPA was founded in 1994 to promote intellectual property and improve patent administration. KIPA assists from invention to commercialization. KIPA also teaches worldwide intellectual property management.

- **Korea Technology Transfer Center (KTTC):** KTTC was established by the MSIT; KTTC is a national TT centre that provides a range of services, such as organizing numerous annual technology, R&D, and collaboration events to support technology commercialization and industry-academic cooperation.
- **Korea Institute of Science and Technology Information (KISTI):** KISTI is a national research institute providing various information and knowledge services to support science and technology research and innovation in Korea, including TT.

The following are examples of TT-related structures at the institute-level in S. Korea:

- **Technology Commercialization Center (TCC):** TCCs are located within the Korea Advanced Institute of Science and Technology (KAIST); TCC supports TT and commercialization by providing consulting services, intellectual property management, and industry collaboration programs.
- **Technology Transfer Office (TTO):** Many research institutions in Korea, including universities, have their own TT offices responsible for managing intellectual property, negotiating licensing agreements, and supporting industry collaboration.
- **Industry-Academic Cooperation Foundation (IACF):** IACF was established by the "Pohang University of Science and Technology (POSTECH)"; IACF is a non-profit organization that supports industry-academic collaboration and TT by providing consulting services, funding support, and intellectual property management.
- **Government programs for TT:** South Korea has implemented several programs to promote TT and innovation. These programs are designed to support research and development activities, enhance the competitiveness of local industries, and encourage collaboration between academia and industry. Some of the notable programs are:
    - **Technology Development Program:** This program is administered by the "Ministry of Trade, Industry, and Energy", and it provides funding and support for technology development projects in numerous fields such as ICT, biotechnology, energy, and materials science.
    - **Korea Institute of Science and Technology (KIST):** KIST is a government-funded research institute that conducts cutting-edge research in science and technology. Its mission is to promote national development by fostering innovation and advancing scientific knowledge.
    - **Small and Medium Business Administration (SMBA):** SMBA is a government agency that provides financial and technical support to small and medium-sized enterprises (SMEs) in South Korea. The agency offers various programs to help SMEs develop and commercialize new technologies, including the Technology Innovation Program and the Innovation Voucher Program.
    - **Korea Institute for Advancement of Technology (KIAT):** KIAT is a government agency that promotes developing and commercialising advanced technologies in various sectors such as electronics, machinery, and biotechnology. The agency provides funding and support to research institutes, universities, and private companies.

There are several government programs aimed at promoting TT and innovation in South Korea. The government's strong support for research and development, a highly educated workforce, and a vibrant entrepreneurial culture have made South Korea a leader in technology and innovation.

D. Snapshot of Good Practices in Technology Transfer

Reference from the overall TT ecosystem in South Korea and TT Ecosystem at Seoul National University at Seoul & Korean Intellectual Property Office (KIPO). Table 14 lists the ood Technology Transfer practices in South Korea.

Table 14: Good Technology Transfer Practices in South Korea

Attributes	Inputs from the Technology Transfer System
1. Governance Practices	
Legislature and Policy Inputs: ● National level (National impetus on TT through Act/Law/Policy/Guidelines) ● Institute level (Designing flexible institute policies on TT)	● South Korea has a legislative framework for promoting and stimulating TT-related activities. The key legislative norms and acts that regulated TT in the country are "The TT and Commercialization Promotion Act", "The Invention Promotion Act", "The Industry Education Enhancement" and "Industry-Academia—Research Cooperation Promotion Act", "Industrial Technology Innovation Promotion Act". ● The "Technology Transfer and Commercialization Promotion Act" allowed the government to issue directives to form TTOs in all the higher education institutions.
Governance Model: Among the elements that influence the policy formulations for the TT ecosystem in Korea are "incentives for transfer", "a sense of common purpose," "person-to-person contacts," "concreteness of technology," "understanding of the nature of business" and "awareness of transfer" etc.	● Diverse structures are proposed to boost the ecosystem for TT, including: ○ The Science and Technology Innovation Office ○ Leaders in the Industry-University Cooperation Program ○ Fostering Human Resources for the University-Industry Cooperation Program ○ Commercialization of Industry-University Collaboration Group Technology Support Program ○ Technology Licensing Offices and Technology Management Offices ○ Offline IP-Mart
2. Organizational and Managerial Practices	
Organization Culture: ●Entrepreneurial and focused on identifying and commercializing breakthrough technology and starting new businesses. ●South Korean TTOs understand that TT needs collaboration between researchers, industrial partners, and other stakeholders. ●South Korean TTOs frequently adapt to market and industry trends and government TT policies.	● **Industry-Academic Cooperation Foundation (IACF)** at various universities focuses on the proceeding of patent litigations to help researchers and professionals. ● **Technology Commercialization Centres** help in negotiations among the stakeholders of technologies developed at the institutional level. ● At the institutional level, Special **Technology Development Programs** assist ongoing research, aiming to commercialise that research when it reaches its full potential.

Managerial Position in TTO: To direct the TTO's operations as a whole, there is a requirement for both a team leader and an administrative post.	**The TTOs and TLOs in S. Korea have developed a dedicated team to undertake TT activity. For example:** **The staff of the SNU R&DB Foundation** comprises a team of professionals with diverse backgrounds and expertise in research, TT, entrepreneurship, and industry-academia collaboration. While specific roles and responsibilities may vary depending on the department or unit, the staff of the SNU R&DB Foundation typically includes the following: ● Director ● Managers and Coordinators ● Technology Transfer Officers ● Business Development Officers ● Research Project Managers ● Administrative Staff ● Patent management advisor It consists of a field expert in charge of each associated field. A defined procedure for TT comprises the following steps ● Signing Memorandum of Agreement ● Signing of Confidentiality Agreement ● Technology Testing ● Negotiations of agreement terms ● Agreement signing
3. Financial Sourcing and Administration Practices	
Financial sourcing ensures the effective management of resources and the successful commercialization of innovative technologies. It includes: ● Government Funding ● Licensing Revenue ● Equity Investments ● Donations and Philanthropic Contributions	● The government provides funding through a range of programs, including the Technology Innovation Program ● TTOs in South Korea generate revenue through licensing agreements with industry partners. Under these agreements, companies pay a fee to use or commercialize a technology developed by a university or research institution. Licensing revenue is often shared between the TTO and the inventors or research institutions. ● TTOs in South Korea sometimes take equity stakes in startup companies developing technologies based on research conducted at universities or research institutions. These equity investments provide the TTO with a share of the company's ownership and the potential for a return on investment. ● TTOs in South Korea may receive donations or philanthropic contributions from individuals, companies, or other organizations.

4. Functional Practices	
Variety of functional practices to facilitate the transfer of technology from research institutions to industry partners. It includes: ● Technology Assessment and Evaluation ● Intellectual Property Management ● Business Development ● Licensing and Commercialization ● Entrepreneurship Support ● TT Education	● TTOs evaluate new technology's commercial potential and license-ability. This includes finding industry partners and researching technology demand. ● TTOs identify patentable technology, file patent applications, and license university and research institution intellectual property to commercial partners. ● TTOs recruit industry partners and negotiate licensing or TT agreements through business development. Examples include attending industry conferences, networking events, and creating industry partnerships. ● TTOs help innovators and researchers build firms to market their technology. ● TTOs train and help inventors and researchers launch businesses. Mentoring, business planning, and funding are included. ● TTOs teach researchers and students on TT. This comprises intellectual property management, licensing, and entrepreneurship workshops, seminars, and training programs.
5. Output /Reporting Practices	
Reporting practices are an essential aspect of the TT ecosystem in South Korea, as they provide stakeholders with information on the outcomes of TT activities and enable them to make informed decisions about future investments and collaborations. These reports include:TT Reports ● Annual Reports ● Impact Reports ● Surveys and Feedback	● TTOs publish their initiatives and results. These studies describe licensed or commercialized innovations, revenue, and TT's economic and social effects. ● South Korean universities and organizations publish annual research, cooperation, and TT reports. ● TT impact paper records social, economic, and environmental impacts. These reports often cover job creation, money production, product and service development, and TT's larger social advantages. ● Surveys and comments can promote TT and identify investment and partnership opportunities.
6. Linkages and Network-Oriented Practices	
● Industry-Academia collaboration	● In South Korea, industry-academia collaboration is often facilitated through government initiatives such as the **Industry-University Cooperation program**, which provides funding and resources to support joint research projects between universities and industry partners. ● South Korea has a thriving startup ecosystem, with several incubators and accelerators that support early-stage companies. For example, the **Seoul National University Startup Support Foundation** provides funding, mentorship, and other resources to startups affiliated with the university.
● Incubators and Accelerators	● South Korean researchers and institutions collaborate with international partners to facilitate TT and commercialization. For example, S. Korea started the "**Global R&D Partnership program"** to promote collaboration between South Korean companies, foreign companies, and research institutions. The program provides funding to support joint research projects and TT activities.

7. Incentivising Practices	
● General tax credit for R&D expenditures and a separate credit for acquiring R&D equipment. ● New Growth Engine Industry or Original Source Technology Programs ● Tax credit for IP purchased from SMEs	● Tax incentives and reductions encourage TT between enterprises to improve technical skills and capital recovery in technology development. SMEs and some medium-sized firms pay 50% less corporate income tax on patent transfers to Korean nationals. SMEs and medium-sized firms can claim a 25% tax credit for patent and utility model licencing income if they first register these rights. Transfers and leases receive this interim credit until December 2023. The remaining credit can be carried forward for ten years. ● A qualified domestic firm merging with a technology-innovative SME can claim a 10% tax credit on the merger payment up to the value of the acquired technology. ● **"New Growth Engine Industry or Original Source Technology Programs"** is an improved research and development tax credit system for medium-sized and large companies.
●Financial support for the patent application fee.	● It helps in reducing the cost of obtaining patents and accelerate the acquisition of patent rights
● Recommendation of Patented Products of Good Quality for Government Procurement	● Good ideas are suggested to national, state and regional governments to encourage recommended patented items and commercialize them.

D. Case Study

A. Technology Transfer ecosystem at "Seoul National University (SNU)

SNU is one of the top universities in South Korea, known for its excellence in research and innovation. SNU has a dedicated TTO that works to commercialize and transfer the university's technology to the private sector. It's R&DB Foundation for Research and Development Business (R&DB) was established in October 2008 to encourage the founding of business ventures by faculty and students of SNU and to facilitate the commercialization of the school's excellent technology resources.

SNU has established several programs to facilitate technology transfer to industry partners. These programs include:

- **Technology Commercialization Program (TCP**): SNU's TTO manages the TCP, which aims to support the commercialization of SNU's technology by providing funding and expertise to researchers. The TCP provides funding for proof-of-concept studies, patent filing, and prototype development.
- **Patent Management Program:** SNU's TTO manages the Patent Management Program to ensure that SNU's intellectual property is effectively protected. The program supports researchers in patent filing, prosecution, and maintenance.
- **Industry-Academia Collaboration Program:** SNU's Industry-Academia Collaboration Program facilitates collaboration between SNU researchers and industry partners. The program aims to promote the exchange of knowledge and expertise and to facilitate the transfer of technology from SNU to industry partners.
- **Technology Licensing Program:** SNU's TTO manages the Technology Licensing Program, which aims to license SNU's technology to industry partners. The program supports negotiations and ensures that licensing agreements are fair and equitable.
- **Startup Support Program:** SNU's Startup Support Program supports researchers interested in launching their own startup companies based on SNU technology. The program provides funding, mentoring, and access to resources that can help researchers launch successful startups.

Overall, these programs demonstrate SNU's commitment to promoting TT and commercialization. Here are some best practices that SNU's TTO follows to ensure successful TT:

- SNU's TTO encourages researchers to engage with the TTO early in the research process to ensure that intellectual property is protected and commercialization opportunities are identified from the beginning.
- The TTO provides training and support to researchers on intellectual property protection, patent filing, and commercialization. This helps ensure researchers have the knowledge and skills to engage in successful TT.
- Before pursuing TT, the TTO conducts a thorough market analysis to identify potential industry partners and assess the technology's commercial potential.
- SNU's TTO works to protect the university's intellectual property by filing patents and copyrights. This ensures the university's technology is protected and can be licensed to industry partners.
- The TTO is critical in negotiating licensing agreements with industry partners. The TTO ensures that licensing terms are fair and the university's interests are protected.
- The TTO provides technical support to industry partners to ensure they have the necessary expertise to develop and commercialize the technology.

Article 3-4 of Seoul National University royalty allocation guidelines defined the distribution method of royalty revenue.

The TTO monitors the progress of TT projects to ensure that they are progressing as planned. The TTO works closely with industry partners to ensure they meet their obligations under licensing agreements.

SNU's TTO fosters collaboration between researchers and industry partners. This helps to ensure that the technology is being developed to meet the market's needs and that the resulting product or service is of high quality.

B. Contribution of Samsung — the classic chaebol, the TT ecosystem

Samsung operates in electronics, insurance, construction, and shipbuilding. Samsung dominated the computer chip design and tablet and mobile phone markets in the 1990s and 2000s. The following are the significant contributions of Samsung:

- **Research and development:** Samsung finance R&D, which has enabled the company to develop cutting-edge technologies. This has helped Samsung to transfer technology to other companies and industries through licensing and partnerships.
- **Patents:** Samsung is among the most significant patent holders globally, actively licensing its patents to other companies. Samsung's patents cover various technologies, including semiconductors, displays, and wireless communication.
- **Open Innovation and Knowledge Transfer:** Samsung has embraced the concept of open innovation and knowledge transfer, which involves collaborating with external partners to develop new technologies and sharing expertise through training programs and partnerships. For example, the Samsung Strategy and Innovation Center focuses on creating partnerships and investments with early-stage startups. Through this approach, Samsung has leveraged other companies' expertise and accelerated innovation.
- **Global partnerships:** Samsung has partnered with various companies and organizations worldwide, including universities, research institutes, and other corporations. For example, Samsung collaborates with MIT, Stanford, and Cambridge University. These partnerships have enabled Samsung to share its technology with other companies and industries while gaining access to new technologies and markets.
- **Corporate social responsibility:** Samsung has a solid commitment to corporate social responsibility, and the company has established several initiatives to promote TT and innovation. For example, Samsung has established the Samsung Innovation Campus, which provides young people interested in technology and entrepreneurship training and resources.

The company's investment in research and development, patents, open innovation, global partnerships, and corporate social responsibility have all helped to promote the transfer of technology and accelerate the pace of innovation.

Annexure II (f)
ISRAEL

Israel

A. Innovation Profiling

Israel is commonly called the "Startup Nation" due to its vibrant and dynamic culture of innovation. Israel is a country with a thriving culture of innovation, earning it the nickname of "Startup Nation." Its advanced technology, entrepreneurial spirit, and supportive ecosystem have created an environment that fosters creativity and the development of ground-breaking technologies. These factors, coupled with a strong culture of collaboration and global market reach, make Israel a leader in innovation and entrepreneurship.

As per the GII report 2022, Israel is globally ranked 16th out of 138 economies on the innovation scale. Israel was ranked 15th out of 48 high-income economies and 1st out of 19 economies in North Africa and West Asia. In terms of innovation outputs, it is ranked 12th. Israel is performing well in innovation output attributes compared to the innovation inputs. In the field of PCT patents and the export of ICT (Information & Communication Technology) services, Israel ranks first in the world in the above-mentioned innovation outputs. In Israel, R&D is mainly done by the private sector, showcasing the prominent feature of Israel's growth. Compared to other countries, Israel has more tech start-ups per capita than worldwide. This can be attributed to its technologically advanced market economy supported by high-technology exports, education system, per capita income, and other human development index indicators.

As per the GII report, in 2015, Israel spent 4.3% of its GDP on research and development, the highest ratio in the world. In 2020, it increased to 5.44%, still the highest GERD as % of GDP (Figure 1_Israel). This is one of the strongest stimulators for innovation in the country. Israel is home to more than 350 R&D centres of multinational corporations, of which many are Fortune 500 companies, which illustrates Israel's high impact on the progress of global innovation.

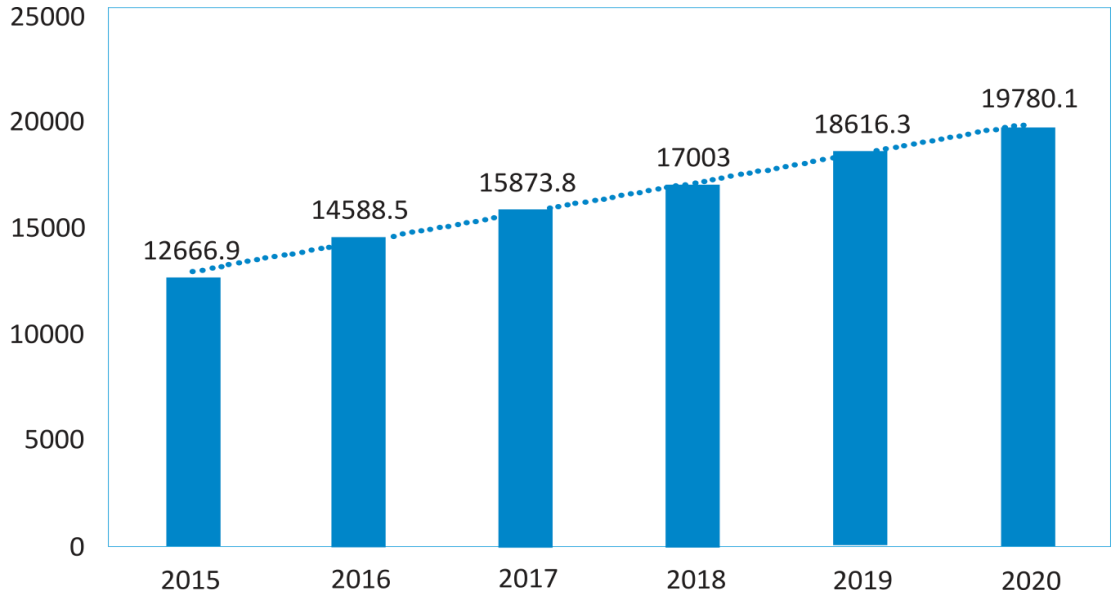

Figure 1_Israel: Gross Expenditure on R&D by Israel in Million USD[15]

Israel has five R&D priorities: Bio-convergence (which merges engineering and medicine), food tech, renewable energies and energy storage, civilian space industry and Bluetech (the sea as a national resource Quantum AI and Data Science. The business sector provides the larger chunk of the GERD, as shown in the Figure 2_Israel below. Israel shows unique qualities regarding R&D investment made in the country. The

[15] Source: OECD, 2022

maximum share of R&D investments (nearly 50%) is attributed to investments from abroad, followed by industry, government and higher education sectors (Figure 3_Israel).

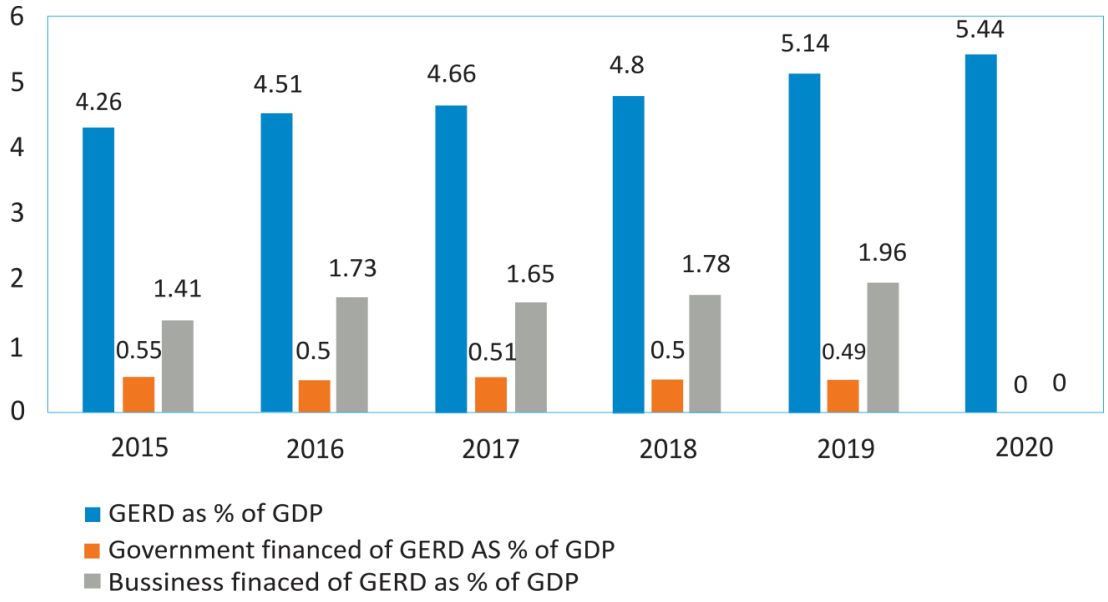

Figure 2_Israel: Gross Expenditure on R&D (GERD) as % of Gross Domestic Product (GDP)[16]

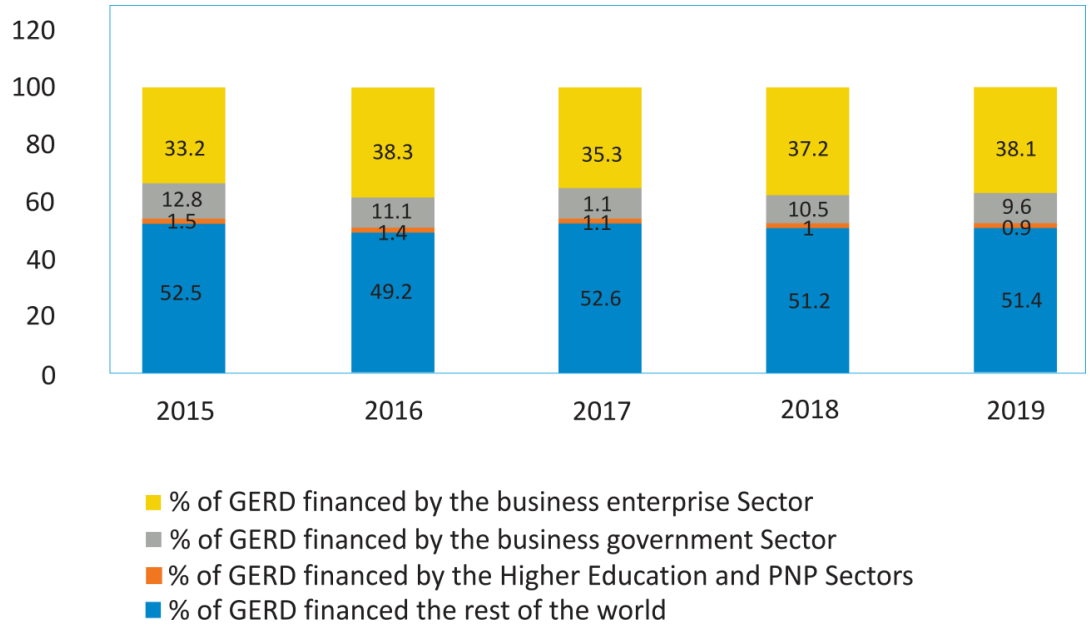

Figure 3_Isarel: Percentage of GERD financed by various Sector[17]

*(*Data for GERD financed by different sectors for the year 2020 is not available)*

R&D performance in Israel is dominated by the industrial sector (over 90% of GERD performed by the industry), followed by the government and higher education sector. This highlights that with its efficient business and innovation environment and foreign policies, Israel has attracted investments in R&D from abroad, and R&D is carried out in collaboration with Israeli industries and multinational companies (MNCs), leading to the majority of R&D performed by Israeli industries in Israel.

[16] Source: OECD, 2022
[17] Source: OECD, 2022

B. Innovation Actors

B.1 Government System

Israel has a well-developed innovation system supported by various government institutions, policies and initiatives. Chief Scientist of the **Ministry of S&T** and Space operates several programs to promote research and development in various fields, including basic, applied, and industrial research. It also manages and funds research institutions and academic research in Israel. In addition to promoting scientific research, the Ministry of Science and Technology also works to create a supportive environment for technological innovation and entrepreneurship. It supports startups and small businesses through programs like the Innovation Authority and the Israel Innovation Fund. **Ministry of Industry and Trade** in Israel develops policies and strategies that promote innovation across different sectors of the economy, encourage research and development, support startups and SMEs, and facilitate international trade. By doing so, the ministry drives economic growth and job creation through innovation and entrepreneurship. **Ministry of Finance** supports innovation in Israel by providing financial resources. The ministry oversees the national budget, including funding for research and development, startup incubators, and other innovation-related initiatives. By allocating financial resources to these areas, the Ministry of Finance helps to create a supportive environment for entrepreneurs and innovators in Israel. Israel also has a strong venture capital industry, which helps to finance new businesses and ideas.

There are numerous umbrella organizations in Israel to strengthen the innovation ecosystem. A few of those are mentioned below:

- **Israeli Innovation Authority (IIA): T**he IIA, a publicly funded autonomous organisation, was specially established to provide diverse practical tools and funding platforms for successfully handling the needs of the local and global innovation ecosystems. The prominent targets are the early-stage entrepreneurs, companies manufacturing and developing novel products, product commercialization, exploring new markets, collaborations with global partners, traditional establishments, and plants seeking innovative and advanced manufacturing in their operations.
- In January 2019, the government joined the World Economic Forum and established a network of **centres for the Fourth Industrial Revolution** (C4IR) to support government regulation in adopting fast-evolving technologies. In August 2019, the Innovation Authority established the Israeli 'Center for Regulation of Innovative Technologies as an affiliate center inside the C4IR network.
- **TELEM Forum:** The Israeli National Academy of Science (INAS) established the National Infrastructure Forum for Research and Development (TELEM) in 1997. Through developing national R&D infrastructures and strengthening inter-organizational/departmental and international collaborations, the forum supports R&D programmes and initiatives in the scientific and technological fields.

Some of the key government policies aimed at promoting innovation in Israel include:

- **Investment in R&D:** The Israeli government has made significant R&D investments by emphasizing innovation in strategic industries such as cybersecurity, biotechnology, and renewable energy. The government provides tax incentives, grants, and other funding mechanisms to encourage private sector investment in R&D.
- **Intellectual Property Protection:** Israel has a robust intellectual property protection regime, which includes patent laws, trademark laws, and copyright laws. The government has established various initiatives to support startups and small businesses in protecting their intellectual property.
- **International Collaboration:** The Israeli government has partnered with other countries to promote international collaboration and knowledge sharing in science and technology. These partnerships include joint R&D projects, academic exchanges, and technology transfer agreements.
- **Education and Training:** The government has invested in education and training programs to support the development of a skilled workforce. This includes initiatives such as the Israel Innovation Authority's "Technological Leadership Program," which provides funding and training for students pursuing degrees in science & technology.

The Israeli government has adopted a comprehensive approach to promoting innovation, particularly supporting startups and early-stage companies, investing in R&D, protecting intellectual property, and fostering international collaboration. These policies have contributed to developing a flourishing innovation ecosystem in Israel, with a high concentration of entrepreneurs/startups, innovative businesses, and leading-edge academic/research institutions.

The legal system: Due to tax exemptions, a common legal system, and an independent court, foreign investors can invest and repatriate funds without currency controls. Investments involving equity, debt, and hybrid structures are legally permissible. Additionally, the legislation protects trade secrets, patents, copyrights, trademarks, trade attire, and designs. In Israel, in-licensing, cross-licensing, and technology disposal are prominent business practices. By law, the board of directors must supervise the management. Exculpation, compensation, and insurance safeguard the directors and executives. Table 15 lists Israel's acts and laws for the promotion of R&D and technology commercialization

Israel has no specific legislation for knowledge transfer from academia to industry to the general public. Although they support universities for policy formulations and technology transfer by incentivizing and subsidizing through programs such as **'Magnet and Magneton'.**

Table 15: Israel's acts and laws for the promotion of R&D and technology commercialization

Sr. No.	Laws/Acts/Policies	Details
1.	Encouragement of Research and Development Law, 1984 (the "R&D Law")	The objectives of this law are as follows: ● Creating the employment scope in the industries and absorbing the scientific and skilled manpower. ● Creating surplus yield, which means "excess yield, " increases economic benefit through R&D. ● Developing science-based industry whilst exploiting and intensifying the technical and scientific infrastructure and human resources existing in the State. ● The enhancement of the payments of the State through the manufacturing and exporting of science-based Products and encouraging industrial R&D.
2.	Companies Law and the Securities Law of 1968 ("the Securities Law")	The Companies Law and the Securities Law of 1968 are two important pieces of legislation in business and finance. ● The Companies Law regulates the formation, organization, and management of companies in Israel. It sets out the legal requirements for creating a company, including the different types of companies that can be formed, the procedures for registering a company, and the rights and duties of its officers and shareholders. ● The Securities Law regulates the issuance, trading, and disclosure of securities in Israel. It requires companies that issue securities to provide accurate and complete information about their financial condition and operations to potential investors. It also regulates the activities of brokers, dealers, and other market participants in the securities industry.

Government incentives for promoting innovation

Israeli Innovation Authority (IIA), formerly the Office of Chief Scientist, a branch of the Israeli Ministry of Economy and Industry, released new rules for Israeli enterprises receiving funds from the Authority (funded company) in May 2017. On July 1, 2017, the rules applied to funded companies' innovation authority-granted know-how. ("funded IP").

- **Licensing of funded IP outside Israel:** The innovation authority licenses funded IP to a non-Israeli entity after the effective date, without the funded company having to pay a one-time "exit" payment.

- **Reducing royalty rates payable to the authority:** After the effective date, funded companies must pay 3-5% of revenues from the sale of products incorporating funded IP or licensing funded IP, down from 3.5-6% to the innovation authority.
- **Changes in the interest rate:** After the effective date, the annual interest rate accumulated will be either (i) the LIBOR rate, i.e., if the funded company's income in the year preceding its application to the innovation authority for the grant relating to the relevant funded IP is up to 70 mn USD, or (ii) the higher of the LIBOR rate plus 1.5% or 2.75% if its income is greater than 70 mn USD.

Government key innovation programs are as follows:

- **MAGNET Consortia**: The MAGNET Consortia encourages the creation of consortia comprising of companies and academic research institutes that collaborate to develop advanced technologies. These partnerships promoted long-term R&D and created a constructive work environment. Collaboration with the industry supported by consortia further increases research institutes' commercialization capacity and aids in comprehending industry and market needs**.**
- **Kamin**: This Program addresses preferred application-oriented research. Its goal is to foster functional research in research institutions (RI), which is an extension of the preceding fundamental research, and then to take it to the point where businesses and industries can take it to the stage of commercialization or make a decision to enter into a commercialization agreement with specific RI. As a result, the aforementioned plan aims to bridge the gap between basic and applied research to boost research outputs and innovations.
- **NOFAR:** The NOFAR Program focuses on application-oriented research in the fields of energy, biotechnology, nanotechnology, medical devices, water technology, and other multidisciplinary technologies. The Program was created with a mandate to promote and nurture the 'applied research', which would ultimately increase work during the preceding basic research.
- **Magneton:** Israel's Magneton project exhibits direct funding for translating research. This incentive instrument intends to encourage the transfer of technologies and related information concentrated in academic settings for application in the industry by establishing collaborative links between Israel's various academic research groups and enterprises. Such collaborations expose academic research outputs to industry, assisting them in identifying successes relevant to their activities and subsequently assisting researchers in converting the outcomes into commercial entities. Through this relationship, this program fosters the direct transfer of research output to industry. The Magneton Program aims to maximize the commercialization capacity of universities' technical capabilities, consequently developing Israeli business.

B.2. Educational and Research System

- Israel has a strong education and research system that plays a crucial role in driving innovation in the country. Israel's government has strongly emphasised investing in education and research, recognizing that a well-educated and innovative population is critical to the country's long-term success. The education system in Israel is highly developed, with a literacy rate of 97% plus a focus on Science, Technology, Engineering, and Mathematics (STEM) subjects. Israel has several world-class universities, such as the Hebrew University of Jerusalem, Tel Aviv University, and the Technion - Israel Institute of Technology. These universities have strong research programs and collaborations with international institutions. The Israeli government has also established several programs to support innovation and entrepreneurship in the country.
- In addition, Israel has many world-renowned research institutions for their work in fields such as biotechnology, cybersecurity, and renewable energy. These institutions include the Weizmann Institute of Science, the Israel Institute for Biological Research, and the Israel Institute of Technology. Israel's education and research system has played a crucial role in the country's accomplishment in innovation.
- Israel has a high number of patents per capita and is a leader in cybersecurity, biotechnology, and renewable energy. The education and research system has helped to create a highly skilled workforce and a culture of innovation and entrepreneurship, which has driven economic growth in the country.

The top innovation-backed universities are as follows:

1. Weizmann Institute of Science
2. Technion - Israel Institute of Technology
3. Tel Aviv University
4. Hebrew University of Jerusalem ISR
5. Ben-Gurion University of the Negev
6. Bar-Ilan University
7. Tel-Hai College
8. ORT Braude College
9. Interdisciplinary Center Herzliya
10. Ariel University

The top 10 innovation-ranked federal research laboratories of Israel are listed below:

1. Israel Institute for Biological Research
2. Agricultural Research Organization
3. Israel Defense Forces
4. Israel Atomic Energy Commission
5. Israel Oceanographic and Limnological Research
6. Shimon Peres Negev Nuclear Research Center
7. Geological Survey of Israel

Federal research laboratories collaborate with academia, industry, and government agencies to develop new technologies and products and commercialize their research findings. They also provide training and support to startups and entrepreneurs, helping them to develop innovative products and services.

B.3. Industry System

- To create value-driven goods and services based on cutting-edge ideas, the country has built a strong educational infrastructure and a top-notch incubation system. Through these developments, the country has established a significant concentration of high-tech businesses across its regions. A thriving venture capital sector provides finance for these companies. After the United States, it has the most startup businesses worldwide.
- With hundreds of successful Israeli private equity and venture capital firms, Israel's growing venture capital industry has significantly funded the nation's expanding high-technology sector. In addition to venture capital businesses, Israel is home to many of the world's top investment banks, pension funds, and insurance organisations, all of which have made significant financial commitments to support Israeli high-tech companies and benefit from the country's thriving high tech industry. Global organisations have bought numerous Israeli high-tech firms due to their dependable corporate management and qualified workforce.
- **Venture Capital:** In 1993, the Israeli government supported many venture capital funds under the name "Yozma" for the first time. The Yozma plan proposed for the establishment of 10 venture capital funds backed by the government and financed by private investors both domestic and outside. Each Yozma fund included a five-year call option on the Israeli government's shares, incentivising private investors to acquire the government's shares at predetermined rates. The Yozma program effectively lures major firms engaged in Israel's embryonic venture capital industry, thereby supplying them with the necessary funds and experience. Massive domestic and foreign investments, including those from venture capital funds, private equity funds, hedge funds, strategic investors, institutional investors, and early-stage angel investors, fueled the growth of the Israeli IT sector in 2021.
- The Israeli government has also established several programs to support innovation and entrepreneurship in the country. One example is the Israel Innovation Authority (IIA), which provides funding and support to startups and other innovative companies. The number of programmes that are supported by IIA (Table 16) for supporting industry and startup ecosystem in the country are:
    a. Early Stage Companies Incentive Programme
    b. Generic R&D Incentive Programme for Large Companies
    c. Ideation (Tnufa) Incentive Programme
    d. Incentive Programmes for Innovation with Government Entities
    e. Incubators Incentive Programme

f. Innovation Labs Programme
g. Support of R&D and Promotion of Technological Innovation
h. R&D Preparatory Incentive Programme for Companies in the Manufacturing Industry

Table 16: Programs for start-ups and companies of Israel Innovation Authority (IIA):

Sr. No.	Programme Name	Characteristics
1.	Early-Stage Companies Incentive Programme (https://innovationisrael.org.il/en/program/early-stage-companies-incentive-program)	For incentivising start-ups to develop and promote an innovative scientific project and enter the market by attracting funds from the business sector. All start-ups performing R & D within the previous financial year were able to raise 10 million USD and revenues nearing one million USD. The incentive helps start-ups raise funds from the business sector in the initial years of their establishment. The Authority supports through providing a comprehensive professional analysis of the project, which offers itself as a 'mark of quality' for industries in Israel and abroad. The option of marshalling the preliminary supplementary funds for up to six months after the project's approval aids the start-ups in raising funds in their initial stages. The motivation programme is such that it offers sharing in the risks associated with the development process of the start-up but not in any of the profits or successes in the future. The companies repay the funds secured from the Authority through royalty payments from technology sales.
2.	Generic R&D Incentive Programme for Large Companies (https://innovationisrael.org.il/en/program/generic-rd-incentive-program-large-companies)	For encouraging and supporting continuing R&D in large companies (possessing a minimum R&D budget of 20 million USD) and allowing them to focus on creating new technological know-how and infrastructure for developing innovative technologies. It is mandatory for companies submitting this incentive to develop a long-term proposal that includes collaboration with another Israeli organisation (public or private). IIA provides 20% - 50% of funds of the permitted R&D costs.
3.	Ideation (Tnufa) Incentive Programme (https://innovationisrael.org.il/en/program/ideation-tnufa-incentive-program)	For young entrepreneurs to help them advance and validate their pioneering ideas and technological concepts. Offers support for establishing proof of concept and business viability of projects in their initial stages. For two years, a conditional grant of up to 100,000 ILS (~85% of the permitted budget) per year. Funds can be utilized for developing early prototypes, protecting generated IP, consultancy services, exhibition costs, patent attorneys, etc. After two years of the programme, the start-ups can apply for support from other programmes.
4.	Incentive Programmes for Innovation with Government Entities (https://innovationisrael.org.il/en/program/incentive-programs-innovation-	Facilitates grant of financial support to Israeli technology companies for R&D programmes or pilot programmes in select areas. Support is offered for - Trial Programmes in Transportation which is operated by the IIA, the Ministry of Transport and Fuel Choices and Smart Mobility Initiative by the Prime Minister Office. Trial programs in environmental protection are being operated by the IIA and the Ministry of Environmental Protection. Trial and R&D programs in digital health organised by IIA with the Ministry of Health and National Digital Israel Initiative in the Ministry of

	government-entities)	Social Equality. It is intended for Israeli technology companies (not government companies) to implement their initiatives at government companies' sites or via their capabilities and information. Promoting R&D in Space Technologies - jointly with the Israeli Space Agency in the Ministry of Science and Technology. R&D Programmes in Cyber - with the National Cyber Directorate at the Office of the Prime Minister. Pilot Programmes in the Field of Cyber - for facilitating and promoting productization and piloting of innovative Cyber technologies. Further, for conducting probability tests among significant customers. The programme also aims to promote cyber companies with a technology readiness level of 4 or 5, i.e., validation in a laboratory, to a level of TRL 7 or 8, i.e. actual system qualified through test and demonstration. Agricultural R&D and Pilot Programmes - operated jointly with the Ministry of Agriculture. Support for the Investment in Projects for 'Energy Efficiency and Reduction of Greenhouse Gas Emissions' – This programme intends to provide comprehensive support for projects conducting initial commercial installations of novel technology. The Israel Investment Centre, the Ministry of Environmental Protection, and IIA work together to run the scheme.
5.	Incubators Incentive Programme (https://innovationisrael.org.il/en/program/incubators-incentive-program)	For entrepreneurs who wish to establish a start-up based on an innovative scientific concept. Support establishing a company to develop a technology/product based on a scientific idea. Apart from entrepreneurs and research institutions wishing to begin a start-up, any entity in Israel that wishes to establish a TI can also apply for the programme. A competitive process selects TIs, which are granted a license period of 8 years. The Licensees can leverage public and private funds and possess considerable start-up equity.
6.	Innovation Labs Programme (https://innovationisrael.org.il/en/program/innovation-labs-program)	Designed for providing access to entrepreneurs to technological infrastructure, industrial mentorship, marketing insights & avenues for them to reach at the proof of concept stage and translate their ideas into technologies. Innovation Labs are located across Israel and are run by leading corporations. Corporations can apply to establish an Innovation Lab and seek a three-year license, which can be extended for three years. IIA provides nearly four mn ILS for setting up the lab, i.e., 33% of the costs, 50% in the periphery areas, and nearly 500,000 ILS, i.e., 50% of the approved budget for the functioning of the labs each year. Innovation Labs currently operating in Israel are - ● Alliance Open Innovation Lab with Shareholders like Renault; Nissan; Mitsubishi, Sector: Automotive. ● INFRALAB with Shareholders like Enel; Shikun & Binui; Solel Bohne Infrastructure, Sector - Smart Infrastructure and Construction. ● Let-lab with Shareholders like Ham-Let Group, Sector - Industry 4.0 ● PMatX Ltd with Shareholders - Merck Ventures B.V. & Flextronics (Israel), Sector: Novel materials and printing technologies for electronics and devices utilizing them. ● FoodNxt with Shareholders like Frutarom Industries, Sector: Food Tech, functional ingredients, nutraceuticals)

7.	Support of R&D and Promotion of Technological Innovation (https://innovationisrael.org.il/en/program/rd-fund)	Supporting industrial R&D is one of the main incentive programmes. Through this fund, the government provides industries (all domains) with support for upgrading their existing technology or developing novel technologies. The support is available at all stages in the D&D process. IIA shares up to 50% of the R&D expenditures. The companies receiving funds from IIA repay through royalties but only if the project reaches the commercialisation stage. The IIA participates in the entire development process, thereby sharing risks.
8.	R&D Preparatory Incentive Programme for Companies in the Manufacturing Industry (https://innovationisrael.org.il/en/program/rd-preparatory-incentive-program-companies-manufacturing-industry)	This is a preparatory programme that provides incentives to the industries in manufacturing sectors that do not have any prior R&D experience. This tool assists industries in creating an innovation-focused ecosystem in companies and helps them by guiding their R&D activities. The companies receive assistance for identifying gaps and performing up to the scale of their capabilities. This preparatory programme has four tracks - ● Basic support - for assisting in formulating new processes and products. A technology consultant helps the applicant map and analyse the company's capabilities for devising innovative ideas. ● Technology feasibility examination track - the technology consultant helps in the process of evaluating technological feasibility and also in the initial progression of reducing technological risks. ● Solutions for Flaws in the Production Process - the consultant analyses a problem that symbolises a flaw in the production process and then supports finding solutions. ● Improved Production Process - the consultant aims at enhancing productivity by streamlining the process and integrating new technologies.

B.4. Intermediary System

- **The Israeli Centres of Research Excellence (I-CORE) Program**, which dates back to 2011, calls for creating cross-institutional clusters of top scientists from different institutions and young Israeli scientists returning from abroad, each centre outfitted with state-of-the-art research infrastructure. The Planning and Budgeting Committee of the Council of Higher Education and the Israel Science Foundation jointly manage I-CORE.
- **International Collaboration Division (ICD):** The International Collaboration Division (ICD) is integral to the Israeli Ministry of Foreign Affairs, aiming to promote international scientific and technological cooperation between Israel and other countries. The ICD focuses on building and strengthening strategic partnerships with other nations in innovation, technology, and security. Through close collaboration with government agencies, academic institutions, and private sector organizations, the ICD identifies opportunities for joint projects and initiatives that can benefit all parties involved. The ICD also supports and guides Israeli and foreign companies seeking to establish business partnerships or invest in Israel. With a broad range of activities spanning across continents, the ICD plays a critical role in advancing Israel's interests on the global stage, driving economic growth, enhancing national security, and promoting technological innovation.
- **Israel Tech Transfer Organisation (ITTN)**: The umbrella network for Israel's technology transfer businesses is the Israel Tech Transfer Organisation. These businesses are connected to the nation's prestigious research institutions and universities. ITTN is a non-profit organisation with private ownership. The ITTN promotes international collaboration between the Israeli tech transfer community and its equivalents and enables the translation of intellectual property created in Israel
- **Bi-national funds to promote innovation:** Israel is part of various bi-national funds such as I4F – Israel-India, BIRD – Israel-United States, SIIRD – Israel-Singapore, KORIL – Israel-Korea etc.
- **Silicon Wadi:** It is home to many tech startups, investors, and research institutions, which work together to create and implement cutting-edge technologies. Silicon Wadi has played a crucial role in establishing Israel as a leader in technology and innovation, with its startups having produced

numerous successful exits and IPOs. The ecosystem has attracted significant investment from local and international sources, further fueling its growth and development. Therefore, Silicon Wadi has become a key driver of Israel's economy and a model for other countries looking to develop their innovation ecosystems.

- **Incubators and Accelerators:** The government has established a network of incubators and accelerators to support startups and early-stage companies. Funding, mentorship, and other resources are provided through this to support entrepreneurs in turning their ideas into viable businesses.
- **Innovation Hubs:** The government has established several innovation hubs in Israel, such as the Tel Aviv-Yafo Municipality Innovation Lab and the Jerusalem Startup Hub, to provide a physical space for entrepreneurs to work and collaborate.

C. Technology Transfer Ecosystem of Israel

The expansion and success of the Israeli innovation ecosystem are significantly influenced by the government's support for technical innovation. Through various programmes running through the Office of the Chief Scientist for decades, the State of Israel promoted technological entrepreneurship and investment in industrial R&D It continues to do so, even more ardently, through the Innovation Authority established by the Ministry of Industry and Trade, Government of Israel.

The technology transfer support provided by the government to the academic setting is as follows:

- Financial support to take up basic to applied research in academic settings.
- Introducing programmes to resolve valleys of death associated with technology commercialisation.
- Setting the legal infrastructure through IPR, laws, acts, taxation, etc.
- Key examples of government intervention Programs include KAMIN, NOFAR, MAGNETON, and MAGNET Programs, which facilitate research and innovation and take them to market through technology transfer support.

University Technology Transfer (UTT) ecosystem in Israel: University Technology transfer is a subset of the larger field of technology transfer, and it entails the conversion of university research outcomes to businesses so that they can invest in the development of products and services to benefit society at large. The research results may originate from any academic discipline and are transferable to existing and new for-profit and non-profit organisations. The primary activity entails licencing innovations, patent applications and other intellectual property to existing companies and founding new businesses that raise investment funds to translate early-stage research findings into new products and services.

Many independent legal bodies and research universities conduct academic research in Israel. Such research requires funds, primarily public, that is delivered directly to the institution through the Council for Higher Education's Planning and Budgeting Committee and research funding organisations like the Israeli Science Foundation. Approximately 50% of Israelis are engaged in academic research. Tech transfer institutions have established TTOs with various alignments, whether to transfer technology to industry or turn knowledge and technology into a Startup enterprise.

Technology Transfer Offices (TTOs): Research universities have established technology transfer offices (TTOs) to oversee their UTT efforts. TTOs use a project management methodology to assist academic researchers who want to apply their findings to the corporate world. Project phases include identification, assessment, protection, marketing, agreement-making, and deal-related management. Beyond patenting, licencing, and entrepreneurship, TTOs engage in other activities that positively impact society. The TTOs exist in most Israeli research universities. Most TTOs are set up as for-profit companies in the universities, owned by the universities and follow university policy and regulations related to IP and Technology Licensing.

- **Private Technology Transfer (PTT) ecosystem in Israel:** According to the guidelines set forth by the industry, industrial R&D is only carried out by the business sector or, in rare instances, by other sectors. Most industrial R&D is privately sponsored by businesses, investors, and venture capital funds in Israel and abroad. The private sector contributes over 80% of Israel's total investment in civil R&D, which is then used for industrial R&D. The majority of the remaining funding for R&D is provided by the government, with the Office of the Chief Scientist of the Ministry of Industry and Commerce receiving about 40% of them to support industrial R&D.

The majority of the programmes and financial resources of the Office of the Chief Scientist (OCS) in the Ministry of Industry and Trade are devoted to Israel's industrial policy. The policy can be divided into three phases:

1. The goal of Phase I (the 1970s and 1980s) was to establish the scientific foundation necessary to establish a high-tech state.
2. The Office of Chief Scientist (the OIS) greatly expanded R&D subsidies to Israeli businesses during Phase II (mid-1980 to 1992) to encourage firm formation and expansion. The law for encouraging R&D in the industry passed in 1984, expanded business sector funding for R&D in Israel and further specified the OIS's role.
3. In Phase III (starting in 1993), Israel changed its emphasis to investing in strategically positioned businesses by creating "clusters" (i.e., groups of high-tech entrepreneurs). The Yozma Programme, a government capital investment project launched in 1993, was an extraordinary success, helping to finance ten new venture capital funds, the value of which had more than doubled by 1996. Israel fell behind the US in private equity as a proportion of GDP by the decade's end. With a high rate of technology transfer from an academic environment to the industrial setup, the high-tech sector in and around Tel Aviv, also referred to as "Silicon Wadi," is one of the most productive tech clusters in the world today.

- **Israel Tech Transfer Organization (ITTN)**: ITTN is a private non-profit organisation. The ITTN serves as the umbrella organisation for Israel's technology transfer corporations. These corporations are affiliated with the country's prominent universities and R&D institutions. The shareholders are currently made up of representatives from the 12 partner organisations. More people from Israel's government-owned hospitals and research facilities will join ITTN.

  In Israel, there are three autonomous R&D sectors, each developing its technology transfer policies from government research institutions to the private sector based on how it perceives and understands the situation. Without the regulator's apparent involvement, the academic sector created effective technology transfer procedures that benefited institutions and the general public.

- The Chief Scientist's Office of the Ministry of Commerce is the industrial sector's regulator and sponsors and encourages its activities.

- **Mentoring from university professors to encourage industry-academia relations and Tech transfer:**

  - Most industrial R&D leaders are university graduates who value professors as sources of information and skill. Israeli colleges allow the faculty members to consult commercial companies, and they do it once a week. By transferring faculty members' practical experience, skill, and know-how to industry, the government's Chief Scientist at the Ministry of Industry and Commerce, who is in charge of industrial R&D, promoted technology transfer from academia to industry.

  - One approach is through intervention plans like MAGNET, Magneton, and Nofar, which the government launched and supported through the Chief Scientist's office. These plans are focused on enabling and encouraging industry-academia cooperation. However, these programmes' relationships between industry and academia are not symmetrical, favouring the industry and its requirements.

  - Another way to encourage the technology transfer from faculty members to the industry is through tax relief. Clause 34 of the Encouragement of Industrial Research and Development Law, 5744-1984, states that "a faculty member working in the industry on an R&D project during his or her sabbatical year will pay tax up to 35% when the marginal tax is higher, i.e., 55%. This indicates that, in contrast to the academic sector, where technology transfer was carried out independently by the research institute under its policy and understanding, the industrial sector's regulator encourages technology transfer from academia to industry without the government's guidance.

  - From the standpoint of government R&D, the situation is fundamentally different. The general norm in this area is that any knowledge-generated products created by government employees or through outsourcing to research institutes will belong to the state as its intellectual property. This suggests

that all research and development results produced at government organisations, government-run hospitals, or government-funded universities are the sole property of the state. According to the definition above, the government funds fewer than 5% of university-based research in Israel. In 2004, the policy in the governmental R&D sector was modified in line with the Bayh-Dole Act. Since then, much has been done to facilitate technology transfer from the governmental R&D sector to the industry, in lines similar to that of the successful academic sector.

D. Snapshot of Good Practices in Technology Transfer

Technology transfer ecosystem in Israel and TT Ecosystem at Weizmann Institute of Science, Israel is presented Table 17.

Table 17: Good Technology Transfer Practices in Israel

Sr. No.	Attributes	Inputs from Israel Tech transfer system
	1. Governance Practices	
1.	**Legislature and Policy Inputs:** ● National level (National impetus on TT through Act/Law/Policy/Guidelines) ● Institute level (Designing flexible institute policies on TT)	The mandate of the R&D Law, 1984 is to encourage Israeli companies to invest in R&D projects. The Ministry of Industry, Trade, and Labour and the Office of the Chief Scientist provide the majority of the R&D incentive programmes that are available. The Weizmann Institute has a clearly stated policy on technology transfer, which includes four principles implemented through Yeda R&D Company Ltd., As per the fourth principle, the Weizmann Institute reserves the right to commercialise other technologies, even if they might compete with ones already commercialised for a specific enterprise.
2.	**Governance Model:** Setting up a dedicated entity for TT (technology transfer) and sufficient resources devoted to technology transfer by the institute with flexible and efficient institute administrators	**The Israeli Tech Transfer Model** ● TTC is set up as a company and not an office within the University (TTO) ● Wholly owned University subsidiary with a Business focus ● Clear IP ownership (University Regulations) ● Generous revenue sharing (60% Researchers – Big Incentive) ● One-stop-shop for industry **National TTC** ● To explore the technology transfer in colleges, the government initiated "a national TTC similar to TTCs in universities. Although it is monetarily supported by the PBC. ● This TTC provides subsidized technology transfer services to budgeted HEIs and others.
	2. Organizational and Managerial Practices	
3.	**Organization Culture:** ● Impetus from the top leadership and organisational objectives focus on technology transfer ● Organizational standards for promoting technology transfer ● Technology transfer is considered a source of revenue (via royalties, licensing fees; sponsored research agreements)	One example of a TTO in Israel is Yissum, the technology transfer arm of the Hebrew University of Jerusalem. Yissum is pivotal in commercializing innovations generated by the university's researchers. Yissum operates as an independent company owned by the Hebrew University. It has a dedicated team comprising professionals with expertise in various domains such as business development, licensing, intellectual property management, legal affairs, and finance. The organizational structure allows for

	● Organization working to eradicate cultural and informal barriers that impede the TT process	efficient management and coordination of technology transfer activities. Yissum's organizational and managerial practices exemplify Israel's proactive approach to technology transfer and commercialization. By leveraging the expertise of its team, fostering collaborations, supporting entrepreneurship, and engaging with industry partners, Yissum contributes to the successful translation of academic research into practical applications that benefit society and drive economic growth.
4.	**Managerial Position in TTO:** The team leader and managerial position have to be there to lead the overall functioning of the TTO	Yissum, the technology transfer arm of the Hebrew University of Jerusalem ● Board of directors ● TOP management team ● CEO ● CFO/COO ● General of counsel
5.	**Dedicated Team** with the following set of expertise: ● Financial and market analysis ● IP protection and management ● Communication ● Licensing	Yissum, the technology transfer arm of the Hebrew University of Jerusalem ● Business development team ● IP, Finance and legal team ● Marketing and administrative team Those deal with various R&D teams.
3. Financial Sourcing and Administration Practices		
6.	**Financing Sources:** ● Dedicated financial resources should be allocated to the TTO ● Different routes for financial support should be explored by the TTO, such as venture and angel funds, CSR, Alumni funds, etc.	The Israel Innovation Authority has a $400 million budget for technology transfer support programmes. The R&D fund grants 40% of authorised R&D programme costs. Dedicated sources to support gap funding with a focus on accelerating technology transfer are in place (e.g. **National "Bridging the Gap" fund: KAMIN)**
7.	**Financial governance**: Regular audits (focus on technical audits)	The financial audit process of TTOs aims to provide an independent assessment of the TTO's financial operations, internal controls, and compliance with relevant regulations. TTOs follow the annual Audit Cycle. The audit report includes the audit findings, highlighting any areas of concern, discrepancies, or non-compliance. The auditor may also provide recommendations for improving financial controls, processes, or reporting practices.
4. Functional Practices		
8.	**Safeguard the organisational intellectual property:** the organisation should have a balanced approach towards exercising IP rights; they should be more open to licensing the technology rather than blocking it in IP form.	Most institutes are aggressive on IP filing and licensing; Yissum has created open-source platforms to promote IP sharing and licensing.
9.	Understanding of university/ corporate/scientific norms and environment:	TTOs in Israel, such as Yissum, perform several key functions to facilitate the transfer of technologies from academic institutions to the commercial sector, such as:

	● Technology assessment exercise ● Technology Readiness Levels (TRLs) ● Technology valuation ● Commercial potential exercise ● Technical specificities ● IP ownership (type of IP licensing) ● Negotiate Licensing agreements Market the IP to private firms.	• Intellectual Property (IP) Management • Technology Evaluation and Commercialization • Licensing and Technology Transfer • Spin-Off Company Support • Industry Collaboration and Partnership • Funding and Grant Management • Marketing and Promotion • Intellectual Property Education and Awareness TTOs negotiate and execute licensing agreements with industry partners to transfer technologies for commercialization. They negotiate licensing terms, royalties, and intellectual property rights. They assist in business plan development, market analysis, funding strategies, and connecting entrepreneurs with industry networks and investors.
5. Output /Reporting Practices		
10.	**Documented Output of TTO:** Licenses given; Royalties received; Patents generated; sponsored research agreements; start-up companies; invention disclosures; Students details; informal transfer of know-how; Product and Economic Development ● Dedicated website/portal to display information ● Updating the website/portal User-friendly portal to make matchmaking	In terms of output and reporting practices, TTOs in Israel, including Yissum, typically engage in several activities to track and report on their technology transfer efforts, including: • Intellectual Property (IP) Portfolio Management • Licensing Activities • Technology Transfer Metrics • Economic Impact By implementing robust output and reporting practices, TTOs in Israel provide stakeholders, including researchers, investors, industry partners, and funding agencies, transparent and comprehensive information about their technology transfer activities. The output and reports are presented on TTO's websites.
11.	**Reporting in Annual Reports released by TTO**: ● Average Annual Licensing agreement ● Average Annual Licensing Revenue	The annual reports released by TTOs in Israel, such as Yissum, often include information on the average annual licensing agreement and annual licensing revenue. These metrics provide insights into the TTO's licensing activities and the financial impact of technology commercialization. TTOs report the average number of licensing agreements executed per year. This metric reflects the TTO's success in transferring technologies to industry partners for commercialization. It indicates the level of interest and demand for the technologies developed by researchers affiliated with the TTO.
6. Linkages and Network-Oriented Practices		
12.	Effective interface/portal /technology display /exhibitions	In each collaboration for technology transfer, institutes and universities have developed effective website portals/tabs displaying the technology developed and available for licensing and transfer.

	Types of relationship/networks ● Personal relationships ● TTO as a facilitator of collaborations between scientists and firms ● Knowledge/technology transfer from industry to faculty members ● Conference/expo/town hall meetings on TT issues **Contractual relationships:** Network building: Effective communication with stakeholders across the system and forging alliances between scientists and industry **Linkages pre TT** ● Industry-academia connect ● Entrepreneurship-scientist connect Technology exhibitions and technology demonstrations **Linkages post-TT** Scientist/researcher continues involvement with the firm ● Faculty member/scientist serve as a technical advisor or on the board of directors for the firm (especially in case of start-ups)	The technology transfer ecosystem's major strength is linkages and its network-oriented approach to knowledge and technology transfer.
7. Incentivising Practices		
13.	Motivate scientists/ faculty/ researchers to develop technology and undertake the TT process. ● Royalty distribution formula (typically ranging from 25% to 50%) ● Awards (recognition within the scientific community) ● Promotional incentives	● **Tax benefits:** the government initiated a Feed-in-tariffs (FIT) scheme for the promotion of uptake of renewable and low-carbon electricity generation; grants/project financing from different governmental agencies for undertaking successful technology transfer. ● The Annual survey is carried out, and institutes with superior technology transfer are recognized and incentivized through enhanced financial support.
	Motivating industries to collaborate with academia and research institutes for TT ● Financial and technical gain to the industry ● Utilization of CSR funding for R&D	Industries are self-motivated and see the value in knowledge sharing, collaborative research and innovation and active technology transfer from academic and research institutes.

E. Case Study

Technology Transfer Ecosystem at Weizmann Institute of Science, Israel

Tech Transfer Office: Weizmann Institute of Science has established a dedicated office, "**Innovation and Technology Transfer Office", to "secure and protect the Weizmann Institute's intellectual property, by** identifying, evaluating and supporting the scientific breakthroughs achieved by the Institute**.**

Governance and administration: The TTO is governed and administered by the Vice President. There is a dedicated office for the same, i.e. Office of the Vice President for Innovation & Technology Transfer.

Activities:
To identify, assess, and support the scientific advances made by the Weizmann Institute to preserve and defend its intellectual property. It also makes it easier for such discoveries to be turned into innovative technologies that benefit humanity.

- **BINA - Bridge. Innovate. Nurture & Advance** is a new, scientifically applied research unit that aims to nurture innovative, early-stage ideas and technology for applied projects, as well as through instruction, mentoring programmes, and networking events, to develop an ecosystem of translational research at the Weizmann Institutes
- **BINA belongs to the office of the Vice President for Innovation and Technology Transfer.** Bina identifies, nurtures and supports early-stage basic research projects, which has the potential to produce IP with practical applications.
- Yeda, a Weizmann Institute of Science commercial arm, may commercialize intellectual property arising from these projects.

YEDA - 1959 The Weizmann Institute established Yeda, its Tech Transfer Office. Yeda was the second technology transfer office in the world to be established.

- Yeda holds an exclusive right to commercialize the IP developed by the scientists at the Weizmann Institute.
- Yeda registered 3,400 patent families, which amount to 17,900 individual patents.
- A total of 120 companies were established based on Weizmann technologies.

Spinoff Companies: PointAR -The PointAR System allows PEOPLE to receive critical guidance from expert support staff with existing technologies such as AR, smartphones, tablets, etc.
Success Stories:

- Copaxone drug for multiple sclerosis.
- Erbitux antibody-based synergism with conventional chemotherapy
- RSA Algorithm for Secured Transactions

Promoting Innovation and Deployment of Low Carbon Technologies

(UNIDO-BEE-GEF PROJECT)

Facility For Low Carbon Technology Deployment

DST-CENTRE FOR POLICY RESEARCH
PANJAB UNIVERSITY CHANDIGARH

DST- Centre for Policy Research Panjab University, Chandigarh