

## **CHAPTER 4: CHANNELS AND MECHANISMS OF TECHNOLOGY TRANSFER**

Seeing the importance, the management of technology transfer is increasingly becoming an important aspect of strategic economic planning by organizations. All throughout human history, technology has been a profound aspect of human development and an integral part of human lives. Technology is known to change lives of the people and is the most adaptive to change. With the changes in technology at an extremely fast pace, people also feel compelled to adapt to the change. These changes have made people dependent on technology to the extent that right from the start of the day to when the day ends we remain connected to technology in some form or the other. New developments in technology should be gracefully accepted and new ideas should be ushered in, lest all should perish. Businesses will collapse and so will the economy. Technology has become a part and parcel of life and is an expression of how human beings pursue their interests and objectives.

As already established, the acquisition of technology can happen in two ways. Either one develops it by R&D, or if not, then purchases the technology. The latter is what leads to technology transfer. Two of major factors that need to be considered at the time of transfer are the kind and type of technology and the method or means of transfer. Whether it is a state-of-the-art technology, basic technology, core technology, supporting technology or an emerging technology, the appropriate mechanism<sup>236</sup> of transferring it would be a determinant of a successful technology transfer from a source to the receiver.

Technology transfer has been seen as an invariable aspect of the strategic economic planning of the developing countries and the least developed countries. Going by the experience of some of developing countries<sup>237</sup> during the past two decades where the countries have shown increased commercial output, increased rate of industrialisation through the absorption of foreign technologies and increased skill in labour force, reinforces the objectives of technology transfer. By this means, the developing and the

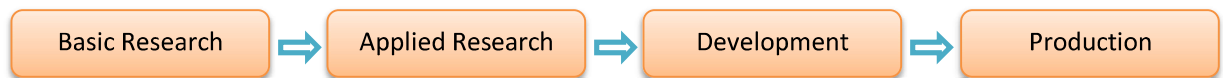
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<sup>236</sup> L. Le Grange & A. Buys, *A Review of Technology Transfer Mechanisms*, 13(1) THE SOUTH AFRICAN JOURNAL OF INDUSTRIAL ENGINEERING 81-99 (2011).

<sup>237</sup> Howard Pack & Larry Westphal, *Industrial strategy and technological change: theory versus reality*, 22(1) JOURNAL OF DEVELOPMENT ECONOMICS 87-128 (June 1986).

least developed countries can catch up with the other technologically developed countries. Acquisition of foreign technology can also help improve competitiveness in the local markets. With the transfer of technology, introduction of techniques which have shown to lead to high productivity have also pushed technological changes in countries which are not so technologically advanced. Technology transfer can also be seen to give a boost to indigenous technology or home-grown technology as absorption after transfer is an important aspect of diffusion.

Once the most appropriate technology is chosen for transfer, the channel of transfer also follows. Mansfield (1975)<sup>238</sup> classified technology transfer into Vertical Transfer and Horizontal Transfer. He stressed that vertical transfer refers to transfer that takes place within the various steps of a particular inventive process. For example, information and technological know-how exchange from:



In short vertical transfer executes principle to practice; the pure science to its practical application. The vertical transfer entails the entire journey from knowledge progression about science to a final finished product. Horizontal Transfer on the other hand takes place when the technology which is being used at one place, organisation or country is transferred for use to another place or country. Mansfield<sup>239</sup> pointed out that “One of the fundamental processes that influence the economic performance of nations and firms is technology transfer.”

## CLASSIFICATION OF CHANNELS OF TECHNOLOGY TRANSFER

One may assess the benefits of technology transfer based on the mechanism that is adopted as different benefits are associated with different channels of transfer. Not much of a distinction is drawn between the terms ‘channels of technology transfer’ and ‘mechanisms of technology transfer’. Technology transfer is an example of economic interaction. Economic interaction between countries may take place in the form of

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<sup>238</sup> Dogra et. al, *Technology Transfer in Pharmaceutical Industry: Transfer of Process from Development to Commercialisation*, 4(5) INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH 1692-1708 (2013).

<sup>239</sup> *Id.*

foreign direct investment (FDI), trade, money flows and with the movement of working professionals and academicians as human resource. Such interaction has a huge impact on the allocation of resources globally and becomes a channel for transfer of technology<sup>240</sup>.

The mechanism of technology may also be chosen considering what part of the technology is being transferred; after all technology is a combination of skill, equipment and knowledge. Studying the two broad categories of technology transfer shall serve a better understanding. The first category relates to the transfer of commercial assets and the second relates to the transfer of non-commercial assets of technology. Following the literal interpretation, the commercial aspects are the parts of technology that have a commercial viability in the market, whereas the non-commercial assets of the technology relate to the know-how and information generally helpful for training purposes and R&D, that is indirectly pertinent to production activities.

The mechanisms of transfer of technology may be different, but can be related as dependent on each other to some extent. The impact of foreign direct investment (FDI) on transfer of technology is directly related to businesses that have been created due to the influx of people and openness to trade. Policies, both national and international on trade, licensing, FDI, all have a crucial effect on technology transfer.

The mechanism of technology transfer has been defined as “any specific form of interaction between two or more social entities during which technology is transferred<sup>241</sup>.” The UNCTAD has attempted to bring out the existence of different mechanisms of transfer of technology. The UNCTAD’s Code of Conduct<sup>242</sup> on Technology Transfer has addressed the issue of encouragement of technology transfer to developing countries as integral to global economic integration. It dedicatedly worked on:

- Making legitimate certain specific domestic policies promoting transfer and diffusion of technology.

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<sup>240</sup> See Working Paper, *Transfer of Technology and Knowledge Sharing for Development: Science, Technology and innovation issues for Developing Countries*, UNCTAD Current Studies on Science, Technology and Innovation.

<sup>241</sup> S. RADOSEVIC, INTERNATIONAL TECHNOLOGY TRANSFER AND CATCH-UP IN ECONOMIC DEVELOPMENT, 1999.

<sup>242</sup> Pedro Roffe, *Transfer of Technology: UNCTAD’s Draft International Code of Conduct*, 19(2) INTERNATIONAL LAWYER (1985), <https://core.ac.uk/download/pdf/216913331.pdf>

- Rules governing the contractual conditions of technology transfer transactions.
- Measures taken for providing differential treatment to developing countries
- Measures for strengthening international cooperation.

UNCTAD did major efforts to liberalise trade in technology and draft guidelines and norms concerning terms and conditions of transfer of technology from developed to developing nations<sup>243</sup>. It also took up as one of its agendas the transfer of environmentally sound technologies for which the mechanism of transfer was provided under the United Nations Framework Convention on Climate Change (UNFCCC). For such technologies, the UNFCCC classified the mechanisms into financing mechanisms, institutional mechanisms and methodological mechanisms which are peculiar to the transfer of environmentally sound technologies.

Transfer of technology can take place through different modes and mechanisms. The channel of transfer may in some case be related to another channel or some may even work independently of other channels. Many researchers have distinguished between the different mechanisms of transfer. Cooper and Sercovich<sup>244</sup> (1971) along with Stewart<sup>245</sup> (1979) have differentiated between **direct and indirect transfer**. Direct transfer as the name suggests denotes the kind of transfer in which the recipient is in direct contact with the supplier of the technology. Transfers that are effectuated by means of contract between individuals or contracting firms (transnational corporations and private companies) are examples of direct forms of transfer.

Indirect or passive form of technology transfer occurs where a country lacks the capabilities for a direct transfer. Indirect transfer involving the exchange of knowledge and technical know-how is accomplished by way of informal meetings, workshops or conferences; for example, a company in a developed country, acting as an intermediary, for the packaging and transfer of technology to developing nations. Examples of direct form of transfer include the direct purchase of capital goods and the necessary equipment, hiring of foreign experts and consulting firms and training nationals in certain specific technologies. Examples of indirect transfer mechanism include joint ventures with local companies, institution of wholly owned foreign company

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<sup>243</sup> *Supra* Note 240, 100.

<sup>244</sup> Cooper & Sercovich, *The Channels and Mechanisms for the Transfer of Technology from Developed to Developing Countries*, UNCTAD, TD/B/AC 1115 (1971).

<sup>245</sup> F. Stewart, *International Technology Transfer: Issues and Policy Options*, World Bank (1979).

subsidiaries, turnkey projects of construction of plants and other equipment and the like.

In short, with the different types of transfers, there are no specified fixed rules with any as to how to effectuate the perfect technology transfer process. At the end, what matters is how well have the terms and conditions relevant to the transfer been negotiated as an effective technology transfer is the result of a good negotiation process. Thus, the key element here is the ability to bargain and negotiate will the surety that technology shall be transferred. The direct and indirect mechanisms can be illustrated with the help of the below table:

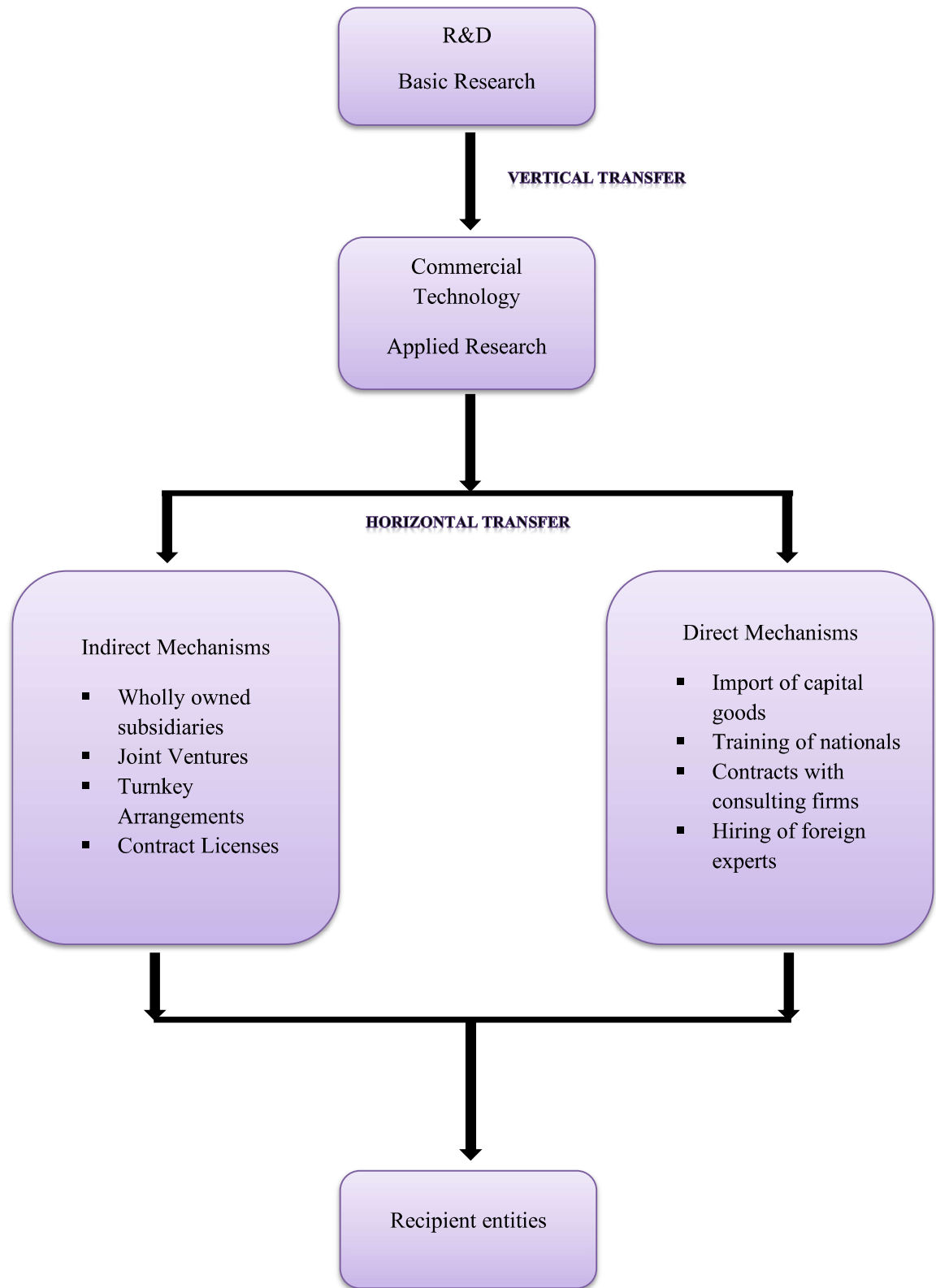


Fig. The anatomy of Technology Transfer

Rapoport and Erdilec<sup>246</sup> made a reference to **formal and informal channels** of technology transfer, which may also be known as market mediated and non-market mediated channels respectively. In the category of formal mechanisms, licensing agreements, foreign direct investment, turnkey projects, cooperative research and joint ventures fall, while on the other hand, informal mechanisms include channels which do not involve an actual contract between the supplier of the technology and the receiver of technology. Such can be instances of reverse engineering, exchange of scientific personnel and information, technological publications and conferences, open literature, industrial espionage and government programs. Formal channels are usually preferred for international transfer of technology.

Another study by UNCTAD<sup>247</sup> has drawn a categorisation between **commercial and non-commercial** channels of transfer of technology. The former relates to instances where either a direct or indirect price is paid for the technology. This results in related issues arising after the transfer has happened unlike in the case of non-commercial channel of technology. A general example would be that the chances of issues arising between the supplier and the receiver is naturally more likely in the case of commercial transfer as monetary terms often attract friction. The nature and the means of interaction between the supplier and the receiver may be a relevant factor in distinguishing the two channels of transfer. Foreign direct investment, joint ventures, licensing, marketing and franchising are more likely commercial channels of transfer; and the non-commercial modes would take the form of review of technological journals, training of personnel and cooperative research in the form of collaborations.

Kim<sup>248</sup>, like Rapoport and Erdilec analysed the international transfer of technology into **market mediated and non-market mediated** transfers. Logically, the market mediated transfers are determined by market forces like negotiating price of the technology before transfer and incorporating the same in the contract; while the non-market mediated transfer will take place without any formal agreement or contract. The

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<sup>246</sup> A. Erdilec & A. Rapoport, *Conceptual and Measurement Problems in International Technology Transfer: A Critical Analysis*, in TECHNOLOGY TRANSFER: GEOGRAPHIC, ECONOMIC, CULTURAL AND TECHNICAL DIMENSIONS (A.C., Samli ed., 1985).

<sup>247</sup> *Supra* Note 242, 100.

<sup>248</sup> L. Kim, *Pros and Cons of International Technology Transfer: A Developing Country View*, in TECHNOLOGY TRANSFER IN INTERNATIONAL BUSINESS (T. Agmon & Glinow, eds., 1991).

market mediated transfers inevitably remain important modes of transfers as the supplier of the technology plays an active role in the technology transfer process.

Similarly, another classification of international technology transfer as **public and private** has been done by Tho<sup>249</sup>. Technologies that are considered public goods and whose transfer is handled and executed by public organisations or government agencies account for public transfer. This transfer of technologies considered as public goods is generally undertaken to support technology transfer to the least-developing nations (LDCs)<sup>250</sup> for the sake of economic-cooperation and technical assistance. Unlike the public, the private transfer mechanisms revolve around the transfer of technologies that are developed by private firms which intend to commercialise the technologies for profit by means of the transfer. The transnational corporations<sup>251</sup> are generally the suppliers of this kind of technology and transfer the same by means of foreign direct investment (FDI) or licensing agreements.

The success and the effectiveness of each mechanism of transfer is dependent on many a factors; some of which are enlisted below:

- the nature of technology at hand
- terms of transfer as agreed upon by the donor and recipient (like purpose, motivation, criteria, incentives and the benefits arising from the transfer)
- technology and knowledge dissemination strategy of the donor
- the technological level and absorptive capabilities of the recipient country
- economic strength of both the donor and recipient
- available resources and bargaining power of the recipient
- policies on trade and technology transfer in both the donor country and the recipient country.
- negotiation skills

Such factors directly or indirectly have an influence on the decision of how well chosen the mechanism of transfer is. In reality, today most of the world's technological production is controlled by few transnational corporations. As these enterprises have

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<sup>249</sup> T. V. Tho, *Technology Transfer in the Asian Pacific Region: Implications of Trend Since Mid-1980s*, in *TRADE AND PROTECTIONISM* (T. Ito & A. O. Krueger eds., 1993).

<sup>250</sup> *Supra* Note 185, 67.

<sup>251</sup> T.A. Faunce, *Technology Transfer*, 2 *ENCYCLOPEDIA OF APPLIED ETHICS* 7 (2012).

the required manpower, suitable allocation of resources, organisation and the expertise to take on technology transfer projects and help them reach conclusion. Such corporations invest in and are prepared to face the risks of modern R&D with regard to competitive products in the commercial market.

## **TECHNOLOGY TRANSFER AGREEMENTS**

As has been mentioned earlier, transfer of technology is transfer of two significant parts of the technology: one having a commercial aspect and the other having a non-commercial aspect. Usually the transfer of the non-commercial aspect happens informally through transfer of knowledge and the transfer of commercial aspect happens formally through technology transfer agreements or contracts<sup>252</sup>.

As far as transfer of knowledge is concerned, transfer and dissemination of technological knowledge is gaining more and more importance in the field of academia with the migration of researchers and students contributing to the diffusion of knowledge all over the world. Knowledge transfer also takes place through seminars, conferences, journals, university-industry collaboration and other academic medium.

The transfer of commercial aspects of the technology is effectuated by formal channels like contracts. While there is no fixed standard that the contracts/agreements should follow, nonetheless, explicit mention of terms and conditions of transfer negotiated between the parties, always serves as a formal documentation of transfer and remains a proof for evidentiary purposes. Some research institutions propose that these transfer agreements as standard models be made part of IP and technology transfer policies. In making such agreements, it is of immense significance that an intellectual property lawyer is consulted and that the agreement is well drafted.

There are different types of agreements by means of which transfer of technology can be put into effect. They are used to ensure a smooth transfer of technology from the research laboratories to commercial market.

### **a) Collaborative Research Agreements**

These agreements are concluded between parties who wish to collaborate on developing a particular technology with an ultimate aim of commercialisation.

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<sup>252</sup> See, *Technology Transfer Agreements*, World Intellectual Property Organisation, <https://www.wipo.int/technology-transfer/en/agreements.html>

Such collaborations can happen between universities and industries also where the academic institutions provide the basic research for development of a technology and the industry works on the research to develop it further and conclude it as a finished product which has commercial value in the market. The parties to the agreements undertake the task jointly. They combine their labour, skill and time to work together and together they define and agree on rights and obligations following the collaboration including benefits and risk sharing.

**b) Consultancy Agreements**

Consultancy Agreements are a result of consultants, generally in the nature of academicians/university professors, providing expert knowledge and services to the collaborating industry partner in lieu of payment<sup>253</sup>. The agreement may also specify the time in which the consultant has to complete the project. In these cases the intellectual property rights shall vest with the company with few limited rights still with the researcher or academician which allows him to publish his own work; depending on the terms and conditions of the agreement. During the negotiation process, the university will not only reserve the rights of the researchers with them but will also try to keep the information confidential till the negotiations have led to the conclusion of the agreement.

**c) Confidentiality Agreements**

Confidentiality agreements<sup>254</sup> or Non-disclosure agreements (NDA) are agreements that legally bind the parties concerned to not disclose or let out any vital information or use it for a purpose other than that as mentioned in the agreement terms. Confidentiality agreements generally concern the technical know-how or are executed before an agreement licensing IP rights is established in case the licensee wants to have any further information about the technology concerned and the IP attached to it. One important thing to be considered before a comprehensive non-disclosure agreement is concluded is that the agreement should expressly mention all the information that is to be treated as confidential. In addition, it may also mention, who may have access to such information,

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<sup>253</sup> Sudeep Basu & Reggie Taylor, *Use of Consultants in Technology Transfer*, 4(1) AUTM TECHNOLOGY TRANSFER PRACTICE MANUAL 1-13 (2010), [https://www.autm.net/AUTMMain/media/ThirdEditionPDFs/V4/TTP\\_V4\\_Consultants.pdf](https://www.autm.net/AUTMMain/media/ThirdEditionPDFs/V4/TTP_V4_Consultants.pdf)

<sup>254</sup> Arnold Vahrenwald, *Confidentiality in Technology Transfer Agreements*, The International Association of the Academics of Sciences and the National Academy of Sciences of Ukraine and Kyiv, World Intellectual Property Organisation (May 2000).

what measures should be taken to keep the information confidential and any terms specifying limitations as regards a reasonable time for which it shall be kept confidential.

**d) Technology Transfer Licensing Agreements**

Licensing Agreements are entered into for the transfer of intellectual property rights from the owner of the IP (licensor) to other person/organisation/company (licensee). It is a means of legally permitting somebody else, other than the owner, to make use of the intellectual property for the desired time as mentioned in the agreement. The rights are granted for a limited period of time subject to payment of royalties for authorised use<sup>255</sup>. There may also be limitations as to the variety of rights transferred, geographical limitations and limitations on sub-licensing. All of these rights are ascertained in the agreement as discussed and negotiated between the parties.

Technology transfer licensing agreement is a licensing agreement which is used to legally transfer technology from one entity to the other. By means of the license agreement the licensee is given rights to the IP in the technology.

Depending on the need, necessity, royalty agreed and similar factors, a broad license can be negotiated which gives broader rights of use with lesser restrictions or a narrow license can be concluded which may have rights and obligations defined as regards territory, technology and time period. The agreement materialises into an actual transfer when the licensor delivers up the technology to the licensee along with the knowledge and technical know-how with the help of which the latter learns how to effectively use and adapt to the technology. The knowledge may also help the licensee to work on how to improve the technology or mould it to suit one's needs.

**e) Assignment of Intellectual Property Rights**

Apart from licensing the rights of IP related to technology, there also exists a way of assigning the rights to the assignee<sup>256</sup>. Thus in addition to technology transfer licensing agreements, agreements concerning assignment of intellectual property rights also aid implementation of technology transfer. Unlike a

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<sup>255</sup> Mark A. Lemley & Robin Feldman, *Patent Licensing, Technology Transfer and Innovation*, 106(5) THE AMERICAN ECONOMIC REVIEW 188-192 (2016).

<sup>256</sup> See, *Patents-Assignment of Patents-Assignment of Right to Sue for Past Infringements*, 36(8) HARVARD LAW REVIEW 1035-1036 (1923).

licensing agreement, the assignment of rights involves transferring ownership of IP rights from owner to the assignee, immediately and permanently. The contract/agreement contains terms regarding the subject matter of rights. For patents, the assignment may not only be of granted patents, but also of those that are in the pipeline (for e.g. PCT applications or provisional patent applications).

**f) Sponsored Research Agreements**

These agreements involve a research organisation and a sponsor (which may be a private entity or government). The sponsor may have a selfish interest where it is concerned about development of the particular technology which may be relevant or may prove to be beneficial to its business. For this, the sponsor agrees to fund the research, transferring funds to the R&D institution of the research organisation in return for access to some IP rights resulting from the research results. The difference between collaborative agreements and sponsored research agreements is that in sponsored research agreements, the sponsor may not be interested in commercialising the technology and hence, may not show equal participation in research and development activities. The IP rights are generally owned by the research organisations and a license (either exclusive or non-exclusive) is granted to the sponsor for access.

**g) Material Transfer Agreements**

Material Transfer Agreements or MTAs are agreements that regulate the transfer of tangible research materials for use by the recipient who wishes to use it for his own research purpose<sup>257</sup>. The tangible materials can be patented that are transferred via a license or can be certain biological materials<sup>258</sup> and even chemical compounds. The agreement specifies the rights and duties of the parties related to the intellectual property associated with the technology. An MTA is typically entered into when an organisation providing these tangible materials does so as a gratuitous act to support academic research. Hence the materials are transferred for free or at extremely nominal costs.

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<sup>257</sup> See generally, Material Transfer Agreement Guidelines, Division of Research, University of Houston, <https://uh.edu/research/sponsored-projects/contracts/mta-guidelines/>

<sup>258</sup> Cf., Letitia M. McCune, *The Protection of Indigenous Peoples' Seed Rights during Ethnobotanical Research*, 9(1) *Ethnobiology Letters* 67-75 (2018).

**h) Contract Research Agreements**

As the name suggests, contract research agreements are concluded for research purposes conducted primarily by an academic institution which a commercial company hires with an ultimate objective of commercialising the research. The goals and objectives of the desired research are laid down by the company. These goals are purely commercial and not academic, regardless of the nature of the institution conducting the research.

The company that hires the institution bears the cost of the research conducted, IP protection and also covers all the risks that may arise during the course of the research. Thus, the results generated therewith have ownership with the company and not the academic institution, although it may assign some of the intellectual property rights to the latter.

**i) Academic spin-off agreements**

Academic spin-off is one of the mechanisms through which knowledge and technology are transferred and subsequently commercially exploited. Academic spin off, commonly also known as spin-outs are entities that are created by an academic or research institution and based on a particular emerging technology. Those researchers who put in their skill, time and labour into developing the new technology often leave their research organisation and join the new company (spin-out). The risks as well as benefits are usually shared by both the company and the research organisation through different joint venture arrangements. The company (spin-off) often own the exclusive licenses of the IP on technology developed by the organisation.

**j) Joint-Venture Agreements**

A joint venture (JV) is a business arrangement where two or multiple parties come together and pool their resources for the purpose of attainment of a common goal, thus forming a commercial enterprise. Its attributes are shared responsibility, ownership, risks, expenses, profits and governance. The roles may be defined and not necessarily similar, but the responsibilities are shared for example, one party to the setting takes care of investment and the other research and development. Technology transfer happens by way of joint

ventures also<sup>259</sup>. The joint venture for technology transfer may happen between industry partners and academic institutions<sup>260</sup>. For a joint venture to be successful, it is imperative that the IP rights are acquired a little beforehand so that any necessary proprietary information aiding the development of technology can be used.

**k) University Research-based Start-up Agreements**

This start-up that is a university research-based start-up is a company that stands on a university granted license. The license is for a particular technology or technologies in general. Unlike a spin off company, the people in the management of or working with the company are not associated with the university where the technology may have been developed. The company's finances are also drawn from external entities or sponsors. The agreement entered into by an academic/research institution and a company should contain terms and conditions addressing intellectual property rights, management obligations, concerns regarding conflict of interest, business plan on commercialisation of the technology, plan for market launch and support extended to the academic/research organisation.

Technology transfer agreements are focused at identifying the technical and collaborative needs of the receiver entity followed by identifying the mechanism of transfer, mutually agreeing upon legal, technical and financial terms and conditions and finally executing the agreement to help the project reach conclusion.

**MECHANISMS OF TECHNOLOGY TRANSFER**

Apart from transferring technology by way of different technology transfer agreements as discussed above, there are various other ways, much opted, to transfer technology in an efficient manner, often chosen according to the needs of the donor and the recipient country.

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<sup>259</sup> Bill F. Kryzda, *Joint Ventures and Technology Transfers*, 12(3) CASE WESTERN RESERVE JOURNAL OF INTERNATIONAL LAW 549-565 (1980).

<sup>260</sup> Kjell Gronhaug et. al, *Technology Transfer through international joint ventures: the case of gamma*, 15(3) SCANDINAVIAN JOURNAL OF MANAGEMENT 307-320 (1999).

## A) TRADE:

International trade has an influence on the worldwide distribution of resources which in turn shapes the growth of the industrial sector<sup>261</sup>. Thus, it plays an inevitable role in the determination of global knowledge and technology transfer. That trade helps in the international transfer of technology rests on two philosophies; the first being that when a good is traded in the market, the technology that lies within the good is transferred as well, along with the good. It is the import of hardware/capital goods produced in a country other than the host country<sup>262</sup>. With this technology, the knowledge too, which is being transferred and one which is essential for further production of the good, is usually tacit knowledge. As tacit knowledge is subject and mostly based on the developer's personal experiences with the development, the knowledge is not very easy to transfer.

The second philosophy rests on the notion that the cost of accessing the technology is an integral part of the transfer. Supporters of trade liberalisation argue that by limiting the different kinds of barriers to trade (legal, political, regulatory or of a kind that are for goods containing an important and complex technology component) the cost of technology transfer can be reduced.<sup>263</sup> Not just the technology, but the cost of communication or of any kind of related information transfer, is a relevant factor which invariably influences the global diffusion of technology<sup>264</sup>. Thus, non-liberal and restrictive trade practices may make the journey of the transfer process to adoption of the technologies by local entities more expensive, whereas open and liberal trade practices with little or no trade barriers may encourage transfer and technology adoption.

Trade by itself does not provide a neutral channel for technology transfer. Technology transfer is a process. Right from development of the technology, innovation requires effort, investment, hard work and risk taking. The regulation of IP rights by firms helps

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<sup>261</sup> *Supra* Note 240, 100.

<sup>262</sup> See, Amrita Goldar et. al, *Working Paper 382 Climate Change and Technology Transfer-Barriers, Technologies and Mechanisms*, Indian Council for Research on International Economic Relations, July 2019.

<sup>263</sup> D. J. Teece, *Technology Transfer by Multinational Firms: The Resource Cost of Transferring Technological Know-How*, 87(346) THE ECONOMIC JOURNAL 242-261 (1977), <https://www.jstor.org/stable/2232084?seq=11>.

<sup>264</sup> *Id.*

them appropriate to some extent the returns on investment leading to innovation<sup>265</sup>. These firms also regulate how, by what means and where the goods are reaching. Open trade environment and good import policies ensure efficient technology transfer.

However, given the obvious connection between trade and technology transfer, the matter has been highlighted in the TRIPS Agreement<sup>266</sup> from a development perspective. The TRIPS Agreement in its Article 66.2<sup>267</sup>, states that the developed countries shall help in “*promoting and encouraging technology transfer to least-developed country Members in order to enable them to create a sound and viable technological base.*” Increased openness to trade, reducing the barriers to technology transfer is directly proportional to growth.

As ideal as the Article<sup>268</sup> may seem, it has attracted raised eyebrows over its implementation and effectiveness. Analysis has revealed its impact to be low and insufficient reporting system to monitor implementation<sup>269</sup>. As regards the North-South trade, what has come to light is that more productivity in technology-importing developing countries is affected more by an open trade environment than investments in research and development. Majority of incidences of technology transfer happen through importing capital goods or technology-intensive goods. Openness to trade cannot be seen in isolation. In order to ensure an environment which is open to trade, one must also look at the country’s trade policies which should address the need for improvement of developing countries capabilities to identify the technology keeping in mind the relevant need and the capacity to absorb technology. The ability to adapt to

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<sup>265</sup> “WIPO (2011), World Intellectual Property Report – The Changing Face of Innovation, Geneva.

<sup>266</sup> See, *Agreement on Trade Related Aspects of Intellectual Property Rights*, Annex 1C, World Trade Organisation 319-351 (1995).”

<sup>267</sup> “Agreement on Trade Related Aspects of Intellectual Property Rights, Article 66.2:

1. In view of the special needs and requirements of least-developed country Members, their economic, financial and administrative constraints, and their need for flexibility to create a viable technological base, such Members shall not be required to apply the provisions of this Agreement, other than Articles 3, 4 and 5, for a period of 10 years from the date of application as defined under paragraph 1 of Article 65. The Council for TRIPS shall, upon duly motivated request by a least-developed country Member, accord extensions of this period.

2. Developed country Members shall provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer to least-developed country Members in order to enable them to create a sound and viable technological base.”

<sup>268</sup> *Id.*

<sup>269</sup> Correa, 2007; ITCSD, 2011; Moon, 2008; WTO, 2010a; WTO, 2010b; See also, Suerie Moon, *Meaningful Technology Transfer to the LDCs: A Proposal for a Monitoring Mechanism for TRIPS Article 66.2*, ICTSD Programme on Innovation, Technology and Intellectual Property, Policy Brief Number 9, April 2011.

the new and put the imported technology to use in the host country is also a skill that needs to be developed<sup>270</sup>.

The question still rests- Why is there a need to import technology? As has been emphasised earlier, a country has two options on furthering economic development by nurturing technology and technological needs- one, either to import technologies or second, to locally develop technology. Countries which are not able to develop technologies of their own accord, import. While present studies have hinted that countries which do not have liberal trade policies do not benefit much from technology transfer; the notion is still debatable as some countries follow restrictive trade as a matter of policy. Developing countries are also encouraged to stimulate local innovation and increase productivity to meet international standards so as to secure a place as a competitor in the global market. This will help them develop a strong exporting sector as well along with sustaining one's needs.

Three reasons justifying how trade leads to international transfer of technology are as follows:

- I. With trade increases the availability of technology advanced intermediate goods<sup>271</sup> for production and use.
- II. It makes the intermediate goods as well as final goods (made with the help of such intermediate goods) available for the study of their technological specifications<sup>272</sup>.
- III. It enables person-to person communication.

Technology is transferred through the import and use of advanced intermediate goods/inputs and is also transferred by means of learning and exploring the technology embodied in the imported product. There lies a fundamental difference between the two forms of transfer. In the case of technology transfer through the use of foreign intermediate good, using the good implies using the latent knowledge behind the good that which may have been a result of the R&D of the foreign inventor. The technological knowledge embodied in the good acts like a blueprint. Using this technologically

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<sup>270</sup> *Supra* Note 240, 100.

<sup>271</sup> Intermediate goods are raw materials that are used to make finished products. They may also be known as semi-finished or partly finished goods.

<sup>272</sup> Background Note by Secretariat of Working Group on Trade and Transfer of Technology is available at WT/WGTTT/W/1 [Dated 2nd April 2002].

advanced intermediate good increases the importing country's Total Factor Productivity (TFP)<sup>273</sup>.

Having access to foreign intermediate goods will turn out to be beneficial to the country only when the cost of having access or importing these goods is less than what it would cost to the country to produce the same good domestically as the latter would also include the R&D costs of product development. This profit/gain is commonly known as *passive* technology and knowledge spillover<sup>274</sup>. It is not the case that the importing country has absolutely no access to the results of foreign R&D activity, but this technological knowledge that rests with the imported intermediate goods, is not easily available to the local inventor. Hence, this technological knowledge travels with the good which is its manufactured outcome<sup>275</sup>. This activity of importing the intermediate good leads to technology transfer which in turn leads to productivity increase. Till the time the imports of the intermediate goods remain uninterrupted, the importing country is in a position to reproduce the knowledge as embodied in the intermediate good, thus maintaining productivity increase.

In another instance where technology transfer takes place on acquiring the knowledge embodied in the imported product by the importing country, be it a finished good or an intermediate good, the situation is different. Here, relevant knowledge is acquired by means of copying, reverse engineering or communication from the suppliers of the product<sup>276</sup>. In such a case, unlike the former means of transfer of technology, knowledge embodied in the imported good will not be lost even if the means of communication or the channel of imports is interrupted. Once knowledge is acquired or the latent technology is learnt, the same remains useful in future for the production of goods. After the transfer, the technology (acquired knowledge and information) remains in the country.

Consequently, the process of learning the technology would cost much less when compared to the expense of creating it which would include local R&D. In contrast with

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<sup>273</sup> Also known as multi-factor productivity, it is often regarded as the major contributor to GDP. Total factor productivity is driven by technology growth and efficiency.

<sup>274</sup> (Keller, 2002). *See also*, Roberta Piermartini and Stela Rubinova, *Knowledge spillovers through international supply chains*, WTO Working Paper ERSD-2014-11, Economic Research and Statistics Division, World Trade Organisation (2014).

<sup>275</sup> World Trade Organisation, *Policy Implications of Global Integration and the WTO*, World Trade Report 2008, [https://www.wto.org/english/res\\_e/booksp\\_e/anrep\\_e/wtr08-2f\\_e.pdf](https://www.wto.org/english/res_e/booksp_e/anrep_e/wtr08-2f_e.pdf).

<sup>276</sup> *Supra* Note 274, 115.

passive knowledge spillover, this gain is commonly referred to as *active spillover*<sup>277</sup>, as the importer is actively involved in the learning of the technology. Both the means of transfer of technology differ in this regard. For technology transfer through these channels, it shall be considered whether the importing country fulfils certain conditions for the transfer to occur, thereby establishing a link between trade and technology.

Transfer of technology through trade may occur by any of the following channels:

- Advanced and specialised intermediate products that have been invented abroad employed by importing country necessarily possessing the skill to be able to use the advanced imported technology and efficiently organise the production process<sup>278</sup>. It is equally important to ensure that the intermediate products be used efficiently.
- Copying/Imitating foreign technologies after learning about a product through trade and then applying them to local/domestic use after necessary adjustments. The technological knowledge behind the product is contained in a blueprint. Thus, the production of the good is based on the blueprint, which can be reproduced by the importing country after analysis of the finished product. The blueprint contains information which is codified, which should be directly reproducible from the good in order to further production process in the importing country. Here communication with the suppliers will aid reverse engineering in a situation where part of the knowledge is tacit and not codified as to be reproducible<sup>279</sup>.
- Through cross border learning of organisational methods, production methods, product design and other market conditions which is facilitated by international trade. Thus communication is a key factor to transfer as encountering parts of tacit knowledge is common. Not every inventor or creator who has come up with an invention, or involved in a problem-solving activity may be able to or may want to disclose to the exact certainty all the efforts that have gone into the creation. It may also be impossible to reconstruct every idea by means of reverse

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<sup>277</sup> *Supra* Note 274, 115.

<sup>278</sup> *Supra* Note 272, 114.

<sup>279</sup> Morteza Raei Dehaghi et. al., *Reverse Engineering: A Way of Technology Transfer in Developing Countries like Iran*, 1(5) INTERNATIONAL JOURNAL OF E-EDUCATION, E-BUSINESS, E-MANAGEMENT AND E-LEARNING 347-353 (2011).

engineering. Hence, person to person communication becomes as important as importation of technology and is crucial to diffusion of technology.

With the availability of both product and knowledge, reproducing the good may not always appear easy. There are economic risks and uncertainties involved. All the channels of technology transfer through trade will definitely, to some extent, reflect an increase in productivity; although it might not be able to match the productivity levels of the exporting country. In case of copying, for production levels of the importing country to rise, there needs to be an increase in the production of the imitated goods along with the spread of knowledge on how to produce the good.

### **B) FOREIGN DIRECT INVESTMENT:**

Yet another powerful method of diffusion/transfer of technology is Foreign Direct Investment (FDI). It has proven to be instrumental in the development and growth of the economies of host countries<sup>280</sup>. Assessing the impact of foreign direct investment on economies as far as technology transfer is concerned, results have shown a significant influence of FDI on the economies of not only developing countries but also transition economy countries<sup>281</sup>. FDI most commonly involves and seeks participation in joint-ventures, technology transfer, management and expertise. The significance of technology transfer via the channel of foreign direct investment has its rationale rooted in the widely recognised wealth gap between the developed and the developing economies. As has been mentioned above, trade in goods and services has known potential for transfer and diffusion of technological knowledge. Whether the investment made through FDI is in the form of purchases made in the target country or in the form of expansion of operation of existing businesses in a country, the motive behind the two is still trade. However, with these investments, some amount of technology is necessarily transferred.

FDI provides capital, opportunities of employment, engages and fuels local innovation and businesses in strengthening international value chains, thus becoming a channel for

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<sup>280</sup> Edyta Gheribi et. al, *Prospects of Foreign Direct Investment in Technology Transfer*, 18(2) ECONOMIC AND ENVIRONMENTAL STUDIES 551-576 (2018).

<sup>281</sup> *Id.*

knowledge and technology transfer<sup>282</sup>. The knowledge may pertain to management skills relevant to technology, marketing or information on regulation standards of exports as regards the technological product. Foreign Direct Investment although a great method of technology transfer, may still have to prove its effectiveness in any developing country based on how economically receptive the country is. The economic receptiveness may be governed by openness to trade and policy capabilities.

Foreign Direct Investment, a crucial part of the international economic system refers to a cross-border investment made by a company when it acquires ownership stake in a foreign company/business such that it gives the former direct control over the assets, thereby establishing a long-term economic interest in another country<sup>283</sup>. FDI is vital to international economic integration as it creates long term relationship between economies. It is also thus, recognised as an important mechanism for transfer of technology between countries, promoting trade between them by allowing them access to foreign markets.

Based on the nature and purpose of investment made, they are categorised into organic and inorganic. An investment is deemed to be organically made when the company expands its business operations in another country and inorganic when the investing entity buys out a company/business in the target country. In developing or transition economy countries, foreign direct investment offers a much needed fillip to business entities that may not be performing well financially and helps increase their production capacities<sup>284</sup>. By means of the investment a foreign multi-national corporation establishes a wholly-owned subsidiary in the host country and manages it.

This transfer from a developed to a developing economy is most likely to positively affect the productivity of the host country. Productivity increase is directly linked to the increase in technological knowledge in the developing world. The phenomenon involves both active and passive technology spillover<sup>285</sup>. The multi-national enterprises

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<sup>282</sup> See Working Paper, *Transfer of Technology and Knowledge Sharing for Development: Science, Technology and innovation issues for Developing Countries*, UNCTAD Current Studies on Science, Technology and Innovation.

<sup>283</sup> See, *Foreign Direct Investment for Development: Maximising Benefits, Minimising Costs*, Organisation for Economic Co-operation and Development, 2002, <https://www.oecd.org/investment/investmentfordevelopment/1959815.pdf>

<sup>284</sup> Ishwar Mittal et. al, *Role of Foreign Direct Investment in the Development of Indian Economy*, 7(1) RMS JOURNAL OF MANAGEMENT & IT 132-137 (2015).

<sup>285</sup> *Supra* Note 274, 115.

of developed countries by investing in developing countries ensure a rise in their own productivity levels as the foreign affiliates are inclined to be of greater productivity themselves. Along with this, active spillovers can be regarded as potentially more significant, as they involve the dissemination of technical know-how from foreign production plants into the domestic country<sup>286</sup>. Here, foreign direct investment to materialise technology transfer may be one step ahead of trade furthering transfer and diffusion of technology owing to the fact that FDI along with involving the entry of goods into the developing country, concern the entire production chains of multinational enterprises. This brings with itself imports of factors of production to developing countries in the nature of highly skilled individuals with efficient management skills and goods of high technological content. The interplay between foreign and domestic firms along with spread of technical knowledge via communication is the core of foreign direct investment.

Foreign Direct Investment ensures that the foreign firms geographically come closer to domestic firms to strengthen the interaction between the two. Technology transfer through FDI can take place by a number of different channels:

- Forward and Backward Linkages
- Training and Skill Development
- Demonstration effects<sup>287</sup>
- Competition effect
- Spillover effect
- Learning by doing

**Forward and Backward Linkages:** Both forward and backward linkages are concepts that relate to the relationship between foreign and local firms which is established when FDI happens.

Forward linkages happen when an investment is made in the host country with local businesses that operate downstream in the supply chain. An investment is made with an entity which is forward in the supply chain and that fuels or favours local suppliers and distributors to raise their quality and service standards to provide to the foreign

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<sup>286</sup> Blömstrom and Kokko, *Multinational Corporations and Spillovers*, 12 JOURNAL OF ECONOMIC SURVEYS 247-277 (1998).

<sup>287</sup> *Supra* Note 272, 114.

affiliates<sup>288</sup>. With this, opportunities are created for local suppliers to supply goods to the foreign company and benefit from its presence in the market. For e.g. A foreign automobile manufacturer expands its business and opens up a factory in a host country. The investment boosts the domestic suppliers which may have an opportunity to supply raw materials in the nature of car parts or equipment to the car manufacturing company.

Backward linkages on the other hand operate in a more reverse order. The foreign companies invest with the potential local suppliers that operate upstream in the supply chain. This provides a higher incentive to the domestic suppliers in return for higher quality standards. An example of this may be a foreign company investing in a host country to set up a R&D centre, which is backward in a supply chain. It may in turn, with the investment, provide expertise and supply good quality products to manufactures ahead in the supply chain and thus, enhance productivity levels and lead to technology diffusion. Both forward and backward linkages facilitate collaboration and knowledge transfer between local and foreign firms with an FDI.

**Training and Skill Development:** Alongside investing in a host country with an aim of increasing productivity, a foreign company may also provide for training programs and technical assistance to the local employees who are involved with the working of the foreign affiliates. Technology transfer does not end with just the transfer of technology; it may be accompanied by transfer of technical knowledge. Thus it becomes imperative to ensure that the host country has not just resources to produce but also resources that have the required skill to make the best use of the technology transferred. This training and skill development would be beneficial even at the time of adoption and moulding of the technology to suit domestic needs.

**Demonstration effects:** Demonstration effect consists of several ways which assist technology diffusion such as copying, reverse engineering and imitation of new technologies. In short, when a foreign direct investment is made, the technological developments brought forth by foreign companies into a host country, together or individually act as a ‘demonstration’ or serve as an example to the local firms of the host country. This phenomenon is called demonstration effect. The demonstration has

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<sup>288</sup> Sadayuki Takii & Dionisius Narjoko, *FDI Forward Linkage Effect and Local Input Procurement-Evidence from Indonesian Manufacturing*, in, DYNAMICS OF FIRM SELECTION PROCESS IN GLOBALISED ECONOMIES 111-146 (C. H. Hahn and D.A. Narjoko eds., 2011).

a positive influence on local firms and encourages them to practice and adopt similar technologies in their working. From the investment that foreign companies make in a host country, the latter has a lot to learn from such an opportunity. Along with the money that is invested by a foreign company, different production techniques and managerial skills are also introduced. This serves an opportunity to the domestic players to learn and benefit in ways of increasing productivity<sup>289</sup> from the ones who have a larger expertise and higher efficiency in dealing with technology.

**Competition effect:** Similar to demonstration effect, competition effect also helps domestic firms reach higher productivity levels, but by casting a different influence. Competition effect suggests that local firms on seeing foreign affiliates and their ways of functioning in the market, begin to adopt new management skills and production methods, trying to imitate the foreign technology which they look up to, as they feel pressurised to match the latter's efficiency. They consider the foreign firms as their competitors in the market and thus, work hard to match the efficiency of these foreign firms who seemingly have an advantage of superior technical and organisational methods of operating.

**Spillover effect:** Foreign Direct Investments are capable of having yet another positive influence on host countries. 'Spillover' signifies how technology, innovation and knowledge from foreign firms diffuse or spill over domestic firms on FDI<sup>290</sup>. Spillovers can occur on importation of intermediate goods into the host country<sup>291</sup>, on learning the technology embodied into the product on reverse engineering or also by labour mobility where employees (labour) working in foreign firms, adept at the advanced technology and skills, relocate/migrate to join domestic firms in the host country to share their knowledge and expertise; thus helping local firms through the investment.

**Learning by doing:**

This channel of FDI relates to person-to-person communication. FDI in general consists of a package of assets and advanced intermediate products including technology assets,

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<sup>289</sup> Hongshik Lee et. al, *Foreign Direct Investment, Technology Diffusion and Host Country Productivity Growth*, No. 272 Asian Development Bank Economics Working Paper Series, August 2011.

<sup>290</sup> Blomström & Sjöholm, *Technology Transfer and spillovers: Does local participation with multinationals matter?*, 43(4-6) EUROPEAN ECONOMIC REVIEW 915-923 (1999).

<sup>291</sup> B. Aitken et. al, *Spillovers, foreign investment, and export behavior*, 43(1) JOURNAL OF INTERNATIONAL ECONOMICS 103-132 (1997).

management skills, capital, production techniques and entrepreneurship. In the exchange and transfer of technology, knowledge is also shared among human resources. FDI brings together foreign experts and domestic workers where the latter receive training and expertise from their foreign affiliates. Once the working and production in these foreign companies in the host countries begin, it naturally casts a learning effect on the domestic workers who are actively engaged in the manufacturing process. One of the ways how learning effect happens is when the employees receive actual training sessions or by active sharing of knowledge. The other way how local employees learn is through 'learning-by-doing'. From basic skills like knowing how to operate machinery to better administration and management skills, all can be learnt by 'learning-by-doing'. This 'learning-by-doing' skill is acquired by human resources either on observation, by training or communication with foreign employees. Here, communication is the key which is an intrinsic part of learning. Effective communication leads to effective learning.

The combination of capital along with knowledge, technical know-how, managerial and entrepreneurial skills makes FDI a strong mechanism for technology transfer<sup>292</sup>, which heavily impacts the economy of the receiver country. The importance given to this mechanism of technology transfer can be made out from how FDI has been preferred by both the home (supplier) country and the host (receiver) country. Back in the 1960's it was observed that the multinational corporations established wholly/majority owned subsidiaries in the host country as a predominant method of investment and technology transfer to the lesser developed nations<sup>293</sup>.

### **C) JOINT VENTURE:**

In the simplest of terms, when two or more entities come together as one business entity where they agree to equally share the responsibilities and profits of their operation, it is known as a joint venture<sup>294</sup>. The motives of formation of a joint venture may vary according to the goals of the business entities. In this association among multiple

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<sup>292</sup> S. Lall, *The Interrelationship Between Investment Flows and Technology Transfer: An Overview of the Main Issues*, UNCTAD/ITD/TEC/1, Geneva, 1992.

<sup>293</sup> N. M. Reddy et. al, *International Technology Transfer, A Review*, 19 RESEARCH POLICY 258-307 (1990).

<sup>294</sup> A. Adeoba, *Technology Transfer and Joint Ventures: The Nigerian Experience*, in, JOINT VENTURE AS A CHANNEL FOR THE TRANSFER OF TECHNOLOGY 107-120, (UNCTAD ed.,1990).

entities, the parties share the equity capital, investment related risks and control over the functions of the company and decision making. It is in the nature of a collaboration which works towards the accomplishment of a particular goal generally characterised by shared ownership, risks, returns and general governance between the domestic firms in the host country and its foreign partner<sup>295</sup>.

A joint venture (JV) is extremely instrumental in the transfer of technology. For the same, it is an attempt by different entities to combine their interests where they can equally share knowledge and resources to develop a product or technology and use their know-how to complement each other's working<sup>296</sup>. Many developing countries preferred this mechanism of technology transfer as they wished for the foreign entities to invest and be part of a formal agreement for transfer of technology where both the parties involved could have equal share in control of affairs and decision making<sup>297</sup>.

Developing a technology through R&D not only is time consuming but also cost intensive and risk oriented. Many a times, when a technology is attempted to be developed from scratch, relying on the research done, it may or may not lead to the expected result (the hypothesis may be disproved). Thus, in order to achieve and absorb the desired technology, transfer and absorption seem to be an easier way out for developing nations. The concept of joint venture fulfils the transfer and absorption of technology through multinational corporations contributing proprietary knowledge and forming an equity association with a local firm in the host country.

Joint ventures are quick in obtaining the required technical knowledge and resources from the parent companies, which acts as an advantage for them as this way they are capable of dissipating and using the knowledge together with their local partners. In this way they facilitate the use of advanced technologies that the local partner in the joint venture could generally not be able to afford or create by themselves. Joint ventures act as a way of strengthening existing firms. It provides opportunity for the firm to explore options with its technical strengths. A joint venture may have better possibilities of functioning more efficiently than a wholly owned subsidiary in the case of an FDI, owing to joint efforts, complementary skills and management and the use

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<sup>295</sup> *Supra* Note 294, 122.

<sup>296</sup> *Supra* Note 192, 73.

<sup>297</sup> TECHNOLOGY TRANSFER IN THE DEVELOPING COUNTRIES (Manas Chatterji ed., 1990).

of expert knowledge by both the parties (the use of foreign partner's knowledge of advanced technology and the domestic partner's knowledge of the local environment and working conditions).

The significance of joint ventures have become more prominent in recent times owing to lower operating costs, better products in market, increase in the number of firms becoming global competitors which previously operated only in domestic market<sup>298</sup>. Both the foreign partner and the domestic partner have something to benefit from the collaboration. The incentive for a foreign partner is that the domestic partner can help the former through the local working environment and steer through the regulatory and other complexities which may hinder transfer of technology when entering a foreign market. In this pursuit, a well-established market, capacity for innovation and absorption and a strong export structure, all account for the choice of a good domestic partner for a joint venture. The host country also has obvious incentives. With the idea of a joint venture, foreign multinationals bring in advanced technologies; the shared use of which benefits the host country, along with expert skills in the area and relevant knowledge which paves the way for future innovation also, through direct or indirect channels. The extent of cost asymmetry and number of operating firms in the market are important factors for consideration in the formation of a joint venture<sup>299</sup>.

#### **D) STRATEGIC ALLIANCES AND ACQUISITION:**

Yet another method of technology transfer is by way of formation of strategic alliances between a foreign and a domestic firm or acquisitions which is in the nature of a controlling purchase or a non-equity alliance. The category of strategic alliances is so broad that virtually all linkages may somewhere fit within its ambit, including joint ventures. With such interpretation, there is a risk of failing to actually define the spectrum of 'specific alliance' and bring to light its meaningful distinctions. There are alliances that do not account for a direct knowledge or technology transmission for e.g. alliances formed: short-term or for pure marketing purposes or any other purpose which

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<sup>298</sup> K.R. Harrigan, *Joint Ventures and Competitive Strategy*, 9 INTERNATIONAL STRATEGIC MANAGEMENT 141-158 (1988).

<sup>299</sup> Tarun Kabiraj et. al, *Technology Transfer, Merger and Joint Venture: An comparative welfare analysis*, 14(3) JOURNAL OF ECONOMIC INTEGRATION 442-466 (1999).

is devoid of the intention of obtaining technology, fall in this category. However, there is still a wide category of alliances that do result in technology transfer<sup>300</sup>.

Strategic alliances, like joint ventures involve an alliance between a foreign firm and a domestic firm where both possess different business ideas and assets which on collaboration can benefit both the entities by enhancing businesses. The coalition thus formed rests on the expectation that both the partners shall benefit more from the alliance than their own individual efforts<sup>301</sup>. The alliances have an aim to pursue mutual benefits by combining and utilising resources like products, distribution channels, capital investment, project funding, manufacturing skills and capability, expertise or even intellectual property. The alliance is generally agreed upon mutual terms and objectives while remaining independent organisations. A strategic alliance may not necessarily result in both the firms losing their individual identities and becoming one separate body like in the case of a joint venture. Since the alliance has been formed for a specific purpose, both the firms can return to their individual beings once the purpose is fulfilled.

An example of a successful strategic alliance is that of Apple Pay and Mastercard. The time that Apple released its 'Pay system' for contactless transactions, it required credit card companies to partner with it and support the technology. Apple wanted the collaboration and backing of credit card companies before proceeding. MasterCard<sup>302</sup> became the pioneer in joining forces with Apple. Consequently, when Apple Pay was introduced, it allowed exclusively MasterCard customers to link their cards to an iPhone, enabling them to make payments even without carrying their physical cards.

Based on the purpose ought to be achieved by the alliance, they are classified into different groups. Generally, the broad groups of categorisation of strategic alliances are:

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<sup>300</sup> NATIONAL RESEARCH COUNCIL, U.S.-JAPAN STRATEGIC ALLIANCES IN THE SEMICONDUCTOR INDUSTRY: TECHNOLOGY TRANSFER, COMPETITION AND PUBLIC POLICY, The National Academic Press (1992).

<sup>301</sup> *Id.*

<sup>302</sup> *See*, Gazal Singla, Vendor Specialist, Amazon, Can rivals beat the Strategic Alliance of Apple and MaterCard, LinkedIn (Oct 2, 2022) <https://www.linkedin.com/pulse/can-rivals-beat-strategic-alliance-apple-mastercard-gazal-singla#:~:text=About%20the%20Alliance,to%20develop%20its%20contactless%20system.>

- R&D Alliances: This includes agreements entered into for-barter of intellectual property, patents use for royalties, technology exchange not involving transfer of money, visitation and research participation, technology acquisition investments and the like.
- Manufacturing Alliances: This includes agreements entered into for-manufacturing a product for another company and handling its services and marketing (Original equipment manufacturing), second sourcing where a company with due permission manufactures a product developed by another company and acts as a second source of production and supply, use of another company's fabrication facilities to manufacture a product, manufactured parts and components sent to another company for testing purposes.
- Service and Marketing Alliances: This includes agreements entered into for-procurement of certain quantities of goods over a period of time as specified (procurement agreements), selling of partner's original products in specified markets acting as sales agency or servicing contracts for providing follow-up services in foreign markets for a specified period of time.
- General Purpose Tie-Ups: This includes joint ventures or standards coordination where partner may provide for common compatible standards which connect not only devices but users of different systems<sup>303</sup>.

Apart from the above a classification can also be drawn on the basis of movement of transfer. Horizontal Alliances in the context of technology transfer can be understood as collaborations supporting transfer between firms engaged in the same business while Vertical Alliances can be collaborations advocating and implementing technology transfer between a company with another which may be upstream or downstream in the supply chain. There are also equity and non-equity alliances. While equity alliances are formed on a company's acquiring equity stake of another company, non-equity alliances are more of informal alliance between smaller enterprises, commonly set by a contract. Alliances and acquisitions have now become more valuable means of acquiring technology<sup>304</sup>.

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<sup>303</sup> *Supra* Note 300, 125.

<sup>304</sup> Michael Camp et. al, *Strategic alliances and technology transfer: An extended paradigm*, 14(5) INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT 513-527 (1997).

## **E) INTELLECTUAL PROPERTY LICENSING AGREEMENT:**

Sometimes the transfer of technology can happen seamlessly by the transfer of the intellectual property attached to the technology if it is protected. Technology can either be unprotected or protected by intellectual property rights (patent). If the technology is protected, its transfer would mean the transfer of the patent with respect to the product or process which is patented. Sometimes the technology is so inherently embedded in the product or the product being the natural obvious resultant that the two cannot be distinguished and thus it is the product which is protected by intellectual property rights<sup>305</sup>. For the said transfer, the foreign firm (generally the licensor in this case) licenses the rights to the technology to the domestic firm (licensee). The receiver country/firm is purchasing the rights to the technology in order to utilise technology/product developed by somebody else. The purchase payment may either be an outright lump-sum payment or royalties/percentage of sales and profit depending upon the terms of the agreement.

Although licensing has an important role to play in international technology transfer, it attracts some serious concerns too. “Licensing as a mechanism to transfer technology may sometimes not seem as a very viable option owing to the differences regarding the access to information and knowledge and in the negotiating power of the parties concerned. The decision whether to obtain a license or not, **from the perspective of the licensee**, will involve a judgment call on the consideration of certain factors for example

- market size and growth potential for the product;
- purchasing capacity and R&D potential of the licensee; and
- licensee’s confidence in the human capital and service infrastructure that will aid in the required adaptation of licensed technology after the transfer.”

Only after working out these considerations will the product be launched in the market. The major concerns, **from the perspective of the licensor**, revolve around payment in the form of royalties in return for the shared technology. The licensor would want to charge such a rate of royalty as would not just be a sufficient incentive for the technology for what it’s worth, but would also cover for the risks of further potential

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<sup>305</sup> *Supra* Note 67, 20.

problems that can arise such as inability to pay remainder of royalties, distribution of product into unlicensed markets and reverse engineering of proprietary technology.

Depending on IP licensing as a mode of technology transfer will depend on available support for research and development, technological and managerial skills which are central to the acquisition and adaptation of technology and learning<sup>306</sup>. The use of technology is undoubtedly more valued in developed or technically advanced economies owing to the overall technological sophistication and shared interests in technology advancements. For an efficient transfer of technology by means of IP licensing, it is imperative that countries develop a conducive ecosystem where technology can flourish alongside working on their absorptive capacities.

Rights of a protected technology are transferred from the licensor (owner/developer of the technology) to the licensee under a legal agreement in a licensing agreement. There may be certain limitations to the use of these rights. The rights may pertain to only a category of rights and not all rights, for a specified duration of time and its use may even be limited by geographical boundaries<sup>307</sup>. The rights are licensed in return for certain royalties payable by the licensee. The extent of the use of these rights are specified clearly in the licensing agreements; for e.g. it may pertain to the use of patents, trademarks, copyrights, unpatented know-how relating to the technology or the product embodying the technology.

As the mechanism for transfer includes a certain degree of flexibility in negotiating over the choice and opportunity being provided to the recipient country, the mechanism is considered quite versatile in effectively transferring technology keeping in mind the wants and needs of both the parties to the agreement.

A difference lies between license agreements as a channel for technology transfer and joint ventures. The former, unlike the latter does not entail sharing of equity by the entities involved. The licensor in case of a license agreement agrees to give up/sell the rights as discussed and contained in the agreement to the licensee upon payment of the remuneration as per the terms and conditions of the agreement. License agreements also differ slightly from technology transfer agreements wherein the latter is broader in

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<sup>306</sup> UNCTAD, 2007.

<sup>307</sup> P.J. Killing, *Technology Acquisition: License Agreement or Joint Venture?*, COLUMBIA JOURNAL OF WORLD BUSINESS 1980.

terms of use and more focused on the idea of development, improvement and diffusion of technology.

Apart from their respective concerns, a major incentive<sup>308</sup> for the licensee is obtainment of advanced technologies at a relatively low cost. The royalties agreed upon in the agreement by the licensee would be comparatively less than the cost that the recipient country (licensee) would have incurred in developing the technology and related R&D costs. This results in quicker commercial development and growth owing to enhanced market share<sup>309</sup>. The incentive for the licensor here typically is popularity and growth of the technology in other countries with some financial gains in the form of royalties. By transferring technology through this mechanism, the licensor may also establish such relations with the licensee (recipient country) that it could along with the latter's willingness, help strengthen the growth of technology better and also share associated risks. This makes licensing a strategic decision for both the licensee and the licensor. Factors like size of the market, stage of development in recipient country, availability of labour and skill in the recipient country, knowledge and use of technology are considered before drafting an agreement.

A licensee can, on acquisition of rights to the use of technology through the license agreement, learn about the technology and acquire skills to be able to reproduce the technology or the product and thus become a competitor for the licensor in the market. However to be able to reproduce the technology, the licensee has to have enhanced understanding and control of the product embodying the technology with the ability to absorb and mould technology further. This would require both technical and managerial skills.

#### **F) MOVEMENT OF HUMAN RESOURCE:**

Human capital is all knowledge, expertise and skill that human beings invest in and gather over a period of time, enabling them to realise themselves as potent and productive members of the society. In measuring the rate of economic development of

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<sup>308</sup> E.G. FRANKEL, MANAGEMENT OF TECHNOLOGICAL CHANGE, THE GREAT CHALLENGE OF MANAGEMENT TO THE FUTURE (1990).

<sup>309</sup> D. W. McDonald et.al, *Licensing has a Technology Strategic Planning* 28(1) RESEARCH MANAGEMENT 35-40 (1985).

a nation, human capital is a key component. It accounts for an increasing capacity to benefit from the transferred technology.

The loss of human capital with their technological skills through the “brain drain<sup>310</sup>” concept has been commonly recognised. For human resource to best utilise their talent, the country needs to have a strong technological and innovation base. Many a times, the developed nations on advancements in technology attract skilled persons with a scientific mind more from different countries than the home country as production of human expertise and capacity lag behind the developments in technology which are more spontaneous and unpredictable. Scientists and researchers from developing countries (who may not have the resources to develop technology in their own country) have been known to contribute to patents abroad<sup>311</sup>.

A temporary movement of these skilled and educated human resources might not have a lasting impact on the country’s overall talent benefaction, on the contrary may have a positive influence for the country making its name and reputation on the world map; however, a permanent emigration of professionals shall severely impact the human capital and also affect the country’s opportunities to receive technology transfers. This negative effect may be lesser if the professionals were not permanently employed in another country.

From the developed country’s perspective, in order to materialise the “brain gain”, it is imperative that the country provides good working environment to the migrated professionals. There is not an iota of doubt that the educated and skilled lot from the developing countries will for sure benefit from working abroad in better technologically sound environment, however, it is equally important that the developed country providing such opportunities to the professionals feel that they are responsible towards the countries of the working professionals and ensure knowledge transfer and technology diffusion to those countries. The migration of the people should be regarded by the developed economies as a means to export advanced technology to other nations

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<sup>310</sup> The brain drain theory as propounded by Dadabhai Naoroji explains the migration of educated and skilled people from their home country to another country for want of better opportunities. This human resource, in the best of available opportunities could have been an asset to their own country’s economy.

<sup>311</sup> A study of a project conducted by WIPO for its Committee on IP and Development on Patterns of Skilled-Worker Migration in 2013, available at [www.wipo.int/export/sites/www/econ\\_stat/en/economics/pdf/wp8.pdf](http://www.wipo.int/export/sites/www/econ_stat/en/economics/pdf/wp8.pdf).

which shall aid in the production, marketing and management of technologically advanced products.

In case of movement of people from LDC's, developed countries should consider providing financial assistance to them for proper training of researchers and scientists in order to improve the likelihood of technology transfers for LDCs, in particular for technologies which are utmost essential in the domain of public services, health, agriculture, infrastructure development and governance<sup>312</sup>. In situations where the young generation decides to pursue higher studies abroad and later on settles there considering plethora of good opportunities, then policies should be devised between the countries to bridge the gap between the local human capital pool and emigrants who decided to settle in developed countries.

#### **G) SPIN-OFFs:**

A spin-off company usually denotes a new company which is formed after the parent company “splits” into a new and independent creation. This can happen when the company distributes new shares of an existing business into a separate entity. The term spin-off refers to a new creation from its parent. It separates the parent's subsidiary to form a new and independent entity. In the context of innovation, it means separating a part of an existing creation to create something new or novel. A technology spin-off is a product or service derived from tapping an existing technology usually through research and development by concerned organisations in the domain. For e.g. NASA<sup>313</sup> spin-off technologies- Under its Technology Transfer Program<sup>314</sup>, NASA has co-ordinated with private entities to commercialise its products which it claims as spinoffs. The NASA spinoffs or spinoff technologies are basically commercial products in the market that have been developed with NASA's help through research and development contracts.

Some examples of the spinoffs are use of data obtained from research done by NASA, training or technical assistance received from NASA personnel, use of NASA facilities and many other. The United States has even gone a step ahead in the initiation of programs such as Small Business Innovation Research (SBIR) which receive funding

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<sup>312</sup> United Nations Industrial Development Organisation, Annual Report 2008.

<sup>313</sup> National Aeronautics and Space Administration

<sup>314</sup> See, *NASA Technology Transfer Program*, <https://technology.nasa.gov/>

from the government and is intended to help small businesses conduct research. These businesses may work on research conducted by NASA and develop it further. A private healthcare company collaborated with NASA for the development of an infrared thermometer that can measure thermal radiation emitted by the human eardrum in a similar fashion as the temperature of stars and planets are measured. In the technology driven program, the healthcare company<sup>315</sup> received continued support from NASA.

The power of information and communications technology has left its mark over the world and has touched almost all areas of life. Small businesses, in the nature of start-ups and spin off companies that are backed by higher education institutions and research organisations have become a very viable mechanism for the transfer of technology, promoting the idea and putting it into practice across geographical boundaries. Usually promoted by a university team on realisation of a promising research product, the group of researchers are allowed to create a spin off and introduce it into the market. On reaching the market, it allows investors to seek interest in the business plan and invest accordingly if it matches their objectives.

Technology transfer through spin off creation is a strong means of commercialising innovation. An example of a success story of commercialising innovation by creating spin off is that of Institute for Materials and Wood Technology by Bern University in Bern, Switzerland. The institute has spent years of research in the field of sustainable development and bio-based solutions in the form of bio-based products wherein through its robust team and academic and industrial collaborations all over the world, it has supported entrepreneurial ideas through creation of spin offs by promoting its students<sup>316</sup>. There are also examples of spin off companies from government organisations in the countries of United States and Japan where the new company was formed by former employees of the parent company. This new company worked around a core technology developed by the parent organisation and developed its offspring<sup>317</sup>.

The case of MIT (Massachusetts Institute of Technology) demonstrates the significance of spin-offs as a means of transfer of technology which in turn provided job

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<sup>315</sup> Diatek Corporation

<sup>316</sup> Commercialised Innovation of ‘Cocoboards’ and ‘WoDens Technology’, available at: <https://www.innovationnewsnetwork.com/commercialised-innovation-technology-transfer-through-spin-off-creation/6120/>

<sup>317</sup> Elias G. Carayannis et. al, *High-technology spin-offs from government R&D laboratories and research universities*, 18(1) TECHNOVATION 1-11 (1998).

opportunities and a boost to the economy. BankBoston's analysis<sup>318</sup> in 1997 revealed that MIT had generated 4,000 spin-offs, leading to an employment of approximately 1.1 million people. The amount of wealth that would have generated is worth praise. Other universities such as Stanford University in California (Silicon Valley) have also played a vital role in the spread of technology.

#### **H) TURNKEY AGREEMENTS:**

A turnkey or a turnkey agreement is basically a contract wherein the contractor is obligated to implement the project at hand such that he is able to deliver it to the buyer as a complete and finished product. The party to deliver as per the terms of the contract is entirely responsible for the construction of a facility starting from creation of the idea to supervision. The product delivered under a turnkey contract is usually ready to operate or serve the buyer.

Technology is usually transferred through turnkey agreements. In this situation, the country in need of a particular technology purchases a complete technology from an outside source which designed, implemented and then delivered as a final product. This may be accompanied with necessary instructions and training along with other operational support so long as the technology is put to use. All related terms and conditions may be included in the agreement as negotiated between the parties.

Malaysia serves as a good example where technology transfer mostly occurs through turnkey contracts<sup>319</sup>. It a suited mechanism to transfer technologies which are tested and established as new technologies may require dependence on the turnkey contractor (provider MNC) for service and maintenance. The supplying company bears full responsibility of delivery of 'end product' along with a full range of technical and managerial operations that may come handy with it. Thus a "package" is handed by the supplier. There exists no laid down format for a turnkey contract; it usually is drafted as per the requirements, objectives and specifications of the buyer. It is usually bigger multinational companies that are the supplier of technology under the turnkey contract

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<sup>318</sup> BANKBOSTON, MIT: THE IMPACT OF INNOVATION, 1997.

<sup>319</sup>Hamimah Adnan, *Risk Management in Turnkey Projects in Malaysia*, 15 WSEAS TRANSACTIONS ON BUSINESS AND ECONOMICS 35-43 (2018).

as amassing funds for the technology R&D, technical and training support might be beyond the means of smaller companies.

### **1) BUILD-OPERATE-TRANSFER (BOT) AND BUILD-OWN-OPERATE-TRANSFER (BOOT) CONTRACTS:**

In addition to the turnkey contracts, both Build-Operate-Transfer (BOT) and Build-Own-Operate-Transfer (BOOT) contracts are project delivery models commonly used in infrastructure development, but they can also be employed to facilitate the transfer of technology. In a BOT contract, a private entity (usually a company or consortium) is granted the rights and responsibilities to design, finance, construct, operate, and maintain a project for a specified period. For the period that the private entity has to operate the technology, the project contractor may recover its investment, operating and maintenance costs. Throughout the project's lifecycle, the private entity may also share technical knowledge, provide training to local personnel, and transfer operation and maintenance practices. This helps build local capacity and facilitates the adoption of new technologies and practices in the host country. Once the contract term expires, ownership of the project is transferred back to the public sector or the project owner. Technically the private party in a BOT contract does not own the project as an asset, rather only get a concession to operate it for a limited time.

Similar to BOT contracts, Build-Own-Operate-Transfer (BOOT) contracts involve a private entity responsible for designing, financing, constructing, owning, operating, and maintaining a project. However, in BOOT contracts, the private entity retains ownership of the project for a usually long time as BOOT contracts are given for large scale infrastructure development projects which receive a bigger funding from the state. The private entity owns and takes over the operation of the eventually government owned project. The transfer of technology occurs during the construction phase as well as throughout the project's operation. The private entity may transfer proprietary technologies, provide training and knowledge transfer to local staff, and introduce efficient operational processes.

In both the type of contracts, technology transfer is driven by the private entity's expertise and investment. The aim is to transfer technological knowledge, operational practices, and management capabilities to the host country or project owner, enhancing local capacity and promoting sustainable development.

The specific terms and conditions of BOT and BOOT contracts are of great significance in governing the agreement between the private entity and the public sector. The technology transfer aspect can be explicitly stated in the contract or may be a natural outcome of the private entity's involvement in the project.

#### **J) CONSORTIUM AGREEMENTS:**

The Organisation for Economic and Co-operative Development (OECD)<sup>320</sup> defines R&D as, “creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.” As has been discussed in the previous chapter, R&D forms the base for development of a new technology. It is not unusual where for the development of a particular technology several entities come together. Consortium refers to this association or coming together of two or more companies.

With reference to technology and technology transfer, technical consortium agreements are concluded between several companies on joint R&D projects. The reason multiplicity is preferred is because the resources of one company may be felt to be inadequate to execute the project on technology development and technological change and pooling of resources from several entities may be desired to fulfil the goals of the project. The R&D may be jointly conducted between a local firm and a foreign firm for the ease of sharing of available information and resources. The primary objective of all these cooperative initiatives in the field of technology is to encourage research advancement, technology development, technology transfer and the exchange of information among the participating members.

#### **K) FREE TRADE AGREEMENTS AND BILATERAL TREATIES:**

Free trade Agreements are agreement concluded between two or more trade blocs that are aimed at reducing or eliminating tariff or non-tariff barriers to trade. Since trade and technology share an inseparable bond, free trade agreements (FTAs) and bilateral treaties play an important role in the transfer of technology. With the reductions in trade barriers in the form of tariffs, quotas, import/export restrictions, the incurred costs of

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<sup>320</sup> OECD is an intergovernmental international organization of 37 member countries that was formed in 1961 to enhance and promote sustainable economic growth and world trade by the formulation of policies for a better living.

exporting and importing technology related goods is automatically lowered, which eases the transfer of technology.

In the instances where the technology is protected by intellectual property rights, the FTAs usually contain provisions for the protection of these rights as they provide incentives for technology creators. This affords a sense of relief to the creators against unauthorised use of their creation. In addition to this FTAs also contain provisions that promote market access and increase investment opportunities for member countries. This can in turn attract FDI and lead to technology transfer.

Technology transfer by any of the above mechanisms can occur via the following channels:

- Reverse Engineering: It is the means of discovering the process of manufacture and underlying principles of a device, technology, object or system by means of analysing its structure, functions and operability<sup>321</sup>. It is going back from product to process by simply investigating the final outcome. Hence, called reverse engineering. The engineering entails exploring the working in detail to finally come to the retrieving the constituting elements of a product, in situations where there is lack of primary knowledge to build on the concept. With the import of advanced technological products, reverse engineering has been made possible with regard to technology. Thus reverse engineering can aid technology transfer in most of the mechanisms.
- Collaborative Research: Industry-Education partnerships have come a long way in establishing good collaborative efforts to initiate the transfer and commercialisation of technology. Knowledge and the related know-how are generally developed and available at research organisations and university institutions and then further transferred to industries to develop it further and commercialise it. This way both can benefit from the commercialisation. Successful commercialisation diffuses technology.
- Copying/Imitating technology: Copying and imitation of a foreign technology is possible on the import of technologically advanced products. On learning about a technology and gathering the necessary information and resources obtained from the blueprint of the technology, the production is generally

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<sup>321</sup> *Supra* Note 279, 116.

reproduced by the importing country. The blueprint along with effective communication with suppliers helps local manufacturers and firms to learn and copy the technology in order to reproduce it the same way.

An analysis into the different mechanisms of technology transfer will help understand that no particular mechanism of transfer can be deemed to be the most appropriate. No method can fit perfectly in all situations. The choice of the method of transfer can be made after the recipient country weighs its pros and cons. The nature of technology and the prevailing specific circumstances cannot be ignored in any case before making the transfer.

Since no particular approach to transfer technology is the most appropriate, the effectiveness of the different approaches also differs in terms of the ability of the recipient country to learn and absorb the technology. The decision regarding choice of the method should be made after duly examining the desire of the transferor to transfer and the needs of the transferee. Transferee's absorptive capacity also affects this decision. The need of advanced technology of the developing countries has made them opt for a variety of mechanisms for transfer in order to decide which method suits their needs best. This shall help the countries to absorb and use technology more efficiently.