

CHAPTER 6: JUDGING THE EFFECTIVENESS OF TECHNOLOGY TRANSFER

A Complex Process: Introduction to the different factors and challenges posed

Technology Transfer is lengthy and a quite complex process. It involves a multitude of facets. The primary reason why technology transfer is gaining importance can be attributed to companies and country's limited capacities to produce technology which in turn can be used to manufacture technologically advanced products. Such products are becoming the basic demands of the people. Production and distribution of such products do not take place overnight. For a company/country (manufacturing unit) to be able to achieve this, has to ensure its R&D leading to significant development of technology. Research might be preceded by a technological bent of mind. Thus, developing a scientific temper⁴⁴⁰ can be seen to be a pre-requisite for actual manufacturing. This would automatically stir research in the area of technological innovation provided it is backed by funding from the state/government. Appropriate funding from the government can motivate a nation to realise its potential for research. Having a technological mindset would be of little significance in the absence of sufficient expenditure dedicatedly utilized for research.

Hence before even reaching the point of commercialization of technology, factors like a technological mindset, R&D activities, appropriate funding, combination effort by the state and the individual entity all play a major role in assisting the efficient technology transfer process. The establishment of each and every contributing factor shall ultimately culminate into commercialization of the technology, the desired ultimate objective of development of the same in the first place.

Commercialization is the inevitable outcome of technology transfer. When a technology is transferred, the end goal of the transferor is ascertaining that it not just compensated by the transferee by means of payable royalties decided as per the transfer agreement, but also that the technology is diffused in the recipient country. In order to properly commercialise the technology, assessing the commercial potential of the technology is important. Many factors may determine the commercial viability of the

⁴⁴⁰ *Supra* Note 1 at 1.

technology. Demand, utility, pricing may be few of them. In addition, the commercial success of a technology may also largely depend on technical development which includes the time effort, raw materials investment and human resource that went into making the product. Similarly, whether the technological invention has received the necessary market clearances also counts. These clearances may act in the nature of green flags as permits without which the product might not be able to enter the commercial market. The clearances may be given after the product has undergone certain safety and utility checks to weight associated risks.

Commercial feasibility of the product may also be determined by market development and the increasing demand for the product because of such development. It may also be the case that at the time of development of the technology there may not be a potential market for the product but with the gradual passage of time and change in scenario, the demand of such a product increased. Marketing and advertising may also lead to increased sales which signify that the amount spent in promoting the product and spreading awareness, highlighting the advantages that the product might have over competing products may by all means increase the commercial success of the technological product.

Thus, a product may be financially feasible at the time of production and its commercial potential is assessed properly before the same is tapped; or it may not be financially feasible at the time of manufacture but can be made so with efforts and successive commercialization in the market.

While there may be a host of factors that determine the success rate of a technology transfer, there are in addition certain challenges that may arise, hampering the transfer process. Identification of these challenges thus becomes important. These challenges, also called barriers to transfer of technology⁴⁴¹ are defined as, “any kind of limitations and features that hamper the effective functioning of a technology transfer and research commercialisation system, and, as a result, block interactions between the R&D sector and enterprises, therefore impeding the development of innovative entrepreneurship⁴⁴².” The IPCC (Intergovernmental Panel on Climate Change) has also

⁴⁴¹ Adam Mazurkiewicz et. al, *Technology Transfer Barriers and Challenges Faced by R&D Organisations*, 18(2) SCIENCE DIRECT 457-465 (2017).

⁴⁴² *Id.*

discussed the barriers to technology transfer in the context of transfer of green technology⁴⁴³. These barriers affect both development and commercialisation of technology, varying in form in different sectors and contexts and also manifesting themselves differently in different economies (developing and transition).

Technology Push v. Market Pull

There are two major reasons how technology transfer can originate⁴⁴⁴. One is by means of technology push which is generally initiated by research, and the other through market/demand pull which is commonly initiated through industry. In the industry market, there has been a continued debate over ‘technology push’ and ‘demand pull’. There are products that develop as a result of continuous research and the emergence of advanced technologies, ready to be commercialized in the market. The other scenario demonstrates the development of products due to the industry demand. There may exist a peculiar demand for a product in the market at a given point of time which drives the research and development for that product to fulfill the market demand. Here the market demand is the driver for technological invention.

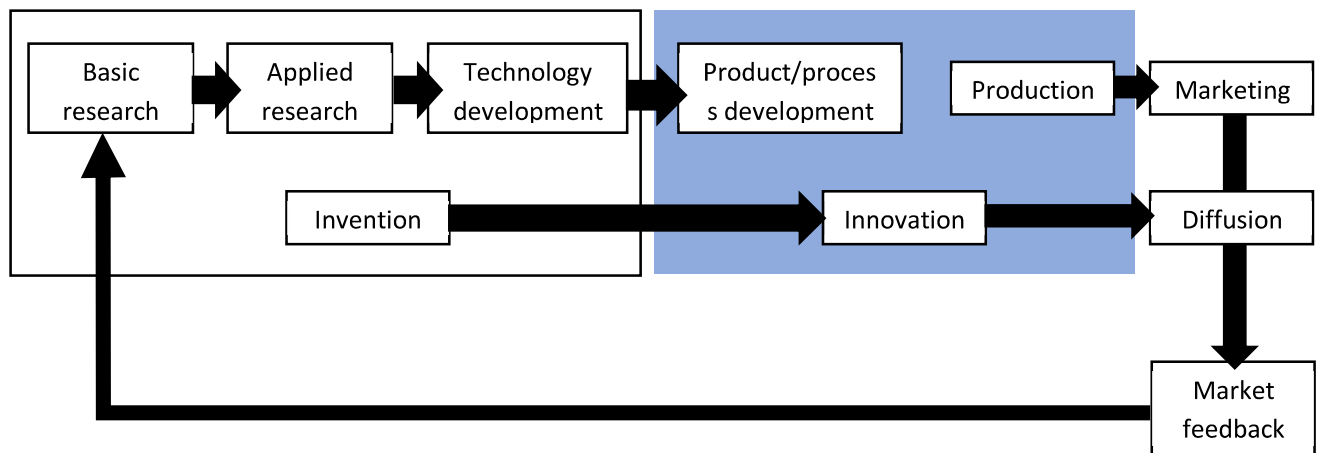
In the commercial market, the development projects that are pulled by demand are more likely to do better commercially in comparison to the ones that are pushed by technology growth so to say that the commercial success of the technologically advanced products is often more dependent on user acceptance than on the technology itself while user acceptance in the case of demand pull does not stand as an issue⁴⁴⁵. Inventors who develop technology are also naturally more inclined to push the technology in the market in order to balance out the expenditure spent on development of technology with the profits that it reaps on commercialization. This contrasts with the situation where market pull or demand pull caters to the specific needs and requirements of the people as it the demand which forms the base of the technological product.

⁴⁴³ Para 3.4.3.3, Barriers to technology transfer, diffusion and deployment for long-term mitigation, Climate Change 2007: Working Group III: Mitigation of Climate Change, IPCC (2007).

⁴⁴⁴ Ravi R. Janodia, *Factors affecting Technology Transfer and Commercialisation of University Research in India: A Cross-sectional Study*, 13 JOURNAL OF THE KNOWLEDGE ECONOMY 787-803 (2022).

⁴⁴⁵ Kate Ehrlich, *Factors influencing Technology Transfer*, 17(2) SIGCHI BULLETIN 20-24 (1985).

The ‘technology push’ model of transfer is usually called a linear model that is associated with the organic progression of research concluding into production and finally diffusion in the market and not a process that is triggered by industry demand. This involves the journey from the application of fundamental aspects gathered through the available knowledge and technology coupled with efforts to develop research further with ultimately a commercially viable product or service ready for commercialization in the market. Since the process is repetitive, a crucial element of this is the market feedback from the first round of commercialization which may be taken seriously into consideration and may form part of the basic research for the next cycle. A pictorial depiction of this linear model can be seen as follows-



FACTORS AND ELEMENTS INVOLVED IN THE EFFECTIVE TRANSFER OF TECHNOLOGY

When the discussion pertains to judging the effectiveness of technology transfer, an analysis into various factors that have the potential of significantly affecting the transfer process is crucial. Beyond these factors, there lie several challenges or “barriers” to technology transfer for which devising a sound methodology to completely let go or lessen the effects of the barriers is highly recommended. Although there is awareness about the potential barriers, not much clarity is drawn on tackling such issues in the absence of guidelines and suggestions from policymakers.

The four pillars of strength for any effective and successful technology transfer are:

- Accessibility
- Availability
- Affordability; and
- Acceptability

These pillars are further dependent on various other factors as shall be discussed hereunder, however, these pillars form the base of any technology transfer and ensuring all would give essence and meaning to the process of transfer. In terms of a patented invention, the two important essentials that are emphasized are availability and affordability of the patent. As most technological inventions are protected by means of patent, in addition to the above two, accessibility and acceptability assume equal importance.

As technology transfer is a process involving a multitude of steps or components, any or all of these components may be affected by certain factors⁴⁴⁶ which may have the capability of affecting the entire process of the transfer. Some of the identified factors affecting the transfer are:

1. Human Factor: Human behavior is unpredictable and yet important in the context of technology transfer as human beings are the ultimate users of the technology. In order to accept the new technology and make efficient use of it, they must bring a change in their behavior pattern. This is understood, given the fact that expecting users to adapt to the technology in a very short span of time is unrealistic. The users may find themselves incapable of immediately responding to the new technology. Gathering facts and having the aptitude to learn about the product or the technology, requires effort. It is human psychology to resist change including new ideas. The capability of bringing a change in the behavior so that one may be able to use the technology is required in place of a myopic vision which is limited to only the things which one has got comfortable using and learning about. This makes the chances of successful

⁴⁴⁶ Satyadeep Singh, Transfer of environmentally sound technology EST role and prospect in climate change mitigation and adaptation in special context of SAARC countries (2019) (Thesis submitted to National Law School of India University, Bengaluru for the award of the degree of Doctor of Philosophy) (available at: <https://shodhganga.inflibnet.ac.in/handle/10603/332222>).

technology transfer dependent on human factors like their time, patience, learning ability, acceptability and openness to experiment with a new technology/product.

2. Communication Factor: Communication which involves the diffusion of knowledge and information concerning the new technology, is one of the key elements in the process of transfer. Since communication forms an integral part, any obstruction either within the organizational setup or outside such environment which detrimentally affects communication shall cause to impede the entire process of effective technology transfer. Before any such technology is actually commercialized in the market, some basic information about the technology or product or even the company which may be the manufacturing unit, shall serve to spread awareness and educate the people who will be the ultimate consumers. This thread of communication exists at different levels with different stakeholders who have their individual roles to play in the transfer process. If the communication of the information regarding the technology does not reach people timely and effectively, they may not be able to use the technology to its maximum potential.
3. Economic Factor: There are many monetary or financial factors too that play a major role in determining the success of a technology transfer. It is extremely reasonable for the inventor of any product (technology in this case) to have apprehensions about the economic justifiability of his production when commercialized in the market. Profit shall ensue when the financial return is more than what has been invested for the development of the product or technology⁴⁴⁷. Ensuring a good return on investment shall also depend on the customer's readiness to utilize the product and other market factors. The irreversibility of the investment is a major concern for developers when the means, amount and the period of payback seem all uncertain. A fiscal justification reliant on transfer and adoption of the product requires what may seem to be a long wait but inquisitively anticipated. The agreement on the royalties or the prices offered and the availability of financial instruments play

⁴⁴⁷ David B. Audretsch et. al, *Technology Transfer in a Global Economy*, 39 (3) THE JOURNAL OF TECHNOLOGY TRANSFER 301-312 (2014).

a major role. The instances where the technology is slightly higher priced economic factors become much more prominent relatively.

4. External Factors: External factors in the nature of environment factors also affect the process of transfer of technology. The factors that can externally affect the transfer process occur naturally in the relevant market, nation and the world in general wherever the product is exposed. These extrinsic factors arise in the overall basic ecosystem surrounding the technology or the product and can have significant influence on the commercial viability of the product. A change in the market pricing, or a scheme initiated by the government affecting the related industry are examples of extrinsic factors affecting the consumer's decisions to purchase, thereby affecting process of technology transfer.
5. Corporate factor: One of the major factors that affects technology transfer is how decisions are taken at the management level. From the decision of development of the technology to its commercialization and further adoption, the stages are all influenced by various organizational factors. Decisions at the corporate level might involve a company's willingness to bend towards a technology that is ready to offer more advantages to the firm rather than meeting the current demand of the public. It may also happen that the borrower borrows raw technology and looks forward to work on it to develop it further. A technology on which further development seems difficult would be resisted whereas a technology which on further development would bloom into full utility adjusting best to the local conditions of the recipient country would be preferred. Also adopters of technology look disapprovingly on technologies whose evaluation as per the current market seems obscure which would make calculation of royalties and procurement of monetary profits even more difficult. In instances where the organization is looking for a replacement for a technology, the corporate entity may be choosy for a technology which shall if not maintain status-quo, be able to better the current situation, but in no way disrupt existing practices.
6. Technological factor: As surprising as it may be, technology itself is a crucial factor to be considered in a transfer process. Owing to the dynamic nature of technology, which in order to keep pace with industrial revolutions and changes in the society, advances in nature itself. This judgment call of promoting a particular technology depends on the proper testing of the technology to ensure

that it delivers the desired result. Once the functional efficiency is thus tested, it is deemed proper to be the subject matter of transfer. The operational performance aspect of the technology here plays an important role in determining the success of the transfer process. There would be a greater demand for a well desired and functionally potent technology which would make technology transfer more desirable. Keeping all other factors aside, if technology itself fails people, or does not make itself useful, the very aim of technology transfer would stand defeated.

Besides these major factors affecting the transfer process significantly, there are also additional elements that do cast their influence too on transfer.

- a) The fact that there is no other competitor technology in the market automatically contributes to the overall successful implementation of technology. If the technology in question (subject matter of transfer) is the only technology serving a particular need at a given point of time, there is little chance of it not being successfully commercialized⁴⁴⁸.
- b) A technology fulfilling essential standards as laid down by a professional standard setting organization is more likely to be accepted and preferred by companies to procure compliance towards that particular standard⁴⁴⁹. This would result in better commercialization of the particular technology.
- c) Technologies which generally address a larger public interest or meet a societal goal tend to be better commercialized. For example, transfer of green technology for addressing environmental degradation, directly affecting human health, would have much more demand in the market as compared to other technologies not addressing similar concerns.
- d) If a technology's physical purchase or the operational aspect comes at a significantly lower cost in comparison to the competing technologies in the market, it shall have better chances of adoption by others.
- e) More novel or emerging a technology is, more are the chances of heavy commercialization in the market. A technology in order to be novel along with

⁴⁴⁸ A. O. Martyniuk et. al, *Critical success factors and barriers to technology transfer: case studies and implications*, 2(3) INTERNATIONAL JOURNAL OF TECHNOLOGY TRANSFER AND COMMERCIALISATION 306-327 (2003).

⁴⁴⁹ See generally, Ankita Tyagi et.al, *Standard Essential Patents (SEP's)-Issues and Challenges in Developing Economies*, 22 JOURNAL OF INTELLECTUAL PROPERTY RIGHTS 121-135 (2017).

emerging has to show potential in order to attract buyers in the market. A technology may not have immediate potential of making it big, but it may prove to be extremely useful and reliant in the future. Such technology will also have better prospects⁴⁵⁰.

- f) Sometimes, the inventor of a technology, might be on the lookout for a partnership or collaboration with a technology developer who may be able to develop the technology further, which in turn may increase the chances of successful commercialization. Both the inventor (often referred to as the technology champion in this case) and the developer work towards a common objective: successful commercialization of the technology.
- g) A company developing technology with strategic planning ensuring prospects for higher capacity utilization with lowering its production costs eventually also affects the commercialization and in turn the transfer process, positively.

The above mentioned factors serve as additional elements having a positive influence on technology transfer process. The cost effectiveness of a technology marks its economic sustainability, the reason why as a factor it is most emphasized. A cost effective technology would ascertain sustainability in terms of market and use⁴⁵¹. Thus from an economic point of view, the transfer process would be regarded as over-all cost-effective if the transfer results in the market commercialization of the technology being more beneficial than the cost spent on its procurement. In short the cost should seem feasible both from the perspective of the buyer and seller. Technology transfer provides technology to the buyer and incentives to the seller. Similarly, as much the technology should be economically sustainable, it should be socially sustainable as well. Social sustainability marks the society's readiness to accept the borrowed technology. Well drafted policies can help affirm faith in the buyers of the technology leading to more acceptances. While technological sustainability may not be much discussed, the technology, which forms the subject matter of the transfer, should prove its effectiveness as regards quality function potential to maintain technological sustainability. Regular periodical performance checks can help in the maintenance of

⁴⁵⁰ *Id.*

⁴⁵¹ *Supra* Note 2, 2.

quality standards which if not fare well, can be checked with the help of constant monitoring and incorporating improvements.

SUITABLE ECOSYSTEM FOR TECHNOLOGY TRANSFER AND SUFFICIENT ABSORPTIVE CAPACITIES

The channels or methods to transfer technology are several. In the context of the practical success of transfer of technology, whether it is any method of transfer that is chosen, some factors remain unchanged. Out of these two extremely important factors are the absorptive capacities of the entities at the receiving end and the innovative ecosystem in which they operate. Howsoever much borrowed the technologies are, there is absolutely no replacement for a domestic infrastructure supporting technology production and local absorptive capacities.

An extremely close interrelationship exists between a strong ecosystem supportive of transfer and good absorptive capabilities. While good absorptive capabilities leads in the matter of importance but not to an extent where the significance of an innovative ecosystem can be ignored⁴⁵². Also, the two are interdependent on each other in a way that the degree of effectiveness of absorptive capabilities depends on the characteristics and working of the innovative ecosystem. The ecosystem surrounds and sets up a complete background for the transfer, thus its little details have their individual important role to play in backing the transfer process. Market factors also are a part of the innovative ecosystem; the price that the market decides for a product on commercialization based on demand and supply is a factor on which subsequently the incentives offered to the firms and other agents involved in the transfer process are dependent. If the market offers incentives to adopt borrowed technology, the chances of firms making the required efforts to develop sound absorptive capabilities would be more likely.

Innovative Ecosystem

After the fourth industrial revolution, emphasis on science and technology has been more than how it was during the 1950s when after the emergence of India as an

⁴⁵² See, *Transfer of Technology and Knowledge Sharing for Development: Science, Technology and Innovation issues for Developing Countries*, United Nations Conference on Trade and Development N° 8, UNCTAD/DTL/STICT/2013/8, 2014.

independent nation, the concept of a welfare state could not be sketched without including technology as a means for the advancement of standard of living of the people⁴⁵³. Science and technology were seen as major game changers for the developing nations who for long wanted to catch up with the developed nations. As developing and lesser developed nations lagged in the area, it demonstrated a policy concern to them.

First things first, the highlight was laid on increasing as much as possible, investments in the area. Unless and until a nation spends on research and development, there lacks an innate impetus to technology and innovation, resulting in less or no significant economic growth. Good expenditure in the area of research leads to great output in the form of potential technologically advanced products and services. Developing countries on realizing how underprovisioned research was in a developing market economy, called for government policy intervention to formulate a better response to stir scientific and technological research for growth.

Beyond the 1980s, policy decisions on STI (science, technology and innovation) were very strongly influenced by approaches that were led by innovation as the ultimate goal. The National Innovation Systems (NIS) approach that illustrates the flow of information and technology among different enterprises, people and organisations in an attempt to boost innovation at various levels, works on the theory of identifying causes of market and system failures that call for policy interventions. Traditionally, innovation has been perceived as an occurrence limited to "Silicon Valley garages" and research and development (R&D) labs. However, the reality is that innovation activities are better comprehended as an integral part of a wider national innovation system (NIS), which plays a central role in fostering growth driven by innovation and the overall well-being of an economy. Furthermore, just as innovation encompasses more than solely science and technology, an innovation system encompasses more than just the components directly related to advancing science and technology. It encompasses a comprehensive array of economic, political, and societal factors that influence innovation. These factors encompass the financial framework, the structure of private enterprises, educational systems ranging from primary to university levels, the labor

⁴⁵³ Udgaonkar, B. M. *Implementation of the Scientific Policy Resolution*. Economic and Political Weekly 5, no. 52 (1970): 2091–95. Available at: <http://www.jstor.org/stable/4360884>.

market, cultural influences, regulatory policies, and the effectiveness of institutions dedicated to fostering innovation⁴⁵⁴.

Building and sustaining an innovative ecosystem which is conducive to technology transfer requires addressing pressing issues in the areas of education, health, finance, infrastructure, access to information and the like. A supportive ecosystem should also provide incentives for activities that further the idea of technology transfer such as collaborative efforts between firms or between university and academia, or coordination among different research organisations, ministries and other public or private agencies. The NIS also draws attention to tacit knowledge, one that may not be available explicitly but may accompany the technology or the product. This type of knowledge is generally hidden and thus difficult to learn. One may not get a hold of the knowledge on simply buying the technology however, with efforts and reverse engineering, it may help innovators work on the technology better.

Absorptive capacity

The discussion on the topic of technology transfer is generally incomplete without stressing on the significance of absorption of the technology. The success of technology transfer greatly depends on absorptive capacities of the firms/nations which commonly are the recipients in the technology transfer process. While there are many factors instrumental in the accomplishment of a technology transfer process, absorptive capabilities assumes equal importance or maybe more than the other contributing factors. It would be difficult for the recipient to effectively embrace and apply external knowledge in the absence of good absorptive capacity⁴⁵⁵. Technology transfer is fundamentally important to developing nations. For developing and lesser developed countries where natural resources are limited⁴⁵⁶, technology transfer becomes all the more important to help these nations survive the global cut throat competition. This has enabled industries in the developing nations to shift from the traditional methods of manufacturing to much more advanced techniques of production. Furthermore, this

⁴⁵⁴ See, *National Innovation Systems*, Organisation for Economic Co-operation and Development, <https://www.oecd.org/science/inno/2101733.pdf>

⁴⁵⁵ Chinho Lin et. al, *The Critical Factors for Technology Absorptive Capacity*, 102(6) INDUSTRIAL MANAGEMENT AND DATA SYSTEMS 300-308 (2002).

⁴⁵⁶ *Id.*

shall lead to the manufacture and exports of technologically advanced products in the developing countries also go up significantly.

Taiwan presents itself as one of the very good examples of a developing nation turned into a developed economy by adopting “an export-oriented trade strategy” to boost its economy. Today the nation is one of the biggest manufacturers of some of the electronic gadgets like tablets, scanners and semiconductors.

Absorptive capacity can generally be defined as “the receiver organization’s ability to search, acquire and exploit external technology, as demonstrated by its characteristics⁴⁵⁷.” Effectual absorptive capacity is directly proportional to technology transfer performance. It lays the foundation for technological learning so as to enable the firm to understand the borrowed technology better. The learning process may involve understanding of the modus operandi of technology transfer and the technology itself. This is required as it is extremely important to test the development and application of the technology before the same is put to use in a totally different setup. The borrowed technology may call for minor changes to suit adaptation to the recipient environment and herein the absorptive capacities play a major role.

Absorptive capacity as an ability has also been discussed as “ability of an economy - and its entrepreneurs, firms and institutions - to recognize the potential value of new or novel knowledge and technology, and to transfer and assimilate it with the objective of bringing to market a product or a service⁴⁵⁸.” This ability together with other innovative potentials, goes on to determine a company/firm/organisation or a country’s aptitude to make best use of the training and technical knowledge available, to be able to facilitate a transfer. An enabling technology transfer includes “developing absorptive capacities through, among other things, investing in a skilled workforce, guiding skills formation in strategically important sectors, and supporting the interaction between academic institutions and firms in order target and incentivize for potential skills in demand⁴⁵⁹.”

The major determinants of a country’s absorptive capabilities are the research and knowledge base of the country, skilled labour and resources, policy initiatives,

⁴⁵⁷ Justin J.P. Jansen et. al, *Managing Potential and Realized Absorptive Capacity: How do Organizational Antecedents Matter?*, 48(6) THE ACADEMY OF MANAGEMENT JOURNAL 999-1015 (2005).

⁴⁵⁸ *Supra* Note 13, 9.

⁴⁵⁹ UNCTAD, 2011

incentives offered by the state, technological learning and support provided, collaborations between university and industry (also implying good relationship between knowledge provider and productive sector). A good STI policy also helps in shaping good absorptive capabilities. The existing reservoir of technological knowledge plays a critical role in the capacity to create, recognize, adopt and adjust to, and derive value from new or innovative knowledge and technology. The foundation of such a helpful knowledge base should inherently be a policy matter where the level of knowledge absorption should be such as to appropriately suit the development needs of the country. Such policy decisions should be arrived at after constructive discussions from relevant industries, academic institutions and interested people from the field.

Absorptive capabilities grow from the political will of the industries and receiving forms to grow with technology. Efforts at the organizational and policy levels revolve around the commitment and political resolve of companies and institutions to internalize emerging technologies and knowledge. This entails making decisions to allocate funding and establishing a reasonable timeframe for addressing challenges related to identifying, adapting to, and assimilating technology. Furthermore, there is a need for provisions that support experimentation, testing, and iterative processes, which facilitate learning not only at the technological level but also within institutions and between different institutions⁴⁶⁰.

More attention is to be drawn towards raising the levels of education and awareness in the technological context along with polishing labour and industrial skills. Consistency in technical proficiency spanning the various related industries with fundamental scientific knowledge with an understanding of operational practices in relevant fields of logistics, technology management, or finance holds significant importance. It is crucial to underscore the significance of entrepreneurial and managerial competencies in this context because it's entrepreneurs and managers who make critical decisions regarding the adoption of technology within their organizations.

This leads to an important point of realisation that the absorptive capabilities at a company level, industrial sector level and at a national level will differ significantly as it is on many an organisational and institutional factors that this capacity depends. It

⁴⁶⁰ UNCTAD-ICTSD Project on Intellectual Property Rights and Sustainable Development, International Centre for Trade and Sustainable Development, Issue Paper No. 2, June 2003.

obviously would be greatest at a country level since a nation is provided with an aggregate of capital from different sources, human labour and more institutional units that work together in support of managing the technology. In such a scenario, the success of technology transfer shall depend on the coordination of the different units, effective communication between the organisation and its environment and amongst people within the organisation. It is also directly motivated by the incentives that are provided to the firms.

The technological advancement opportunities leading to innovation on appropriate utilisation, may not occur as ready for implementation. They may have to be worked upon and developed as they may have arrived in an unstructured form, difficult to understand and integrate. As these difficulties in understanding and utilising the knowledge grows, the country recedes on research and development. Large institutions or organisations may still have a better chance of coming back up again for air as they have the capacity to afford IP protection for their innovation whereas at a much smaller level, insufficient or total lack of organisational capacities and IP protection small firms are not able to live upto the expectation.

The extent to which a technology transfer processes helps in bringing innovation on the table is far from certain. This is so because the success of market commercialisation of the technology rests on several factors many of which may fail to influence or be out of the control of the innovator. However, this should not in any manner dissuade the innovator institution from developing and managing well its absorptive capacities so as to reduce the uncertainties in the prediction of commercial success of the technology. The corollary of this also hints that if the innovating firm loses interest in polishing its absorptive capacities, it shall not find itself in the best capacity to innovate. Thus, while opportunities of technology transfer might be readily available, the chances of grabbing such opportunities will be low in light of insufficient investment for effective absorption.

A company in order to progress with innovation has to maintain its absorptive powers. It can do so internally by means of capacity building, or if not, then companies like Apple and Google have set examples for how the same can be achieved through

mergers and acquisitions⁴⁶¹. However independent the two concepts might sound, but there is required a certain level of R&D proficiency with a company to be able to effectively absorb borrowed technology. The role of research and development today extends beyond mere evaluation of the practical and commercial viability of existing technology.

ISSUES AND CHALLENGES TO THE PROCESS OF TECHNOLOGY TRANSFER

Effectiveness of technology transfer can be ensured when efforts are made to minimize or do away with the issues and challenges that are faced during the technology transfer process. These issues and challenges act like barriers to effective technology transfer faced especially by developing countries, that obstruct the successful and timely transfer of technology. In the context of transfer of green technologies the IPCC⁴⁶² has identifies many such hurdles which include the extremely high cost of the technologies, insufficient access to necessary information⁴⁶³, administrative or institutional difficulties in transfer between developed and developing nations, not adequate infrastructure in the developing recipient nation leading to poor absorption of technology and absence of a strong IP protection to name a few.

The developing countries which are in a dire need of advanced technologies to fulfil their development goals in general face certain challenges during technology transfer. The reason for this may be attributable to a single factor or many factors at once. Some general challenges that the beneficiary (recipient unit) faces are:

- a) General Market Challenges are challenges where the recipient market may not be mature for the borrowed advanced technology. If the market is not ready to advance and adopt the borrowed technology, there may be little scope for it to internationally trade in with the technology. The reasons for it may be lack of awareness and knowledge of the technology, unskilled labour and insufficient resources to handle technology and lesser demand owing to different

⁴⁶¹ See, Press Release, Newsroom, Apple to acquire the majority of Intel's smartphone modem business (July 25, 2019), <https://www.apple.com/in/newsroom/2019/07/apple-to-acquire-the-majority-of-intels-smartphone-modem-business/>

⁴⁶² *Supra* Note 4, 2.

⁴⁶³ Bert Metz et. al, *Methodological and Technological Issues in Technology Transfer*, Special Report of the IPCC Working Group III, UNEP (2000), <https://archive.ipcc.ch/pdf/special-reports/spm/srttp-en.pdf>

requirements of the public. The market may be inept to support the production of the technology or products using the borrowed technology⁴⁶⁴. If the demand of such technologies will be less, commercialization understandably will not be very successful. Market challenges may arise due to insufficiencies in policy making, general market practices, available resources and access to those resources⁴⁶⁵.

- b) Knowledge and Information Challenges are caused by lack of awareness among the masses of the technology and inadequate access of essential information among the skilled labour to operate the technology leading to difficulties in the process of acquisition of technology. Knowledge gaps can be created when required training, education and information exchange is by any means not possible to the extent that it should be. Lack of access to information also impairs skill and capabilities of human resources. Also, the development of a new technology or the process of reverse engineering can be severely hampered in the instance of deficiency of the requisite technical information. While efforts should be taken in this regard to create platforms for the exchange of novel ideas relating to technology and innovation, sometimes information challenges occur even when there are policy regulations in this regard but accompanied with inadequate supervision. Ensuring proper access to relevant technical know-how and information can be done by building strong networking and communication channels between research centers and technology developers.
- c) Organizational and Policy Challenges are challenges that arise due to lack of support from the institution or organization. The organization involved in the research or development of technology or is an active party to the transfer may lend its support by ensuring proper funding, implementation of necessary policy legislations, incentives to promote research, hiring skilled professionals in the field, administration support and other related actions that may facilitate the transfer of technology. Policy challenges on the other hand affect parties involved in technology transfer when they are faced with difficulties due to lack of policy considerations addressing issues on technology and its transfer. “Lack of legal and regulatory frameworks, limited institutional capacity or excessive

⁴⁶⁴ Michael Blakeney, *Transfer of Technology and Developing Nations*, 11 FORDHAM INTERNATIONAL LEGAL JOURNAL 703 (1988).

⁴⁶⁵ *Id.*

bureaucratic procedures are some of the major policy challenges that should be addressed for a smooth transfer process⁴⁶⁶.” Bringing in positive and supportive policy considerations require the effort of both developed and developing countries. After all, a transfer that is solely dictated by the efforts of the donor (donor-push approach) and not equally anticipated by the recipient (lacking recipient-pull) is less likely to succeed.

- d) International Law and Procedure Challenges occur because many developing countries are still struggling to draft legislations on technology transfer. As there are few countries who have clear laid down codes or legislations regulating technology transfer, an issue arises when such countries engage in technology transfer with a country that does not have any law governing the same⁴⁶⁷. In such cross-border transactions, since there are no standardized dealings on procedural aspects, a dispute between private parties will lead to a conflict of laws issue and dealt with under Private International Law whereas a dispute between states (parties to the transaction) shall become a Public International Law problem and will have the route of WTO dispute resolution mechanism which entails inconsistencies in the international trade regime⁴⁶⁸. The non-existence of a specified and enforceable legal regime in the context of technology transfer is set to impede the process. This kind of challenges may even further cause enforcement and regulatory challenges.
- e) Capacity and Infrastructure development Challenges are common challenges caused due to deficiencies in infrastructure and the environment lacking the capacity for transfer of advanced technology. The state governments should play an active role to do away with such infrastructural challenges, as they are the major stakeholders in context of ensuring a sound and healthy environment for transfer. Not only in matters of incentivizing innovation with appropriate financing but also establishing a robust domestic innovation system suited to properly adapt to and absorb technology are key considerations which the government should fulfil. The focus on strengthening national innovation

⁴⁶⁶ “Extracts from the secretariat’s technical paper on Barriers and Opportunities related to the Transfer of Technology, UNFCCC, Document UFCCC/TP/1998/1, (1998).”

⁴⁶⁷ *Infra* Note 522, 227.

⁴⁶⁸ Prabhash Ranjan, *Restoring the World Trade Organisation’s crown jewel*, THE HINDU, (Jul. 10, 2023), <https://www.thehindu.com/opinion/op-ed/restoring-the-world-trade-organizations-crown-jewel/article67061171.ece>

system in regard to environmentally sound technologies has been a lot emphasized; “The priority area relating to strengthening national systems of innovation and technology innovation centres is of importance, as this may be the first time that the concept of ‘innovation’ has been given such a prominent standing in UNFCCC decisions on technology transfer.”⁴⁶⁹

Such are common challenges that may be faced by the nation generally or particularly by the transferring parties. In addition to this, sometimes, lack of motivation to develop, adapt, absorb and transfer technology at the micro or macro level, can pose limitations to the seamless transfer of technology.

The demand for a particular technology and the nature of technology may vary in different sectors as per its need. Also, a favourable institutional framework and a robust infrastructure for manufacture are extremely essential. For the majority of developing countries, advanced technologies will have to be borrowed or imported whether it is through patent licensing, trade, FDI or any similar method of transfer. What encourages such flow of technologies to these countries are policies aiming for better access to foreign technology, improvements in infrastructure and capabilities of absorption and openness to trade.

In pursuit of the endeavor, multilateral organisations can help play a major role in effectively meeting the obligations laid down under the TRIPS Agreement by encouraging capacity building, promoting local innovation and focusing on a technology transfer which can be said to derive the maximum benefit from the TRIPS Agreement by being in compliance. Multilateral organisations can help tap the legal and technical expertise of technology transfer. They encourage honing research skills and deduce ways in which the results of the research can benefit humankind. These organizations also promote healthy collaborations among nations by ensuring proper communication and information transfer. As a result of friendly collaborations, the organization could help create a group of experts from the relevant field to aid in institutionalizing technology transfer from a developing country’s perspective.

⁴⁶⁹ ZHOU CHEN, THE LEGAL BARRIERS TO TECHNOLOGY TRANSFER UNDER THE UN FRAMEWORK CONVENTION ON CLIMATE CHANGE: THE EXAMPLE OF CHINA, TILBURG UNIVERSITY (2013).

The role of multinational organizations is underrated. To do away with certain issues and challenges that the parties anticipate may cause a hurdle to the transfer, initiatives by such organizations and even governments in the form of taking successful examples of technology transfer in different countries as case studies, could make a huge difference. The case studies serving as a good example will help in suggesting the path to a successful technology transfer and will help eliminate the mistakes that could crop up inadvertently.

The multilateral organisations like the WTO and UNCTAD have in particular researched and published about developing country's needs that can be effectively met by technology transfer. Such bodies have a potential of significantly helping the developed countries. They could provide and fund for effective training programmes for the training of personnel involved in the technology transfer process. This could also include ways to establish certain trust funds by the donor country and the multilateral organization to be specifically utilized for the purpose of technology transfer so that the developing recipient country could prosper⁴⁷⁰. The organisations can also keep a check on the efforts made by developed country in this regard in order to fulfil their obligations as per the international treaties and agreements. Lastly, safeguarding developed countries efforts in allowing adequate market access for technologically advanced products to the lesser developed countries is a purposeful step towards successful technology transfer.

BARRIERS TO TECHNOLOGY TRANSFER

The identification of barriers that could impede the process of technology transfer is rather important. Barriers to technology transfer refer to the obstacles and challenges that hinder the successful dissemination and adoption of technological knowledge, innovations, or practices from one entity or context to another. These barriers can arise from various factors and can impede the efficient flow of technology⁴⁷¹. Identification

⁴⁷⁰ Rod Falvey et.al, *The Role of Intellectual Property Rights in Technology Transfer and Economic Growth: Theory and Evidence*, Working Paper Series, Strategic Research and Economics Branch, United Nations Industrial Development Organisation (2006).

⁴⁷¹ NATIONAL RESEARCH COUNCIL, TRANSFER OF POLLUTION PREVENTION TECHNOLOGIES (2002).

shall lead to better solutions to deal with the barriers, which is particularly essential in context of developing and transition economies⁴⁷².

Some major barriers to effective technology transfer are listed as under:

1. **Identification of Needs:** At the outset, what comes to mind as what may be called the 'entry level barrier' is the issue of identification of needs. There are numerous advanced technologies in the market, commercialised and successful ones. Not all technology is desired by everybody. Not all technology may even work for everybody. Many times developing countries are stuck with the issue of realising what they actually need. A major step towards effective technology transfer is the transfer of desired technology to the recipient which involves a crucial decision of the recipient country to critically analyse its needs and requirements. Identifying and evaluating the needs of the people or the firm which is at the receiving end, measuring what exactly shall suit the demand and something which can be adapted and developed further are factors that may help the recipient (developing country) arrive at the decision of borrowing a particular technology.

If a country does not take the local needs and environment conditions into consideration before taking a decision and may proceed ahead with what it sees works in different other nations in different capacities, it may never be able to fully absorb the technology or get to adapting to it. This shall result in the entire process of technology transfer to destroy the intended purpose to help achieve the developing nations, higher levels of technological advancement. The ability to progress and develop as a nation cannot be attained without identifying the areas where one needs to focus on. Detection of such areas of lacking shall be the only rational base which supports development ideas and innovation. Such needs will always differ from one nation to the other. A wrongful assessment of needs may result in a country borrowing a technology that it shall never be able to absorb or one which may never result into bringing the desired technological enhancement that the nation intended. Thus, ascertaining technology based on

⁴⁷² A.H. Jasinski, *Barriers for technology transfer: the case of a country in transition*, 4(2) JOURNAL OF TECHNOLOGY MANAGEMENT IN CHINA 119-131 (2009).

needs is the first and the most basic step which if not fully adhered to, may become a major setback in the technology transfer process.

2. **Choice and Nature of Technology:** While the barrier relating to choice and nature of the technology may be interdependent on the rightful assessment of needs, it is extremely important for the developing nation to know exactly what technology it wishes to borrow⁴⁷³. Developing countries often make the mistake of believing that since developed countries have an edge over others in matters of research and development, the technologies that are borne as a result of it, are all superior and most likely to benefit all other nations as well in the exact same manner like it did for the country which developed it. Unfortunately though, this does not happen. If it were to function this way, the developed nations as apparent ‘pioneers’ would dictate how a technology should be developed and used. Eventually this would give them a monopoly in the field where the developed nations would develop technology for the purpose of its diffusion to the developing or least developed nations. Consequently, it is the developed nations taking a call on what technologies should reach the other nations, which should not be the case. A developed country could also use this power to the detriment of other nations if the developed nation wishes to remain all powerful. Thus, if the nature and form of the technology is not appropriate for the borrowing nation, technology transfer can lead to doing more harm than good.

A question may arise whether the technology as desired by the developing nation is even available. In a case where the availability is of a much more advanced technology, the borrowing nation is either left with an option of purchasing the technology and then working on moulding it to meet needs or developing the desired technology from scratch with the help of necessary information which is readily available.

3. **Mode of Transfer:** The manner in which a technology is transferred makes quite a difference to the effectiveness of the transfer. If not chosen appropriately, the mode of transfer can also become a barrier to transfer. The mode generally refers to the method or mechanism used to convey technological knowledge, innovations, or practices from the source (such as a research

⁴⁷³ *Supra* Note 192, 73.

institution or company) to the recipient (another organization, industry, or country). The mechanism chosen to transfer technology should consider the nature and type of the technology in question, the recipient's situation and needs, the profitability on part of the owner and the feasibility of the process. An inappropriate mode of transfer can lead to misinterpretations, or incomplete knowledge transfer. A lack of access to technology platforms where if the mode of transfer heavily relies on specialized software, tools, or platforms that are not readily accessible or affordable to the recipient, it can hinder the adoption process. If the recipient lacks the necessary technological infrastructure to support certain modes of transfer, it can hinder their ability to receive and implement the technology effectively. Certain modes of transfer may even face legal and regulatory challenges, such as restrictions on the export of certain technologies. While there may be more than one method of transferring a particular technology, all the factors must be weighed before deciding on which way the technology is best transferred.

4. **Financial Barriers:** Just as identification of needs and choice and mode of transfer may broadly be seen as human barriers which may arise due to human intervention and human analysis of what may seem right and wrong, financial barriers on the other hand appear to be more of a technical barrier. Limited financial resources may prevent organizations or individuals from investing in the acquisition, adaptation, or utilization of new technologies. The financial barriers are generally present due shortage of funds and financial resources along with a scarcity of developed markets for the technology. Developing countries mostly go experience financial and economic barriers when borrowing technology due to their underdeveloped economic sectors which results from higher rates of unemployment, high rates of inflation, high import duties and uncertainty in the levy of taxes and lower public investments and returns. The private sector, particularly small and medium enterprises, often encounter significant challenges in obtaining capital due to limited financial resources. This can be a major hindrance. In some cases, markets may not be well-established due to the absence of robust financial institutions or systems that support investments in transferred technology. Additionally, concerns about the economic, commercial, or technical feasibility, along with the scarcity of manufacturers and a lack of consumer awareness and acceptance, often

influenced by cultural norms, further aggravate these difficulties⁴⁷⁴. The Energy and Resources Institute⁴⁷⁵, in the context of clean technologies has stated financial barrier to be the most experienced barrier by the transition economies as these nations get deterred by the high cost of advanced technologies. Also, because of insufficient utilisation of the technology owing to lower absorptive capacities, the profit that is derived from the commercialisation of technology is smaller than the cost incurred to procure these technologies, making borrowing undesirable by the transition nations. The relatively expensive technologies that are brought into the domestic market from abroad have also to compete commercially with the lesser advanced but subsidised domestic technologies, making the exploitation of borrowed technology difficult.

Pricing is an offshoot of the financial barrier. While there is no doubt about how the highly priced technologies can be out of the reach of a country with limited means but developmental needs, there is also a concern that lies with the inventor. Pricing of a technology or a product depends on several factors; most importantly the market forces (that take note of the demand and supply cycle, the current rate at which similar technologies are charged and the level of innovation that can be brought about by the technology in question) and also the investment that has been spent into development of the technology. The inventor would want the technology at a price that makes up for the costs incurred on developing the technology, preferably more to ensure profits. However, if profit rearing assumes prime consideration over and above public interest resulting in the technology available in the market at a price that majority of the people cannot pay, the invention does not fulfil social utility. A balance here needs to be established between ensuring the fruits of the creator's labour and public access (availability and affordability) to the technology. This shall be borne in mind so that the technology or the product is appropriately priced.

5. **Intellectual Property Rights**: Having discussed in detail in the previous chapters how intellectual property rights play a major part in the development, establishment, commercialisation and transfer of technologies; IPRs

⁴⁷⁴ Philippe Crabbe et. al, *Barriers, Opportunities and Market Potential of Technologies and Practices*, Intergovernmental Panel on Climate Change (IPCC), 2000.

⁴⁷⁵ Established in 1974 and formerly known as the Tata Energy Research Institute.

simultaneously can act as a major barrier too. That a nation in order to progress in matters of trade and technology, requires a strong intellectual property regime, needs no further emphasis. IPR help in strengthening trade ties among nations and could make the entire process of technology transfer easier through detailed and explanatory licensing agreements. IPRs have become necessary in protecting the technology/product involved in trade as conducting business operations in innovation in a foreign market would require a legal protection extended to the goods which comprise of specialised and complex technologies⁴⁷⁶. The IPR protection extended to the technologies can be a major factor in the determination to transfer technology, even though it is equally pertinent to note that not all technologies may be subject to a strong patent regime. However, with the diversity in the kind of protection offered by IPRs, it is difficult to imagine a situation of technology transfer where the transfer of the intellectual property right is not involved. As intellectual property forms the core of invention, its focus is on guaranteeing profitable returns to the inventor who is worthy of the returns because of his labour, energy, time and investment spent on the property which is a creative result of his intellect. While a major part of protecting the physical manifestation of a novel idea by means of intellectual property is incentivizing creativity, it should not be viewed from just that aspect. Intellectual property protection ensures access to the property by the society through commercialisation while also motivating young minds to contribute in a similar fashion.

Every invention solves some purpose and fulfils some need, when offered to the public. However, a detriment to the strong legal protection is the high licensing costs attached to these property rights which deter procurement of the much needed advanced technologies⁴⁷⁷. Not legally protecting the technology might result in the inventor company losing its business and goodwill. Put this way, the IPR becomes a necessary evil; evil to the developing countries that are faced with financial issues in buying technology. Research today discusses how

⁴⁷⁶ Research Report, Colas Bernard, *Barriers to the Transfer of Clean Technologies: Mitigating Legal Obstacles*, Centre for International Governance Innovation 12-22 (2019), <http://www.jstor.org/stable/resrep24957.11>

⁴⁷⁷ Michael Hasper, *Green Technology in Developing Countries: Creating Accessibility Through a Global Exchange Forum*, 7(1) DUKE LAW AND TECHNOLOGY REVIEW 1-14 (2009), <https://scholarship.law.duke.edu/dltr/vol7/iss1/9>

attention should shift to creation of platforms where developing country entrepreneurs, technology holders and venture capitalists can come together to fix the financial barrier posed by IPRs in buying and selling of technology as ensuring legal protection to technological inventions is as important as the need for the transfer of technology. Thus, the task of finding out a way where IPRs can help facilitate this transfer and help the inventor bring fruits of his labour should be soon achieved.

6. **Social and Cultural Barriers**: Regional differences bring with them differences in cultures and other socio-economic factors. Demographic diversity includes different societies with their own cultures, practices, traditions, work ethics, professionalism and the relationship that exists between individuals and corporate structures. Differences in organisational culture affects technology transfer process as the donor and recipient may have different expectations. In addition to this, political instability, economic challenges, or social factors can create an unfavourable environment for effective technology transfer. Cultural differences affect the way individuals identify themselves as regards technology or the manner of technology consumption in society. It also helps determine the public's tendencies and attitude towards market competition and cooperation. Furthermore, there may also exist, certain social norms and beliefs which may oppose acceptance of advanced technologies. These norms and beliefs may stem from a general lack of awareness of the technology among the masses⁴⁷⁸. Sometimes, learning about a new technology may seem like too much of an effort to people who simply do not want to step out of their comfort zones even if it is for their betterment and lifestyle upgradation. This "comfort zone" may be synonymous with an inefficient and backward lifestyle. A want of knowledge and awareness about technological advancements calls for serious concerns as it can detrimentally affect development. Social factors also include a difference in public decision making and one which is considered a major barrier in matters of advancement and growth. Other social factors may be the presence and influence of media in society, working of industries in the market affecting market conditions,

⁴⁷⁸ See, *Climate Change: Technology Development and Technology Transfer*, United Nations Department of Economic and Social Affairs, United Nations (2008).

government's formal and informal alliances with industry partners of the technology field and the position and power setting within the governmental setup and within institutions⁴⁷⁹.

7. **Institutional and Infrastructural Barriers:** Infrastructural barriers usually hint at the lack of required infrastructure in cities and other settlements or the nation as a whole, for adoption and utilisation of the borrowed technology. Inadequate infrastructure including manufacturing and production capacities may adversely affect the flexibility which would otherwise be there in permitting the adoption of advanced technologies to change lifestyle standards for the better. Institutional barriers may lead to poor planning and implementation at the development and regulatory level affecting distribution. The limitations posed by infrastructural barriers namely not providing an innovation ecosystem conducive to transfer, are somewhere related to lack of finances sanctioned by the government for areas like research and technology. At the institutional level, existing laws and policies may also be restrictive in nature and not compatible with the idea of allowing adoption of newer alternative technologies. The receiving party whether a private company, corporation or a country needs to have a minimum level of infrastructure to support technology transfer. Not only the production capacities should be such to have a supportive innovation ecosystem but lack in infrastructure will severely impact absorption capacities also. Infrastructural obsolescence would incapacitate the benefits arising out of the technology transfer process.

The IPCC⁴⁸⁰ has stated that the other potential barriers to the transfer can be, “lack of understanding the role of developed and developing countries and international institutions in the failures and successes of past technology cooperation arrangements; insufficient human and institutional capabilities; inability to access, select, import, develop and adapt appropriate technologies; lack of science, engineering and technical knowledge available to private industry; insufficient R&D because of lack of R&D investments and inadequate science and educational infrastructure; and institutionalized corruption in both developed and developing countries.”

⁴⁷⁹ *Id.*

⁴⁸⁰ *Supra* Note 35, 22.

Removing potential barriers in a technology transfer process is paramount for fostering innovation and economic growth. These barriers, whether they stem from inadequate communication channels, complex technology, or financial constraints, can impede the seamless flow of valuable knowledge and innovations. By addressing these obstacles, we create an environment that encourages the exchange of technological expertise and accelerates the adoption of cutting-edge solutions. This not only benefits industries and businesses but also bolsters overall societal progress. It ensures that advancements reach a wider audience, driving forward progress in various sectors, from healthcare to renewable energy. Moreover, a streamlined technology transfer process promotes global collaboration, enabling diverse regions to pool their expertise for collective advancement. In essence, dismantling potential barriers in technology transfer is a pivotal step towards a more interconnected, innovative, and prosperous global landscape.

SOME CASE STUDIES TO LEARN FROM

There have been cases of successful technology transfer among different private companies, university collaborations, spin off companies, joint ventures and different nations for the exchange of technology and technical know-how. It is true that today multinational corporations and private organizations are the ones developing technologies but the trading of these technologies are taking place at a much higher level than expected. Technologies like green technology is desired by almost all nations today, irrespective of their status as environmental problems like climate change does not discriminate between developed or transition/developing nations and is a global concern. However, even these kinds of technologies are more desired by the developing nations from the developed nations because the latter have the means and the resources to tackle the global problem relatively better by bringing in radical and potent technological solutions.

It is not the case that the flow of technology is as a rule of thumb always directed from the developed to the developing world. Instances of technology transfer from Japan to US or from Japan and US to Korea⁴⁸¹ have proved that the transfer caters to the need of a country for a particular technology. While the chances of developing countries to

⁴⁸¹ Chung H. Lee, *Transfer of Technology from Japan and the United States to Korean Manufacturing Industries: A Comparative Study*, 25(2) HITOTSUBASHI JOURNAL OF ECONOMICS 125-136 (1984).

be at the receiving end are more due to inadequacy of resources required for developing the technologies themselves, developed countries too sometimes may borrow a technology from other nations for varied reasons. These reasons may be the expertise and skilled labour that a country hold in a particular domain, or the recipient country's means to borrow the technology at the demanded royalty and price, or the choice that the recipient country exercises in choosing to buy technology over developing it. Hence, while the reasons may be different for borrowing technology, the recipient may be developed, developing or least-developed economies.

This may lead one to believe that what actually counts is the need of a particular entity (the recipient) that leads it to make a reasoned decision about the choice of technology and its transfer therefrom. In the same context, below are mentioned some examples of successful technology transfer attempts-

A. Philippines

Philippines is a developing/emerging but fast paced newly industrialized economy. It is considered as one of the most dynamic countries in the Asia-Pacific region. Realizing that “science, technology and innovation are essential for national development and progress”, the country also has a law enforced on Technology Transfer (2009)⁴⁸². On its way to development the state of Philippines has prioritized research and development and encourages investments in the field of innovation and its further commercialization.

The WTO⁴⁸³ in 2002 in Doha constituted a Working Group on Trade and Transfer of Technology (WGTTT)⁴⁸⁴ with an objective to analyze the correlation between trade and the transmission of technology from developed to developing nations, seeking avenues to augment the influx of technology to the latter. In its 20th session⁴⁸⁵, Philippines presented its success story in front of the world on technology generation and subsequent transfer in the semi-conductor sector. How successful technology

⁴⁸² Philippine Technology Transfer Act of 2009 (Republic No. 10055).

⁴⁸³ World Trade Organization 1995.

⁴⁸⁴ See, The Agenda for Transfer of Technology: The Working Group of the WTO on Trade and Transfer of Technology, Trade-Related Agenda, Development and Equity (TRADE) Analysis Series, SC/TADP/TA/IP/1, South Centre, Trade Analysis Report, Geneva Switzerland (Oct 2005), https://www.southcentre.int/wp-content/uploads/2013/07/AN_IP1_Working-Group-of-WTO-on-Trade-and-Transfer-Technology_EN.pdf

⁴⁸⁵ Report (2007) of the Working Group on Trade and Transfer of Technology to the General Council, available in WT/WGTTT/W/14 [Dated 29th September 2007]

transfer help in facilitating the growth of entrepreneurial start-ups, which in turn contributed to the overall economic development of the country by bringing more revenues, was highlighted during the presentation. Foreign Direct Investment (FDI) had played a major role in assisting technology transfer and accordingly building a strong technical base, adding value to the semi-conductor sector. The Intellectual Property Office in Philippines also played a proactive role in promoting the transfer with the aid of the relationship that it shared with other private research organisations, leading to increased knowledge flows, sharing of know-how and technology diffusion and absorption.

Philippines has played a crucial role in the global electronics value chain for an extended period and serves as a hub of excellence for electronic manufacturing services. “The country primarily specializes in the production of hard drives and semiconductors. It supplies the global market with 2.5 million hard drives each month and accounts for 10% of the worldwide semiconductor manufacturing services supply. It is also home to about 500 semiconductors and electronics companies, including seven out of the world’s top 20 chipmakers⁴⁸⁶.” For effective transfer, the government as a matter of policy focused on expanding a strong cross-country intermediaries’ network and good communication and rapport between university research centers and the private sector. The country in its presentation also admitted that it could do well owing to the congruent linkage between its IP laws and regulations on technology transfer.

B. Brazil

Brazil has been rooting for the implementation of a national development program which calls for a much-needed government intervention in matters like health, education and economy. Brazil’s IP legislation is also drafted in a way that the Brazilian Patent and Trademark Office (INPI)⁴⁸⁷ as an administrative body is much powerful. As per the latest regulation⁴⁸⁸, the INPI would in addition to examining the formal aspects of contracts, get into rightfully assessing the terms and conditions of the transfer

⁴⁸⁶ Angelica Cayus et. al, *The Philippines: Your Ally in the Global Chip Race*, Available at: <https://semi.org/sites/semi.org/files/2021-10/The-Philippines-Your-Ally-in-the-Global-Chip-Race.pdf>

⁴⁸⁷ Instituto Nacional da Propriedade Industrial (National Institute of Industrial Property)

⁴⁸⁸ Ordinance No. 11 of January 27, 2017, on Approval of the Internal Regulation of the National Institute of Industrial Property-INPI, with Resolution INPI No. 191 of May 18, 2017, Establishing the Pilot Project for Prioritized Examination of Patent Applications Filed by the Science and Technology Institutions, 'Patenting of ICTs', Brazil, <https://www.wipo.int/wipolex/en/legislation/details/19147>

contract. In regard to technology transfer, the laws provided licensing as the major method for the transfer of technology. The INPI also provided for the transfer of know-how either by ‘technology supply agreement’ or ‘technical and scientific assistance service agreement or invoice’⁴⁸⁹.

Brazil’s economy falls in the category of middle income developing mixed economy. Brazil's case study revolves around the utilization of technology transfer in the development of the sugarcane-based ethanol industry. The Brazilian government, in its quest for alternative energy sources, identified sugarcane as a viable option for ethanol production, which could serve as a substitute for gasoline in automobiles. This led to the initiation of the National Alcohol Programme in 1975, aiming to boost sugarcane production, upgrade and expand distilleries, and establish new manufacturing facilities. As the program gained momentum, it resulted in a remarkable shift, with 90% of Brazil's new vehicles running on ethanol by 1989⁴⁹⁰. This success can be attributed to several factors. Firstly, both public and private sectors invested in research on sugarcane breeding techniques, yielding newer, adaptable varieties suited to diverse soil and climatic conditions. These varieties boasted shorter production cycles, higher yields, and resilience to water scarcity and pests. Furthermore, research efforts led to the development of advanced grinding systems and fermentation processes, utilizing different microorganisms and enzymes to accelerate ethanol production. Additionally, researchers devised methods to utilize sugarcane fiber residue (bagasse) for generating electricity through controlled combustion, utilizing residual heat from distillation turbines. Collaboration with foreign experts played a significant role in diversifying research efforts, but the substantial capacity building in Brazil was made possible due to proactive initiatives from both public and private sectors.

C. China

China emerged as a role model among technology transfer recipient nations, concentrating on disseminating 'clean' technologies such as those related to pollution control, energy efficiency, and renewable energy. Owing to the government initiatives

⁴⁸⁹ See, *Technology Transfer in Brazil*, Latin America IPR SME Helpdesk, European Commission, <https://intellectual-property-helpdesk.ec.europa.eu/system/files/2021-01/FS%20Technology%20Transfer%20in%20Brazil.pdf>

⁴⁹⁰ Report on “*Climate Change: Technology Development and Technology Transfer*”, UN Department of Economic and Social Affairs, 2007.

taken towards improving the wind energy sector, China in 2005, had the presented the largest national annual capacity addition in the sector. The initiatives taken by the government were in the nature of (a) a goal to achieve a power production of 30GW by the year 2020; (b) launching a wind concession program involving government-run bidding to encourage both domestic and foreign companies in the development of wind projects; (c) Facilitating this program by offering companies a 25-year power purchase agreement, a guaranteed grid connection, and economic support for grid extension; (d) Extending preferential tax benefits, loans, and providing access roads; (e) Additionally, offering incentives for companies engaged in wind projects through the Renewable Energy Law of 2005. This law included measures such as bidding to establish prices for renewable energy development projects and a requirement of 70% domestic involvement to ensure the spill-over of technology⁴⁹¹.

The Chinese wind turbine industry was examined to evaluate the impact that technology transfer had on the same and different types of ownership models were revealed to significantly affect it-

- (a) Limited Joint Venture: In a Limited Joint Venture scenario, foreign companies provide and own materials and technology, while Chinese labor handles the manufacturing, leading to an enhancement of local labor skills. For instance, companies like NEG Micon/Vestas and GE Wind exemplify this model. In the case of NEG Micon/Vestas, Denmark retained ownership of the company, turbine design, the majority of turbine content, and turbine intellectual property rights. In the case of GE Wind, the United States held company ownership and turbine intellectual property rights, with turbine design conducted through a collaborative effort between the USA and Germany, and the majority of turbine content sourced from China.
- (b) Joint Venture: In a Joint Venture setup, the technology is developed by a foreign company, subsequently owned by a Chinese company, with manufacturing executed using Chinese materials and labor. This arrangement facilitates technology spill-over. An example is Xi'an-Nordex, where the company is jointly owned by Germany and China. In this case, Germany oversees turbine

⁴⁹¹ *Id.*

design, while the majority of turbine content and turbine intellectual property rights are owned by China.

- (c) Chinese owned Venture: In a venture owned by China, the technology is developed, owned, and exclusively manufactured by a Chinese company, exemplified by Goldwind-China⁴⁹². In this instance, company ownership, the majority of turbine content, and turbine intellectual property rights reside solely with China, while turbine design development involves collaboration between Germany and China. A challenge arose from the mandate for 70% local content, yet foreign-owned companies participated in the project despite this requirement, leveraging their market performance and the ability to retain control over their intellectual property.

D. Korea

In the 1960s and 1970s, Korea was focused on acquiring and assimilating foreign technology, laying the foundation for its current status as a technology-rich country. Subsequently, in the 1980s, Korean firms transitioned to creative imitation, enhancing technological capabilities, and shifted strategies towards knowledge-intensive intermediate technologies across various sectors. The advancement of the existing knowledge base was significantly influenced by the transfer of technology, contributing to the development of sustainable industries. The Korean government adopted foreign direct investment and foreign licensing as crucial mechanisms to facilitate this technology transfer. These governmental strategies played a pivotal role in allowing Korea to acquire technologies that were rich in knowledge. A notable instance of such technology transfer is exemplified by Samsung Electronics Company, a multinational corporation based in South Korea. A significant proportion of the company's original equipment was sourced from Japan. Consequently, the growth of the Korean electronics industry had a notable impact on the Japanese market, displacing Japanese competitors in the competition for basic items such as radios, televisions, and cassette recorders⁴⁹³.

⁴⁹² J. Lewis., *International Technology Transfer Experiences in China's Electricity and Transport Sectors*, Pew Center on Global Climate Change. Arlington: Pew Center on Global Climate Change (2006)

⁴⁹³ Kiheung Kim, *Technology Transfer: The Case of the Korean Electronics Industry*, Conference Workshop Paper, Proceedings of the Thirty-First Hawaii International Conference System Sciences, 10.1109/HICSS.1998.654779

While technology is transferred through different channels and agents, the electronics industry in Korea is largely dependent on just licensing from foreign companies. This has made Korea rise to a level where the success and completeness of the electronics industry in Korea nearly matches that of the developed nations. Licensing of advanced technologies may have given Korea that competitive edge over similarly placed developing countries, however, this has sharply affected local manufacturing capabilities of the nation. Korea till date falls behind many other nations in terms of basic engineering and production of raw materials.

An illustrative case study revolves around the licensing agreements forged between Phillips and several Korean companies for the manufacturing of compact disc players. Leveraging the considerable technical expertise of Korean electronics firms in the production of such devices, and recognizing Phillips as a major producer of compact disc player deck mechanisms, Phillips granted licenses to ten Korean corporations. These licenses empowered them to produce compact disc players without constraints.

Similarly, in the case of Hitachi's transition from 1M DRAM microprocessors to 4M DRAM microprocessors, a collaborative approach was adopted. Hitachi licensed the technology to Goldstar and provided technical assistance for the production of 1M DRAM microprocessors. This cooperative strategy enabled these companies to strengthen their technological foundations. Notably, these instances of technological transfer have proven to be mutually beneficial for both the Korean companies involved and, respectively, for Phillips and⁴⁹⁴.

Achieving noteworthy progress with some of the most advanced technologies in the electronics industry, Korea still lacks technological self-sufficiency. The idea of technology transfer is not only to keep on importing advanced technologies but also developing those technologies further or building up similar technologies on imported ideas. High investing power cannot guarantee productivity, which has to be built.

E. India

Similar to other developing nations, India recognized the significance of technology transfer for both technological advancement and economic growth. The Indian government endeavored to boost technological capabilities and enhance

⁴⁹⁴ *Id.*

competitiveness in the domestic industry by encouraging technology collaboration agreements with foreign firms to acquire overseas technology. In India, technology collaboration can be pursued through the automatic route, where dealers authorized by the Reserve Bank of India are permitted to remit royalty payments or lump sum fees not exceeding US\$ 2 million⁴⁹⁵, or through the government route, requiring prior approval from either the Project Approval Board (PAB) or the Foreign Investment Promotion Board (FIPB). In both cases, the fees encompass technical know-how fees, fees for design and drawing, fees for engineering services, and royalties⁴⁹⁶. With the gradual passage of time, India has moved forward and streamlined the rules further. Since 1991, there has been an increase in the number of technology transfer activities in India especially from developed countries like Japan, USA, Germany, Italy and the like. The following ten to fifteen years saw a significant surge in technical collaborations more specifically in the electronics and electrical equipment sectors, including computer software apart from the ones in transportation sector, industrial machinery and mechanical engineering.

One of the sectors in which the Government of India (GOI) initially facilitated technology transfer was the transportation sector. The focus was on establishing a public sector production unit for fuel-efficient small cars. To assess the available technology globally, representatives from the GOI conducted visits to manufacturing units in various countries. Based on their evaluation, Japan was identified as having expertise in the manufacturing of small and fuel-efficient cars⁴⁹⁷. Negotiations with equity participation in mind, began with different Japanese firms. Equity participation was preferred as it was proposed that both technology and working culture including operation of technology would be borrowed and be incorporated into domestic manufacturing and production. Japan's Suzuki Motor Corporation and Government of India finally collaborated with each other and formed Maruti Udyog Limited⁴⁹⁸ where Suzuki initially held 26% equity slowly increasing to 50% after 1991.

⁴⁹⁵ See, *Technology Transfer Regulations in India*, King Stubb & Kasiva (Mar. 14, 2023), <https://ksandk.com/information-technology/technology-transfer-regulations-in-india/>

⁴⁹⁶ Subbarao P. S., *International Technology Transfer to India on Inpedimenta and Impetuous*, Working Paper No. 2008-01-07, IIM Ahmedabad, Januray 2008.

⁴⁹⁷ See, *Fuel Economy in Japan*, Technology Report, Global Fuel Economy Initiative 2021 (Dec. 13, 2021), <https://www.iea.org/articles/fuel-economy-in-japan>

⁴⁹⁸ Sushil & Zafar Husain, *Active transfer of technology in the automobile industry: Indian experience*, International Journal of Services Technology and Management, July 2000.

Japan had the policy of following 25% vertical integration in technology transfer cases along with some mandates such as replicating the borrowed technology and using the components from the same vendors. Soon, Maruti in India began collaborating with vendors, monitoring manufacturing process and setting up joint ventures for the production of a variety of spare parts of automobiles such as steering systems, seats, glass, fuel tank, sheet metal components etc. There were also that began manufacturing crucial additional parts like the air conditioner by either borrowing technology from Japan or through joint venture, which could technically increase the sales of the automobiles. This led to around thirty five of Suzuki's partners to have joined hands with Indian companies for the production of different automobile parts. Focus was laid out for indigenization of the technology so that the same could be better absorbed and was done for various such components like plastics, seats, radiators, steering, sheet metal components, suspension wires, electric wiring, switching systems and many more. These venture partners of Suzuki thus became suppliers of Maruti.

Any issues that may arise in the functioning of the parts used to get referred to Suzuki in Japan. Maruti propelling the idea of open innovation made a database of available technologies and their working which could be accessible to the suppliers. Maruti manufactured the components whilst providing information of available technology to manufacturers. Encouraged to enhance their products, the companies fostered a culture of innovation, recognizing the appreciation and satisfaction from end users. Consequently, these companies emerged as technology leaders. Maruti Udyog Limited, in particular, attained market leadership through adept assimilation and absorption of transferred technology, swift indigenization of design, ongoing research on existing technology, and effective marketing strategies, spare parts availability, and after-sales service. Initially adopting semi-monopolistic marketing approaches, Maruti introduced competition by opening the market to new entrants after 1994.

Indian companies of the solar energy sector are becoming quite significant in transfer of technology. The general technological understanding related to this sector is usually available in the public domain; hence the issue of payment of high licensing fees for the intellectual property rights does not arise. One of the leading companies to enter

into joint venture for technology transfer in the particular sector is Tata-BP Solar⁴⁹⁹. It has brought with it new opportunities of using nanotechnology in appliances and applications for solar energy which is likely to be absorbed into India in the coming years⁵⁰⁰.

The Indian Space Research Organisation (ISRO) has enabled the involvement of diverse Indian companies in various space projects, incorporating space technologies into domestic products, leveraging spin-offs from such technology, and applying these advancements for commercial exploitation. The European Business and Technology Centre is actively assisting in the technology transfer of space technology in the Indian market by providing guidance and support to Indian companies⁵⁰¹. Additionally, the Steinbets Centre for Technology Transfer India plays a pivotal role in facilitating technology transfer within the clean technology sector, encompassing solar, wind, RoR hydro, biogas, marine shore-mounted, and more. In this regard, the contribution of Defence Research and Development Organisation (DRDO) in providing products to the Armed Forces cannot miss attention.

India should consider a lot of factors before implementing technology transfer like the cost and effectiveness of technology, the choice of technology befitting people's needs, its own socio-economic conditions and the level of dependency in terms of technology that it has on others. While the success stories do give us an example of how India too can, as a developing country, benefit from the process and hone its technical skills at the same time, a small mention of cases that could not turn out to be how they were planned in technology transfer should also be discussed to understand the reason behind its failure and figure out a solution to resolve underlying issues.

One of the perfect examples of a failure case of technology transfer is that of **“Hero Honda”**, which could be seen as more of a technology partnership. In 1980 when Honda of Japan, the largest two-wheeler manufacturer in the world, wanted to enter India to start manufacturing products and sell it in India, they had to mandatorily work with an Indian company as the Indian government regulations specified so. The rules

⁴⁹⁹ J. H. Barton, *Intellectual Property and Access to Clean Energy Technologies in Developing Countries: An Analysis of Solar Photovoltaic, Biofuel and Wind Technologies*, Geneva: International Centre for Trade and Sustainable Development (2007).

⁵⁰⁰ *Id.*

⁵⁰¹ Teresa De Oliveira, Policy Brief: Technology Transfer between the EU and India, challenges and opportunities, Indigo Policy, 2007.

prevented foreign companies to expand their business in India without forming partnerships with Indian companies with a 51:49 split between Indian and foreign partners⁵⁰². Many other foreign companies formed joint ventures with Indian companies such as Maruti-Suzuki, Suzuki-Sunderam, Yamaha-Rajdoot, Kawasaki-Bajaj Auto and Eicher-Mitsubishi. Thus, Honda formed a JV with Hero, owned by the Munjal Group (that made the most famous “Hero Cycles” from its inception in 1975). Honda had a majority stake because they had the technical know-how and the capital to set up the manufacturing units. Hero had the experience of the local regulations, dealerships and people. With these combined skills complimenting each other so perfectly, Hero Honda performed exceptionally in India and became the largest two-wheeler globally by the year 2001. By mid 2000s Honda was selling their own line of 2-wheelers alongside Hero-Honda and started to eat into its market share.

What was disturbing for the Munjal Group was that Honda which relied on Hero for its local experience began using that knowledge at Honda to sell their own brand, undercutting Hero-Honda. Hero was also asked to pay high licensing fees for the manufacturing units opened up in India through which know-how and technology was transferred. Even after a decade long partnership, Honda was hesitant in not sharing the full technology which went behind their motorcycles to Hero. The Munjal Group by 2010 gained the required technical expertise, capital and the confidence to form their own business and thus, broke away from the Japanese dominance to gather their own pieces and emerge strong. Hero MotoCorp presently hold the largest market share in the Indian two-wheeler sector. This case illustrates that while sometimes due to the foreign party showing dominance or charging high royalty fees, the collaboration for technology transfer may lose its ground, but it still does benefit in some way with the expertise and skill that gets transferred along with technology and capital.

Another example of strategic acquisition was of **Google and Motorola** in 2012 for 12.5 billion USD. The strategy that Google had in mind was that it thought that acquiring Motorola, it would buy the opportunity of producing higher quality mobile handsets which would improve the situation of Google’s android operating systems. Google android OS was the second biggest player in the market but Google strived for better.

⁵⁰² See Comment by Utkarsh Bhardwaj titled Hero MotoCorp | The Name You Know, The History You Don’t, India (March 30, 2020), <https://gomechanic.in/blog/hero-motocorp-history/>

Another reason that Google thought the acquisition would make easy is the heavy licensing fees that Google was paying Motorola for some of its licenses on exclusive android phone features. Google thought that this merger would prove to be very beneficial as Google is great with software and Motorola was great at making devices. However, with such low quality devices that Motorola delivered due to its inferior manufacturing that the acquisition could not last long and Motorola in 2014, was divested for 2.9 billion USD⁵⁰³. Motorola which was an American multinational telecommunications company could not deliver the quality which made it difficult for it to survive in the competitive market.

This brings one to the conclusion that integration of a product into the fabric of another can prove to be extremely profitable for the latter but does not seem to be an easy process as it requires substantial amount of dedication in ensuring a healthy interaction between the technology and the environment of the receiving entity⁵⁰⁴. A proactive environment having the potential of investing and creating new research can only benefit from technology transfer in the true sense as it can develop technology, even if borrowed to mould it according to local conditions.

These studies sure act as a yardstick to nations and other organizations that look forward to borrow advanced technology and incorporate it within their own system. From the success stories one does learn as to how religious efforts made towards technological growth can turn out fruitful in the instance of technology transfer whereas the failure stories bring to light the issues and hurdles that can be avoided during a transfer process. The learning in both the situations may be very different, yet helpful.

⁵⁰³ Verne Kopytoff, *Motorola Was a Gargantuan Mistake Only Google Could Afford to Make*, TIME (Jan. 30, 2014), <https://time.com/2650/motorola-is-a-gargantuan-mistake-only-google-could-afford-to-make/>

⁵⁰⁴ Mark V. B. Hughes, *Success and Failure in Technology Transfer: The Story of the Handpump* (1999) (Directed Research Dissertation Submitted to the Institute for the History and Philosophy of Science and Technology, University of Toronto for the award of degree Master of Arts) (available in the National Library of Canada)