

AN INTROSPECTION OF THE TECHNICAL AND HUMAN FACTORS INVOLVED IN TECHNOLOGY TRANSFER PROCESS

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Abstract:

In this analytical paper, the conceptual clarity on technology and technology transfer are discussed at length. The need for technology transfer is explained. The types of technology transfer and the problems associated with them are discussed. Various steps involved in the transfer of technology and one of the models governing the transfer of technology are presented. The scope of technology transfer agreements, criteria for its selection and various forms of technology transfer are explained. The issues relating to human factors involved in the technology transfer are also discussed in the paper.

1. Introduction:

The word technology came from a combination of two Greek words – techni (skill to do something) and loges (knowledge) signifying the inherent meaning of the word technology as the knowledge of doing something. Quite obviously it will take into account both the physical part of the technology like the plant, equipment, machineries etc., as well as the knowledge part comprising of the skills, experience, methods etc. No matter to whatever use it has been put to, the role and implication of technology in our life is going to have only an upward journey. The whole gamut of economic demand analysis can be applied in finding out the same. The main aim of technology development is technology utilization. The latter involves collection, documentation and successful dissemination of science and technology (S & T) information from technology generator to technology receiver through a series of steps – formal and informal, visible and invisible, passive and active. Technology Transfer (TT) is the mechanism of technology utilization to its logical conclusion i.e. commercialization. Technology transfer can be of imported or indigenous. There are several issues in technology selection, technology acquisition, technology adaptation, technology absorption and technology diffusion. Indigenous technology development through one's own R & D needs a thorough understanding of scale-up factors, proto-type development, design and engineering. Here parameters of vertical transfer play a dominant role. The technology policy of the government aims at making the country technologically self-sufficient; but, at the same time, as the country is not yet technologically self-sufficient, permitting transfer of advanced foreign technology to India for local absorption, adaptation or Indianisation and further improvement, with due consideration to Indian economic objectives and natural resources, is allowed with

due permission from the statutory authorities. Import of technology is also permitted for immediate commercial exploitation, especially to sharpen our competitive edge in the international market. It is known that the local development of high technology in certain fields involves high cost and more than cost, its gestation period is relatively long. In the subsequent sections of this paper, various issues concerning the technology transfer are discussed.

2. Imported Versus Indigenous Technology Transfer:

The term technology transfer is often used for transfer from one country to the other, usually from a developed to a developing country. Such a horizontal transfer can take place within the country also (indigenous technology transfer). Technology transfer is also used to denote vertical transfer i.e. laboratory to field situation. This happens more often under indigenous technology development situations. It is equivalent to laboratory to land programme of agriculture. The problems associated with technology transfer can be quite different for import of technology (generally horizontal transfer). The import of technology poses a set of problems at different stages:

- Selection of technology.
- Acquisition of technology.
- Adaptation of technology.
- Absorption of technology and.
- Diffusion of technology.

The problems of commercialization of indigenous technology developed at the laboratory scale may pose the following problems.

- Scale – up factors vis-a-vis need for pilot plant.
- Optimum operational levels and parameters.
- Design and fabrication of equipment.
- Product quality and quality assurance.
- Performance and technical service.

3. Steps in Transfer of Technology:

Although technology transfer is essentially an “affair” between technology generator and technology seeker, there are many organisations and agencies that must approve this affair, such as financial institutions, promotional agencies, environmental protection agencies, policy making government department etc.,. At times, there is a need for a catalyst or a facilitator (technology transfer centers or individuals) for awareness creation and to bridge the communication gap between the generator and the seeker of technology. The problems of technology transfer may vary widely from one technology to another, from one technology generator to another, and from one technology seeker to another. Broadly the steps may be described in table (1).

Table - (1) : Steps in Technology Transfer

S.No	Technology Transfer step	Process Involved
A	Pre-Technology Transfer step	Information on technology procedures and confidence building including aspects of educational levels, cultural factors and training needs (selection of technology)
B	Technology Transfer process step	Licensing and sale of technology (acquisition of technology)
C	Post-technology transfer step	“After-sales” service by way of trouble shooting, up gradation, diversification etc., (adaptation, absorption and diffusion of technology)
D	Management	Capability building to handle the above steps through human resources development, training and re-training including attitudinal skills and communication skills.

One of the models developed by researchers in the area of technology transfer are as follows:

$$\text{Magnitude of transfer} = f(\text{Innovator, Innovation, Structure of channels for transfer, recipient})$$

4. The Scope of Technology Transfer:

Besides confirming, in general, to the Government’s industrial and technology policy, every technology transfer agreement should in particular be clear in regard to the nature and scope of the technology transfer. It should place at seeker’s use the technology generator’s knowledge, experience and skill necessary to

- a) set up the sturdiest, but at the same time inexpensive, production facility which is easy to operate and maintain.
- b) Produce the planned goods or services in a manner capable of capturing the local and foreign markets within the shortest period of time, keeping within the national economic parameters.

The technology transfer, whether indigenous or foreign, agreement shall include the following to enable the technology seeker to benefit from the knowledge, experience and skill of the technology generator.

- Systems concept, data and specification for the design and development of plant, equipment, process and product.
- General documentation including operation and maintenance manuals.
- Provision for future modifications.
- Quality management techniques.
- Selection of equipment
- Continuing technology support, without delaying the timely freezing of specifications.
- Determination of plant capacity and production levels in varying conditions.
- Supervision and monitoring of implementation and production stabilization.
- Training of the personnel.
- Any other item necessary for present and future technical success and cost effectiveness of the project and the end product.

5. The Choice of Technology:

Department of Industrial Development, Ministry of Industry, Govt. of India has a technology data bank which gives information on a wide choice of technology and collaborators. The most appropriate technology should be chosen to suit ones project in the Indian environment. The environment in which the undertaking is set up and the type of equipment and production techniques employed are inter-related. Our developing economy and production techniques employed are inter-related. Our developing economy has a certain level of technology absorption capacity. So it will be ideal if one chooses a technology suited to that level, with the potential for improvement, keeping pace with the changes in our socio-economic environment.

Other factors to be considered in the choice of technology are as follows:

- One must not choose either an obsolete or an unproven technology.
- The choice of technology must be related to the projected product quality and marketability.
- The cost of technology, comprising license fee and royalty, should be reasonable and its absorption in the product cost should not render the product highly priced, with no buyers.

6. The phase and Forms of Technology Transfer:

The phases of technology transfer are as follows:

- Choosing
- Source searching
- Negotiation
- Contracting

The important forms of technology transfer are as follows.

- Licensing
- Outright purchase
- Joint venture with capital participation
- Technology transfer associated with buy-back agreement
- Technology transfer associated with plant operation and management contract.
- Technology transfer forming part of a consultancy contact.
- Technology transfer associated with equipment supply contract or turnkey contact.

7. Human Factors in Technology Transfer:

The human factors in technology transfer can be analyzed by the following determinants.

7.1 Training and experience:

Since many innovations are achieved on the basis of readily available knowledge, it follows that the training and experience of the persons involved would be a critical factor. Isenson and Tanenbaun (1967) demonstrated in their findings that critical inventions were contributed in much greater frequency by the personnel with higher levels of education (above a bachelors degree level) when compared to the personnel with lower levels of education, working in comparable technical fields. Studies of experience effect indicate that age is of critical importance. Apparently, a number of years is required before a technically trained person is likely to contribute to significant technical events. Pelz and Andrews (1967) found that the productivity of scientists and engineers did not reach a maximum before age of 35.

7.2 Individual Personality Characteristics:

Studies revealed that frustration tolerance, need for achievement and other such personality traits generally vary from one individual to another. The positive traits of individual(s) involved in the technology transfer are very important and are highly desirable. Transfer of technology is an activity that required a high level of motivation due to the difficulties inherent in the process. Organizational environment is also a key factor. Efforts have been made in number of firms to reduce the barriers to innovation.

7.3 Communication patters:

It appears that the existing channels for communication both within and between the scientific and technological communities are not performing well, as it should have been. Inorder to close this gap of the communication process in Science and Technology, a number of research studies have been undertaken with the goals of developing descriptive models of the existing communication systems. Meadows and Marquis (1967) reported that the commercial value of R & D projects initiated by marketing and customers was far greater than that of projects initiated within R & D. Cochrane (1967) reported that the firms where non -- R & D managers were more involved with the control of R & D were rated as having more effective R & D efforts (and, therefore, more transfer of technology into utilization) than firms where more of the control of R & D was maintained by R & D personnel.

7.4 **Organizational effects:**

Studies carried out by researchers in the area indicate that major invention rarely occurs in the large firms. It was also observed by many researchers that the major inventions most frequently occur as a result of activity from sources other than the industry most involved with the application of the invention. The reasons are

- a) The resistance to change within the organization. Once an activity has become established with a given pattern, the response of the employees generally in an organization is to reject innovations that would alter the existing activities.
- b) People trained to do a job in a particular way will not experience novel demand feasibility recognition.
- c) Organizations acting in a given way have a vested interest due to capital investment and other related issue, in maintaining the status quo.

7.5 **Orientation:**

An Innovator / technology generator is normally a technocrat, who works with physical laws, adopts a structured mechanical approach to his problems. When he assumes managerial responsibilities of technology transfer which involves different organizations and people, he faces a different world in which he is supposed to:

- perform the tasks of planning, organizing, directing and controlling the resources responsible for transfer of technology in a world of uncertainty.
- adopts a more creative approach to resolve non-programmed and unstructured issues.
- attach greater importance to efficient utilization of resources and resolution of human relations problems.

Thus the manager responsible for technology transfer has to strengthen his managerial orientation so that the mission of technology transfer can be efficiently achieved within the constraints of time and budget.

7.6 **Motivation:**

Human beings are motivated by a variety of needs: physiological needs, social needs, recognition needs and self-actualization needs. Individuals differ greatly in the importance they attach to various need satisfactions. It is dependent on four factors viz., a) Competition, b) The reward structure, c) Visibility of results and d) Government regulation. If there is no competition, it leads to low motivational level for a technological change. Reward structure becomes a motivational factor when the situation is that, organizations or individuals will generally do an innovation for which they are adequately rewarded. Visibility of results also affects motivation because low visibility tends to reduce the level of motivation. Government regulation often motivates organizations to respond in a given way that leads to the ability / willingness to achieve the utilization of technology.

8. Conclusions:

The various issues governing the technology transfer are discussed in this paper. It is obvious from the literature that enough care should be exercised while selecting the appropriate technology and framing the technology transfer agreements, MOUs etc., Human Resource factor, being one of the key factors, should be given due consideration and concentration for successful technology transfer.

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