

Some Problems of the Transfer of Technology from the Developed Countries to the LDCs

Hyo-Joon Hahm*

Abstract

This paper attempts to identify the factors which are directly related to the effective transfer of technology from developed countries to LDCs.

The recipient countries should have the capability of alteration/adaptation based on cost-minimization criteria.

Some problems are such that technologies are transferred on the conditions of MNFs, packaged forms and under state management which result in lack of competitive pressure.

Non-technological criteria are shown to be a problem under state management in the transaction of technology.

I. INTRODUCTION

In recent days, one of the most significant and frequently mentioned issues regarding developing countries is the transfer of technology, which typically is seen to be a key part of the overall plan for the industrialization and economic development of the developing countries. In some circles, the development of modern technology based on research has been to be the determinant of productivity and economic growth in modern developed countries such as United States and Western Europe.

Accepting the presupposition that technology is the major determinant of industrialization and economic development, and due to a lack of indigenous technological knowledge, the developing countries have accelerated their importation of technology from the developed countries during past decades. The major sellers in non-military technology market in the West are private multinational firms. But it has also been argued that technology transfer which is embodied in the multinational firms is not always result in net social advantage to the developing countries and remains a controversial issues.

An attempt has been made in this paper to identify and demonstrate the importance of new criteria that have been typically unattended, not identified and not utilized explicitly for the effective transfer of technology.

In discussing the problem of the transfer of technology to the developing nations, one must realize that, in general, there are two broad concepts of what technology is. The first sees technological change to be a modification of hardware and, consequently, the transfer of technology

* Korea Institute of Energy Conservation.

is viewed as the acquisition and importation of up-date ready-made technology as embodied in hardware such as machinery and equipment. Under this view, the developing countries can increase their production capability so long as the technology is available. The crucial problem, in this approach to the transfer of technology, is how to import or acquire as much modern, sophisticated technology at the most reasonable price. One of the consequences of this approach to the transfer of technology is evergreater payment for the importation of technology by developing countries. The acceleration in their importation of technology has forced the developing countries to assume enormous burdens of financial indebtedness, and in addition has created a dependence on foreign technology.

The second approach has considered technology as an input to production which is embodied in capital goods and skilled labor. The simplest neo-classical approach assumes that capital and labor can be substituted. Given a wide variety of technical methods available to produce any given amount of output, the transfer of technology is perceived to be a process of choosing the most appropriate technology. According to this approach, the choice of a technology appropriate to the labor and capital cost situation is the key element for an effective transfer of technology. Because one of the characteristics of the developing countries is typically an abundance of labor and a scarcity of capital, the greatest concern for the developing countries has been to find, and to import labor intensive technology. Under this assumption, the most appropriate technology is a labor intensive or a capital saving technology,

However, this approach has often been challenged. First, labor intensive technology typically does not exist in the international technology market, and secondly, a labor intensive technology raised many problems for the process of industrialization and economic growth in the developing countries,

Another hypothetical approach may be developed to analyze the transfer of technology. First, technological development can be viewed as an economic-managerial phenomenon. In other words, the direction of technological development is decided by economic, social, managerial criteria. (1) Technology is not just vague concept or value-free. The impact of technological development on society and economy has been well analyzed such that technological change or innovation changes a specific market structure or society as a whole. But at the same time, technological alternatives such as specific design and selection of equipment and machineries are controlled decisively by the specific decision-making criteria and processes such as those of industrial managers, political planners and government officials. In other words, technological change should take into account any society's specific developmental requirements and needs, and its economic and managerial criteria, objectives and skills.

Secondly, another important aspect concerning about technology is that technology is composed of many elements and components. Therefore, the component parts of a technology are subject to separate for analysis and synthesis from other component parts without the change of its actual nature within certain limits. It is not impossible to separate a technology into its parts.

Based upon these two basic nature of technology, the transfer of technology is perceived to be intentional and planned process of the alteration and adaptation of foreign technology and of the recipient country's social structure. In other words, transfer of technology is not natural flow or process of technology. Transfer of technology is not just importation of sophisticated hardware,

nor importation of labor intensive technology. It is a purposive and well-planned alteration and/or adaptation.

By alteration, I mean the design of such modification which will affect the characteristics of operation. Alteration is the change of the components or elements of a technology. It also is a change of the magnitude of the inputs, outputs, and/or the processes of technology in accordance with its characteristics. The alteration of input includes such elements as initial cost or alternative cost or raw materials. Output includes built-in-capacity or design of finished product, etc. Process involves production flows, proportion of capital and labor, man-machine system, etc.

Adaptation includes the change of technical skills, engineering capabilities, industrial organizations, or cultural values or patterns. It also includes operational patterns such as a change in management style to fit the new technology.

II. ESTABLISHMENT OF A MODEL

Theoretically, from the point of view of the technology recipient, the mechanism of transferring technology involves two main issues: the recipient himself who imports technology and must ultimately use that technology as a means of input or as an element in production; and the technology itself which defines the change of the structure of the technology recipient as a new input or an element in the production or operation. The technology recipient hopes to analyze its components, predict its consequences and synthesize the technology into a new system, while the new technology may make the recipient versatile. Intuitively, it can be expected that if technology is simple the recipient can control the technology more easily. In other words, a new technological change can be easily absorbed as an input to production such that its impact on the organizational structure is minimal. On the other hand, if technology grows in complexity, size and variety, the recipient has more difficulty in understanding and controlling it.

The relationship between the technology and the recipient can be assumed to be the relationship between the system and the analyst. The system can be defined as an arbitrary selection of variables and relationships according to the analyst's purpose. It is an aggregation or assemblage of objects jointed in some form of regular interaction or interdependence. A system is composed of elements and their relationships. In connection with their definition, technology is a system.

When a new technology is introduced to a production or operation system, the most important concern is its real outcome. If real outcome is within the desired limits, then the technology recipient could be said to be in complete control of the outcome. The relationship between the system and system controller is well explained by W. Ross Ashby (2) and Van Court Hare, Jr. (3) through the explanation of information theory and systems analysis. "Law of Requisite Variety" in cybernetics which describes a measurement to ascertain whether analyst control the system or not says that only variety in the systems analyst can change the variety due to system. In other words, for the analyst to gain control over a system he must be able to take at least as many distinct actions, i.e., as great a variety of countermeasures, as the observed system exhibits. In order to control a system which has variety to define the complexity of itself, the controller must also solve satisfactory the complexity that system causes.

Alteration and adaptation can be explained by the law of requisite variety, which suggests powerful operational implications in order to explain transfer mechanism. As mentioned earlier,

the most important concern to technology recipient is how to control the new incoming technology in order to get the desired outcome in accordance with his own particular objectives. The technology has variety which defines the complexity of that technology. In order to control the technology effectively, the recipient must have many more alternative than the technology presents.

It tells that there are two major alternatives for the effective transfer of technology:

- (i) The technology recipient should increase the capability to adjust to incoming technology or
- (ii) The technology must be modified or altered.

In other words, the effective transfer of technology needs one of the following conditions:

- (i) There should be genuinely appropriate technology to the technology recipient in terms of recipient's requirements, criteria, local factors, conditions, etc.
- (ii) The technology recipient should alter or modify the incoming technology so as to convert it to an element of their own production functions. This implies that technology is dissected or dissembled into the parts or components and altered for their own purposes.
- (iii) The technology recipient should adapt himself to the incoming technology with regard to technical skill, raw material, structural change, maintenance, repair, supply of the parts, etc.

III. THE PROBLEMS

I) Conditions of Technology Donors

The transfer of technology is not a one-sided problem, but it involves bilateral problems, that is, the technology donors or sellers are an aspect of the mechanism. Therefore, it is critically important to understand that circumstances under which the technology owners wish to sell their technologies, and under which circumstances the donors may hinder the transfer to another country.

According to R. Vernon's Product Life Cycle Theory (4), which has, though, serious deficiencies (5) and G.H. Hall and R.E. Johnson's (6) argument in "U.S. Space Technology Transfers to Japan", the multinational firms which are main sellers of technology in the international technology market have their own purposes in the process of transaction of technology to the developing countries, which typically are not consistent with those of the developing countries, i.e., promotion of economic development and industrialization. The transfer of technology is primarily done to exploit a quasi-monopolistic advantage by technology owners. It is also argued that the willingness of a firm to diffuse its technology is a function of the type of technology involved. In other words, if a technology is firm-specific technology which is based upon the monopolistic advantage, then the owner hinders the diffusion of that technology.

When MNFs plan and establish the global business strategy including technology transfers, they typically practice total systems approach. In system analysis, each country or technology recipient is just an element or component of the total system. MNFs are not likely to set up a whole-process of production, but to specialize in particular intermediate products. Their main concern is usually profit maximization of the system (firm) for which each technology recipient is only a means. It is not argued that MNFs do not make any contribution to the transfer of technology which could result in economic development of the developing countries.

However, by analysis of the conditions of MNFs, they do not initiate or develop appropriate technology to the developing countries in terms of product design, production equipment, production processes and techniques, market size, factor costs (labor and capital cost), etc., nor alter

they their technology appropriately to the developing countries. In other words, production techniques and processes exported or used by a multinational firm or its subsidiaries are typically similar to those which would be used in seller's country. They are independent of the technological level or development stage of the recipient country in which the subsidiary is established. In reality, there is a research that multinational firms do not, on the whole, seem to have any noticeable policy of alteration of their product range to local market conditions or to the conditions in which those products are to be used. (7)

In international technology market, technology is not available in a ready-made form for the recipients in the developing countries, nor is accessible to all potential users.

2) The Packaged Forms of Technology

There are two kinds of packaged forms of technology in transfer mechanism. One is the transfer of packaged technology and the other is the packaged transfer of technology.

(i) Packaged technology means the delivery of a unit of machinery or set of machineries, where the buyers specify the function to be served but none of the details, and the vendor delivers a whole mechanism or a set of mechanism, or an entire factory or industry to accomplish the stated purposes. That is to say, the buyer does not specify any of components in detail. The vendor takes full responsibilities for the delivery of a working entity. The buyer as only responsible for paying for delivery and demonstrates operation of the functioning entity.

The transfer of a turn-key plant is a good example of the transfer of a highly packaged technology, which involves many technological elements. This kind of technology transfer includes the decision-making power of the technology sellers in terms of the design criteria of the whole plant and at the same time each subsystem of the total production system. In addition, the technology seller typically is the decision-maker regarding the purchasing of all equipment and material necessary, the man-power training, operation, inventory control, testing, accounting, maintenance, and organizing of the firm's structure and general administration.

When technology is transferred to the developing countries, it typically involves a wide range of packages from the establishment of the enterprise to the final operation of that enterprise. The typical transfer of package technology includes the following steps, although these steps may overlap. (8)

- a) Preinvestment studies, including preparation of a feasibility study and a detailed project report (DPR);
- b) Basic and detailed engineering, including preparation of machiney specification, plant design, factory layout;
- c) Selection of equipment, plant construction, erection and installation of machinery and start-up of plant;
- d) Acquisition of process or manufacturing technology;
- e) Technical assistance during the post-installation period, including training and various forms of management assistance.

Considering these characteristics of the package technology, it will be seen that the developing countries do not take part in the decision making process in the establishment of the enterprise. Each and every stage has different alternatives. For example, after having completed the stage(a), there could be many alternative ways of engineering design or factory layout, based on the

recipient's decision-making criteria. But all of these are usually completed by one or a few technology sellers so that the whole process of the establishment of an enterprise depends upon the seller's decision-making criteria.

One of the most important roles in the package of technology is the engineering function. In short, engineering is the function of the design of investment projects and the management of their implementation to optimize their objectives. As a matter of fact, it is a basic engineering function that a proposed project be broken into discrete pieces and components in order to adapt the project to its new environment. The role of the design and implementation of an industrial project and investment in that project make the engineering organization establish close relations with other industrial activities such as R&D, machine manufacturers, equipment producers, and production oriented people. But unfortunately the developing countries lack the engineering capability and as a result, do not have a close working relation with these other activities. Consequently, the developing countries depend on foreign engineers or foreign engineering consultants.

The developing countries have little experience of engineering design so that are heavily reliant on the decision-making of foreign consultants in transfer mechanism who have accumulated experience in techno-economic contexts. The problem is that most of engineering consultants and their organization which perform the task of transferring technology from the stage of feasibility study to the post installation period to the LDCs have their own decision-making criteria which are influenced by their own country. The LDC as a recipient should accept foreign machinery, production facilities, techniques and products designed to foreign specification primarily to their own design criteria. Therefore, the transfer of packaged technology minimizes alteration and adaptation process.

(ii) The Packaged transfer of technology is such that when technology is transferred to the third country, it is packaged to the seller's managerial criteria, which typically is far removed from the technical elements. In other words, the packaged transfer of technology involves capital, management, marketing, etc., which are defined by the seller's management decision-making criteria and influenced by his own business objectives. They attempt to maximize their business objectives or maximize control their technology in the transferring process. The patterns of control involved in the packaged transfer of technology imposed upon by the technology sellers are as follows in according to the United Nations report (9):

- a) The prevention of the recipient enterprise from buying equipment and intermediate goods or raw materials from other sources, by obliging the recipient to purchase these goods from or through the parent company and its affiliates;
- b) The restriction of export (total prohibition, partial limitation, geographical constraint);
- c) The requirements of guarantees against changes in taxes, tariffs and exchange rates affecting profits, royalties and remittances;
- d) The limitation of competing supplies by: i) restriction of competing imports; ii) preventing competition for local resources; iii) obtaining local patents to eliminate competitors;
- e) Constraints limiting the dynamic effects of the transfer of technology such as i) excessive use of expatriate personnel; ii) discouragement of the development of local technical and research and development capabilities.

There are numerous forms of contracts drawn-up by the buyers and sellers of technology, as regards the packaged transfer of technology. This classification partially shows the degree of

packaged transfer from another viewpoint in a particular industry, as it represents the managerial decisionmaking criteria of the sellers as well as of the buyers. For example, assuming that a technology seller has a criterion such as control over the market in the host country, the transfer of technology may be packaged into a home-country (seller)-controlled joint venture or seller-controlled direct equity investment in accordance with the host country's circumstances. If the host country's market is imperfect and the seller has a monopolistic advantage in terms of a particular technology, its packaged transfer could include the establishment of a branch or a wholly-owned home-country subsidiary.

The packaged forms of technology which involve the decisionmaking criteria of technology seller rather than buyers minimize the "learning by doing" process. These transfers make relatively little use of local materials, technical skills and management required for construction and operation of major projects. It also displaces rather than complements the local innovative skills.

These packaged forms of technology in transfer mechanism are typically far removed from alteration and adaptation.

3) State Management

It is well known phenomenon that government in a developing country has dominant and important decision-maker in the process of overall industrialization. The government has multiple roles as a legitimizer, goal setter, regulator and even producer. It often wields strong and decisive decision-making power on production and the entire economy. The government sometimes retains major part of decision-making power over the transfer of technology in terms of choice of technology and selection criteria among alternatives. Under such conditions of weak civilian economic sector and underdevelopment of industry, it is imperative for the government to retain such decision-making power over not only transfer mechanism, but also entire economy.

A government sponsored entity can be cost minimized, that is, there is nothing in the nature of government as a manager that should make the process of either cost pass along or cost maximization in the design an operation. However, there is a part of the functioning as a managerial entity that makes possible very readily either cost pass along or cost maximizing. What makes it possible is that the government stands in the very special position of being able to draw on the wealth of whole society so that it is not limited as most private firms are limited with respect to access to capital. If access of the capital is regarded as readily available, and if there is no strong imperativeness to minimize cost, then the participation of government sponsored enterprise may very well choose the less difficult or less work requiring option which put include cost pass along or even cost maximizing. (10)

When technology is transferred under these circumstances, that is, decision concerning about technology transfer is made by government sponsored entity which would result in cost pass along or cost maximizing, there are two visible phenomena, that is, absence of explicit criteria for technology and lack of competitive pressure.

Alteration and/or adaptation is a kind of innovation action. Technology involves certain criteria such as the number of employees, scale of works, types of equipment and machinery, and the degree of sophistication. Therefore, effective transfer of foreign technology also means the alteration of such variables to the degree that they can be controlled for the technology recipient's own purposes. Adaptation to that technology means considerable effort including hard work such

as redesign of the organization, training of employees, increase of technical skill including maintenance and repair capability, and increase of management techniques. For the purposes of carrying out these missions, technological criteria play decisive role. Engineering function can perform such changes in the design and implementation stages. In other words, the role of technologists is a significant element in the transfer process. What factors are included for the effective transfer of technology for the particular project and to what degree that technology can be altered or changed should be decided by the technical professionals based upon their own technical criteria. In other words, within certain limitations, the technologists should have the controlling criteria, which are desperately needed for identifying the conditions and factors for the effective transfer of technology.

Under state management which lacks imperativeness of cost minimization or technological capability, there is absence of explicit criteria of technology in transferring technology.

As mentioned earlier, alteration and/or adaptation may be said to be a process of innovation. A firm may invest in research and development in order to development of a new technology or may quickly accept a new technology that becomes available, not because it wishes to do so, but because it must.⁽¹¹⁾ In other words, competition is an environment under which technological development is activated. But sometimes state management does not activate competition. Under such a condition as lack of competitive pressure, innovation is hardly initiated. Cost minimization criterion typically is decided by a competitive market. In other words, if a firm is relatively free from price competition, it is likely to cost pass along as a criterion, which is far from alteration and adaptation.

IV. CONCLUSION

Technology is laden with a set of social variables. Main point of this paper is that effective transfer of technology as an input or element for production function of the recipient country should follow alteration and adaptation, which maybe viewed as innovation process. Foreign technology limits the production function. The worth of technology alteration and adaptation is linked to the interest of developing countries in maximizing the productivity of capital on behalf of the industrialization process. The paper underscores that in the delivery process of technology, such as capital equipment and machinery or disembodied technology such as licencing or patents, cost minimization play a crucial role for the effective transfer of technology to the developing countries. If there is no cost minimization, alteration and adaptation can be bypassed.

Technology is only necessary condition but not necessarily sufficient condition for increase of production capability or productivity growth. Effective transfer of technology is not necessarily the amount of the importation of as much modern, sophisticated technology as possible. Each developing country has its own requirements, objectives and uncontrollable variables (constraints) and at the same time at different stages of its development. As such, identifying the appropriateness of technology in generalized and unspecific term is meaningless.

State management in the developing countries is likely to be imperative. But a government sponsored entity should have cost minimization criterion in the transferring process of technology.

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