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Thoughts about Technology Transfer for Development

Réflexions sur le transfert de technologie en faveur du développement

Gedanken zum Technologietransfer und Entwicklung

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SUMMARY

In the context of technical development cooperation between the industrialized and third world countries, technology transfer is a key item which has received considerable verbal attention during the past couple of years. In the actual implementation, however, major difficulties have emerged both with donors and recipients, which have hampered the development of the third world countries. The major problems are related to the financial compensation for the transferred technology, and the acceptance of the new technologies in the developing countries. The technical aspects of technology transfers, the problems of national development, the need for acquiring new technology, and the education required for handling the transferred technology are described.

RÉSUMÉ

Dans le domaine de la coopération technique pour le développement pratiquée par les pays industrialisés, le transfert de technologie a joué un rôle prépondérant, ce qui lui a valu avant tout de s'attirer un intérêt verbal considérable au cours des dernières années. A l'heure actuelle, la mise en œuvre d'une telle coopération soulève toutefois d'énormes difficultés, aussi bien dans l'offre que dans la demande; ce qui a eu pour conséquence d'entraver le développement des pays du Tiers monde. La compensation financière exigée pour les technologies transférées et l'acceptation de celles-ci constituent les problèmes essentiels. La présente communication décrit les aspects techniques d'un tel transfert de technologie, les problèmes soulevés par les développements nationaux, la nécessité d'acquérir de nouvelles technologies et les problèmes dus à l'éducation et à la formation en vue de l'utilisation pratique des technologies transférées.

ZUSAMMENFASSUNG

Im Zusammenhang mit der technischen Entwicklungszusammenarbeit der Industrieländer spielt der Technologietransfer eine zentrale Rolle und hat dementsprechend in den vergangenen Jahren vor allem verbale Aufmerksamkeit erhalten. Bei der Implementierung traten jedoch bei den Gebern und Empfängern beträchtliche Probleme auf, welche die Entwicklung von Dritt-Welt-Ländern erschwerten. Die Hauptprobleme stellen die Bezahlung für die transferierten Technologien sowie deren Akzeptanz in den Entwicklungsländern dar. Die technischen Aspekte des Technologietransfers, die nationalen Entwicklungsprobleme, die Notwendigkeit neuer Technologien und die Erziehung und Ausbildung für die Handhabung transferierter Technologien werden vom Gesichtspunkt der Entwicklungsländer diskutiert.

INTRODUCTION

Much has been said and written about the usefulness of technology transfer in the overall development process of the third world countries, which is very much needed but sometimes misapplied. However, when we look into those countries who have received substantial amounts of development assistance from the West, we can notice that the development process has been plagued by all kinds of obstacles and that they have more often not really benefitted from the technological assistance. How technology transfer should actually be implemented in the least developed countries is largely unknown. Where private enterprises are the owners of most of the new technologies and have the corresponding expertise and can respond faster to the needs of development, it is desirable that the private sector assumes a greater role in the transfer of technologies. The cooperation between the private sector and government agencies in the countries of the suppliers and clients is necessary. This involves negotiations with the local leadership and elite, which in the various countries consists of different groups such as businessmen, bureaucrats, politicians, feudal landowners, military officers, religious leaders, (feudal) party leaders, members of royal families, tribal leaders, family clans, etc. Engineers and scientists who are responsible for the innovation, development and application of new technologies are usually underrepresented in this group. It must also be realized that the ethnic, cultural, linguistic and religious diversity within and among developing countries is much wider than, for example, in Europe.

In the subsequent part, important factors which have to be taken into account in technology transfers are analysed.

PROBLEM OF NATIONAL DEVELOPMENT AND NEED FOR TECHNOLOGY TRANSFER

For the developing countries, the problems of growth are mainly centered around the optimal resource utilization through indigeneous technology, rural development, manpower planning and adequate development of education, both formal and nonformal, with environmental factors being important constraints. Raising the standard of living is a primary need. Entrepreneurship, technological assessment, problems of technology transfer and optimization of social goals are the other major problems most urgent for these countries to overcome. The growth of technology, and to a lesser extent, science, as well as progress of education are, therefore, key contributors to the development

of these countries.

The idea of endogenous progress and self-reliance in national development has been widely accepted among both the developed and developing countries. Endogenous development is opposed to the importation of social models and lifestyles and seeks to create a self-sustained ability for a country to freely choose the type of development, technological change, higher education strategies, institutions, and life according to self-chosen form of modernity. UNESCO has been active in relating education, and science and technology to development through cooperative programs among the participating countries and institutions, wherein reciprocal relationships are promoted and mutual learning and self-reliance are stressed and supported.

One of the best modes of technology transfer, keeping the above in view, is the concept of Technical Cooperation among Developing Countries (TCDC), since some of the developing countries have reached a level of technological development which makes it possible for these countries to assist other countries of the region (Al-Nasri and Varma).

Manpower resource provides the initiative, motivation and action for development, and is itself produced by education and training. The right kind of leadership and management is required to identify the tasks needed for development and the course of action best suited for implementation of these tasks. Most developing countries have serious shortages of skilled manpower in qualitative as well as quantitative terms. In this context, the transfer of relevant technology to the developing countries is vital for their survival and growth. Education and training may, thus, be seen as essential aspects of technology transfer.

Technology is applied knowledge and science. Science forms the basis of technology. Science is a common good; it is essentially unprotected and everybody who has the means has access to it. On the other hand, technology is either protected or unprotected. For example, the free cantilever construction technique of a prestressed concrete bridge is an unprotected technology; however, the know-how to construct such a bridge at minimum cost, maximum safety, and best quality is protected. Protected technology is, for example, the production process and composition of superplasticizers in concrete, whereas the use of superplasticizers can be handled easily by local staff on a construction site if suitably trained, and may be called unprotected. Donor countries would have less hesitation to transfer of unprotected technology.

The transfer of technology from developed countries to developing

countries takes many forms, such as, providing assistance in defining technology needs, preparing basic reports and plans for specific projects, implementing engineering projects, operating and maintaining projects, setting up manufacturing plants under licence, operating consultancy services, etc. There are many problems associated with such transfer, apart from the payment for it in terms of foreign exchange. It has been alleged that what has been transferred in several cases has been obsolete. Supply of technology that is already known, amortized, obsolete, surpassed or discarded, capital intensive, reducing the levels of occupation and the standards of living of the people, and favourable to the concentration of income is hardly worth the money. In some cases the engineers and technicians of the native country have the ability to innovate and manage the collaborative industries, but are not allowed to do so under the terms of technology transfer. On the one hand, the benefit of their expertise is lost, and on the other hand, they are victims of frustration. Sometimes, the motive of the transferring country has been to keep the recipient country technologically backward by suppressing local talent and putting them on routine rather than innovative operation.

A suitable technological base, which would include local machinery industry, know-how, and research and development activity, is necessary for a beneficial transfer of technology from abroad. In addition, the transferred technology needs to undergo further improvements. UNCTAD (1974) has, therefore, aimed at strengthening the technological capability of developing countries so that the technology after transfer should sooner or later cease to be foreign and become domestic technology for the importing country. It encourages institutional arrangements with the recipient institution possessing suitable technology accounting capability.

APPROPRIATE TECHNOLOGY

In order to be useful to the population in general, technology must fit within the social, economical, political and cultural context. Appropriate technology is the application of scientific knowledge, usually from different disciplines according to the need, to solve a certain problem or to achieve a desired goal, by utilizing available resources as input to the process consistent with the economical, social, political and cultural context. Appropriate technology is conceived as flexible so as to conform to the changes in the boundary conditions of the society at different periods of time. In the developing countries, it aims at introducing such processes and

innovations as are not highly capital intensive but are able to generate employment and could be managed through local skill, using local raw material. It should lead to capital formation in due time, and mobilise available labour in the region where it is applied. Such technology goes beyond hardware and includes social institutions, management techniques, feasiblity studies, and market research. It necessarily needs entrepreneurship to become a reality, managed by self-employed persons rather than by industrialists. It has therefore, to be backed by appropriate education.

Indiresan (1981) has argued that the constraints of simplicity, capital minimization and objective of self-sufficiency are not real in the utilization of appropriate technology in developing countries. It is possible to train the worker to a sufficient degree of capability to handle a process or equipment. Increase in productivity will increase prosperity and contribute to economic growth and a rise in the standard of living of the people. Another important objective should be to make the community more self-reliant by having an export oriented activity which will balance the import of its minimal requirements. Therefore, he argues, the technology should be up-to-date.

In many cases, if a modern technology is not working, it is not because the technology itself is not appropriate, but because it has not properly been integrated with the social, economic and institutional features of the community and is not an appropriate technology in true sense. Technological decisions must be made by integrating and balancing economic, social and environmental factors to provide technological solutions which are indeed appropriate. There is often too much emphasis on economic and not enough on social needs. On the other hand, social programmes ignore the economic and technological considerations.

It is for each country to make its choice and set its objectives of development and the kind of scientific and technological input that would be needed. An appropriate educational system for the special skills and knowledge needed to absorb the technology should then be selected or designed to make the plan operative.

TYPES OF TECHNOLOGY TRANSFER

As mentioned earlier, technology is applied knowledge and science, and very often it involves aspects of know-how, know-why and do-how without which new technology can never be applied successfully.

In the economic development of the third world countries, technology transfer is a crucial issue. The transfer of technology can be achieved in the form of capital, goods, work force and/or information. Various types of technology transfers are given in Fig. 1. The classical types are the export of finished products and direct foreign investment. New forms of international economic cooperation are barter/compensation, license agreements, contract manufacturing, turnkey projects, technical assistance in the form of consulting and management contracts, joint ventures and any combination of these types of technology transfer.

With regard to direct foreign investment, the technology is controlled by the foreign supplier and substantial financial involvement of the supplier may be needed. Foreign investments are only suitable for medium to long-term ventures. In general, multinationals favour this type of limited technology transfer. A relatively low level of technical knowledge and no financing are required of the host country, although basic infrastructure is needed.

For license agreements, a legal framework for the technology transfer is required because the technology must be protected. This is usually a time consuming and rather complicated matter.

Contract manufacturing deals with shifting of production to a plant in the customer's country. This may involve supply of specialized equipment. Marketing and exploitation rights must be settled first with the supplier.

In the case of turnkey projects, one party (supplier) is responsible for the whole project. This is also referred to as a package deal and the technology of realizing such a project remains essentially with the supplier and is hardly transferred.

Technical assistance or consulting and management contracts are concerned with the supply of know-how and know-why (software) rather than hardware, as in most of the above mentioned types of technology transfers. Technical and/or management assistance is a service to the client to cope with the new and complex technologies. A major component of such assistance would involve manpower training.

In the case of joint ventures (industrial cooperation), the foreign investor and the local partner cooperate through financial participation of both parties, through profit and risk sharing as well as sharing of the management duties. Joint ventures have replaced classical forms of technology transfers in many developing countries. Joint ventures appear to have a bright future.

Finally, barter deals with the purchase of technology for the production

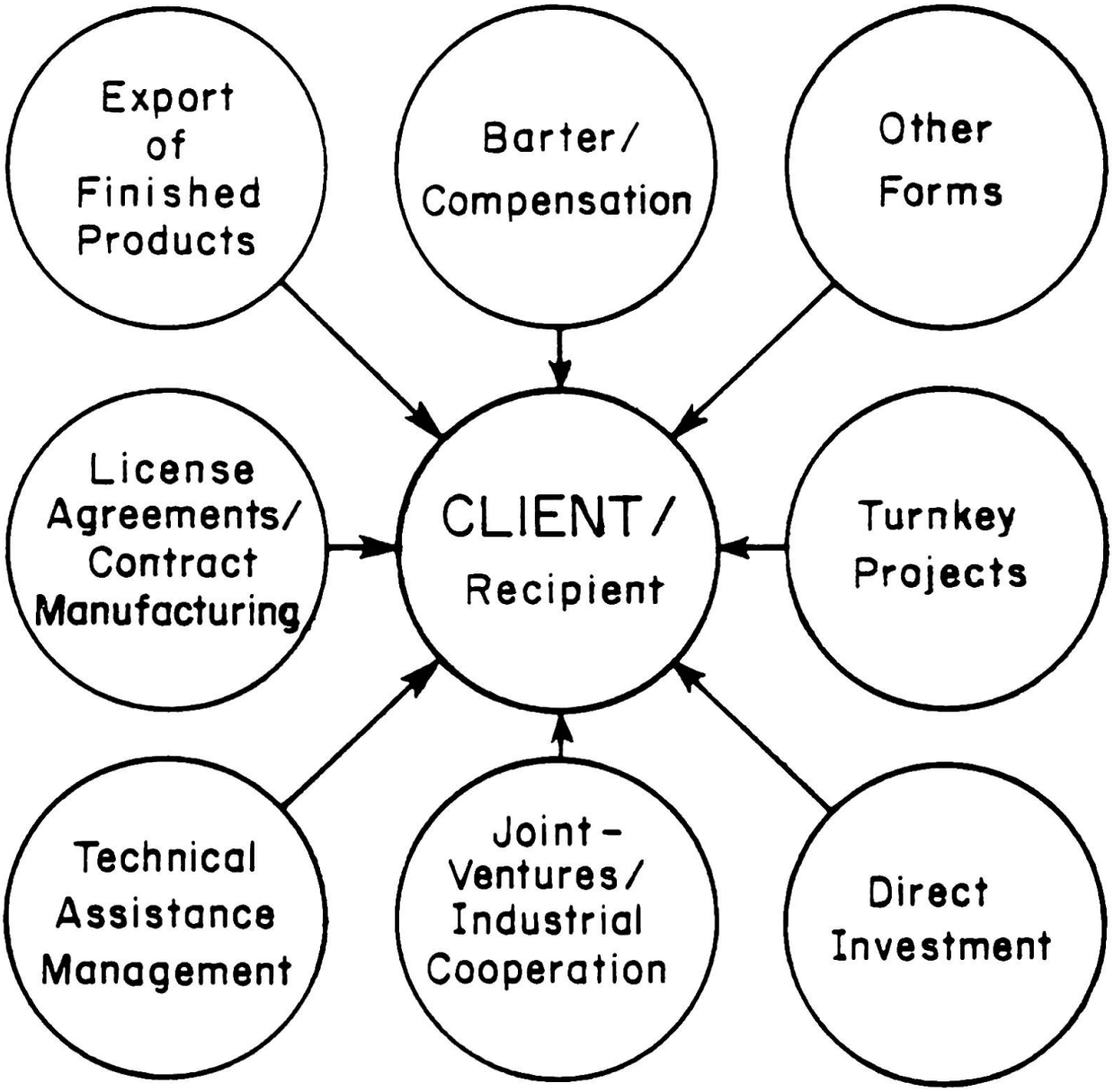

Fig. 1 Types of technology transfer

of goods. The supplier of the technology will then take over the locally made products by that technology for compensation. Through barter, the purchase of technology is financed by the supplier of the technology. The economical risks are with the supplier.

Very recently, for large-scale infrastructure projects like mass rapid transport systems and expressways, governments of some developing countries have encouraged the private sector to invest in such projects. In this case, the design, construction, financing and operation of a tunnel, bridge, expressway system, railway system, etc. is managed by a consortium of private enterprises and/or government agencies. The projects are financed through loans and equity and are paid for by the users (toll fees) over a given concession period of say 30 years. The economical risk is with the private investors and a government can reduce its local/foreign borrowings. Therefore, the overall investment capacity of a country can be increased. Typical examples of such projects are the tunnel between England and France, the Hong Kong cross harbour tunnel, the second stage Expressway in Bangkok, Bangkok's skytrain and a number of major highways in Thailand, etc. It can be concluded that privatization is speeding up the development of transportation infrastructure and will contribute to a faster economic growth.

We can easily see from this enumeration that technology transfer has many facets and there are virtually no limits in the number of ways technology transfer can be achieved. With respect to the construction industry operating in developing countries, all of the above mentioned types of technology transfer are probably practised, with different segments of the construction industry favouring different types of technology transfers. Three major sectors of the construction industry can be identified; they are the engineering consultants, the contractors, and the suppliers of equipment and construction materials. In the context of technology transfer, the primary roles of the consulting engineers are to advise on the selection of the most suitable technology, to suggest the best price for a technology, to propose schemes for the integration of local engineers, to be competent in all technical, financial and economic aspects, and to be capable of organizing and conducting training programs for local engineers. The consulting engineer is essentially a vehicle to arrange, facilitate and manage technology transfers. The know-how of the consulting engineer can be shared most effectively through local partnership, which means assigning the local engineers to work together with the experienced consultant.

It is necessary for the government of a developing country or the

authority that draws technology to insist on local combination in case of consultancy and construction, and many countries do this. Even consultants and contractors are insisting on them. Unless local or domestic agencies are involved, there can be no transfer of technology.

The technology transfer of the general contractor is usually achieved in the form of joint ventures or in the case of turnkey projects through employment and training of local technicians and engineers. The labour intensive work is usually carried out by local people, whereas the management and specialized works are mainly done using foreign expertise, sometimes with very little local content. In joint ventures with technologically and financially strong foreign contractors, it is expected that the technology transfer goes from the stronger to the weaker partner and not in the opposite direction. Sometimes, foreign firms use joint ventures mainly to learn how to do business in a new environment and how to penetrate or dominate the market. Once they have got that know-how, they drop the local partner who is now no longer of use, and continue to conduct the business on their own. A typical example of that practice was Malaysia which was almost overwhelmed by foreign contractors during the period of the oil boom. However, technology transfer is always a two way exchange.

The suppliers of equipment and construction materials favour the direct export of finished products rather than sharing the technological know-how with the prospective competitors. If the capacity of the local market is adequate, direct foreign investment may be an alternative. However, as mentioned earlier, all types of technology transfers are possible depending on the circumstances.

Specifically, the following items are of relevance in the field of structural engineering and construction:

(i) Quick and reliable methods for site investigations;
(ii) Design technology for unconventional types of structures;
(iii) New construction materials;
(iv) New construction techniques which increase speed, reduce cost, and ensure quality of construction;
(v) New construction plant and machinery offering higher production and lower costs;
(vi) Contract administration skill, and project management technology;
(vii) Data acquisition, recording and retrieval;
(viii) Ability to use personal computers for design and management;
(iv) Improved project organization and personnel management;

(x) Managing finances;

(xi) Control of quality of construction, etc.

The selection of the item(s) from this list would depend on the needs and the current ability of the recipient to absorb the technology.

It is clear that only the most suitable technology should be imported by a developing country; the imported technology must develop local technology and priority should be given to fields with good development prospects. Again, the importance of teamwork and training must be emphasized.

Examples of the success and failure of the different types of technology transfer can be found everywhere. The difficulties in the transfer of technology responsible for the failure of such ventures are briefly discussed in the following section.

DIFFICULTIES IN TECHNOLOGY TRANSFER

One of the principal reasons causing inadequate technology transfer is sometimes, the lack of genuine interest on the part of the donor and/or recipient in making the deal successful. The deal itself may have been entered into by an agency unwillingly for reasons not genuinely aimed at technological upliftment of the recipient country or organisation. The donor agency may be obsessed with the fear that his hold on the technology will lapse resulting in a commercial setback. The terms of the agreement characterise a closed mind denying the right to the recipient to change or modify parts of the technology to suit local conditions. The agreements are overtly in favour of the donor with the result that the recipient starts losing interest in the deal soon after take-off. On the other hand, the recipient often lacks adequate technological background and the organization conducive to the implementation of the conditions laid down in the agreement. Often, language constitutes a barrier in smooth communications, making the process of technology transfer slow and difficult.

The supply of construction equipment is one of the common items in the transfer of technology for the construction of projects. In many cases, however, the prospects of commercial exploitation overtake the suppliers or manufacturers, subduing the instinct to render development aid. The equipment supply is not adequately backed with the supply of services like technicians, spare parts, and tools with the result that expensive pieces of construction machines lie on the sick bay waiting for repairs for weeks and sometimes

months. The element of training is practically non-existent in the deal, or is inadequately implemented.

The lack of education and training of the local technocrats in the technology under transfer is an obvious reason for the failure in several cases. This aspect which should include education, both international and national, and on-job training requires carefully prepared education plans which should be implemented with honesty and dedication. The education/ training done overseas should be pertinent to local environment - social, political and economical. The selection of trainees from the side of the recipient is another crucial factor in the success of the plan. In one case, instead of people who needed to be trained, senior bureaucrats and administrators undertook the visit abroad, viewing the exercise as a world holiday. In a few cases, persons trained for specific jobs were not posted on these jobs and were employed elsewhere.

Where supply of equipment is involved, it is necessary for the supplier to go into infrastructural details, such as, availability of proper roads, bridges, workshops facilities, spare parts and fuels, lubricants, etc., and maintenance skills. Equally important is the need to ensure availability of spare parts at reasonable cost since a developing country is not generally in a position to pay high costs in foreign exchange. Proper maintenance of equipment through improved skill of the recipient organization is necessary for fruitful transfer of technology.

CONCLUSIONS

The international activities of engineering consultants, construction enterprises, and equipment and construction material suppliers always involve components of technology transfer. Different types of technology transfers are favoured by different segments of the construction industry. A construction takes shape in the local country, but it is always necessary to bring in elements from outside. Besides the hardware, a construction company provides the planning and management of the work, including financial resources for executing the work. These services are obtained as far as possible from the local country; however, this contribution depends on the nature of the project, the local conditions and the given time frame. Except for hardware suppliers, joint ventures are the most appropriate means for effective technology transfer. For example, with the assistance of international professional organizations and UN-agencies, standardized

contractual frameworks for optimum technology transfer should be developed, which could then form a part of all types of joint venture contracts between technology suppliers from the developed countries and the local enterprises. Socio-economic, cultural and environmental conditions in the local country must be observed carefully, in order to make any project a success. Finally, we have to realize that technology transfer is a two way exchange.

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