A Comprehensive Approach to Purchasing Technology Part I : Development of the Approach

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Abstract

A common assumption which is frequently made by many managers in developing countries is that any technology transferred from outside is useful. But due to their lack of capability in scanning the international marker; technology assessment; and negotiating, very often they end up purchasing obsolete or nearly obsolete technologies which makes it difficult for companies to achieve their objectives. Even if the required technology is purchased it is not uncommon to hear complaints that the transfer of technology was not complete.

The models which have been developed so far for Technology Transfer lack the detailed exposition of negotiation at the company level which is a key factor for successful technology transfer. On the other hand, steps such as implementation and monitoring which are crucial for systematic acquisition, have also been ignored. This study is an attempt to develop an approach for technology transfer which can be used at the company level by manufacturing-sector organizations in developing countries, in their dealings with foreign sources to acquire new technologies. The proposed approach consists of seven steps, these are: scanning, assessing the external business environment, assessing the internal environment, selection, negotiation, implementation, and monitoring and improvements. The details of these sections are clearly explained in this paper.

1. Introduction

Technology is at the center of the dynamic process of social change. In developing countries, technology provides hope, value and faith for the people. It brings hope of bridging the gap between the haves and the have-nots; it is expected to alter economic and social values; and it is the faith upon which the world of tomorrow is being built [1]. Because of this there has been a widespread belief in developing countries that, unless technology is properly managed, changed and controlled accordingly, there can never be adequate industrial and economic development in general. However, there are three ways an enterprise can introduce technological change: acquire from out side (usually called technology transfer); generate from within (called technology development) and buy some from outside and make some from within. The buy all option has the advantage of giving instant results with minimum risk. The make all option, on the other hand, has the advantage of total self reliance. But from the developing country point of view self-reliance is neither economically efficient nor practically possible. Also make all is a very slow and painful process. The approach which is most practical is *buy-some-and-make-some*. But what needs to be transferred and what can be locally developed depends upon the strength of a firm's indigenous technological capability, locally available supportive infrastructure, the national technology climate and global technological trends. Monitoring world technological trends and trade opportunities is important to ensure

future orientation and long term considerations in make and buy technology decisions.

Technology transfer simply means movement of technology. When we refer to movement of technology within a firm from the Research and Development (R&D) lab to production, it is called *vertical* transfer. When we are concerned with the movement of technology from one organization to another, the process is called *horizontal* transfer. Any transfer of technology requires a medium or a mechanism for effecting the transfer. There are many ways to categorize the various mechanisms for the transfer of technology. The most popular way is to categorize these mechanisms into two categories entitled market-oriented and non-market oriented mechanisms. The term *market oriented* is used to emphasize that certain mechanisms in technology transfer are initiated purely with the profit motive as a basis and market forces become critical in determining the growth, competitiveness and profitability of both the transferor and transferee. On the other hand, the term *non market oriented* is used to indicate that such mechanisms are not always motivated by market forces and financial considerations.

A variety of these mechanisms are normally used for the transfer of manufacturing technology. Each of these mechanisms for technology transfer has certain advantages as well as limitations corresponding to the specific situation of the transferor and transferee. Nobody gives away useful technology free. Therefore technology transfer is simply a business deal between a seller and a buyer. The question of why buy? why sell? purely depends on the motivations of the transferor and transferee.

If technology is viewed from the proposed *polytrophic component* perspective [2], it may be said that technology transfer is successful only if it leads to the eventual acquisition and balanced development of all components of technology. The application of the polytrophic components definition of technology for examining technology transfer issues shows that it can facilitate the understanding of the limitations of the various mechanisms of technology transfer. The non availability of such an approach has often led to transferee managers in developing countries to have unrealistic expectations of the extent of technology that can be transferred through the various mechanisms commonly used for technology transfer. This has often led to disillusionment and frustration in many developing country transferee firms. In fact, based on the polytrophic component definition of technology, it may be said that a firm should perhaps consider the use of several mechanisms simultaneously for ensuring comprehensive and effective transfer of technology.

According to an earlier study [3], it has been found that host countries, the Less Developed Countries(LDCs) in particular, derive general economic benefits from technology transfer between international partners. These benefits include the generation of exports and foreign exchange, tax revenues, employment, accumulated capital and entrepreneurship skills. Many writers support this contention and argue that transferred technology can have benefits of various sorts to host countries, including the reduction of costs of products or processes and of supply inputs used to produce the product or process based on the transferred technology.

On the other hand, opponents accuse foreign partners of charging excessive prices for technology exports, manipulation of transfer prices, the provision of technology that is too sophisticated and inappropriate for the best possible use of local resources, the provision of technology that is obsolete and only capable of producing inferior products, and not providing foreign capital.

Other researchers hold that the impact of international technology on the host country are situation-specific. Whether technology transfers are beneficial or not depends on what the transferors and the transferees can do to assist the LDCs to alter their resource bases so that they can transform themselves through development to achieve a comparative advantage.

Although research on international technology transfer is somewhat more substantial, the primary focus has been on the limited issue of LDCs. Many researchers have viewed this from the host country perspective and noted: government policy, LDCs regulatory approaches, technological capability and choice of technology as important issues of the technology transfer process. Since technology is defined as firm specific knowledge, negotiation at the company level (host and home country) is a key dynamic component of the technology transfer mechanism. A review of the literature indicates a limited exposition of this dimension. On the other hand, some key steps such as implementation and monitoring involved in successful technology transfer process have also been ignored. Therefore a more systematic and integrated approach for purchasing technology by developing countries' firms is a timely requirement today. In this paper an attempt will be made to develop a comprehensive approach [4] that can meet these requirements.

2. Objective and Scope

The objective of this study is to develop an approach for technology transfer which would be suited to local conditions and could be used as a tool by the senior management of firms which are planning to acquire manufacturing technologies from foreign sources. The scope of this study is to look at the technological benefits received by local manufacturing companies through international technology transfers. This study will focus only on technology transfer from the transferee firm perspective and will not be studying the impact of international technology transfer on the home country. In-depth studies of legal aspects and financial evaluations will be excluded from the scope of the study.

3. The Proposed Approach to Purchasing Technology

A framework for purchasing and implementing new technology is developed and presented in Fig. 3.1. This framework basically contains three main stages: preparation, implementation, and operation. The preparation stage includes five steps namely: scanning, assessing the external business environment, assessing the internal environment, selection and negotiation. The implementation stage includes one step namely, implementation and the operation stage comprises the steps of monitoring and improvement. At the end of each decision point of the framework, candidate technology is either funded, backlogged or rejected. Backlogged technologies are kept aside to resurrect later when the environment is more suitable and resources become available. The suggested approach is schematically represented in Fig. 3.2.

3.1 Preparation Stage

As mentioned above, the preparation stage includes five main steps. The details of these steps will be explained in the following section.

Scanning

As there are many similar technologies available in the international technology market, *scanning* is important to find out the most appropriate one. The following sequential procedures are helpful in this regard.

Identify Needs

The recognition of the need for technology transfer is an initial step. This initial step is important as the success or failure of technology transfer depends on the ability of the receiving nation to identify the right technology for its needs.

Scan the International Technology Shelf

The aim of this step is to scan the available technologies through formal and informal channels. To make the scanning procedure effective, it is necessary to establish an information database using scientific and technological information, industrial and other relevant information and by internal networking. To supplement the information analyzed from the database, a team can be

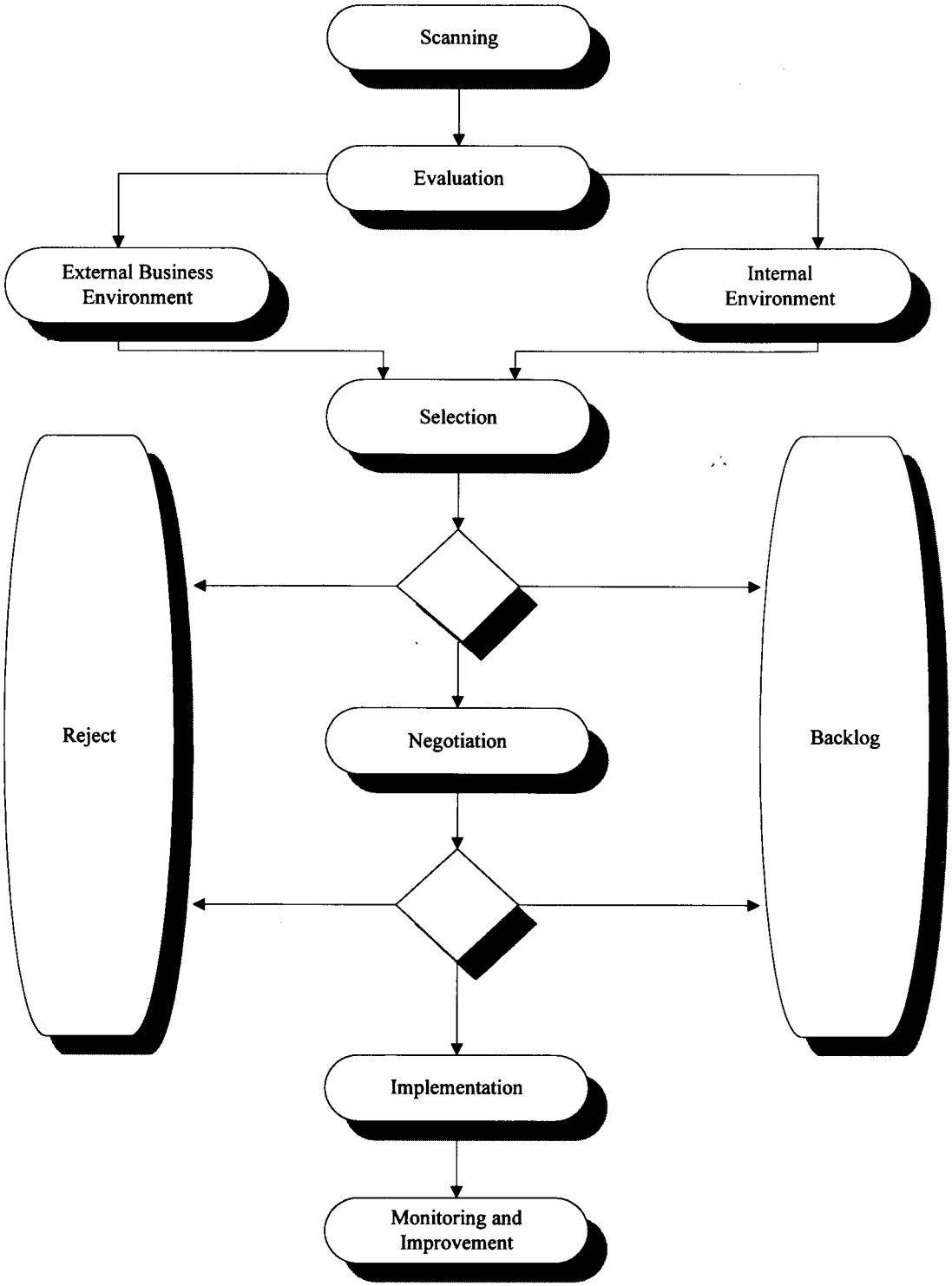

Fig. 3.1 Framework for Purchasing and Implementing a New Technology

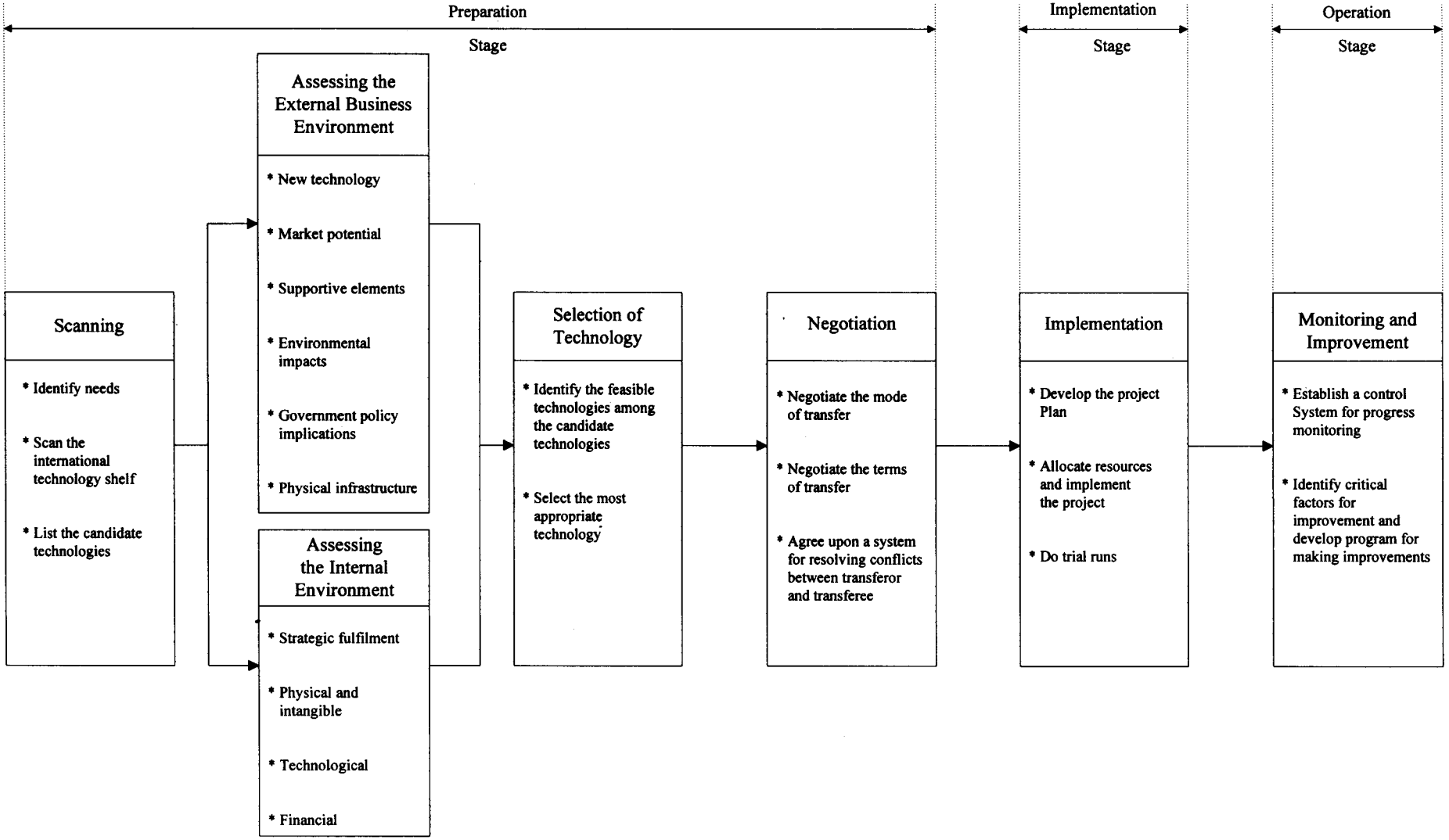

Fig. 3.2 A Technology Purchasing Approach for Developing Country Firms

appointed for in-depth examination of relevant technologies.

List the Candidate Technologies

All the possible candidate technologies, found by scanning are listed at this step.

Assessing the External Business Environment

Due to the existence of very complex interactions between technology and its surroundings, many factors in the business environment need to be considered in technology transfer assessment. Therefore the assessment of the following areas are required.

Evaluation of the New Technology

Before a new technology is adapted, the scope and limitations of the traditional or existing technology has to be studied. The knowledge gained from this process will help in evaluating the new technology that can better satisfy the LDCs' needs [5].

The recipient firm must focus their attention to evaluate the following three areas of the new technology.

(a) Economic perspective: Products should be manufactured at a price not exceeding the current market price.

(b) Technological perspective: New technology should not be too sophisticated or obsolete.

(c) Financial perspective: Returns should be adequate relative to the capital investment.

Evaluation of Market Potential

The market demand for the intended product must be attractive enough to justify a firm's investment. The market attractiveness can be determined by demand growth rates and by uncertainty concerning the nature of demand [6].

Evaluation of Supportive Elements

Supportive elements are important from the point of view of cheap inputs and quality of outputs. Therefore the presence of supportive elements such as competitive suppliers and related industries will significantly help to enhance competitiveness in the market.

Evaluation of Environmental Impact

The degree of environmental friendliness of the acquired technology is assessed at this step. There are three main areas to be looked at [7]:

- Impact on physical environment (Air, Water, Land);
- Impact on living conditions (Comfort, Noise); and
- Impact on life (Safety, Health).

Evaluation of Government Policy Implications

The aim of this step is to examine legal and regulatory measures on candidate technologies. This is important as different countries have different foreign investment legislation or rules to monitor the inflow of technology and therefore it is necessary to analyze the government regulations to ascertain the feasibility.

Evaluation of Physical Infrastructure

Physical infrastructure such as transportation facilities, availability of utilities, telecommunication facilities etc. contribute immensely to the successful operation of a manufacturing process. Therefore careful evaluation is necessary to ensure the availability of required facilities before selection.

Assessing the Internal Environment

In this step, an assessment is done to evaluate whether the new technology satisfies the firm's objectives and matches with the firm 's capabilities and resources. It includes the following four sub-steps.

Evaluation of Strategic Fulfillment

It is necessary to examine, to what extent the candidate technology will fit into the organization's missions, objectives, goals and strategic focus.

Evaluation of Physical and Intangible Resources

Physical resources such as location, buildings, materials, plants, machinery, tools, equipment etc. and intangibles such as availability of knowledge and experiences of people, specifications, design parameters, organizational practices, brand name, contacts, goodwill, image etc. need to be evaluated to find the suitability of the new technology to the organization.

Evaluation of Technological Resources

In this assessment phase, an in-depth analyses of the technological resources should be done. This includes an assessment of the status of the existing technological capability of the firm. Technological capability is one of the major resources that a firm should have to achieve success in assimilating, adapting and improving the technology. Assessment is mainly of the existing skill level of the organization. The operative capability is the most important capability that the firm should have at the initial stage [8].

Operative capability is the primary capability of a manufacturing firm. It is the capability to transform inputs into outputs. The main sub-elements of operative capability can be listed as follows:

(a) Capability to utilize and control the production plant and equipments;
(b) Capability to plan and manage production operations;
(c) Capability to provide information support and networking for production operations; and
(d) Capability for carrying out preventive, routine and breakdown maintenance including the capability of trouble shooting.

Evaluation of Financial Resources

Assessment of the financial resources mainly includes the ability of the firm to find the required capital for the new project.

Selection of the Technology

Selection of technology includes the following two sub-steps.

Identify the Feasible Technologies from Among the Candidate Technologies

All the technologies which have been successful in the above evaluation phases namely: assessing the external business environment and assessing the internal environment are identified individually at this stage for final selection.

Select the Most Appropriate Technology

The choice of technology at the company level should be made based on the analysis of the firm's external business environment and the internal environment. These two factors are considered in the second and third parts of the approach. The task of the decision maker is to find the technology that yields maximum revenue, minimal production costs, and has the least harmful effects on human beings and the environment.

Negotiation

Negotiation is the last step of the preparation stage and it includes the following three sub-steps.

Negotiate the Mode of Transfer

Negotiations by both sides to affect the terms of trade in their favour is a key dynamic in deciding upon the technology transfer mechanism. The decision to select the technology transfer mechanism is crucial from the point of view of developing countries as the effectiveness of the technology transfer leading to the upgrade of the technological capability of the transferee is dependent on this. Therefore a

preliminary assessment of the firm's absorption capability gives some guideline to decide the mechanism which will provide the maximum benefits. But the supplier of the technology often enjoys a monopoly or oligopoly situation on the decision of the transfer mode that is the mechanism by which the technology is transferred [9]. As a result, in many instances, the transferee is compelled to accept the mode which is decided by the transferor. However the following factors will help to strengthen the bargaining power of the acquirer of technology:

- Information and commercial knowledge required to assess the merits of what is available;
- Required technological capability to buy unpackaged technology;
- Required capability to do the preparatory work for the actual project;
- Knowledge about alternative sources;
- Sufficient capital for financing the project;
- Necessary managerial competence;
- Knowledge and ability required to acquire other inputs;
- R&D capabilities; and
- Knowledge about the market potential.

Negotiate the Terms of Transfer

At this step all the other related aspects that will be included in the technology transfer agreement will be negotiated.

The importance of different negotiating factors will change according to the mechanism selected. However the factors like payments for transferred technology, ownership, inputs of manufacturing, output handling (especially market aspects), management style and training are key factors to negotiate. The price setting process mainly depends on the competitive conditions prevailing in the technology market. But in the context of LDCs' limited knowledge of the international technology market, excessive prices can be charged on technology exports. Therefore 'Evaluation of the New Technology' included in the second stage of the technology purchasing approach would help the transferee firm to match the charges and anticipated benefits and negotiate positively in their favour. Among the other factors, training is of crucial importance in terms of technology transfer because technology transfer involves learning, and learning can be improved by appropriate training methods.

Agree upon a System for Resolving Conflicts Between Transferor and Transferee

Since many technology transfer projects may lead to failure due to conflicts between transferor and transferee, it is of great importance to establish a system to resolve them. This could be in the form of a consultation unit comprising members from both parties to seek advice on technology transfer issues.

3.2 Implementation Stage

The implementation stage includes one step namely, implementation and it has the following three sub-steps.

Develop the Technology Transfer Project Plan

This step mainly includes three parts namely: planning, budgeting and scheduling. Planning starts with preliminary coordination where both parties (if the foreign partner is involved in the management of the technology transfer project) involved in the project, get together and make preliminary decisions about what will be achieved and by whom. Final planning must have sufficient details to determine what must be done next.

After designing the project plan, the next priority is to obtain resources with which to do the work. For this the budget for the project needs to be approved by the senior management. A budget is a plan for allocating resources. Thus, the act of budgeting is the allocation of scare resources to the various endeavors of the project.

A schedule is the conversion of a project action plan into an operating time table. It serves as a fundamental basis for implementing the project on time.

Allocate Resources and Implement the Project

After successful completion of project planning, budgeting and scheduling, it is time for management to allocate resources and put the project plan into action. Resources allocation relates directly to the topic of scheduling because altering schedules can alter the timing of resource needs. If the project schedules can be adjusted to smooth the use of resources, it may be possible to avoid project delays and, at the same time, avoid the high cost of excess resources.

Do Trial Runs

Before starting full capacity production, it is important to do trial runs to make sure that the newly implemented process has zero defects. It is easy to rectify any defects at the initial stage in consultation with the foreign partner.

3.3 Operation Stage

The operation stage comprises the step of monitoring and improvement which has the following two sub-steps.

Establish a Control System for Progress Monitoring

Control must focus on the performance of the project. A periodic performance assessment system is of great importance to evaluate the success and failure of the transfer. This will lead to prompt remedial actions. Assessment can be performed on the following criteria:

- Impact of technology transfer;
- Technical difficulties;
- Insufficient resources;
- Quality and reliability problems of the technology;
- Changes in market demand;
- Organizational problems;
- Scarcity and price changes of the inputs;
- Wastages; and
- Rules and regulations of the government and transferor.

Identify Critical Factors for Improvement and Develop Program for Making Improvements

Strengthening of the overall scheme of the technology transfer process is required in order to ensure a successful transfer. Crucial managerial issues which can be helpful to enhance the technology transfer process can be listed as follows:

1. Periodical upgrade of planning, policy making and strategy formulation.

2. Development of innovative and supportive capability. Innovative capability is the ability to carry out reverse engineering, adaptation and improvement of imported technologies and also come out with its own product and process innovations as well as inventions [8]. From the developing country perspective this is not an easy goal to approach but there should be some initiative for future development. Therefore innovative programs through R&D can be introduced to further modify and improve the acquired technology.

Supportive capability is the ability to provide a foundation for the development and improvement of the operative, acquisitive and innovative capability of a firm. Without this capability it will be difficult to continuously develop the other three capabilities. The various sub-elements of supportive capability include the following [8]:

- Capability for undertaking project execution
- Capability to get funds for expansion and upgrading plant and equipment
- Capability for planning and implementing human resources development. This includes education and training of concerned staff and recruitment of new staff.
- Capability to identify new markets for products and to obtain the necessary inputs needed for production.

3. Give incentives for outstanding technological improvement.

4. Strengthen cooperation with government and related industries.

4. Validity of the Proposed Approach

Five case studies were carried out for the purpose of determining the validity and usefulness of the proposed technology purchasing approach for developing country firms. The general information about the firms where the case studies were undertaken are given in table 4.1

Table 4.1 General Information on the Firms Studied

Companies	**A**	**B**	**C**	**D**	**E**
Ownership of the local partner	35%	65%	100%	50%	100%
Type of industry	Manufacture of automotive tyres	Tyre rebuilding	Manufacture of paints	Manufacture of polypropylene fabric and bags	Bus body assembling
Date of registration	24.02.1992	16.03.1992	1963	12.03.1993	18.12.1990

According to the case studies from selected manufacturing sector organizations, it was found that the proposed approach is applicable to developing countries. The details, analysis and discussion of these case studies and the guidelines for local firms and government will be given in the second part of this paper.

5. Concluding Remarks

With the liberalization policy of many developing countries, the economic success of a firm may depend on its focus towards technology based competition. To be competitive both in the local and foreign markets, local firms may need to apply a variety of previously usused technologies in their production process. Developing all these new technologies within the firm is not at all feasible from developing countries' point of view. This is mainly due to heavy R&D expenditures and lack of other required inputs for activities. In such a case obtaining the desired technology from foreign sources is a plausible approach to developing countries.

In many technology transfer projects, the transferee firms are often not satisfied with the inputs and knowledge that they have gained through the technology purchasing agreement. In today's liberalized economies it is of great importance for firms to have a sound approach to deal with technology suppliers so that they can get the maximum benefits through the purchase of technology. The lack of such an approach has been found to be the cause of ineffective technology transfer agreements. Previously developed models for technology transfer indicate very little on *negotiation* and totally ignore key steps such as *implementation*

and *monitoring*. Therefore the suggested approach has attempted to introduce a comprehensive approach for technology transfer that can be used at the company level by manufacturing sector organizations, in their dealings with foreign sources to acquire new technologies. This approach has provided a list of activities to be undertaken by transferee organizations intending to engage in a technology transfer project. In the context of such a project these activities would be of greater value if they were carried out in the sequence suggested in the approach.

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