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Absorption and diffusion of imported technology

Proceedings of a workshop held in Singapore, 26-30 January 1981

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Absorption, Assimilation, and Diffusion of Imported Technology in Pakistan: A Case Study of the Textile and Pharmaceutical Industries

Firasat Ali[1] and Jamal Ahad Khan[2]

The purpose of this study is to describe. analyze. and evaluate technology transfer and its absorption and diffusion within the textile and pharmaceutical industries of Pakistan. The study focuses on the mode. means. and cost of technology transfer in an attempt to answer the question of why. what. and how technology is transferred. The mode and means have been evaluated in the light of government policies. characteristics of supplier and recipient. contractual framework under which the transfer is effected. structure of participation. and negotiation processes. The analysis of cost was carried out to ascertain its importance on balance of payments. the situation of the country. and its influence on macrolevel indicators such as employment and income.

Problem Areas in Technology Transfer

The problems associated with the process of technology transfer in Pakistan include:

(1) Inability of the government to procure technologies that are best suited to the needs of the country due to: the government's dependence upon the technology supplier for information and advice related to the technology being imported. subsidiaries of multinational firms procuring most of the production techniques from their parent firms without involving government in the selection. dominance of foreign investors in cases where technology is imported through joint ventures involving both local and foreign capital. foreign technical assistance from international organizations frequently being oriented toward nonpriority fields. and tied loans offered by developed countries limiting the role of government in the selection of technology.

(2) Lack of technical capacity in various sectors of the economy causes difficulty in defining the problem that requires the import of technology. A further lack of information about the type of technology required to solve the problem and its source leads to the procurement of inadequate and expensive technologies. which hinders the incorporation of the technology into the productive process and makes absorption difficult.

(3) Technologies imported are inadequate to meet national development needs. e.g.. labour-intensive technologies should be imported in order to make use of Pakistan's surplus of labour.

(4) Lack of capabilities for searching for appropriate technologies and for the evaluation and absorption of imported technology in the private sector due to the limited capacity of public institutions to advise the private sector and because technical and research and development institutions have not been approached to deal with this problem.

(5) Costly and ineffective technology transfer due to conditions imposed by the supplier as part of the technology procurement deal.

(6) The role of subcontracting as a means of technology transfer has not yet been realized.

(7) Lack of coordination among various government agencies and overlapping in their functions. Because various agencies are involved at different levels in the import of technology, the selection of appropriate technology is difficult. In addition. there is a lack of communication between policy-executing agencies and technical and research and development organizations and the government. which results in the government

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being uninformed about the technological competence of these organizations. Similar communication problems exist within the private sector.

Policy Measures Aimed at Improving Technology Transfer

Several policy measures aimed at resolving Pakistan's problems related to the import of appropriate technologies and their rapid absorption and diffusion have been established. To formulate and implement these policies, a national system for technology development has been proposed. The National Commission for Technology Development would be the highest national body within this system and would be responsible for formulating the goals and objectives for the technological development of the country. To assist the National Commission for Technology Development in implementing its policies, a Technology Development Board is proposed. This board would function through two separate units: Indigenous Technology Development Cell and Imported Technology Cell. The Indigenous Technology Development Cell will promote indigenous technologies to assist entrepreneurs in their technology development efforts and provide assistance to units engaged in capital goods manufacturing. As well, it will develop data on indigenous technologies and the absorption and diffusion of imported technology and act as a liaison between innovators and research institutes and financial institutions. The Imported Technology Cell will deal with the import of technology into the country through receiving applications for the import of technology and giving sanctions. It will also act as a coordinating agency between the entrepreneurs and financial institutions. To provide logistical support for the entire system, an institutional framework will be used. In this regard, the establishment of a data bank; research development corporation; forum for capital goods manufacturers; and an agency to evaluate, monitor, and follow-up technology development will be set up. Additional institutions will be created as required.

In addition to the national system for technology development, an Information Development Centre is proposed. This centre will act as a repository for all available technological information that meets the needs of agricultural, industrial, research and developmental, and governmental bodies. The information system will play a vital role in developing science and technology policy that will, in turn, determine priority areas for data/information collection and dissemination. In this way, the information centre will act as a coordinating body between the various agencies involved in the development of technology in Pakistan.

The actual formulation of federal policies/incentives for technology development, utilization, and diffusion will be made at the Cabinet level, based on information supplied by the Ministries of Science and Technology, Agriculture, Industry, Education, Commerce, and Finance.

Some broad policy measures will also have to be established to meet the demands for technology transfer. For example, appropriate training and education is important if a country is to develop and become self-reliant; the needs of the masses must be met by selecting technologies and implementing projects in areas that suit balanced development; a relationship between supplying countries and recipient countries must be developed to facilitate technology transfer; a science and technology plan must be developed to deal with technological manpower, service/technology infrastructure, industrial technology, and public understanding of the issues involved; all technologies should be appropriate to the social and economic environment prevailing locally; efforts must be made to increase the number of training facilities available if technological manpower requirements are to be met; industry and government must provide opportunities within their systems for employees to develop administrative and managerial skills; and research and development should be promoted.

Problems Facing the Textile Industry

Pakistan's textile industry is confronted with several problems requiring resolution:

(1) There are many instances of articles being placed on the free list for import despite the fact that sufficient production facilities exist locally for the same goods.

(2) Virtually all textile mills complain of market constraints in the utilization of technology due to competition from foreign cloth, which finds its way illegally onto the domestic market.

(3) Many fiscal anomalies exist, with the result that raw material is heavily taxed, whereas subassemblies and finished goods are allowed to be imported with relatively low import duty.

(4) There are cases where the import duty rate has been increasing simultaneously with the cost

of raw materials abroad. The consequent increase in the cost of production has seriously affected the profitability of manufacturing concerns.

(5) Inaccurate interpretation of the nomenclature has often lead to tax evasion and malpractice.

(6) The price of cotton is based on ad hoc decisions. Frequently, cotton is not available at the price and illegal dealings occur at higher prices without intervention by government bodies. The sudden decrease in the price of cotton, when the present regime came into power, caused significant losses to many textile mills that had stocked large quantities.

(7) The procedure for rebate of customs duty on raw materials and subassemblies, used in the manufacture of local machines, is cumbersome. Machinery manufacturers generally cannot afford to keep large stocks of raw materials and parts. They purchase a small stock from the local market when required. Suppliers of the raw materials and parts do not provide sufficient information to satisfy customs rebate procedures. In addition, the rebate is allowed only after the imported raw material/part has been utilized in the manufacture of a new machine. Because of this, the amount of money that is legally refundable is blocked for a considerable length of time.

(8) Several textile mills complain of a heavy incidence of tax and the procedure of double taxation.

(9) Water and Power Development Authority (WAPDA) tariff rates, compared with 1976, show an average increase of 38% for different loads and a 76% increase per unit. Karachi Electric Supply Corporation tariff rates show an increase of 25% in billing and 170% for additional energy charges per unit. The consequent increase in the cost of production for the ailing textile industry must be considered before such increases are made. Perhaps, special rates should apply to the textile sector until it recovers.

(10) Some textile mills are facing a power shortage. Perhaps, such mills should be allowed to import electric generators without payment of any duty.

(11) Interest liabilities of several mills have reached prohibitive levels. Serious consideration must be given to waive these charges or reschedule payments at reduced rates.

(12) The 10% surcharge in tax liability has further increased the cost of production. The prices of spare parts, accessories, industrial raw materials, dyes and chemicals, etc. have increased accordingly. The abolition of this surcharge must be considered.

(13) Balancing, modernization, and replacement (BMR) is a continuous process. The limiting of the time period for concessions in BMR is not appropriate for the textile industry.

(14) Despite the fact that machinery for BMR is imported under a valid import licence, which takes about 6 months to obtain, industrial units are required to obtain an Exemption Certificate from the Textile Commissioner, Karachi. It should be noted that the exemption is not necessary because the list of machinery not entitled to exemptions is clearly defined. This formality requires an additional 4-5 months. The inconvenience, time lost, and need for frequent travel to Karachi is a disincentive for BMR, as well as a waste of resources.

(15) A further requirement of BMR is that the existing old equipment be scrapped. Measures should be employed to overcome wastefulness of resources in this manner.

(16) The licence fee of 1% for an import licence, up to a maximum of Rs0.1 million (U.S.$10 000), was levied prior to devaluation by 131%. The same rate continues today.

(17) Textile mills complain that insurance claims are not paid on the basis of goods insured but on the cost and freight value, and settlement of claims takes a long time.

(18) There are complaints regarding damage, theft, and pilferage of imported goods during loading, unloading, and storage in warehouses, for which nobody bears the responsibility.

(19) To promote export in a buyers market (textiles), the government should consider subsidizing export.

(20) Because locally produced gums are substandard and not available in sufficient quantities, they must be imported, for which there is a prevailing import duty of 120%, plus an additional 10% sales tax. Moreover, the Customs Department views "thickeners" as banned items. Because local gums are not stable under acidic and alkaline conditions, which are the important media for transferring the dye stuffs into the fabrics, the government must consider the import of glue at a reasonable cost to the mills. This is imperative because printing charges have decreased from Rs5 to Rs2.50 (U.S.$0.50 to U.S.$0.25) per metre.

(21) Local capital goods and spare parts manufacturers are not producing bolting cloth and rotary screens for making printing designs because the import duty is 85%, plus 10% sales tax.

(22) Lacquers and emulsions are important for screen making. Local industry does not manufacture fancy chemicals, yet the lacquers and emulsions used for textiles are banned.

Pakistan's Experience with Imported Technology

Pakistan did not inherit any significant industrial base at the time of independence, which made the import of technology necessary. The technology import influx did not decrease with the passage of time, however, because the proper environment was not created for effective absorption, assimilation, and diffusion of imported technology in the various sectors of the economy. The major sufferers in this respect are local machine manufacturers who, in spite of having a good technological capability level, cannot play their part in making Pakistan self-sufficient in some of its technology requirements.

A policy of continued dependence upon imported technology directly affects the growth of the local capital goods manufacturing sector, which has happened in the case of Pakistan. With the changing situation around the world, no developing country can rely indefinitely upon imported technology as a means for development. It has become essential for a developing country such as Pakistan to create an environment conducive to duplicating imported technology. A stage may come later when the duplicated imported technology can be improved further, as in the case of Japan. The most essential requirement to achieve this objective, however, is the creation of an appropriate base. This can be only achieved through close cooperation between government, policymaking, financial, and research and development agencies. Contradictory policies that affect the growth of the local capital goods sector will have to be abandoned and new blood will have to be infused into this sector by providing the proper incentives.

The importance of building up indigenous technological capabilities expeditiously was generally lost sight of under the pressures resulting from food shortages, rapidly growing population, and other sociopolitical problems, and above all, the absence of the trained manpower required for the planning, evaluation, selection, and adaptation of technology transfer. No institution existed to plan the transfer of technology according to needs, evaluate various alternatives available for the import of technology, select the proper type of technology, negotiate the most favourable terms, or develop the capability to assimilate the technology.

The adverse effects of the absence of a proper institutional mechanism and a well-coordinated policy for acquisition of technology are reflected by the present state of Pakistan's spendings in the form of royalties, technical fees for consultancy, trademarks, and licences. During the 5 years between 1965 and 1970, Pakistan spent an average of $102 million annually on patents, know-how, trademarks, and management and technical services. According to careful estimates, the annual average for the last 8 years has risen to about $175 million. The component of expenditure is one of the highest amongst the countries of the region. This clearly indicates that the country will continue to depend heavily upon foreign sources of technology and pay exorbitant prices for such transfers unless serious efforts are made to enhance the national science and technological capability and support national research and development institutions that are presently working at subcritical levels without sufficient financial and manpower resources.

In 1978, the cost of imported technology was estimated to be approximately Rs177 million (U.S.$17.7 million). The breakdown of technology costs is given in Table 1.

Technology has been transferred in Pakistan mainly through licencing or joint ventures. The licencing agreements are normally process- or product-oriented and involve high payments for the licence. Royalties and the costs of licencing agreements have been as high as 3%, followed by a royalty of an equivalent percentage on the price of goods produced.

Most licencing agreements with Pakistani firms relate to patents and trademarks. A sample study revealed that about 37.5% of the licences are for the use of trademarks. Licences for the use of patents and patent technology are obtained by about 42.8% of the technology importing companies.

Licencing has remained almost entirely limited to a small number of individual enterprises, which has prevented further dissemination of general technological development throughout the country. The distribution of licence agreements has also been unbalanced and emphasis has remained on consumer goods, with very little attention being paid to intermediate and capital goods. Frequently, the licensees of patents/trademarks

Table 1. Technology costs (thousand rupees).[a]

Technology	1964–1965	1965–1966	1966–1967	1967–1968	1968–1969
Capital equipment	50.3	22.0	45.2	51.0	74.9
Royalties and trademarks	7.4	9.0	16.3	10.5	7.4
Technical fees	64.6	32.7	33.3	36.2	4.4

[a]Re 1 = U.S.$0.1.

are also obliged to seek additional technical information in addition to further payment.

A recent study of technology transfer contracts has shown that they contain various types of restrictions on exports, the purchase of spare parts and intermediate products, and the pattern of production, as well as financial restrictions that affect the validity of patents, etc. The results of a study of 54 contracts are summarized in Table 2.

Regarding technology transfer through joint ventures, the technology transferring agencies often succeed in syphoning as much revenue as possible through expatriates, service charges, and other costs. The situation warrants revision of the international patent system, on the one hand, to make it more realistic and take into account the problems faced in developing countries such as Pakistan, and, on the other, to enable the governments of such countries to take measures such as creation of technology evaluation institutions, which would assist the local entrepreneurs in making the proper choice of technologies and negotiating more reasonable terms in licencing agreements. In such efforts, assistance from United Nations agencies may prove to be of great value for making available the necessary information/data from different countries.

Table 2. Evaluation of restrictions in transfer of technology contracts.

Type of restriction	Percentage of contracts with restrictions
Territorial restriction	
Requires prior approval of licensor	31.4
Export only to certain countries	12.9
Restrictions on source of:	
Raw materials	27.7
Spare parts	16.6
Intermediate products and capital goods	25.9
Competing technologies	14.8
Restrictions on pattern of:	
Production	18.5
Sales and distribution	14.8
Financial restrictions	
Long term of enforcement	38.8
Discriminatory royalty	25.9
Limitations affecting the technology	
Absence of provisions regarding training	22.2
Grant-back provision	42.5
Other restrictions	
Not to contest validity of patents	24.0
Foreign law governing agreement	23.3
Foreign jurisdiction in settlement of disputes	33.3

Efforts at the international level, in this regard, should ensure:

(1) International technology transfers promote national and collective self-reliance of the developing countries in scientific and technological fields.

(2) International scientific and technological cooperation and optimum use of world resources for the equitable benefits of all member states.

(3) Nondiscrimination in conditions for the supply of technologies on fair and equitable terms to developing countries; including nuclear technology for peaceful purposes.

Elements of Transfer in Various Industries

In developing countries, labour-intensive processes are desirable. The introduction of new processes, however, is difficult. Therefore, an underdeveloped country such as Pakistan cannot afford to adopt new processes unless the prospects of success are high. The manufacturing processes in Pakistan, transferred from developed countries, fall into two categories: new processes and modified processes.

New processes are processes that have not previously been available within the country but their success has been proven in similar economic and industrial climates. For example, machine tools manufacturing in Pakistan has started very recently. Therefore, all processes brought into this sector are new. The percentage of technology imported with new processes in engineering, chemical, and electrical industries, on the other hand, is 25, 26, and 41% respectively.

The primary reason for not importing up-to-date technologies is the lack of experience of local industrialists concerning the worth and value of the technology. Another reason is the lack of interest of government agencies and institutions because they are more concerned about the financial soundness of both the supplier and recipient enterprises. The government makes little effort to study the nature of imported technology and its chances of diffusion within the country. Similarly, no investigations are made to determine the prior status of the technology and its degree of assimilation within the country. As such, the rate of duplication of technologies is high compared with the rate of diffusion of imported technologies, which is low.

Table 3. Channels for technical and managerial know-how (%).

Channel	Engineering	Machine tools	Chemicals and fertilizers	Electrical	Pharmaceuticals
Assembly techniques	96.0	100.0	82.5	91.0	71.5
Documentary information	100.0	100.0	100.0	100.0	71.5
Preinvestment studies	12.5	66.0	13.7	22.7	14.3
Project reports	25.0	66.0	23.5	36.4	35.6
Plant design fabrication	100.0	100.0	100.0	100.0	100.0
Erection and installation of plant	83.3	100.0	100.0	100.0	100.0
Plant management	12.5	33.0	21.5	26.7	35.7
Organization of research and development	8.5	100.0	19.6	31.8	71.5
Training of local personnel	66.7	66.0	68.8	65.0	—

According to a survey, the percentage of process modification in various sectors is: engineering industries, 12.5%; machine tool industries, 33.0%; chemicals and fertilizers, 11.7%; electrical industries, 27.3%; pharmaceuticals, 14.3%. The modifications have been made either due to the danger of obsolescence or due to market limitations.

In chemical industries, modifications and improvements are generally made in view of special environments regarding local inputs. In the pharmaceutical industry, the major portion of modifications is made in accordance with improvements introduced by the parent company in production processes.

Technical and managerial know-how is one of the major elements in the process of technology transfer. For Pakistan, it constitutes an important channel through which technology has been transferred on an enterprise-to-enterprise basis as depicted in Table 3. Technical know-how has also has been imported in the field of planning and supervision. The greatest amount of technology transfer, however, has been facilitated through the sale of equipment in the various sectors of industry in Pakistan.

Absorption and Diffusion of Imported Technology in the Textile Industry

Plant layout and design have always been undertaken by Pakistani-trained engineers. Expatriates generally supervise the erection and installation of machinery, however, despite the fact that this skill has been thoroughly absorbed and diffused within Pakistan. This is generally done to avail the guarantee clause of foreign machinery manufacturers.

Research and development are the two factors lacking within the textile industry. Government policies have not favoured such undertakings. Almost nothing has been imported through this means.

Technical, financial, and personnel management are poor compared with European mills. However, nothing worthwhile has been imported directly. Virtually nothing has been imported in marketing and textile mill owners are generally shy of consulting expertise (which is present in Pakistan) to assist them with their management and marketing problems.

Product design generally consists of copying imported products with very little local input. Practically no technology has been imported directly by textile mills for designing products, and because it is not a significant feature of the industry, the existing units are quite self-reliant.

Preventive maintenance is carried out by most mills. Due to the age of the machinery and a lack of details, however, the product is generally not up to the standards of European mills. However, because they do not avail themselves of foreign expertise in this matter and are able to schedule and manage preventive maintenance on their own, the knowledge and techniques can be considered to have been absorbed by the industry. Several mills have been able to innovate on imported machinery with good results. Diffusion of this know-how, however, has been negligible.

Conventional inventory control is still employed. There has been no direct import or absorption of this know-how.

All relevant quality control methods are known to textile workers. However, they are partially deficient in the calibration of quality control equipment. They have no knowledge of the maintenance of quality control equipment.

Absorption and Diffusion of Imported Technology in the Pharmaceutical Industry

Pakistan is self-sufficient in technical personnel requirements. Pakistani nationals have acquired considerable expertise from expatriates, with the result that they can be compared with any other professional around the world. Furthermore, there are many Pakistanis with foreign post-graduate qualifications and experience in different aspects of the pharmaceutical industry.

Subsidiaries of foreign firms and the larger local firms established themselves with imported machinery and equipment. Those in the early 1950s even imported minor equipment such as buckets, which were readily available in Pakistan. In the late 1960s and later there has been a general shift toward locally manufactured machinery because of several factors, the foremost being that local machinery is 40% cheaper than imported machinery and is just as efficient. Sophisticated machinery, which cannot be manufactured locally, is still imported. Small local firms depend entirely upon local machinery manufacturers. This shows the extent of assimilation that has occurred in the past two decades.

There is considerable know-how present locally in terms of designing plant layout, etc. Despite this fact, foreign subsidiaries supervise design through their expatriate staff. Local firms rely completely upon indigenous skill and know-how.

Pharmaceutical firms of Pakistan are able to modify and adapt drugs to suit local requirements if the need arises. This has been done in several cases; however, they do not possess the funds, facilities, or know-how for research and development regarding new drugs. The Pakistan Council of Scientific and Industrial Research has been able to prepare certain basic drugs independently. Local firms, which do not have a licence to manufacture foreign patented drugs, utilize pharmacopoeias and conduct sufficient research and development so that they are able to manufacture them on an industrial scale.

There is considerable import, absorption, and diffusion of technology through literature and foreign magazines concerned with pharmacy and medicine.

All the subsidiaries of foreign firms had expatriates as their top management during the initial years of development. They were later replaced by local personnel. Because most local managers claim that during the latter period the company functioned better, it is safe to assume that the imported know-how was completely absorbed and innovated to suit local requirements.

Many local firms copied the management structure of foreign subsidiaries. There was, therefore, considerable diffusion of technology in this respect. Similar comments can be made for marketing know-how and techniques.

Larger firms were well aware of the concept of preventive maintenance and utilized it with the help of Pakistani staff. Much of this knowledge has come through maintenance journals, expatriate staff, etc. It is fully absorbed by the local people. For financial reasons, however, very small local firms do not utilize preventive maintenance.

Quality control is effectively carried out by Pakistani staff; some of them highly trained. The equipment used by some of the leading firms is modern. All the techniques have been absorbed but they still rely upon the agents of the manufacturers of the quality control equipment to maintain it. These agents are Pakistanis who have been trained in the field by expatriates.

Inventory control is being practiced by foreign subsidiaries along the lines set by expatriates who have since left. This shows that they have fully absorbed the imported know-how. Some of this know-how has diffused to local firms through the transfer of personnel.

Comments: Woo Hee Park

These comments refer to both Pakistan's comprehensive report and the summary report prepared for the workshop, the latter having been edited substantially for inclusion in these proceedings.

The report has four main components: (1) scope and methodology; (2) policy guidelines, together with a macroreview of industrial development; (3) a macroreview of transfer issues; and (4) a set of case studies on textiles and pharmaceuticals.

The case studies are the major contribution of this report, in which the topic of absorption and diffusion of imported technology is touched upon. Parts III-5, IV-4, IV-6, profiles of the surveyed units in parts III and IV, and Table 7.10 (technological capability levels of the firms) are very interesting.

There are, however, problems with the report in its present form. In brief these are:

(1) Substantial general editing is required. The policy guidelines and macroreview of transfer issues portions are fuzzy and parts seem to be irrelevant to the topic. The technology-oriented component of the introductory macro-review seems to be weak, not well organized, not well presented, and with a "drift" of argument that seems to lie somewhere between "not very convincing" and "dubious." There are a number of detailed problems with the data presentation and analysis.

(2) Policy suggestions do not pull together very well the main threads of the empirical case studies. Also, little evidence is provided to support the generalizations or assertions in policy implications.

(3) More important are serious problems with the scope and methodology section, which does not relate to the empirical studies of the textile and pharmaceutical sectors. Definitional clarification is essential in this study, where much variation and confusion in usage seem to prevail.

(4) The main problem relates to the absorption or assimilation concept — a process of learning to relate to bodies of knowledge and a state, e.g., the level of local execution of tasks varies. Inherent in the definition of absorption as a process of learning is the need to distinguish between the process and various performance indicators from which one can infer something about the rate and qualitative nature of the process. A relationship between absorption learning, on the one hand, and performance, on the other, should be clarified.

(5) A slightly less serious problem relates to the diffusion concept. What is shown in the text is a pattern of local supply of parts, etc. What is not shown is the role which diffusion of technological knowledge plays within that process. What technological knowledge is diffused from the initial importing enterprise to other suppliers? To what extent did they already have the technical know-how necessary to supply the parts and equipment?

(6) The evidence presented does not seem to support the question of whether absorption and diffusion are, in fact, fast or slow. Furthermore, there is no indication of against what yardstick absorption and diffusion are so firmly and repeatedly judged to be slow or fast.

(7) No distinction is made between operating performance and design capacity. Also, it is not clear whether the cost reduction results only from the physical input/output charges, i.e., cost savings at constant input prices or whether they include an element of price charge as well.

(8) No measurement has been made at all of the ADIT problem.

In summary, more emphasis should be directed toward the absorption and diffusion of imported technology, which is a neglected area and one of considerable academic interest as well as one of widespread practical, policy-oriented relevance for industrialization and development of self-reliance within developing countries.