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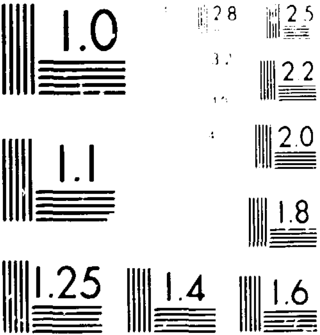
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TECHNOLOGICAL CHOICE AND INFORMATION SOURCES FOR DEVELOPMENT FINANCE INSTITUTIONS*

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I. OBSERVATIONS ON TECHNOLOGICAL CHOICE

1. This paper will address technological choice and related techology information sources from a technological rather than from a financial point of view. It is clear that only if the entrepreneur has a technological choice, based on reliable assessment and substantiated by appropriate information, will the entrepreneur be able to minimize the risks inherent in transferring and adapting technology for his own use. An effective assessment of available technologies will also assist the entrepreneur in making decisions whether to support indigenous development of technology, to adapt existing technology, or to import new technology.

2. The development finance institutions are seen to be important partners in this process of technological choice. Such institutions can assist entrepreneurs, not only from the standpoint of financing acquisition of the technology, but also to make available to the entrepreneur guidance and counsel relative to potential sources of technology assessment, such as research institutes, universities, and engineering consultancy firms, and complementary information available from all elements of the national development infrastructure. Further, the sharing of information and experiences with other development finance institutions through the proposed Development Bank Technological Information Exchange Network (DB-TIEN) will, with time, strengthen the ability of such institutions to provide more effective guidance on appropriate technological choice.

3. At the same time, it must be realized that most entrepreneurs are not technical experts. Thus, they require information presented in a clear, concise, non-technical format, which they can relate to markets, operating costs, and profit and loss statements. Unfortunately, many data banks or sources of technological information are designed principally for use by scientists and engineers, and even if available, do not readily meet the needs of an entrepreneur interested in acquiring technology.

Technology Transfer and Related Information

4. One of the great problems in transferring technology is that frequently the potential for the technical process or device is evaluated with limited consideration of such factors as appropriateness in relation to local or national level of development, raw material and human resources, product marketability, environmental and social impact. The transfer, adaptation, and utilization of technology, to be effective, must be considered within the larger context of a total system for technology acquisition. Such a system should include, in addition to assessment of the technology, appropriate technological "know-how" information, techno-economic analyses, related experiences, in addition to legal and financial factors.

5. The scope of information required for effective decision-making is very broad. Such a data base includes:[1]

a. Business and management information: financial and commercial data; names, addresses, reliability of firms in given sectors, productivity, inventories, resource distribution, etc.;

b. Marketing information: markets, products, forecasts, costs and pricing;

c. Negotiable information: licenses, patents, consultancy assessments;

d. Design information: standards, specifications, blueprints, industrial catalogues, regulations;

e. Operational information: maintenance and repair manuals; replacements; process specifications and guides;

f. Laws and regulations: national and international

6. Much of this information, however, is either not readily available, or simply does not exist, in an accessible form, in many developing countries. It may be seen that the above range of information encompasses the needs of a number of decision-makers: government entities; financial institutions; entrepreneurs; industrial operations personnel. At the same time, all of the above categories of information obviously impact on appropriate technological choice.

Technological Choice Profile

7. The above observations suggest a matrix approach to developing a technological choice profile (TCP) to include: requirements; resources; problems; solutions; related experiences. An effective TCP should include: availability of process material and labor resources; energy sources; transportation modes; market and product potential; technical analysis and techno-economic assessment; technological alternatives; social and environmental impact; related experiences; and related appropriate information.

8. While certain elements of such a TCP will be seen to be common to, or similar for, technology acquisition in general (laws and regulations, negotiating information, financial and commercial data), some of the components of a TCP will be specific to industry sectors or to discrete industries (raw materials, marketing information, techno-economic assessment, operating data). Inputs for establishment of a TCP will come from a variety of sources: government policies and plans; industry and business associations; financial institutions; equipment producers; data banks of information; research institutes, universities and engineering consulting firms; and exchanges of experiences with others.

9. Appropriate dissemination of the data contained in a well developed TCP is perhaps the most difficult task to perform. Unless the information is effectively disseminated to potential users, the impact on appropriate technological choice will be minimal. The logical agents for dissemination are seen to be development finance institutions (directly and through DB-TIEN), industry associations, national Industrial Research and Service Institutes (IRSIs), engineering consulting firms, Bureaus of Standards and Quality Control, and technical extension mechanisms.

II. SOURCES FOR TECHNOLOGY ASSESSMENT

Industrial Research and Service Institute

10. Most developing countries have one or more Industrial Research and Service Institutes (IRSIs). These exist at varying levels of development and capability, but are mandated to perform R&D and services related to industrial development. The UNDP/UNIDO Joint Evaluation of IRSIs,[2] the USAID-sponsored Comparative Analysis of Industrial Research Institutes in Developing Countries,[3] along with other studies, have shown that, in many instances, IRSIs are insensitive to the problems and needs of the industrial sectors. In most cases, IRSI directors are aware of this weakness in their institutions, which appears to derive, in part at least, from inability to attract and retain staff members with industrial experience under the terms of prevailing salary and benefit schedules. IRSIs seldom have the funds or available staff to maintain a technical extension effort for liaison with industry. Thus, IRSIs are seldom sufficiently aware of "real" industrial problems as contrasted with the IRSI's preception of industry needs.

11. Industry, in general, is often reluctant to use IRSI services, other than for routine analysis and testing, quality control, etc., for a number of reasons, including:[4]

a. Suspicion by private industry of the IRSI-government relationship;

b. Lack of information about IRSI objectives and functions;

c. Lack of confidence in IRSI knowledge and experience in industrial problem solving and competency related to specialized industrial technology;

d. Belief that the IRSI tends to carry out its activities in an "ivory tower";

e. Belief that IRSI fees and costs are unreasonable (although industry is perfectly willing to pay for other services such as attorney fees, promotion and public relations);

f. Lack of IRSI appreciation of the cost/benefit industrial motivation;

g. Difficulty in obtaining firm IRSI commitments on delivery dates for services;

h. Lack of IRSI response speed due to bureaucratic procedures.

12. If, as has been stated, the role of the development finance institutions is not merely the provision of finance for development but also to influence and promote the development of national technological capacity, it is clear that these institutions can impact on the disparity between IRSI and industry. This indicates that development finance institutions should make greater use of IRSIs in assessment of technology, in preparing technological choice profiles, in recommendations on alternative technologies as well as for technology acquisition, absorption, adaptation, and innovation. Such use of IRSIs by development finance institutions in the technological choice process will, with time, strengthen the ability of these IRSIs to interact directly with the industrial sector. It is necessary to recall that an IRSI is only one element (often neglected) of the infrastructural system required in developing countries to carry out effective industrialization.

The Role of IRSIs in Technology Transfer

13. Table I[5] is an illustration of the potential role of an IRSI in the technology transfer process, as well as those transfer functions which an IRSI probably cannot, or should not, undertake. Depending on their present capabilities (or capabilities which can be developed with appropriate funding and other support), IRSIs have the potential for providing assistance in the following:

a. Providing information on desired technology;

b. Identifying alternative technological possibilities;

c. Identifying alternative technology sources;

d. Selection and adaptation of technology;

THE ROLE OF AN INDUSTRIAL R&D INSTITUTE IN THE TECHNOLOGY TRANSFER PROCESS

Table I

TECHNOLOGY TRANSFER STEP	ROLE OF INSTITUTE
A. Information on Section of Technology:	
(i) obtaining and providing information on desired technologies;	(i) major responsibility: must maintain up-to-date technological information service;
(ii) identification of alternate technological possibilities;	(ii) major responsibility: ties in with (i);
(iii) techno-economic and feasibility studies	(iii) depending on responsibilities and capabilities of the institute; input can therefore be major or minor;
(iv) selection of the most desirable technology;	(iv) only technical and techno-economic inputs, ties in with (iii); legal and financial considerations outside the institute's responsibility;
(v) identification of alternate sources of the desired technology;	(v) major role: ties in with (i);
B. Obtaining and Introducing the Technology to be Transferred:	
(vi) acquisition of rights to technology and obtaining technology know-how, including the formulation and closing of all types of technology transfer and licensing contracts;	(vi) this is not a responsibility of R&D institutes, except to provide technical information during negotiations; ties in with (i) and (iv).
(vii) establishing physical facilities and factories;	(vii) not the responsibility of the institute;
(viii) absorption of transferred technology, i.e., training of staff and personnel using technology;	(viii) a major responsibility of R&D institutes; one key function is the introduction of new technologies through the institute's laboratories or pilot plants by demonstrating these to industry personnel, i.e., introduce the technology through training;
C. Maintaining, Supporting, and Further Developing Transferred Technology:	
(ix) providing technical services for the transferred technology;	(ix) a major responsibility of R&D institutes;
(x) carrying out R&D for improving and further developing the technology;	(x) a responsibility of the institutes;
(xi) continued training of industry staff and personnel;	(xi) a continuing responsibility, although not always carried out by R&D institutes;
(xii) maintain information surveillance in the field of transferred technology;	(xii) an important institute responsibility;

e. Techno-economic studies;

f. Providing technical services;

g. Performing back-up R&D;

h. Industry personnel training.

14. Even though IRSIs may not currently have practical experience in industrial problem-solving, their staff members usually have knowledge of standard industrial processes and technologies. This knowledge is gained from training, scientific and technological journals and data bases of information, and from attendance at congresses and symposia presented on technological developments. Further, such staff members usually have contracts in other IRSIs in developed or in developing countries from which they can request additional information. Unfortunately, IRSI staff members are not always adept at synthesizing such information into terms readily understood by entrepreneurs and development financing institutions (thus, the role of technical extension agents, to be described later).

15. A principal function of IRSIs in developing countries involves assistance in exploitation and development of natural resources and raw materials on behalf of their governments. Often, IRSIs are involved in adapting existing technology or developing indigenous technology for processing national natural resources into useable form. Usually, their understanding of available material resources and how these can be used to reduce imported raw materials and/or semi-processed materials, is an important asset to be utilized in assessment of a particular technology or development of a technological choice profile.

IRSI Cooperative Agreements

16. A number of IRSIs in developing countries, recognizing their need for accessing technological information sources and for assistance in adapting technologies to local industrial use, have established technical cooperation agreements with other IRSIs. These linkages or twinning arrangements, as they are usually called, can be created between IRSIs in developing countries and IRSIs in developed countries, so that the developing country IRSI has an opportunity to draw on the experiences and capabilities of the more mature developed country IRSI. Alternatively (and in some cases, more appropriately), twinning arrangements are often made between IRSIs in developing countries, whereby one institute extends technical assistance to another institute at approximately the same level of development. The principle here is that the technological gap between two institutes in developing countries is more narrow than in a developing country IRSI - developed country IRSI linkage. Of course, appropriateness of technical assistance or technology acquisition will be a determining factor in such linkages.

17. The philosophy behind IRSI linkages or twinning arrangements can be stated as follows:[6]

a. It is impossible and too costly for every IRSI to posses facilities, equipment, staff composition and skills to solve all of the problems encountered;

b. Much valuable time and effort can be saved if a cooperative agreement can be established with another IRSI which has prior experience in the problem area;

c. Often a client is more willing to sponsor a research project if he knows that the IRSI in his country is being backstopped or assisted by another IRSI — particularly if the backstoping IRSI has demonstrated expertise in the problem area;

d. It is easier to gain technological information and "know-how" when two or more IRSIs have developed the ability to work together.

Examples of IRSI Cooperative Agreements

18. A few examples will demonstrate how IRSI technical cooperation agreements can impact on technology transfer, technological choice and acquisition of technological information.

a. In 1973, a technical cooperation agreement was established between the Denver Research Institute (DRI) in the United States and the Instituto de Pesquisas Tecnologicas do Estado de Sao Paulo (IPT) in Brazil, funded by a USAID Science and Technology Loan to the State of Sao Paulo. One objective was to transfer to IPT the aero-space generated expertise of DRI in explosive metal working processes. The programme involved assessment of the potential for explosive forming in Brazil by metal-forming industries, training of IPT engineers in the process, and design and construction of an industrial explosive forming facility, which IPT uses to perform service for industry and to train industry users in the process.

b. The technical cooperation is continuing between DRI and IPT's Center for the Study of Fertilizers (CEFER), funded by an agreement between IPT, Financiadora de Estudos e Projetos (FINEP), and the Interamerican Development Bank. CEFER's mandate is to provide technical assistance, process design and assessment, and development of fertilizer processes appropriate to Brazilian conditions (e.g., limitations on availability of sulfur and sulfuric acid, agronomic requirements, etc.). DRI accesses the world data banks, equipment manufacturer's information, and other sources for CEFER, and sends fertilizer experts to CEFER for specialized consultation on specific process problems or development. CEFER also has a technical cooperation agreement with the International Fertilizer Development Centre (IFDC) in the United States for complementary technical assistance and training.

c. Guyana has extensive forest reserves and at the same time imports 3000 tons/month of charcoal to maintain its metal working industries. IPT has developed a continuous process for production of metallurgical grade charcoal and recovery of tars and volatiles for chemical industry feed stock. IPT operates a commercial process, using babassu coconut shells and eucalyptus wood chips as feed stock, in the State of Piaui in northeast Brazil. IPT and the Institute of Applied Science and Technology (IAST) in Guyana have recently signed a cooperative agreement whereby IPT will train IAST in the process, assist in the design and construction of a continuous charcoal demonstration plant, and work with IAST to adapt the process to local raw materials and the needs of industrial users. When the programme is completed, IAST will be able to further transfer the technology to industrial users in Guyana. The programme is expected to be funded by the Interamerican Development Bank. IAST and

IPT's CEFER are also discussing a cooperative effort to develop a fertilizer production process based on Guyana's extensive reserves of aluminum phosphate rock, the results of which will be available to fertilizer enterprises.

19. Many other examples of such technical cooperation can be found. There are several important comments to be made about such cooperative agreements:

a. Funding support is necessary to ensure that the cooperation will be successful;

b. The cooperation provides a mechanism for promoting the development of national technological capacities, and to build a base for indigenous technological development;

c. Acquisition of needed appropriate technological information is made easier;

d. As IRSIs become involved to a greater extent in assessing the industrial impact and potential for such transferred technology, through assistance from their linked IRSIs, they will become experienced in assisting entrepreneurs and development finance institutions in making an appropriate technological choice, relevant to local conditions.

20. Of course, in the case of the IPT-IAST cooperation on charcoal production, as an example, there is no reason why an individual entrepreneur from Guyana could not go directly to IPT and contract for technical assistance in building a charcoal plant in Guyana. It is probable that no one in Guyana, except IAST, knew of IPT's capabilities in this respect. Under the umbrella of a technical cooperation agreement between Brazil and Guyana, IPT and IAST representatives were able to visit each other's institutes and to discuss areas of potential cooperative interest. Charcoal production was determined to be one of several areas of mutual interest.

Engineering Consulting Firms

21. The importance of engineering consultancy firms must be recognized as a potential source for assistance in technology assessment. These firms usually provide technological expertise over a narrower range than do IRSIs. At the

same time, their personnel are almost always experienced in industrial problem-solving in one or more specialized engineering fields, and the firms are profit-motivated, so that technical assistance can be expected to be directed efficiently to the heart of the industrial problem.

22. It is believed that cooperation between IRSIs and engineering firms on technological assessment would be an effective mechanism to develop technological choice profiles. The IRSI is probably more knowledgeable about raw materials and natural resources, while the engineering firm is more experienced in engineering specifications and design. It is suggested that development finance institutions could be the nucleus to bring the respective expertise of these two elements of the industrial development infrastructure together.

III. ACQUISITION AND DISSEMINATION OF TECHNOLOGICAL INFORMATION

Acquisition of Information

23. Appropriate technological information has been mentioned several times in this paper. The broad scope of information often involved in making a technological choice was referenced in paragraph 5. Much of the time, such information is not available because it simply does not exist in accessible form. Almost every developing country is attempting to establish a National Science and Technology Documentation Centre, but even if these exist, technical personnel trained in interpretation of such information are limited, and frequently, while there may be a system for acquisition, there is seldom a parallel system for dissemination.

24. Furthermore, it appears that science and technology acquisitions are directed more to information of interest to scientists and engineers, and practically not at all to information such as design information, equipment specifications, patent literature, and other information of interest to entrepreneurs who are thinking of starting up an enterprise. There is no reason why National Information Centers should not contain this type of information. Certainly, as it becomes available, through IRSIs, industry associations, de-

velopment finance institutions, and other sources, it should be fed into the Information Centres as a source of future reference.

25. Government entities and development finance institutions normally can disseminate commercial data and negotiating, licensing and other related information, and now have access to some of this information through UNIDO's INTIB and TIES systems. Generally speaking, the entrepreneur is more comfortable about locating this type of information than technological data and "know-how" information.

26. Accessing of world data banks for technical information is usually considered difficult, expensive, and time consuming. Yet, when an entrepreneur and a development finance institution are discussing a loan or other financing for a new enterprise, which may involve a million dollars or more, the cost for such data search is relatively insignificant. Cooperative agreements between IRSIs in developing and developed countries can be an important factor in reducing time delays, since technical personnel in the IRSIs will usually be familiar with the technical terms or descriptions needed to define the search.

27. Recently, for example, the Instituto de Pesquisas Technologicas (IPT) in Sao Paulo, Brazil, wanted to acquire current technical literature (for the past 10 years) on coal washing and cleaning, directed toward coal with high ash, high sulfur content, and to include descriptions of techniques and/or processes for cleaning coal. The computer search was limited to only two data bases - U.S. National Technical Information Service (NTIS) and the Engineering Index. These data bases include government and private engineering reports, scientific reports, patents, etc.

28. A search of the two data bases revealed 15,680 references related to coal cleaning. Further refinement of the descriptors used reduced the number of references to 659 abstracts. These were printed "off line" and received in a week. The total cost of the search and printing of the abstract was less than $200. Review of the abstracts will enable IPT to request only selected documents appropriate to their needs, either on micro-film or in printed form.

29. Nearly every developing country has access to such data banks in developed countries through bilateral agreements as well as through INTIB. The important consideration is to be able to adequately define the key words or descriptors, which, in turn, requires involvement of technical personnel from IRSI and engineering consultancy firms, in addition to documentation librarians.

30. A further example shows how information can be acquired and disseminated.[7] A few years ago, the Instituto Nacional de Tecnologia (INT) in Rio de Janeiro estblished a Centre for Information and Field Services, which was combined operation for acquiring and disseminating technological information, "know-how" information and technical extension activities. The Centre had a staff of 48 people at the end of 1973, a mix of engineers, economists, sociologists, technical writers, and technical information specialists.

31. During 1973, 10,000 Brazilian industries were contacted by the Centre to indentify information needs, and identify industrial problems. Some 4,000 Brazilian industries were on a regular mailing list to receive technical information appropriate to their needs; technical abstracts and new technological developments were sent to all of the 10,000 industries. The Centre received about 400 inquiries per year for additional information which was provided by mail or through personal contacts by the Centre's technical extension personnel.

32. One additional point about acquisition of information is appropriate here. Specific expertise and experience exists in some countries which can be accessed through the vehicles of country-country cooperative agreements, industry association agreements, IRSI linkages and through development banks. For example, the most appropriate source of information for small-scale, wet land agricultural machinery is undoubtedly the International Rice Research Institute (IRRI) in the Philippines. Rubber processing techniques are probably most appropriately obtained from Malaysia. Both Malaysia and Bolivia have expertise in tin ore processing. Certainly, Brazil is the unquestioned leader in use of fuel alcohol and production or retro-fitting of engines for fuel alcohol use. Trade missions between countries can identify a sizeable amount of proess or product information. The problem remains, of course, to access this information and put it into a format useful for dissemination to others.

Technical Extension Agents[8]

33. Mention has been made, earlier in this paper, about the apparent insensitivity of IRSIs to needs of industry and their inability sometimes to "translate" technical information into terms that entrepreneurs can understand. It has also been stated that, in general, IRSI staff lack practical industrial experience and it is difficult to attract and retain staff who have prior experience in industry. Lack of such capabilities suggests the need for technical extension or industrial liaison agents, analagous to the agricultural extension workers who bridge the gap between the agricultural universities and the farmer.

34. A technical extension agent is defined as a person, usually an engineer, with practical industrial experience, who, because of his personality, understanding of industrial problems, and business affairs, will be capable of interacting with researchers and documentation specialists as well as with entrepreneurs, development finance institutions, and government entities. His purpose is to identify, interpret, and serve as a "broker" of technology. A technical extension agent can bridge the gap between R&D activities of IRSIs and the needs of entrepreneurs and development finance institutions. Since he speaks the language of the industrialist, he can interpret to the IRSI the technological needs of industry. A technical extension agent [illegible] as an important element in preparation of a technological choice pr[illegible]

35. It is appropriate for a technical extension agent to [illegible] within an IRSI, but to have freedom to interact frequently and continuously with industry, National Documentation Centres, and development finance institutions. Most IRIs will not be able to provide funding support for such an activity without external financial assistance.

36. Technical extension agents can also operate out of industry association offices or the development finance institutions. In some ways, this would be a preferable arrangement, since the agent would thus have closer contact with the day-to-day technological and information needs of such organizations.

37. Admittedly, it is difficult for a technical extension agent to be a specialist in all fields of technology. Thus, consideration should be given to using one or more agents in a specialized area, such as food processing, metal-mechanical processes, machine tools, etc. Such an approach would cover the most important industrial sectors, and specialists could be called upon to fill the gap when other expertise is occasionaly needed. Such specialists could be obtained from IRSIs, IRSI linkages, industries, the UN System and others.

IV. CONCLUSIONS

38. In view of the often limited availability of appropriate technological information, it is difficult for the entrepreneur to make a realistic technological choice. Certain types of information simply do not exist. Other data are frequently biased or misleading resulting in selection of outmoded or inappropriate technology in terms of local or national development conditions.

39. Development of technological choice profiles (TCPs) for specific technologies is considered desirable, in order to make a comparative analysis of the technologies available. Such a profile should include, in addition to negotiation, licensing, cost data, etc., sources of raw materials, availability of labour skills required, transportation modes, energy sources, market potential, social and environmental impact, technical and techno-economic analysis of the process or device.

40. The Industrial Research and Service Institute (IRSI) is seen as a potential partner in developing a TCP. Admittedly, most IRSIs are presently limited in their capability to perform such tasks. This capability needs to be strengthened, with time, so that the IRSI will be able to assume this role. Financing by industries, industrial associations or development financial institutions for specific technical assistance will be necessary to develop this indigenous capability for the future.

41. IRSI cooperative agreements with IRSIs in developed or developing countries are seen as an effective mechanism for accessing world data banks of information, obtaining advice and technical assistance with regards to specific technologies. Such linkages also require funding support.

42. Engineering consulting firms are also seen as useful sources for specific tecnological information and assessment of this. Cooperation between such firms and IRSIs can be an effective mechanism in preparing the technical aspects of a TCP.

43. Country-to-country agreements for technical cooperation are seen as a good mechanism for accessing technology in which one or the other of the countries has expertise.

44. Technical extension agents can be effective in bridging the gap between IRSI R&D personnel and entrepreneurs, industry associations, and development finance institutions. Such agents can also make important inputs into a TCP.

45. While development finance institutions will have access to certain types of information through INTIB, TIES, and the proposed DB-TIEN, it is clear that such institutions must also support financially the development of indigenous capability within their countries by funding, as a portion of the loan cost or by other means, specific projects involving estblishment of meaningful TCPs.

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