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08145



Distr.
LIMITED

ID/WG.275/7
17 May 1978

Original: ENGLISH

United Nations Industrial Development Organization

Meeting of Government Experts on
Regulatory Functions in Transfer of Technology
Vienna, Austria, 29 May - 2 June 1978
Agenda Item No. II

THE ROLE AND FUNCTIONS OF TECHNOLOGY
REGULATORY AGENCIES IN TECHNOLOGICAL DEVELOPMENT *

prepared by
the Secretariat of UNIDO

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INTRODUCTION

1.1. In recent years, several developing countries have introduced varying degrees of governmental regulation in respect of the inflow of foreign technology in their countries. In some countries, such as India, such regulation has been exercised since the 1960s, but it was mainly since 1971 that technology regulation was extended in several other countries, particularly in Latin America, where specific legislation was enacted in this regard in certain countries, including Argentina and Mexico. At present, regulation of technology contracts is practised in a number of developing countries, particularly where a significant level of industrialization has been achieved. The usual approach has been to entrust this responsibility to an agency within one of the governmental departments. In some cases, the agency responsible for screening technology agreements also scrutinizes foreign investment proposals, as in the case of the Foreign Investment Board in India, while in several other countries, National Registries for Technology or similar screening and registering agencies have been separately set up for this purpose. In Brazil, this function is performed in INPI, which is the national agency primarily dealing with industrial property rights. By and large, however, such regulation has tended to be exercised only in relatively limited aspects in most of the countries where it has been introduced. In some cases there is a close relationship with national agencies dealing with scientific and technological development, while in others such a relationship tends to be rather tenuous.

1.2. Experience of the functioning of such regulatory bodies, which may be referred to as Technology Regulation Agencies (TRAs) indicates that a fairly similar pattern has generally evolved. Most TRAs have hitherto primarily viewed the question of foreign technology in relation to specific contractual terms and conditions under which such technology is imported by enterprises operating within a country. Considerable literature has emerged in recent years on various restrictive conditions often imposed by licensors and technology suppliers and the need for strengthening the weak bargaining position of domestic enterprises, and regulatory agencies have largely tended to ensure that such restrictive conditions are excluded or minimized and that foreign technology inflow is consistent with certain broad national objectives. The degree to which such regulation can be effectively exercised without unduly affecting the inflow of required foreign technology inevitably depends on various factors, including the level of industrial development, the capacity of domestic enterprises, and policies on foreign investment with which technology inflow is often closely linked, particularly in earlier stages of industrial

growth. Considerable knowledge and awareness has, however, undoubtedly developed in respect of the intricacies of technology contracting in countries where such regulation has been introduced, together with the implications and constraints of such regulation in the context of particular country situations.

1.3. The impact and experience of foreign technology regulation in most developing countries where such regulation has been introduced has been fairly positive and has, in fact, highlighted the essential need for such regulation. In most such countries, technology regulation has resulted in significant improvement in the terms and conditions of specific agreements for import of foreign technology and knowhow, together with technological services. Apart from considerable savings in the direct costs of foreign technology agreements, various restrictive conditions sought to be imposed by technology suppliers have been excluded or minimized, placing domestic enterprises in a much stronger position to adequately absorb and adapt foreign technology for their effective growth. In some countries, such regulation has also greatly assisted the growth of technological service capacity. In several countries, technology regulation has also focused attention on the close relationship between foreign investment and technology and the technological implications in respect of enterprises having significant foreign capital participation, including foreign-controlled subsidiaries and affiliates.

1.4. The issues and considerations relating to technology regulation in developing countries must, however, necessarily be viewed in the context of overall industrial strategy and policies relating to a country's industrial and technological development. The regulation of foreign technology constitutes an integral part of the overall framework of national technological development and it is necessary to relate the various issues and implications of technological development with the more detailed consideration of selection, evaluation and acquisition of foreign technology. It is consequently necessary to consider the role of Technology Regulation Agencies against the broader canvas of overall technological development and to discuss the policy and institutional relationships between such regulation and the fulfilment of broader objectives of broad-based industrial growth and development of indigenous technological capability.

1.5. Apart from the broader issues of technological development, it is increasingly being recognized that closer co-operation is necessary among developing countries in respect of technology policies and programmes. Such international co-operation can take various forms and TRAs can and need to play a significant role in this regard.

1.6. It is proposed, in this paper, to review the principal issues relating to technological development and its relationship to the regulation of foreign technology and the role and functions of TRAs. The more specific contractual issues relating to technology agreements have been covered in another paper. A separate paper has also been circulated in respect of technological co-operation between developing countries, which deals with specific fields of mutual assistance and co-operation between Technology Regulation Agencies and between various countries, besides other forms of co-operation which may be necessary at the international level.

I. Pattern of technology flow to developing countries

2.1. The present structure of international industry highlights the concentration of modern industrial and manufacturing technology almost exclusively in industrialized and developed economies. This is combined with similar concentration of production of machinery and equipment and a wide range of technological services, together with concentration of research and development activities in most manufacturing sectors. As developing countries emerge to various levels of industrialization, there continues to be a very high degree of dependence on the flow of technology, capital goods and technical services from developed countries and the gap in technological development and capability has tended to become increasingly accentuated. The structure of industry in developing countries has also largely followed the pattern and structure of industrialized nations - even in the choice of manufactured products.

2.2. In recent decades, industrial technology has increasingly emerged as a marketable commodity and the extent of trade in technology has risen from around US\$ 2,700 billion in 1965 to US\$ 11,000 billion in 1975, largely in the form of lump sum payments, fees and royalties. Most of such technology trade has taken place between enterprises in developed countries, with the U.S.A. continuing to occupy the principal role of technology supplier. While technology payments by developing countries constituted only a small proportion of the total money value of transaction in technology, the magnitude of direct annual payments for technology during 1974-76 was about US\$ 1,000 million. This figure is likely to increase considerably during the next few years with increased industrialization in a larger number of countries. The process of industrialization would continuously generate not only new and increased technological needs to requirements of more sophisticated processes and technologies in certain sectors, which may have to be acquired at considerable cost. It is estimated that the direct costs of technology acquisition by developing countries would increase to over US\$ 6,000 million by 1985. This would still constitute only about 15%

of the total trade in technology by that year if the growth in the volume of such trade is maintained at present levels. Although the projected payments for technology would represent only a small proportion of the additional costs and services produced as a result of such inflow, the physical magnitude of the resources outflows in the case of individual countries is likely to prove fairly significant.

2.3. It is necessary for developing countries to assess the quantum of direct payments for foreign technology, including technical services, in various sectors.

In countries where TRAs have been set up, detailed information is now available regarding such payments. An analysis of these figures can serve as a valuable indicator to trends in foreign technology inflow, both in quantitative terms and in respect of specific industrial sectors. This would also focus attention on whether foreign technology is being acquired in sectors of priority from the viewpoint of overall industrial strategy. In the light of such analysis, TRAs can determine the nature and extent of selectivity that can be exercised in respect of technology inflow. Certain TRAs have initiated studies in this regard which have proved very useful in determining the pattern of future technology inflow considered necessary.

2.4. The question of foreign technology inflow has, however, to be viewed in the context of overall industrial strategy and the essential need for domestic technological development. Consequently, the basic issues and aspects in this regard need to be considered.

II. Industrial strategy and foreign technology

3. Apart from the objective of ensuring rapid domestic technological development, certain basic issues of industrial strategy which can have a direct bearing on policies and programmes relating to foreign technology inflow are (i) policies in relation to foreign investment, particularly foreign branches and subsidiaries; (ii) sectoral priorities; and (iii) programmes for rural industrialization.

4.1. It is necessary to emphasize the close linkage that exists, principally for historical reasons, between private foreign investment and inflow of foreign processes and techniques in developing countries. With foreign branches and subsidiaries occupying a pivotal role in major production sectors in several developing countries, technology inflow has in the past been contingent on investments. With the activities of foreign subsidiaries being primarily governed by the interests of foreign parent enterprises, usually transnational corporations, the flow of foreign techniques and knowhow has been limited to the

immediate needs of such subsidiaries, with decisions regarding techniques and knowhow being taken by foreign parent enterprises. Thus, in extractive industries, foreign technology was initially confined to extraction techniques in the fields of oil, mining and exploitation of other natural resources. In the non-durable consumer goods sector, foreign technology was confined largely to the need for controlling internal markets. In sectors such as drugs and pharmaceuticals, technology supply was related to repacking and formulations, with basic materials and intermediates imported from parent enterprises. In respect of durable consumer goods and most manufactured products, foreign technology inflow was often designed to limit operations to the stages of assembly or semi-assembly. By and large, inflow of foreign techniques in the case of foreign subsidiaries has not only been limited in scope, but has tended to follow the tail-end of technological innovations in parent foreign companies. Research and development activities have also inevitably been conducted in foreign locations and subsidiaries have been wholly dependent on the results of external research.

4.2. In recent years the pattern of foreign ownership and control and technology supply to foreign subsidiaries and affiliates is changing rapidly. Largely under governmental pressure and with increased regulation of private foreign investment, foreign subsidiaries are developing technological capability to a much greater extent to meet targets of domestic integration, exports and the like. At the same time, it must be recognized that investment and technological decisions of foreign-controlled subsidiaries would tend to be governed by considerations other than national, or even pertaining to the enterprise in question. Apart from the nature and extent of technology flow in such cases, payments and pricing of foreign processes and services assumes different forms, including significant elements of transfer pricing in various sectors. There is no simplistic solution to dealing with investment-cum-technology packages, and most developing countries must ensure that the package is appropriate to the needs of the economy. At the same time, new forms of corporate arrangements are being evolved in several developing countries, with mixed capital ownership between foreign and domestic interests. Such "joint ventures" necessitate the identification and determination of foreign knowhow and technological services to a much greater extent than in the case of foreign subsidiaries.

4.3. It is also necessary in such cases, however, to determine the extent of foreign equity participation. Licensees in developing countries are often prone to accept foreign equity participation as generally desirable. This may well be the case where highly sophisticated techniques are involved, where a great deal of "hand-holding" and support on the part of the foreign licensor may be

necessary over a period of time, or where a particular technology is not available, except to an affiliate company. In many cases where techniques can be easily absorbed and where the domestic market has a high and rapid growth potential, foreign equity participation may need to be avoided or kept to a minimum. However, it is precisely in such cases, particularly when the foreign party cannot otherwise enter a domestic market, that technology suppliers would be interested in part-ownership and there has to be a trade-off between technology and knowhow on the one hand and entry into protected or insulated markets on the other.

4.4. National policies on foreign investment can have significant effects on the nature of technology flows and the pattern of technological relationships at the enterprise level. Thus, for certain "high" technologies such as sophisticated electronic or chemical processes, foreign technology may not be available without substantial foreign investment, often in the form of wholly-owned subsidiaries. In other sectors, foreign technologies and knowhow may only be forthcoming if accompanied by majority or significant foreign holdings.

4.5. Technology Regulation Agencies must necessarily view the role of foreign investment in relation to technology inflow and in determining the detailed contractual terms for such inflow. This is obviously easier when the regulatory agency for foreign investment is the same as that for technology, as is the case in India. When the governmental agencies are different, it is necessary to ensure close co-ordination. The nature of such co-ordination and the experience of TRAs in this regard needs to be elaborated.

4.6. A related question is that of capitalization of knowhow costs. By and large, such capitalization should be viewed with care. Even where technology costs are high and constitute a heavy burden on licensee enterprises, especially in new production units, the balance of advantage lies in charging such costs to the cost of manufacture rather than to permit such costs to be converted into equity, constituting a burden on the dividends of the enterprise in perpetuity. The fact that much of the knowhow may be in the form of intangible items is an added reason for non-capitalization. Even where capitalization becomes inevitable because of the oligopolistic situation of the technology supplier, such capitalization should be kept to a minimum and should not exceed a small percentage of the total equity capital involved.

5. The question of sectoral priorities also assumes considerable significance in technological development. The emphasis on particular sectors may vary significantly in the context of policy objectives such as import substitution or a high degree of export-orientation in particular countries. In general, however, certain industrial sectors have a high degree of priority in most countries. These include industries based on natural resources, agro-industries, basic industries related to local factor endowments and certain other sectors of common interest to most developing countries. Technology Regulation Agencies should ensure that inflow of processes and techniques in such sectors takes place to an adequate extent and is, at the same time, consistent with domestic technological development in these sectors.

6. In recent years, considerable emphasis is being given to decentralization of industry to semi-urban and under-developed regions in developing countries. This aspect of industrial strategy can also have a significant effect on technological needs. With increasing emphasis being placed on the need for dispersal of industries to semi-urban and rural areas, developing countries will need to place greater emphasis on processes and techniques more closely related to the needs of such a policy. Certain sectors, such as food products, agricultural imports such as implements, pesticides, most fertilizers and the like, agro-industries, building materials, and a wide range of consumer items including clothing, shoes, household items, etc., would need to be given greater emphasis in terms of dispersed or decentralized manufacture. The greater the extent to which such demands can be served by production units located away from areas of industrial concentration, the greater the direct impact of increased employment income and fulfilment of basic needs is likely to be for a wider section of the population. Technological needs for such dispersed and decentralized sectors could vary significantly as production scales would be different, unit investment outlays considerably reduced and greater adjustment required to local factor situations, including human skills. It may well be that less sophisticated production techniques already utilized in developing countries or being used by small-scale units in developed economies may be more appropriate in this context, both from the viewpoint of costs and other economic criteria. The identification of such appropriate processes and techniques would necessitate a systematic search for such technology in specific sectors, and even the development of appropriate processes through research and development efforts. It is necessary for TRAs to assess technological requirements for the dispersed or decentralized sector in the above context.

III. Basic aspects of technological development

7.1. The issues relating to domestic technological development need to be considered on a comprehensive basis and highlight the essential need for technology planning as an essential aspect of industrial strategy. Such planning must essentially cover an assessment of projected technology needs in the context of a country's socio-economic objectives, factor endowments and level of development, and should thereafter proceed to create the necessary technological infrastructure and institutional mechanisms which are necessary in order that technological needs and objectives are adequately fulfilled within a reasonable time span. Technology Regulation Agencies need to be fully involved in the above process.

7.2. The essential ingredients of a programme of technological development should comprise:

- (i) the identification of technological needs and objectives;
- (ii) the development of an adequate technological infrastructure, including a comprehensive information system and the growth of technological service capability and specialized manpower skills;
- (iii) the creation of institutional mechanisms for evaluation, selection and acquisition of technology considered most appropriate in a given set of circumstances;
- (iv) the establishment and development of appropriate institutional mechanisms for monitoring the impact, absorption and adaptation of various processes and techniques;
- (v) the growth of research and development activities in significant industrial sectors and in basic infrastructural fields such as energy, in close linkage with industrial activities;
- (vi) the defining of policies and guidelines in terms of fiscal or regulatory instruments to encourage indigenous technological development and to ensure adequate inflow of appropriate foreign processes and techniques in critical and priority sectors.

7.3. These aspects are closely interlinked and, although the institutional and policy mechanisms may be covered by several institutions and instruments, an essential feature of technology programming is to effectively dovetail the functioning of such mechanisms so that the various basic issues receive adequate consideration. Such a co-ordinating role may need to be performed by the Technology Regulation Agencies.

Identification of technological needs

8.1. It is necessary to define the extent and nature of technological requirements at various stages of industrial growth. Obviously, technological needs would vary considerably, depending on factor situations and circumstances. Technological needs have to be identified both at the macro-level in relation to sectoral priorities and at the micro-level of individual industrial enterprises. At the macro-level, sectoral priorities are normally identified through national plans and growth strategies. At the technological level, these have to be broken down in terms of process or production knowhow, supply of technical inputs, provision of technological services and the like. Once such needs are identified, the task of TRAs, in conjunction with other promotional agencies, is to ensure that technological needs are adequately met. At the micro-level, technological needs comprise principally aspects such as improvement of productivity, quality control, institutional technical support to industry, including information linkages and the like, which relate primarily to the workings of individual enterprises.

8.2. An assessment of technological needs would highlight not only the gaps in technology in significant and critical production sectors, but would also indicate the pattern of appropriate technological development. The extent to which large-scale production and highly capital-intensive techniques can be increasingly effectively substituted by more appropriate technologies, with greater labour intensity and relatively smaller-scale production, which are more directly related to the smaller markets in developing countries, undoubtedly needs to be investigated. At the national level, consideration of appropriate technological alternatives must be viewed as the responsibility of TRAs, as selectivity in foreign technology will often need to be exercised in this context. While the choice of techniques is the ultimate responsibility of user enterprises, TRAs can and should play a significant role in providing suitable guidance with regard to foreign technology which would not be appropriate or suitable from this viewpoint. This can impose a heavy burden on TRAs in terms of definition of norms and guidelines regarding the use of more appropriate techniques, particularly for small and medium industries. Appropriateness or otherwise has to be viewed in the context of a given situation. For products which must compete in international markets, the most efficient techniques may obviously be the most appropriate and, in several sectors, it would undoubtedly be necessary to use sophisticated, capital-intensive techniques, particularly where economies of scale or the basic nature of manufacture permits no viable alternative. At the same time, the pattern of human skills, the relatively smaller markets in most developing countries, the limitations of investible

resources and entrepreneurial initiative and a wide range of other constraints must also inevitably be determinant factors in deciding appropriate technological usage. It may be necessary for TRAs to provide necessary initiative and guidance in this regard, suitably backed by their regulatory authority.

8.3. The identification of technological needs and the consideration of more appropriate alternatives should, therefore, have a significant bearing on the role and functions of TRAs. Such identification would both pinpoint the fields in foreign technology which may be considered necessary, as also sectors where such inflow may have an adverse impact on domestic technological development or where adequate technological expertise may be domestically available. It is only through such identification that selectivity can be effectively exercised. The unrestrictive flow of foreign techniques and processes in all sectors may have significant techno-economic impact, not only on recipient enterprises, but also on overall sectoral growth and on domestic technological expertise. Recipient enterprises in developing countries often have a tendency to remain highly dependent on foreign technology suppliers, particularly where unrestricted technology inflow is permitted and such arrangements are allowed to continue for indefinite periods. This may also serve as a disincentive for other enterprises to use indigenously developed processes and products. Apart from the adverse effect on technological development, competition to import foreign technology and knowhow in the same field or for similar products becomes as much a question of foreign brand name as the use of imported processes or techniques. Nevertheless, it must be emphasized that significant flow of industrial technology in selected growth sectors must take place to developing countries if industrialization in these countries is to be broad-based and sophisticated. In the increasingly complex economic society, based on close international inter-dependence, developing countries cannot afford to be isolated from the mainstream of international technological development and the various mechanisms of technological exchange must ensure that adequate and suitable technology flow does, in fact, take place in developing countries in identified and selected sectors of growth.

8.4. The role of Technology Regulation Agencies must, therefore, extend beyond the exercise of purely regulatory functions, as these agencies must also ensure that technology inflow does take place in the sectors where such inflow is considered necessary. While technological needs may be identified by other agencies, these needs must be dovetailed with effective acquisition of appropriate technology in the selected sectors. In certain countries, such as India, certain fields have been defined in which foreign technology and knowhow is considered necessary. At the same time, several other sectors have been

identified in which foreign technology is not permitted on the grounds that indigenous technological capacity has been adequately developed. Such sectoral lists would necessarily need to be continually reviewed in the light of rapidly changing requirements. Developing countries would need to consider whether a similar approach could be adopted in the context of their respective requirements. This task would necessarily have to be discharged by TRAs, in consultation with other policy-making institutions.

Technological infrastructure

9.1. The development of technological infrastructure is also a basic aspect of technology planning with which TRAs need to be actively associated. The gaps in such infrastructure need to be defined for each developing country in terms of (i) information networks and (ii) technological service capability, including consultancy and engineering services.

9.2. An essential feature of technology planning is the creation and development of an adequate information network which can ensure a flow of fairly detailed data and material regarding production and technical requirements projected over a period of time and provide, at the same time, alternative sources of technology, both indigenous and external, in various sectors and enterprises. A comprehensive technological information system at the national level is an important requirement for developing countries, which needs to be closely co-ordinated with the activities of TRAs.

9.3. Inadequate technological service capability constitutes a major constraint in most developing countries. Such services range from macro-level industrial planning to micro-level project identification, feasibility studies, plant specifications, detailed engineering designs, civil constructions and machinery installation, and plant commissioning, start-up and operations. While the extent of the gap varies from country to country, the most significant gap is in respect of detailed engineering and designing and sectoral consultancy services through nationally-owned units. This makes disaggregation of imported technology packages extremely difficult and also creates a critical infrastructure gap, resulting in undue dependence on foreign designs and engineering services, with consequential impact on the pattern of investment for particular projects, the requirements of capital goods and equipment and subsequent plant operations and management. In the lesser developed countries, the gaps in consultancy services are even more marked and extend to almost the entire range of service activities indicated above. The identification of gaps in service capability has to be done both on a country-wide basis and for critical and priority sectors in each economy.

Once such gaps are identified, TRAs need to prescribe suitable policy provisions to ensure that domestic service capability is adequately encouraged and developed.

9.4. A close relationship should therefore exist between the development of domestic technological infrastructure and the effective functioning of Technology Regulation Agencies. A TRA cannot discharge its role adequately without the support of an effective information network which would, on the one hand, provide data regarding technological requirements and, on the other, identify technological alternatives, both foreign and indigenous. The linkage between the information system and the technology agency can take various forms. In some cases, the TRA itself may gradually develop an information system, particularly in respect of technological alternatives available in different sectors. Alternatively, the information system may be external to the TRA but close linkage needs to be maintained between the technological information agency and the TRA. The experience of TRAs in this regard would enable further elaboration of the nature and extent of such linkage which may be necessary, in order to enable both agencies to function effectively in respect of technological selection and evaluation.

9.5. As stressed above, TRAs need to play an active role in the growth of national technological service capability. This can be effectively exercised through detailed scrutiny of foreign technology proposals and relating such scrutiny with the use of domestic service capability to the maximum extent possible. Such capability can only grow through a deliberate policy of utilizing such capability as is nationally available, even in cases where foreign technology is acquired. Consequently, the preparation of feasibility studies, civil constructions and plant commissioning should normally be done only through national agencies. Over a period of time, domestic consultancy services should be developed to take over the preparation of detailed engineering, plant designs and the like in various sectors. While several TRAs have sought to ensure that national services capability is utilized as far as possible and the size of the foreign technology package is correspondingly reduced, it may be necessary to adopt stricter regulation to achieve the effective growth of service capability, especially in respect of detailed engineering and more sophisticated technical services. One approach adopted in this regard has been to insist on domestic agencies being appointed as prime consultants in the course of scrutiny of foreign technology proposals, with only such elements of engineering and other services being imported as cannot be provided locally. In such cases also, it is necessary to review, on a continuous basis, the functioning of domestic service agencies, so that with successive projects in the same sector being implemented, a larger share of such services are available from domestic sources. Such continuous

review of domestic service capability is also an important function of TRAs.

Monitoring of technological changes

10. It is important that the incidence of technological changes, and particularly of foreign technology inflow, should be regularly monitored so that there is constant feedback regarding the impact of foreign technology or domestic technological progress in specific sectors, and changes in technological needs and indigenous technological capability can be assessed and reviewed from time to time. The absorption of foreign techniques and processes and their suitability in a particular environment also needs to be assessed periodically. Such monitoring would enable the identification of sectors where adequate domestic technological capability has been developed, either through indigenous research and development or through absorption of foreign technology, and which could be utilized by other manufacturing units without taking recourse to further import of technology in the same field. The role of such monitoring should be effectively exercised by TRAs and the results of such analysis embodied in policies relating to technology regulation in various sectors.

Technology institutions and TRAs

11. It is necessary to establish close relationships between TRAs and the wide range of institutions dealing with technological investigations and research and development which have emerged in several developing countries. While the overall technological impact of such activities may be fairly significant in some countries, the linkage and communications with the production sector have tended, by and large, to be inadequate. Domestic enterprises have tended to rely largely on external technological links, as these appear easier in practice and timing and are usually more rewarding commercially. Barring certain instances, the production sector in most developing countries has utilized national research facilities only to a very limited extent in resolving technological problems. This, in turn, has slowed the growth of these institutions as centres of research having direct application to industry. The pattern is gradually changing, but slowly, and the pace of industry-research linkage needs to be accelerated. The commercialization of research and development results from most such institutions in developing countries has also had only limited success, again principally because of inadequate linkages with industry. Close inter-relationship between TRAs and such institutions should greatly assist in the research and development of rations being more directly related to domestic technological needs.

Policy instruments and TRAs

12.1. It is also necessary to establish close relationships between TRAs and other policy instruments that can play a significant role in technological change.

Such instruments can relate to planning, regulation of production capacity or the defining of new and necessary industries, controls over majority foreign equity holdings, employment of expatriates, controls over imports, incentives for exports and import substitution, various forms of financial assistance and incentives for small-scale and rural industries and the like. The complex issues of industrial and technological growth necessitate that various governmental agencies play a co-ordinated and complementary role.

12.2. Apart from various aspects of technology regulation, such policies and mechanisms may need to be defined in respect of (i) the role of private foreign investment, both existing and new; (ii) incentives and measures to encourage domestic technological growth, including tax rebates for research and development; (iii) incentives and measures to promote domestic technological services, particularly consultancy and engineering services, including tax relief; (iv) appropriate fiscal measures to encourage domestic technological capability; and the like. Such policy measures and instruments relating directly to technology must be formulated in the context of each country and should be closely inter-linked with the objectives and functions of TRAs.

IV. Nature of technology inflow and TRAs

13. While the above issues relate primarily to overall aspects of technological development and the inter-relationship between such aspects and the functions of TRAs, it is also necessary to consider certain other critical aspects regarding the nature of foreign technological inflow and the role of TRAs in this regard.

Turn-key operations

14. Project implementation in earlier stages of industrial growth often takes the form of a turn-key arrangement, where a single foreign party is entrusted with full responsibility for all or a number of stages of implementation. This form continues to be used, even after a country is fairly developed, for complex projects such as a refinery or a petrochemical complex or a steel plant. It is also common in "tied-aid" projects, where project financing is linked to a foreign engineering group being entrusted with such responsibility. The turn-key contractor can be the supplier of equipment or the owner of a particular technology, or an engineering consultancy organization, depending on which of these aspects is the most significant for the project. Recipient enterprises must, however, ensure that (i) plant capacity is related to market potential; (ii) technology is appropriate to domestic factor endowments, including growth potential of skills;

(iii) adequate provisions are made for training of local personnel to take over plant operations after start-up; and (iv) adequate tests or trial runs are provided as part of the take-over procedure. It is also essential to avoid such a contract becoming unduly expensive. This is usually difficult to evaluate, as the cost tends to be packaged, but it should be disaggregated as far as possible. In general, turn-key arrangements, though convenient for project implementation, are likely to be more expensive than if the various elements were separately contracted. Even more important, however, is the fact that turn-key contracts tend to inhibit the growth of domestic engineering services, since the technology package in such cases is undoubtedly more comprehensive. Turn-key contracts are looked upon with disfavour in most developing countries where there has been substantial industrial growth, although in certain cases they still continue to be unavoidable. In some countries, however, the concept has been extended to include demonstration of efficient operations and even profitability. This may prove necessary in certain cases, but the costs of such an arrangement are inevitably very high, apart from the impact on domestic technological growth. It is necessary that TRAs should scrutinize proposals relating to turn-key arrangements with particular care.

Reduction of technology package

15.1. Even when a turn-key arrangement is avoided, technology inflow may still cover most stages of project implementation, ranging from feasibility studies and basic engineering through detailed engineering, product or process technology, plant engineering and construction, selection of machinery and initial post-installation operations. From a national viewpoint, it would be desirable that, with progressive industrial development, the size of the imported technology package should be gradually reduced. Even in relatively industrialized developing economies, the technology package often continues to comprise a wide variety of technological services, besides process or product knowhow. Disaggregation of the cost of knowhow and of technological services such as plant engineering, etc. is necessary and such services need to be replaced gradually by national enterprises. The manufacture of industrial materials and inputs should also not be allowed to lag far behind, as this results in continued dependence on the technology supplier for supplies of a wide variety of materials and parts. There is growing awareness of the potential for abusive transfer pricing of such materials and inputs, but this can be tackled effectively only if production of such inputs keeps pace with that of finished products.

15.2. It is necessary for TRAs to play a significant role in the "unpacking" of technology and reducing the size and magnitude of the imported technology package. The pre-investment stage comprising the initial feasibility study and the detailed project report covering the principal techno-economic aspects should increasingly be undertaken by national agencies. Where this is not possible for reasons of project complexity, TRAs should ensure that domestic agencies should be closely associated with the preparation of the detailed project studies. Basic and detailed engineering, including plant designs, would initially need to be imported, but domestic agencies should be increasingly associated. Civil construction and ancillary services should normally be provided by domestic agencies and enterprises, to the maximum extent feasible. Such services are usually available and the induction of foreign agencies often constitutes a major disincentive to domestic consultancy services and construction capability. In machinery selection, erection and installation also, TRAs should ensure that foreign technological services are kept to the minimum necessary. It is principally in respect of manufacturing technology that acquisition of foreign processes and knowhow becomes necessary, and in this regard it is necessary that acquisition is full and complete. In respect of the post-installation stage covering management, including marketing and distribution, it is common practice in many developing countries to enter into management contracts with foreign agencies. While this may be initially necessary, the period of such contracts should be kept to a minimum and adequate training and association in management must be ensured.^{1/} These functions are, of course, closely inter-related and merge into one another. It is, however, necessary for TRAs to define the specific role and responsibilities at each stage, so that foreign expertise and technological services are secured only to the extent necessary, to complement domestic capability as may be available or as can be developed.

TRAs and recipient enterprises

16.1. A significant issue that also needs to be considered is the relationship between TRAs and recipient enterprises in developing countries. It must be stressed that the use and application of acquired technology is at the enterprise level, either in the private sector or in state enterprises, which are assuming considerable significance in several developing countries. Consequently, negotiations with technology suppliers should normally be conducted at enterprise level, with TRAs exercising primarily second-check functions to ensure that technology inflow is consistent with overall national interests and policy objectives and that the technology is suitable from an overall policy viewpoint and is acquired on equitable terms and conditions. While the latter aspect operates normally to the advantage of the recipient enterprise, there may be considerable divergence of approach and views between TRAs and recipient enterprises

^{1/} These aspects are further discussed in Agenda Note on item II.

on the former.

16.2. Recipient enterprises should, however, be made aware of the policies and guidelines regarding the nature of technology which would be permitted to be imported and terms and conditions which may be acceptable to TRAs. They should also have access to the information system, which would provide adequate data and material regarding technological alternatives both within the country and from alternative external sources. Thus, TRAs have to set out the broad policy framework and guidelines for foreign technology inflow, while the related information system should provide the necessary technology information base regarding alternatives, so that recipient enterprises can select and negotiate suitable arrangements. In some countries, guidelines are prescribed but are not published for general information. This may place both potential licensors and licensees in difficulty and may prolong the negotiation process. Such guidelines are necessary so that no undue advantage is taken of the weak bargaining position of developing country licensees: at the same time, these prescribe the policy framework for foreign technology inflow. In most developing countries where regulatory agencies have been set up, such guidelines tend to follow a fairly similar pattern. A model set of guidelines, however, needs to be prepared for the use of developing countries which may be proposing to establish regulatory arrangements.

16.3. The methodology for evaluating technological alternatives in developing countries also requires significant improvement. With limited knowledge and awareness of such alternatives and their implications, recipient enterprises often do not evaluate technology costs in cost-benefit terms. In certain national regulatory bodies, attempts are made towards evaluation of individual technology proposals in terms of foreign exchange costs of direct payments and future imports of materials and components as against foreign exchange savings in the form of export earnings or import substitution. Appropriate methodology needs, however, to be developed, both at the level of recipient enterprises and TRAs, to evaluate alternative technologies in terms of overall costs and benefits. This could necessitate the defining of numerical values for critical parameters such as labour costs and shadow wage rates, foreign exchange costs and shadow prices and thereafter the application of a discounted cash-flow approach. While the information network should provide the basic information regarding alternative production techniques, the evaluation of alternatives would necessarily require to be carried out by recipient enterprises, with TRAs exercising review functions.

16.4. The governmental role in technological choice and selection in developing countries inevitably needs to be extended, as the wider implications of such choice and its impact on industrial and technological development can be of great significance in almost all production and manufacturing sectors. A number of factors, such as the influence of transnational corporations, historical preferences for foreign products and brand names, lack of knowledge regarding alternatives and the relatively easy mechanism of foreign technology acquisition, have combined in the past to channelize scarce investible resources in developing countries towards an industrial technology pattern wholly similar to that in developed countries. While this may be necessary and unavoidable in several fields of manufacture, priorities and objectives in developing countries can be significantly different and must be adequately provided for, in terms of principles governing technological choice and selection. The role and functions of Technology Regulation Agencies are vital and significant in this context.

V. General conclusions

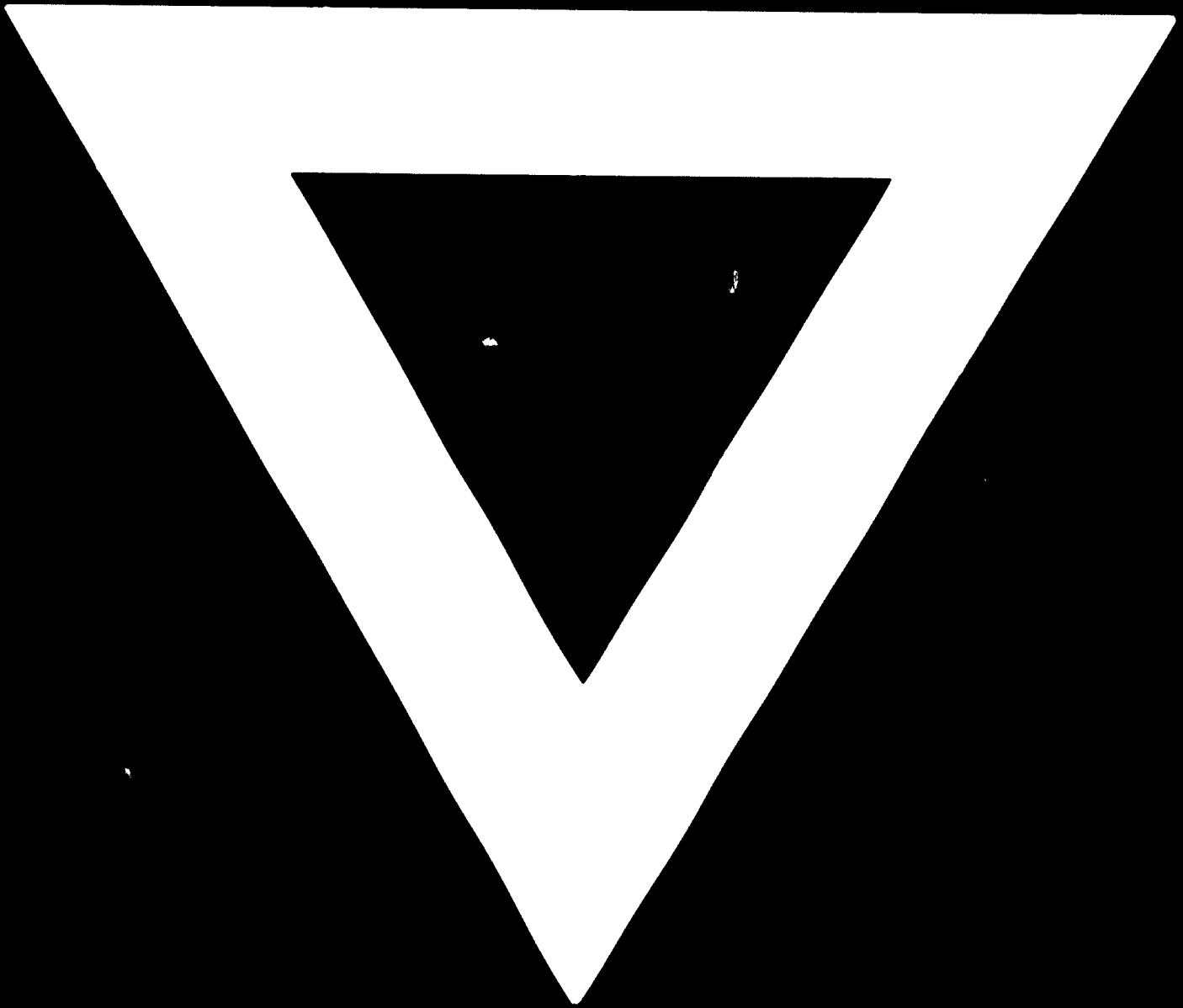
17. Regulation of technology in developing countries is increasingly emerging as a useful and powerful policy instrument and has yielded very positive results in ensuring that such inflow takes place on more equitable terms and conditions.

Such regulations must, however, be considered against the broader perspective of national technological development and rapid growth of technological capability in developing countries. This necessitates that the issues pertaining to choice, acquisition and adaptation of foreign techniques and processes must be directly related to basic industrial strategies and policies, such as those relating to foreign investment and domestic capital ownership, fulfilment of sectoral production and technological objectives and extending the benefits of industrialization over as wide a section of the population as possible. These and other policy objectives have a vital impact on technological choice and close co-ordination and integration is needed between such policies and the functioning of Technology Regulation Agencies. At the same time, the development of domestic technological capability requires the identification and fulfilment of technological needs and the development of necessary technological infrastructure in terms of a comprehensive information system on alternatives and trends, growth of service capability in various sectors and adequate capacity for technological absorption, adaptation and innovation. A close and co-ordinated relationship between TRAs and national institutions responsible for one or other of these functions is consequently an essential prerequisite for overall technological development.

18. It must be recognized that most TRAs are not at present in a position to effectively discharge the broader role and functions, together with the policy and institutional relationships envisaged above. Most such bodies have confined their activities largely to regulation of terms and conditions and have not had the scope or opportunity to extend their functions to the broader perspectives and issues discussed above. These policy and institutional issues are, however, basic to effective technological progress at the national level. It would appear necessary, in this context, to consider the establishment of a more comprehensive executive agency, such as a National Board for Technological Development, which could be directly responsible for the broader role and functions envisaged above, with TRAs serving as the nucleus and service agency for such an organization. It is only perhaps through such an executive and operational organization, covering various facets of technological development, that the complex and far-reaching issues of domestic technological capability can be effectively tackled in most developing countries. It must be stressed that the concept of a high-level Board of Technology and Development, with extensive executive authority over the various institutional agencies concerned, would be a fundamentally different organization than the more limited current concept of Transfer of Technology Centres, which may not be in a position to discharge the complex and manifold policy and executive responsibilities and functions that are essential if domestic technological development is to become an effective reality in developing countries.



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