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METHODOLOGY FOR ANALYSIS OF OBSTACLES AND THEIR REMEDIES IN TECHNOLOGY TRANSFER IN THE ARAB REGION

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* The opinions expressed in this document are those of the author and do not necessarily reflect the views of the United Nations Economic Commission for Western Asia.

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I.1 The Analytical Concept

At the United Nations Conference on Science and Technology for Development. Vienna August 1979 a problem developed concerning the setting up of some realistic goals and the cost of achieving them. The draft plan of action and the expressions used had wide ranging meanings and thus wide ranging impacts on countries whose circumstances, problems and needs differed to a great extent. There were mainly two categories of nations in the debates; developed and developing. But the issues discussed could not have similar impacts on Romania and Somalia for example although both were referred to as developing countries within the group of 77. The geographical grouping did not simplify matters much either as countries like Nepal, India and South Korea have different if not contradictory interests dealing with issues related to TNCs, scientific research or information networks etc. To clarify matters for rational identification of the most pressing problems and setting of priorities and realistic goals, such broadly stated objectives and ideas as strengthening of scientific and technological capacities or information networks or the science and technology component of a project need to be further defined. Countries of the Arab region, for the purpose of analyzing their scientific and technological requirements can be divided into three categories reflecting the availability of financial, natural and human resources.
As to strengthening the scientific and technological capacities, it is necessary to examine the present capacities and how are

they actually employed in the country's development process. Field information is needed, in order to establish a bench mark for present capacity status, shortcomings and what is being done for their development. Evaluation is needed for what actually goes on at the project implementation level where technology choice, adaption, acquisition, application and hopefully transfer is taking place. Science and technology as components of the implementation programmes need to be factorized into their primary elements for various fields of sectoral activities. For each element such as studies - design - supervision - implementation - operation etc. and in each sector the obstacles which contribute to capacity shortcomings are to be identified and a suitable solution for each obstacle as remedy need to be considered.

Concerning the issue of scientific and technological information, clear distinction is needed between proprietary information developed and owned by private enterprises whether kept as industrial secrets or merely protected by patent laws on one hand and non-proprietary information publicly and freely disseminated such as design and construction criteria for dams, highways, irrigation systems, land reclamation and agricultural development projects etc. on the other.

Clear distinction is made between scientific undertakings and technological undertakings. In this regard it is worth noting that when science is applied to development it usually takes the form of a well defined technology such as water treatment or a solar energy irrigation pump or hydroponics as an agricultural practice.

Reference to science imply research and development. While scientific innovations are needed for new development patterns alternative to the path which the developed nations did follow with all the misgivings often referred to as mal-development, the developing countries enjoy the benefits of having advanced warning against those aspects of mal-development which can probably be avoided. And for that, existing scientific knowledge and available technologies can offer a wide scope of choice. Due to the long-term nature of scientific innovations in terms of their applications to development projects, R and D for such innovations should run parallel to the applications of well-chosen conventional technologies provided that it does not pose a serious threat to the availability of scientific and technological capabilities and manpower. In the industrial field, distinction is needed between R and D for industries whose products meet objective consumer demands for technical performance, quality, or standards (typically, science based industries), and R and D for industries whose products meet subjective consumer demand (typically, non-science-based industries).

It is the second type of R and D activities which deal mostly with process adaptation to local conditions (labour and other inputs) etc. which is justifiable for countries of larger population and economic difficulties while countries of the other two categories endowed with oil revenues can plan policies employing the first type as they can fruitfully invest in R and D with the objective of inventing alternative technologies. Alternative technologies as some forms of intermediate technologies may demand science intensive sophisticated research activities. Greater awareness of the nature and benefits of alternative technologies need to be developed in the Arab region where its immediate image along side that of intermediate technologies have already been regarded as a new form of "Apartheid" - technology for North vs. Technology for South - Technology for rich vs. technology for poor.

For a process of development to be self-sustained, flexible, self-correcting and responsive to social and economic change, it is necessary to "Internalize"the machinary of that process. Until a certain degree of progress towards internalization is achieved such issues as choice of appropriate technologies, development and strengthening of endogenuous technologies, science and technology planning and strengthening of capabilities remain merely polemics or rhetoric. The first step towards internalization of the development machine is to involve to the greatest possible extent the internal scientific and technological community in the operation of that machine. Greater than usual effort is needed and scientists and engineers of a developing country must be required to play a larger role than their counterparts in developed countries. Unfortunately in the Arab region as a whole the situation is in reverse. Scientists and engineers are not given the role their counterparts in developed countries play and considerable part of the blame for the unusually heavy state of dependency prevailing in the region is due to this phenomenon of drastic under-utilization of available manpower. The heavy dependence on expatriate operation of the development machine can be held largely responsible for the slow pace of real development being achieved inspite of the enormous investments made.

The analysis is based on an estimate of the degree of dependency a country is suffering from in the use of existing operative technologies in various sectors of the economy and the factors which are contributing to the said state of dependency in any such sector regarding the application of each technological operative element such as feasibility studies, design construction or manufacture, operation, maintenance etc. The said factors are listed in a list of obstacles to each of which a symbol is assigned. Another list is prepared from a selected number of remedies suggested on various occasions; national, regional and background papers, other studies and personal experience. Special effort is made to find remedies which are concrete and obstacle-specific. But due to the complexity of most obstacles, the country analyst will have to do the selection from an illustrative list of such remedies to which he may add his own. In any case the identification or even the mere association of certain obstacles causing a certain degree of dependence concerning a specific element in the S and T dimension of an economic activity with certain concrete remedies should help the science and technology planners move closer towards their goals within their respective spheres of activity. To summarize, the analysis covers five variables needing evaluation or identification on the country level as follows:

1. Areas of economic activity with dependency problems.
2. Elements of the technology dimension in the particular area.
3. Degree of dependency for each element.
4. Obstacles causing the dependency.
5. Suitable remedies.

Once such data are collected from a choice of representative projects, the cost/benefit dimensions can be more readily visualized as inputs to determine priorities. In view of this and considering the regrouping of countries of the region according to additional more basic factors such as oil revenues and human resources, the basis for regional and subregional activities can be considered.

The remedies - usually science and technology intensive development projects or legislations with their costs and anticipated results, can serve as valuable inputs to the process of physical and economic planning of the country while they constitute effective contribution to strengthening national infrastructure, especially utilization of national resources and managerial capacity, in addition to its intended contribution to the strengthening of the scientific and technological capacity of the country.

This analytical approach is intended for assisting countries of the Arab region in identifying and formulating projects for financing by the Interim Fund, individually or in cooperation with one or more other nations.

I.2 The Science and Technology Issue in the Arab Region

Historically, scientific and technological innovations and their applications played key role in shaping the well known civilizations flourished in Arab area for millenia. The wheel was invented and used for the first time in ancient Syria and Iraq. In Yemen Arab Republic about 130 kilometers east of the capital Sanaa still standing high are the stone masonry spillway and abutments of Marib Dam constructed around 500 B.C. reflecting knowledge of basic principles in hydraulic engineering still in practice by the modern dam designers of today. The region pioneered in monumental construction of buildings, pyramids, palaces, irrigation networks, ships with the production of whatever inputs required. Chemicals such as arsenic and alcohol and textiles etc. were produced and partly exported to Europe until as late as the sixteenth century.

Complications brought about by foreign domination - the Ottoman occupation, tariffs and trade practices introduced at the late seventeenth century led to competitive forces contributing to a prolonged process of de-industrialization with the artisans and craftsmen gradually loosing their business, social status and eventually skills giving way to cheaper imported goods. The final result has been near total disappearance of all endogenous technological capabilities.

Now, with tens of thousands of engineers mal-employed throughout the Arab region, even dams lesser in size, value or significance than Yemens Marib dam or Egypts pyramids and irrigation networks smaller than the ancient Nahraran Canal system in Iraq are planned, designed, and constructed by expatriates and transnationals.

The implications of the picture depicted above are not the same for the entire Arab region due to the marked variation between the circumstances of the individual countries, historic background, socio-economic setting, population natural resources etc. In fact what characterizes the region most are the great disparities in the above parameters, which have important impact on the course of their developmental policies and the application of science and technology to their development. The United Arab Emirates for instance is seeking capital intensive advanced technologies due to its shortage of existing and potential human resources. The case is exactly opposite for Sudan which is relatively populous having diversified under-utilized natural resources and is short of capital.

In view of the above and notwithstanding that all Arab countries are in the group of 77 and undoubtedly under-developed, they can be regrouped under three different categories of more or less similar circumstances. Some countries can be treated as belonging to more than one category.

CATEGORY I - Countries relatively large and rich with human and other resources and oil exporting. Such as Iraq, Algeria, Libya, Saudi Arabia, Kuwait and Oman.

CATEGORY II- Countries relatively large and rich with human and other resources without significant oil exports. Such as Morocco, Tunisia, Egypt, Sudan, Somalia, Mauritonia, Syria, Jordan, Lebanon, Yemen (AR) and Yemen (PDR).

CATEGORY III- The smaller states regarded as rich oil exporting countries which lack human and other material resources. Such as The United Arab Emirates, Bahrain, Qatar and Kuwait.

Countries suffering from the obstable "Mal-utilization of available manpower" fall in Categories I and II while countries of the Category III seem to be managing remarkably well combatting the said obstacle-Kuwait in particular.

Thus the technique of studying the obstacles which seem to be more dominant in one group of countries in view of how the same obstacles are being more successfully dealt with in another group may bring to light the hidden causes and suggest more practical cures to those obstacles.

It is hoped that an analysis of the status-quo in the Arab States individually and their comparison may lead to re-evaluation of the remedies long practiced and still being recommended inspite of their failure to cure the ills. One common cure on which hopes were hinged for deca es and still in favour is to graduate more engineers. But adding tens of thousands of engineers of all levels and specializations in both Egypt and Iraq did not help these two nations be self reliant in designing and constructing pipelines or cement factories which technologies existed and practiced in both countries for decades. The training of so many engineers without establishment of appropriate institutions for their propor utiliazation has created an over supply of engineer dumped in the market place. Another myth is constructing new irrigation and drainage projects with the help of dams and storage reservoirs. In spite of investing billions of dollars on such projects in certain parts of the Arab region agricultural production has remained almost flat, while billions of cubic meters of fresh water is lost annually from the surfaces of those reservoirs by evaporation. This indicates exaggeration and misappropriation of emphasis in the application of technology to development. There are similar examples in the industrial sectors of countries of Categories I and III where industrialization has brought about greater dependence.

Countries of these two categorees (I and III) can afford to take a fresh look at their agricultural policies and choice of imported technologies for better compatability with ecological factors. It is here where expenditure on scientific research can be boosted to absorb to potential capabilities of the thousands of misplaced scientists of the Arab region. And as economics are not real constraints escalated R and D activities may attract healthy cooperation with other regions developed and developing. The work of the Kuwait Institute for Scientific Research (KISR) can serve as a model to other countries in the above categories.

I.3 The Mechanism of Mal-Utilization of Trained Manpower

Similar to the phenomenon of "stagflation prevailing in the USA" the Arab region is inflicted with the phenomenon of high degree of dependency coupled with an apparent over-supply of scientists and engineers. In some countries of groups I and II the rate of training scientists and engineers exceeded the rate of growth in jobs suitable for them. This is true particularly during the period which followed national independence when countries lacked the experience and institutions needed for employment of the newly educated and trained specialized manpower. It was common to see an agricultural scientist teaching English language in high school for example. The luckier ones filled administrative positions in government offices where little demand existed for their skills which eventually became obsolete. Unable to cope with the newly arising technology intensive opportunities and lacking confidence in themselves coupled with other influences and factors they refrained from entrusting the younger newcomers with technological tasks which they (the older administrators) could not adequately supervise and assume responsibility for. This led to the growth of marginalized trained and specialized at the same time low paid manpower who in turn gradually became obsolete by the time they arrived to responsible adminstrative positions and the cycle went on repeating itself from one generation of scientists and engineers to another. The process exacerbated by social and economic factors and life-style led to the creation of a new breed of scientific and technological executives to whom broadenning of the information base was neither interesting nor necessary. An engineering college dean who did not know what was a transister was not ashamed since his defunct PH.D. was only in civil engineering. A mechanical engineering professor with 20 years of teaching experience would not feel embarassed not knowing what went wrong with the simple motor of his Volks-Wagen beatle since his thesis was limited to Jet-noise. The same professor would argue that his own students would not merit responsibility after graduation and would advise his government to continue to rely on expatriates of the same formal training and age. He would continue to teach the same way without suggesting any change for a remedy. This breed of scientific and technical executive usually act as obstacles to the transfer and development of technology.

The need for broad-based multidisciplinary technical managers is greater in developing nations than in the developed. This is due to the weakness in institutional infrastructures where trained scientists and engineers can be fitted to play the role prepared for them by the institution. The broad-based multidisciplinary engineer can select the manpower required to perform a certain duty and assign to each person his defined role as in the case of a good orchestral conductor in the process of forming a new symphony orchestra. After the orchestra has been established and in operation, any guest conductor even an amateur can do the conducting.

In short, as a quick solution to the problem of institutional constraints developing countries need to strengthen their multidisciplinary manpower "the GENERALISTS".

The circumstances which prevailed in some countries of group II and in almost all countries of group III being different during their own transitional periods, the above pattern did not develop. Lebanon and Kuwait for instance have done remarkably better in the utilization of their trained manpower although they both could do much better yet. Both countries are still suffering from an apparent oversupply of marginalized scientists and engineers and institutionalized capacity.

Government bureaucracies contribute to mal-utilization by absorbing large numbers of scientists and engineers who are usually engaged in functions which do not contribute to their professional expertise. This leaves a small supply of ambitious professionals thriving on a trickle of opportunities left over from TNCs' operation and are usually performing under adverse legal settings.

The high standards required to satisfy consumers of the most affluent societies of the western industrialized world are usually reflected if not coherently built into standard specifications, design and construction procedures. They are also reflected in the education and training of engineers of developing countries whose majority of population are neither interested nor willing to pay the cost of such standards. Engineers with the limited means and resources available to them are sometimes left helpless in trying to satisfy those standards imposed by imported specifications and contract documents. Projects and Products can be engineered-down for more efficient utilization of available resources both human and material.

I.4 Development Projects and their Analysis for Technological Dependence

Most development projects, and at every stage of their progress; be it the stage of its identification, pre-feasibility studies, feasibility studies, planning, design, procurement and selection of consultants, contractors and their supervisors, construction, fabrication, manufacture, erection, test running, operation, maintenance, expansion etc. entail technological capability. When developing countries lack such capabilities in the implementation of any national development project, they resort to outside help which results in a state of DEPENDENCY. Dependence is a variable entity. The elements of technological capabilities needed for the implementation of a national development project combined have been referred to as the S and T Dimension of the project and the process of enabling a country to become less dependent on outside help with regards to that Dimension is in effect the main factor in STRENGTHENING OF THE S AND T CAPABILITY of that country. In every country there are efforts to accomplish this goal of strengthening to reduce dependence and there are OBSTACLES which reduce the effectiveness of those efforts.

The obstacles can be very intricate and may represent sticky issues. To deal with these obstacles in general terms have in many cases proven to be illusive. A detailed analysis of these obstacles and the degree with which they are felt in the process of strengthening the national capability for each element of the S and T dimension, AT WORK IN REAL LIFE is needed in order to find the cure and enhance the process of scientific and technological self reliance. Obstacles and cures have often been subjects of heated debates in the Arab World. Government planners defend their heavy dependence on outside help by pointing to the disparity between the number of engineers and technicians per capita in their countries and that in self reliant developed countries and to the enormity of development projects undertaken in their respective countries. Yet the number of scientists and engineers among the citizens of the same country who cannot find suitable positions and being forced to seek such positions elsewhere (the brain drain) is on the increase pointing to the existence of an apparent over-supply of highly qualified manpower.

It is a well known fact that many projects implemented in certain developing countries serve as training grounds for expatriates while nationals of similar scientific and technological backgrounds who are eager to receive the training and experience served remain deprived. Such a situation constitutes an obstacle applicable to almost every sector and common to many developing countries. No ready formula is available as a remedy for this kind of obstacle. But further narrowing of the areas of impact and what degree of dependency it is causing with cost tag becoming more evident, the task of choosing the most appropriate remedy becomes more manageable. Planners need no longer dismiss the situation as justifiable or tolerable.

PART II. Methodology

Having been well acquainted with the problematic and the issues involved and the objectives of this analytical evaluation, the analyst in charge may start with one area of activity which can be selected from Sec. II.2 (Areas of Greatest Impact) and let this be for example sub-item 1.(d) food storage and processing. A copy of an unfilled (blank) form entitled "Science and Technology Dependency Evaluation Chart" is allocated for this sub-item alone. The chart is taken to a knowledgeable person well acquainted with all activities going on in the country in that particular area. At this point a decision must be made as to whether to take up one representative project on which the evaluation be based or examine all activities in that chosen sector. The second decision to make is whether to use figures to estimate the degree of dependence in percentage terms or to simply guess-estimate that degree in terms of its being high, medium or low. If a certain representative project is used, its name, location, cost and financing agency can be written on the chart as these factors may reflect on the obstacles and remedies to be identified. Now the analyst may take up the science and technology elements utilized in the realization of that project and put down the degree of dependency suffered from in utilizing the elements one by one, say for example planning and design. Differentiation is made between planning and designing the civil engineering parts of the project and planning and designing the industrial parts. If the project is a grain silo, it may happen that a large percentage of the civil work was accomplished internally in which case the dependency degree is said to be "low".

SCIENCE AND TECHNOLOGY DEPENDENCY EVALUATION CHART

AREA OF ACTIVITY OR NAME OF A REPRESENTATIVE PROJECT ....

The Science and Technology Elements utilized	% or Degree of (Hi-Med-Low) DEPENDENCY civil/industrial	Obstacles from LIST or others (Pl. use ref. nos.)	Remedies from LIST or others)Pl. use ref. nos)
Project identification and pre-feasibility studies			
Survey of existing data and their desk eveluation			
Feasibility studies and preliminary project proposals			
Modelling and testing mathematical or physical			
Planning and Design			
Execution			
Supervision			
Operation and Maintenance			
Reproduction-expansion and up-grading			
R + D process adaptation and product development			
Remarks			

Thus opposite to the element planning and design under the civil part of the column for degree of dependency the analyst writes "low". And if most of the design work for the industrial parts of the project was accomplished externally then under the industrial part of the same column High is written. Now, from the list of obstacles, the factors or obstacles which are thought of causing the degree of dependency in the element involved are identified and their reference numbers written. Similarly, the remedies are selected from the list of remedies and their numbers recorded in the appropriate location. If R & D was not carried out at all for the project analysed, the reason may well be that the country did not have the capacity needed for performing it and the expatriate planners did not bother to suggest any. In such a case the degree of dependence in R & D can be said to have the value "High". If the representative project analysed has a cost amounting to say 1/3 the total cost of activities for the sector or sub-item as a whole, then the cost of carrying out the portions of the project by expatriates and TNCs is multiplied by three to calculate the cost of dependency in that particular sector or for the said sub-item. And when the necessary remedies are identified, their costs can also be estimated. The same remedies may help relief the degree of dependency in several sectors at the same time. This can be the basis for cost/benefit analysis for projects designed to strengthen the scientific and technological capacities of a country.

II.2 Areas of Greatest Impact

The analysis should concentrate on areas of economic activity where the impact of dependence or the obstacles which contribute to its existence are most negatively felt. For this purpose UNCSTD had defined

FIVE Subject Areas as listed below with additional sub-items:

The Five Subject Areas

1. Food and Agriculture:

   (a) Agriculture technology and techniques and their improvement;

   (b) Nutrition;

   (c) Fisheries;

   (d) Food storage and processing; and

   (e) Irrigation, Drainage land reclamation.

2. Natural resources including energy:

   (a) Renewable and non-renewable;

   (b) Conventional and non-conventional sources of energy;

   (c) Development and conservation; and

   (d) Rational management and utilization.

3. Health, human settlement and environment:

   (a) Medicinal plants and pharmaceuticals;

   (b) Health services;

   (c) Housing;

   (d) Social services and environment; and

   (e) Water supply -- sewerage and garbage disposal.

4. Transport and communications:

   (a) Highways, railways, waterways, harbours, and airports;

   (b) Communication systems, classical and satellite linked: and

   (c) Design and manufacture of transportation means.

5. Industrialization, including production of capital goods (1):

- (a) Industrial production technologies;
- (b) Steel and light metal manufacturings;
- (c) Machine-building industry;
- (d) Hardware and sheet products;
- (e) Precision mechanics, optical and watchmaking industry;
- (f) Electrotechnical industry; and
- (g) Vehicle manufacture.

Individual countries may wish to choose the most relevant areas from the above list or add new ones.

II.3 Elements of the Science and Technology Dimension in Development Projects

Since this methodology is based on analyzing the dependency problem-obstacles to self-reliance and their remedies. One of the variables to be evaluated is the science and technology dimension in currently implemented development projects or those recently completed.

The elements or components of the science and technology dimension involved in the implementation of development projects vary according to the type of project considered. But certain elements are common to most projects and they are listed merely as a reminder to the person involved in the analysis who may wish to add other more project specific elements for evaluation. They are the common steps usually taken to implement a project from its inception to implement a project from its inception to final completion and its operation and eventual expansion - upgrading or modernization,

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(1) The sub-items are based on "Cooperation in transferring Technology" by Prof. Dr. Ing. H J Warnecke, Stuttgart, FRG. Science & Technology for Development, selected papers UNCSTD, Vienna 1979.

the accomplishment of which demands operational scientific and technological know-how and capacity.

1. Project identification and pre-feasibility studies
2. Field surveys and desk evaluation of existing data
3. Feasibility studies and preliminary project proposals
4. Mathematical or physical modelling and testing
5. Planning and design
6. Execution [1]
7. Supervision
8. Operation and maintenance
9. Reproduction [2] - Expansion and upgrading
10. Research and development - new products, improved processes and technologies.

For some projects one or more of the above elements may not be needed at all, given the circumstances of a country and nature of
Items 1-5 for instance can be combined to save time and cut on costs.
project./ Developing countries in general suffer from loss of time caused by those un-necessary operations required by donners of Aid.

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(1) Execution includes manufacture of the industrial equipment needed for the project and their installation; in addition to all construction works.

(2) Reproduction means doing it over with less external help than in the previous time. It applies to all elements of science and technology including design and manufacture.

II.4 Degree of Dependency

Certain countries are totally dependent on expatriate help, human and material in implementing certain technology intensive projects such as a modern telecommunication facility. In such a case the most common mode of performance is known as the "Turn-key" mode or what amounts to the same. Other countries where some progress has been achieved towards self-reliance may adopt the "participatory implementation policy" according to which the science and technology dimension of the project is factored out to its various elements such as the feasibility studies - land use plan for the installations - design and construction of the buildings needed and the roads leading to the facilities - extension of power lines or provision of a water supply system, etc. The project is thus un-packaged and in any of the technology elements which comprise the project that country can participate to a certain extent ranging from very little to full responsibility. The degree of dependency in a certain type of technological activity can thus be estimated either by percentage of the cost of foreign involvement in that activity to the total project cost or its significance in terms of number of actively engaged engineers and technicians and material inputs. When an anlysis of this type is completed for certain number of representative projects selected from various sectors of economic activity, areas of greater dependency can be clearly identified and the cost of such dependency can be estimated. Then remedies can be chosen from several options.

Where it might be difficult to determine the degree of dependency by percentage figures it will be sufficient to describe it as HIGH, MEDIUM or LOW.

II.5 List of Obstacles

This list of obstacles to the timely and appropriate transfer, acquisition, adaptation and development of science and technology and indigenous capabilities has been based on a consolidated summary of such obstacles selected from national papers and regional documents originated in the Arab region during the UNCSTD related activities. They have been verified during discussions and with personal experience of those who experienced and felt the obstacles.

1. Shortage of foreign exchange
2. Shortage of local funds
3. Lack of saturation markets
4. Not sufficient export activity with the industrialized countries
5. Not suffident export activity with other developing countries
6. Lack of financial institutions and infrastructures
7. Foreign aid and capital ties and constraints including transnational practices
8. Inappropriate and ecologically incompatable technologies
9. Population increase
10. Uneasy process of social transformation: culture, religion, tradition and the political setting
11. Inappropriate technical managers lacking the needed broad information and experience base, or the lack of GENERALISTS.
12. Lack of institutional infrastructures: engineering design and construction and manufacturing enterprises

13. Lack of institutional infrastructures for planning - standardization, marketing, export, backward and forward linkages.

14. Unfavourable procurement practices with obstructive competition by local influential agents of foreign interests.

15. Unfavourable procurement policies dictated by foreign capital depriving the nationals from gaining on the job training.

16. Lack of proprietary technical information scientific and/or industrial.

17. Lack of non-proprietary technical information and references industrial and non-industrial - civil works etc.

18. Lack of access to detailed information in expired patents or unused patents which may be of particular interest to the developing country.

19. Insufficient utilization of available technical information.

20. Lack of coherent and integrated science and technology policy planning encompassing education, popularization, research, knowledge generation and application for overall improvement of living conditions: material and non-material.

21. Improper land and water management.

22. Failure to achieve the anticipated improvements applying soil drainage technology.

23. Insufficient use of water saving drip and sprinkler irrigation.

24. Improper management of available natural resources including energy.

25. Lack of scientific research for adaptation to local conditions and improvement of technological processes.

26. Lack of scientists and technicians.

27. Lack of incentives to scientists and technicians.

28. Lack of engineers in the industrial discipline including electrical, mechanical, chemical, etc.

29. Lack of skilled workers including machinists, tool makers, operators, welders, etc.

30. Lack of workshops for metal fabrication, and machine tool and foundry equipment and facilities.

31. Mal-utilization of existing available equipment.

32. Mal-utilization of available trained manpower.

33. Lack of civil engineers.

34. Lack of skilled construction workers.

35. Lack of construction equipment and material.

36. Poor organization and inefficient operation of existing civil engineering design and construction enterprises.

37. Need for more appropriate technologies.

38. Environmental factors.

39. Need for legislation to regulate the transfer of technology and curb practices which constitutes obstacles to such transfer.

NOTE: Degree of dependency and their relevant obstacles and remedies for civil engineering components of industrial or non-civil engineering projects are to be evaluated separately. Example: an industrial project's buildings, roads, water supply etc. are the civil components of that industrial project.

II.6 The Remedies

When the factors contributing to the state of dependency or the 'obstacles' have been identified they readily become a guide to the remedies required. While in some cases the remedy can be a direct derivative of the obstacle as in the case of obstacle No. 18 concerning lack of access to information contained in expired patent documents where an obvious remedy would be establishment of the necessary patent information dissemination network or linkage to existing such networks, in other cases the remedy can be of more complex nature as in the case of obstacle No. 9 (population increase) or obstacle No. 10 dealing with social, cultural, religious and political factors. The LIST however, is only an illustration of possible remedies consolidated from existing literature to which a country analyst can add his own to choose from.

List of Remedies:

1. Establishment of science and technology policy planning body linked to the highest executive bureau in the government, to set up guidelines and oversee technology transfer and development.
2. Legislation of laws regulating and governing the process of technology transfer in consultation with policy planning body.
3. Re-examination of curricula of schools at all levels especially engineering and technical colleges and institutes for inclusion of country specific technical courses and for educating general engineers and technologists.
4. Measures for the stimulation of discussions and debates on S & T issues by holding more seminars, work-shops and meetings(with allocation of incentives such as travel and other forms of compensation) national, regional and international.

5. Establishment of technical documentation centers to preserve and disseminate existing technical data and reports used by government and other organizations particularly project reports and documents including blueprints and maps.

6. Computerized linkage of national scientific research councils with patent and other information and documentation centers.

7. Establishment of the Arab Science and Technology Fund to finance and co-ordinate the remedies and measures taken collectively and individually by countries lacking the needed financial resources.

8. Establishment of the Arab Information Bank with the necessary linkage facilities with emphasis on existing S & T capacities, production and services.

9. Enrichment of academic and professional engineering libraries with the internationally available non-proprietary information documents containing design procedures and criteria for engineering works especially in the fields of civil engineering, and agriculture as those published by United States Bureau of Reclamation and the Corps of Engineers.

10. Establishment of and strengthening existing technological institutes specialized in training instrumentation and laboratory testing technologists in all scientific branches: medical - chemical - eletrical - nuclear - mechanical , etc.

11. Increasing the number and capacities of vocational training schools with emphasis on skilled construction - sanitary - electrical - mechanical - foundry - machine tools - construction supervision - engineering and architectural drafting and model making.

12. Establishment and strengthening of existing institutes for traditional handicraft.

13. Establishment and strengthening of existing Fine Arts Institutes for painting, sculpture, ceramics, music, dancing and drama; to create harmony and balance between functional and aesthetic development of performing capabilities (the technique) of the citizens in economic and cultural activities.

14. Establihhment of adult education centers with emphasis on practical and science oriented skills and hobbies and digital micro-electronics.

15. Establishment of United Nations supported specialized centers for development of technology transfer similar to the "Engineering and Industrial Design Development Center", Ministry of Industry and Mineral Wealth, Cairo, Egypt.

16. Incentives and preferential treatment to individuals and groups willing to undertake scientific, technical and professional projects in research, model building, small and medium scale production and engineering consultancy. Special material and non-material rewards for success.

17. Re-examination of lawa and obstacles affecting the mogility of technical and scientific manpower between Arab countries.

18. Survey of existing technical and scientific manpower in the Arab countries with view to determine the degree to which they are engaged in performing the tasks they were intended for in their technical training. And to determine the existing potential for better utilization.

19. Special programmes using existing large government technical establishments including factories and engineering bureaus for the training of individuals and small businesses from the private sector.

20. Establishments of special national funds to assist small industries, individual artisans and small architectural and engineering firms up-grade their operations, services and products.

21. Request international aid and development agencies to maximize real technology transfer according to guidelines in the planning and implementation of development aid programmes and to include an account of special means used and their results to appropriate project reports.

22. Propagate public awareness against indiscriminate transplantation of imported technologies and necessity to exercise choice of appropriate technologies and evaluate ecological compatability.

23. Participation of Arab countries in regional and sub-regional science and technology centers with the Arab national and collective development funds covering partially or wholly the cost of such participation for countries unable to meet such costs.

24. Voluntary adherance to the UNCTAD draft international code of conduct on the transfer of technology 1979.

25. Adopt measures designed to increase exports and stimulate trade between Arab countries.

26. Adopt measures to stimulate trade with other developing countries.

27. Adopt measures to increase exports to and encourage tourism with the developed countries.

PART III. Summary of the most Persisting Obstacles and their Remedies

When the dependency evaluation charts II.1 have been completed for sufficient number of projects or sectors to reflect the true dependency picture in the country, the following two tables can be derived:

III.1 Table of the most persisting obstacles. (Table III.1)

The obstacle to which reference occured the greatest number of times as totalled from all the charts is listed first followed by the other obstacles according to descending order of their respective occurences. This table as well as the charts will be referred to in the process of finding the most appropriate remedies. Now the obstacles are numbered with 1 for the most persistent on top then 2 onwards for the less persistent ones. The percentage of the occurence of each obstacle is given in the third column. (No illustrative example for table III.1 is given due to its simplicity.)

III.2 Table of the most persistently referred to remedies in descending order.

The remedies most persistently referred to in the charts are also listed according to their descending order of occurences they clearly reflect priorities. Against each remedy the appropriate level for action - country - bilateral - subregional - regional or UN is accordingly indicated. This way priorities on various levels are indicated.

TABLE III.2
Most Recommended Remedies
(Illustrative example)

Ref. No. of Remedies from list of ...	New Serial No.	The Chosen Remedies Re-stated (from List of remedies)	% occurence in charts	Action Level: country	bilateral	subregional	regional	U. N.	REMARKS
7	1	Establishment of the Arab Science and Technology Fund to finance ...	34				x		
11	2	Increasing the number and capacities of vocational training ...	29	x					
27	3	Adopt measures to increase exports to ...	22	x			x	x	
		etc.							

PART IV. Recommended Draft Plan of Action

The most recommended remedies identified in Table III.2 cannot be regarded as a plan of action as such. It can serve, however, as a guide to select one or two projects for immediate action as the case may be quite appropriate for purposes of the Interim Fund created by UNCSTD at Vienna 1979. But for a country to embark on a serious plan for strengthening the scientific and technological capacities, Tables III.1 and III.2 can only serve as a reference in considering a plan of action at the appropriate levels. The plan of action will depend on other factors in addition to the most recommended remedies. Among other things, the factors include availability of manpower and funds, social, economic and political considerations.

The science and technology policy planning body of a country will use the recommended priorities and the other factors for a PLAN OF ACTION co-ordinated for implementation at all levels.