TECHNOLOGY TRANSFER IN THE MIDDLE EAST

TOWARDS A STRATEGY FOR SCIENTIFIC AND TECHNOLOGICAL SELF-RELIANCE

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From God is success, and upon Him reliance.

Kavoos Mohannak

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ABBREVIATIONS

ALESCO	--	Arab League Educational, Cultural and Scientific Organization
ASRT	--	Academy of Scientific Research and Technology
AT	--	Appropriate Technology
CASTARAB	--	Conference of Arab Ministers Responsible for the Application of Science and Technology to Development
ECWA	--	Economic Commission of Western Asia
FAO	--	Food and Agriculture Organization
GNP	--	Gross National Product
IDRC	--	International Development Research Center (Canada)
IFSTAD	--	Islamic Foundation for Science and Technology for Development
IROST	--	Iranian Research Organization for Science and Technology
ISESCO	--	Islamic Educational, Scientific and Cultural Organization
MNC	--	Multi-National Corporation
NRC	--	National Research Center
OECD	--	Organization for Economic Cooperation and Development
OIC	--	Organization of Islamic Conference
OPEC	--	Organization of Petroleum Exporting Countries
OTA	--	Office of Technology Assessment
R & D	--	Research and Development

SABIC	--	Saudi Arabian Basic Industries Cooperation
SANCST	--	Saudi Arabian National Center for Science and Technology
S & T	--	Science and Technology
SPMB	--	Science-Policy Making Body
TA	--	Technology Assessment
TAN	--	Technology Assessment Network
TT	--	Technology Transfer
UNCSTD	--	United Nations Center for Science and Technology for Development
UNCTAD	--	United Nations Conference on Trade and Development
UNESCO	--	United Nations Educational Scientific and Cultural Organization
UNIDO	--	United Nations Industrial Development Organization
WIPO	--	World Intellectual Property Organization

PREFACE

Development is the most important matter of concern for people in the developing countries. People in the developing countries believe development surely brings happiness and prosperity. However, such words as development, happiness and prosperity are ambiguous in their meanings. Some people believe development should be carried out according to the model of the modernized Western countries. Creation of a Westernized social environment was once believed to be development. Yet, development in the sense of Westernization faces lot of difficulties throughout the world today. Reconsideration of "development" is an urgent task. People in both the developed countries and the developing countries are required to think again about the meaning of the word "development" at this time. Technology transfer and industrialization are regarded as basic components for the concept of "development." Therefore, first technology transfer and industrialization must be re-examined in order to propose a new model for development which is different from the old version.

Technology transfer could be likened to the transplanting of a tree from one place to another. Just as transplanting needs careful previous investigation of soil and climate of the place where the tree is to be transplanted, so technology transfer needs sufficient previous investigations of the society into which the new technology is to be transferred. If there are any difficulties in the technology which may produce problems in the society where it is to be transferred, the technology itself should be modified and made adaptable to the society. Unfortunately, technology transfer has not been carried in this manner in the past, but has paid little or no attention to the social environment, traditions, history and etc., of the country. As the result, careless technology transfer has often brought about various problems and tragedies in various parts of the world.

Now, industrialization is deeply related to technology transfer. Industrialization in a sense causes the dissolution and reorganization of a traditional society by introducing a new system of technology into it. It needs victims. But an affluent society in which people feel happy is established on the basis of mass-production which is always accompanied with industrialization. Looking at the people in the Third World, who are suffering always from shortage of goods, industrialization is inevitable for the betterment of people's standard of living in the developing countries. But, the number of victims must be reduced in the process of industrialization. Planners of industrialization should take these points into account.

Muslim countries in the Middle East have repeated trial and errors in their development planning, technology transfer and industrialization. Generally speaking, their development plans, technology transfers and industrialization have been implemented without paying any attention to their own traditions and culture. Therefore, people in the Middle East have faced various problems which are side-effects of technology transfer and industrialization. Technology transfer and industrialization in the Middle Eastern countries should be carried in a more appropriate way. Since culture and tradition on the Middle East are based on Islam, development planners of each country in the Middle East should take into account Islamic factors. In fact, Islam itself could be regarded as a blue-print for the constructing of a community. It shows the way to prosperity of the Muslim community.

Therefore, development planners should satisfy the requirements of Islam when they make their plans. The author of this volume, Mr. Kavoos Mohannak makes a great contribution in illustrating the frame-work of the Islamic way of development, technology transfer and industrialization. The frame-work of development theory he proposed in this volume may not be limited to Muslim countries, but is perhaps adaptable to non-Muslim developing countries.

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Akiro Matsumoto
General Editor

INTRODUCTION

I swear by the twilight
And by night what it envelopes
And by the moon in her full perfection
That you shall certainly ride
That you shall certainly ride, stage after stage[1]

Rapid advances in science and technology (S & T) have provided developing nations with unique opportunities to accelerate their economic and social development.

High-speed communications and transportation has made the world small. Medical knowledge and vaccines are increasing life expectancy. Agricultural technologies are feeding more people. Computer sciences are revolutionizing industry and opening new horizons. Theoretical physics has changed our physical image about the structure of the universe. New and emerging areas such as, biotechnology, automation, new materials, etc., represent on the whole a challenge as well as a hope for the future development. In

1 The *Qur'an*, 84:16-19.

short, the possibilities for realizing human potentials have never been greater than today.

However, as developing nations moving towards the new opportunities, are discovering that relatively few of the new sciences and technologies can easily or quickly be absorbed to their expectations. The modern age of development is founded on knowledge, policies, skills and infrastructure which majority of developing nations lack.[2]

Therefore, the questions for developing nations are complex and many. They must decide which sciences and technologies are essential to satisfy their needs for health care and other basic human services. They must decide which agricultural and industrial processes offer realistic and sustainable strategies for development. They must budget for schools and universities and develop curricula which suit their socio-cultural pattern, etc.

Before they can approach those decisions, they need institutions, policies and skilled human resources to analyze possibilities in a vast, sophisticated and expanding world of options. Above all, they need an indigenous decision-making framework in their national development process.

The Middle Eastern countries like the other developing nations faces the same questions and strives to utilize science and technology efficiently to develop many sectors, improve the life and

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2 This is because most of the developing countries suffered from the exploitation of colonial rule and when independence came they found themselves with a weak infrastructure in all sectors.

output of their economic sources, to develop the standards and status of their national manpower and institutions.

In this regard, the main aim of this study is to outline realistic strategies by which the Middle Eastern countries can overcome the present obstacles for scientific and technological development, and to develop their own scientific and technological creativity. Therefore, it addresses the concept of appropriate technology and self-reliance versus technological domination and technology transfer. The thesis further investigates the existence of any form of science and technology policies in this region and the negative impacts of the lack of application of these policies.

The methodology used to assist in conducting such a task is historical, empirical and with the cross-cultural considerations. Hence, In this study, the author is chiefly concerned with that part of the literature which dealing with science and technology policy issues for the developing world in general and to the science and technology policy in the Middle East in particular.

Thus, this study benefits from an extensive literature on both technology transfer and domestic science and technology capabilities. It utilizes available case studies in national experiences and seeks explicitly to extract from these diverse data some generalizations for defining a realistic strategy to increase the national capability in science and technology.

In order to analyze and assess fully the criteria, trends and status of science and technology in the Middle East, the author has divided the thesis into four main chapters which further examines the appropriate policies for science and technology development. The form of presentation consists of the following topics:

First chapter examines science and technology for development and various theories related to scientific and technological development. Moreover, it attempts to present an Islamic view of scientific and technological development and to highlight some of the related issues now being debated in the Muslim world. How Muslims perceive S & T development depends, to a large extent, on the world-view of Islam. Therefore, it is necessary to show how Muslims can synthesize their world-view with their effort to the development of science and technology and their own society. In short, this chapter provides us with an appropriate framework for our study.

Next chapter is designed to analyze the status of science and technology in the Middle East to identify the most critical problems obstructing S & T development within this region. This helps us to assess the extent to which the application of science and technology is needed for the region's development. In order to put this study into its historical context, a brief overview of the history of technology transfer is presented first. After which, the status of S & T planning has examined. Finally, the main problems has been identified and the solution of which has been given in the next two chapters.

Third chapter is an attempt to provide appropriate strategy for technology transfer and generation to argue that even if technology is freely available only transfer of technology is not enough. A nation can only develop if it has a science and technology infrastructure of manpower, knowledge, skills, innovative and productive capacities to absorb and adapt the imported technology. However, the author believes that technological development is best achieved by concentrating on technology generation within the country and developing indigenous technologies and applied research capability. For this purpose, a proposal for appropriate technology generation has been given.

Last chapter is directed to another critical issue for science and technology development in the region. It considers those areas of science and technology planning which needs more attention on fostering networks and linkages with productive sectors. Hence, it argues that the countries of the Middle East need to facilitate in order to bring together the scientific community, entrepreneurs, basic and applied researchers and scientists. It calls for integration of science and technology development and basic needs of the society and addresses the role of government for promotion of technological development.

On the basis of the analysis of the above topics, the author has reached certain conclusions regarding the development of technology in the region which are given in the concluding section.[3] At this point, some explanation is necessary to the reader about the limitation of this study.

First, the thesis investigates the historical and contemporary employment of science and technology for development in the Middle East and specific matters related to them, rather than analyzing a specific case study. To evaluate the existing trends of S & T application in a specific country for formulating an overall policy requires detailed analysis and assessment and thus a lengthy thesis. Therefore, it has been tried to write a thesis not focusing on any particular Muslim country of the Middle East. As such, the examples have been drawn from various appropriate countries and, indeed, some examples from non-Middle Eastern countries have been cited where their experiences and conditions are relevant.

Secondly, due to the difficulties of collecting or the absence of data, in different sectors of the countries concerned, the author had to analyze effectiveness of the application of science and technology in general. Obviously, in analyzing and formulating a national science and technology policy detailed assessment of sectoral studies is of great importance. The author is fully aware of these limitations.

Finally, the author believes that the purpose of this thesis should extend beyond the academic study and hopes for the future

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3 This thesis also has two appendixes. The first one presents the objectives of selected national scientific and technological policy-making bodies of the Middle Eastern countries, and the second one mainly shows the statistical data which are necessary for chapter II.

prosperity of the Muslim countries of the Middle East and the generations to come. However if the thesis, despite all its limitations, is of value in indicating a general direction for a viable development and particularly about the present scientific and technological development strategies of the countries concerned, the author has achieved his purpose.

CHAPTER I

Science and Technology Policy for Development

The special feature of the current age is that it is dominated by science and technology, i.e. It is a situation that is potentially the sources of both a possibility of unlimited progress and of unlimited disaster. S & T have created the basis for new wealth but this has opened a gap between rich and poor countries. As mentioned already, science has made possible the means of advanced transport and communication but also the terrible means of destructions which nations can use to threaten each other.

On the other hand, science and technology play an important role in the various aspects of a country's development. A nation's prosperity, military and political status are all mainly measured and evaluated by the scope and advancement of scientific knowledge and by the effectiveness of her technological, innovation and inventive activities. The importance and critical role of science and technology for development are witnessed by the activities of numerous agencies established by the international community such as; UNESCO, WIPO, FAO, UNIDO, etc.

Perhaps science as a form of progress should be judged by the contribution and output it makes to society.[1] Science could also be used as a means for stimulating human thought, of solving certain problems and of providing understanding of various phenomena that occur in the world around us. It could also promote co-operation between nations, enhance the world's standard of living and assist toward world peace and unity.

Regarding science and technology, it should be mentioned that various definitions have been cited by several authors each in a different context.[2] It is the aim of this chapter to explore the concept of scientific and technological development within different socio-cultural background in order to find out appropriate theoretical framework for our study. To facilitate the discussion it is divided into three sections. The first section defines the concept of science and technology policy. The next section examines the existing theories on scientific and technological development and finally the last section focuses on the concepts of scientific and technological development with specific reference to Islamic cultural identity.

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1 Y.Y. Al-Sultan, *Development of Science and Technology Policy for Kuwait*, (Ph.D. Thesis), Vol.1, (UK: University of Aston, 1983), p.10.

2 See, for example; H. Rose and S. Rose, *Science and Society*, (London: Penguin Books, 1977), pp.1-2. See also; P.T. Durbin (ed.), *A Guide to the Culture of Science, Technology and Medicine*, (New York: The Free Press, 1980).

1-The Concept of Science and Technology Policy

Science and technology policy is concerned essentially with the effective use of science and technology as agents of economic growth and social development. Therefore, S & T policy is not concerned only with a plan for scientific research, nor should it be treated in isolation from the society's needs, ambitions or from socio-economic structure of the country. Hence, the overall development plan must enable the usage of science and technology to be directed towards national goals.[3]

However, all policy decisions are subjected to political criteria and science policy is no exception. Therefore, science is so essential and precious that the dominant policy decisions regarding its development are adopted by the state, rather than by the scientists and their associates. Indeed, Leiserson has defined science policy as:

> Specifying the criteria for allocating by political decision the appropriate portion of national or world resources devoted to the growth and direction of scientific knowledge and personnel.[4]

On the other hand, UNESCO has proposed the following definition:

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[3] Y.Y. Al-Sultan, p.10.

[4] Quoted in Z. Sardar, *Science, Technology and Development in the Muslim World*, (London: Croom Helm, 1977), p.39.

> The sum of the legislative and executive measures taken to increase, organize and use the national scientific and technological potential, with the object of achieving the country's overall development aims and enhancing its position in the world.[5]

The difference in the definitions stems from the UNESCO's view of science policy as "measures," whereas, Leiserson expressed science policy as "criteria." However, both definitions are comprehensive in the sense that they involve science policy measures with optimisation of the natural resources to achieve the national plans and prestige.

It should be noted that science policy objectives are not confined to the collection of policy statements or to the preferences of scientists, instead, they call for studies of statistics of manpower development, the economic contributions of pure and applied research, mechanisms of creativity and innovation, scientific and technological services, etc.[6]

The concepts of science policy and technology policy might create confusion and to some extend could be treated as one policy. Therefore, a distinction between these notions must be drawn and defined accordingly. For example, the technology policy unit of Univ. of Birmingham has defined technology policy as:

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5 Quoted in G. Jones, *The Role of Science and Technology in Developing Countries*, (London: Oxford University Press, 1971), p.34.

6 See; UNESCO, "Science and Technology in the Development of the Arab States," *Science Policy Studies Documents*, No.41, (Paris, 1977), p.135; also Y.Y. Al-Sultan, p.12.

> Technology policy is the totality of measures by private or public bodies which control the creation, application and use of technology. Technology policy research, therefore, covers all areas of knowledge required for the effective formulation and execution of technology policy.[7]

This definition relates the measures of creating a technology to its application and utilization and considers these measures as totality and not as separate items. Therefore, for technology policy, its prime goal is to evaluate the totality of criteria which controls the creation and utilization of a technology and the development of relevant and related matters (manpower, resources, impacts, etc.).[8]

In science policy, the concept deals with actions related principally to scientific research involved with basic and applied knowledge which could not be utilized directly in productive activities. The scientific results of such activities are shown mainly in widespread and open publications. Furthermore, the evaluation of the results of research projects is primarily related to the scientific community.[9]

In short, science and technology policy have two main aspects: the long-term development of a national scientific and

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7 Quoted in Y.Y. Al-Sultan, p.18.

8 *Ibid.*, p.19.

9 Some writers, however, state that science and technology policy form complementary parts of a single system, i.e. science producing new knowledge and technology supplying knowledge to create new ways of instrumental know-how. In other words, science mainly concerns with the know-why and technology concerns with know-how, see for example; F. Hetman, "Planning Prospective Analysis and Science and Technology Policy" in V.L. Urquidi (ed.), *Science and Technology in Development Planning*, (Oxford: Pergamon Press, 1979), p.21.

technological potential, and the most effective use of this potential to meet development needs.

2-Existing Theories of Scientific and Technological Development

The evolution of the theories of scientific and technological development has not only been studied by the economists and experts with similar professional backgrounds, but also being studied by sociologists, political scientists and even philosophers.[10] The reason is quite simple: concepts and tendencies of scientific and technological development are linked to the problems of overall social development.

In his paper Dr. Vladimir Stambuk has examined a critical study of existing philosophies of scientific-technological development.[11] According to him, "in current theory and practice one can distinguish four approaches to scientific and technological development."[12] These approaches might be called technologically optimistic, technologically pessimistic, "appropriate" and self-reliant. In what follows a brief explanation of each approaches is given.

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10 See for instance; P.T. Durbin (ed.), *op. cit.*

11 V. Stambuk, "Philosophy of Scientific and Technological Development" in A. Abdel-Malek, et al. (eds.), *Science and Technology in the Transformation of the World*, (Tokyo: The UNU Pub., 1982), pp.156-194.

12 *Ibid.*, p.183.

Representatives of the first approach "ultimately regard technology as the key which can solve all social contradictions."[13] This view maintains that whenever social problems and contradictions arise, new technological discoveries make it possible to maintain and extend the trend and the volume of production. One can conclude that technological optimism is largely elaborated through certain concepts which emerge within the framework of analysis and development of the consumer society, the welfare state, and the concept of post-industrial society.

Stambuk argues that the most famous advocates of this vision are certainly multinational companies.[14] The developing countries which have to deal with MNCs and at the same time to preserve their national, economic, and political integrity are well aware of the consequences of such a vision. According to this view, depending on the situation and goals of a particular society, technology transfer is an activity which should be encouraged.

A second view of the role of science and technology in the development of society is that which regards "technology as the negative factor of social development."[15] This concept has numerous advocates in the developed world. They blame developed technology for many negative aspects of the capitalist world (pollution, stratification, overnourishment and undernourishment, excessive supply of consumer goods, and so

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13 *Ibid*.
14 *Ibid*., p.184.
15 *Ibid*., p.185.

on). This approach that adopted by numerous theorists is not a new concept. Its early proponents were humanists such as J. J. Rousseau at a time when capitalism was still young.[16]

The third approach to scientific and technological development focuses on the concept of intermediate technology, also known as "appropriate technology." The essence of this concept is that the developed industrial world should continue producing new technology, which should not be sophisticated, but suited to the needs of the developing countries. This concept has been examined in detail in chapter III.

Finally, as a strategy for coping with the problems of development in general, self-reliance should be considered as an approach to problems of scientific and technological development. This is because self-reliance explores the possibility of finding new, different social solutions, rather than some alternative technological solutions.[17] Meanwhile, this concept may take advantage of some achievements of intermediate technology. Such achievements may be integrated into the framework of social structure, human needs, and goals of developing countries, taking into account each country's specific features.

This concept also attempts to develop science and technology on a new basis, making it possible to avoid most negative aspects linked to the developed industrial society's socio-economic

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16 *Ibid.*
17 *Ibid.*, p.188.

relations and its accompanying technologies: pollution, irrational production, waste of materials and human resources, and so on.[18]

Briefly, self-reliance implies attempts to enrich human life in all its aspects: moral, material, political and cultural, but only in accordance with the possibilities, goals and traditions of the given society. In a very simple definition, self-reliance:

> ... is to be understood at the national level of each developing country as the will to build up the capacity for autonomous decision-making and implementation in all aspects of the development process including science and technology.[19]

This approach to self-reliance is reflected internationally as opposition to all forms of dependency. It calls for changing the mode of incorporation of the developing countries in the international, political, economic and cultural systems. On the national level, a development strategy based on maximizing self-reliance implies efforts to produce key commodities which the mass of its population needs. For example, it requires a major degree of self-sufficiency in food of which there is a tremendous shortage in the third world.

Self-reliance also means reducing dependence on external trade, foreign loans and investments, reducing of imports,

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18 *Ibid.*

19 Quoted in A.O. Herrera, "An Approach to the Generation of Technologies Appropriate for Rural Development" in A.B. Zahlan (ed.), *Technology Transfer and Change in the Arab World*, (Oxford: Pergamon Press, 1978), p.134.

especially of luxuries, and an end to large-scale transfer of technology. This means that local industry must have the capability of producing basic consumption goods. However, UNIDO defines technological self-reliance as:

> ... the autonomous capacity to make and to implement decisions and thus to exercise choice and control over areas of partial technological dependence or over a nation's relations with other nations.[20]

It follows from this that technological self-reliance can be effectively pursued only when a nation understands the nature and extent of its technological dependence and possesses the will and self-confidence to seek to overcome it and to maintain its cultural identity. In this regard, a strategy aimed at promoting technological self-reliance has two components:[21]

First it involves appropriate selection and management of foreign inputs, and second it needs the stimulation of indigenous supplies of technology. The first task requires the existence of a well-developed capacity to select and acquire technology from a variety of sources, and to adapt the imported technology and its products in order to ensure that they can be absorbed and can operate effectively in their new environment. The second task is to initiate an autonomous process of technological innovation and

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[20] UNIDO, "Technological Self-Reliance of the Developing Countries: Toward Operational Strategies" in P.K. Ghosh, *Technology Policy and Development*, (Westport: Greenwood Press, 1984), p.110.
[21] *Ibid.*, p.115.

development, which requires the mobilization of the technology system.

The author has selected this approach throughout the thesis because it aims at reducing the technological dependence of the developing countries by strengthening their autonomous capacity for technological change and innovation. Moreover, it requires the participation of the people in local institutions and in the process of decision-making. Also, in this approach it is possible to include some of the achievements of intermediate technology in order to find out how to create the technology which would be suitable to those who use it.

Therefore, as pointed out by Dr. El-Kholy, the basic elements of scientific and technological self-reliance is: "(1) formulate policies and draft and implement national plans, (2) make appropriate technological choices, (3) change and adapt imported technology, (4) exploit imported technology effectively, (5) innovate and deal effectively-whether as buyer or seller in the world technology market to the economic advantage of the country itself, (6) maintain a national cultural identity while dealing with the outside world."[22]

Taking all into considerations, then we have some of the basic building blocks for the new understanding of scientific and technological development which are based on self-reliance and self-sufficiency. These are not just conceptual principles, but also

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[22] O.A. El-Kholy, "Toward a Clearer Definition of the Role of Science and Technology in Transformation" in A. Abdel-Malek, et al., p.274.

they have strong and specific policy implications. Thus, it is in this framework that a strategy for scientific and technological development become meaningful.

3-Scientific and Technological Development within Islamic Cultural Identity

In dealing with Muslim countries of the Middle East it is of great importance to consider the relation between Islamic cultural identity and scientific-technological development. As it is clear from the last section, taken in total developing countries in general and Muslim states in particular have the potential for self-reliance and self-sufficiency.[23]

However, it should be mentioned that it seems the nature of science has received more attention from the side of Muslim thinkers than the nature of technology.[24] This neglect becomes more important when one considers the technological needs of Muslim societies and massive attempts to transfer technology from foreign countries. Imported technology, in most cases, has not been suitable for Muslim societies and has not been matched to the

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23 It is important to note that many developing countries suffer from being so small that is not possible for them to be self-sufficient without cooperation from other states. However, two or more developing countries can cooperate to fulfil each others deficiencies and become self-reliant and self-sufficient.

24 This may relate to the tendency of Muslim scholars to abstract works, also because normally in Islamic countries technologists and industrialists deal with technology who are not working on the application of Islamic principles to their technological activities.

specific conditions of the Muslim countries. For example, Moore who studied about Egypt's attempt to industrialize by importing technology, maintains:

> Apparently, the experiences with the new technologies were not generating applied research, adapting and integrating them to local conditions, rather the new forms of dependence on foreign experts were becoming self-perpetuating and were discouraging indigenous research.[25]

Here, the local conditions should be regarded not only the economic and technological conditions but also the socio-cultural environment and conditions. What is missing so far in most Muslim Countries is a procedure that identifies and compares local problems and their solution from an Islamic point of view. Until now, the emphasis has been put on acquiring all technology, rather than on working out what exactly are the needs of Muslim societies and building indigenous capability of generating desired technological innovations.[26]

Today, the Islamic countries need the capability to make their own choices on the basis of their own culture. The choice should not determined by foreign technical experts without understanding of the cultural background. If the choice is made with this understanding then the technology will fit into the circumstances

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[25] C.H. Moore, *Images of Development: Egyptian Engineers in Search of Industry*, (Massachusetts: MIT Press, 1980), p.98.

[26] Z. Sardar, *Islamic Futures: The Shape of Ideas to Come*, (London: Mansell Pub., 1985), p.179.

and will be an "appropriate" technology. Today, technology is the essential building block of a civilization. The Muslim civilization cannot survive the future without evolving its own technology based on the world-view of Islam. But what does it mean to develop a technology and science which based on world-view of Islam? What do Islamic societies have to do develop Muslim technology?

To answer these questions, first let us have a look at the works of Muslim thinkers who are working currently in the field of Islamic science. In his paper Kirmani, identifies two trends of thought related to Islamic perspective of science: "one refers to science in Islamic perspective and the other to a kind of science essentially different from the current dominant model."[27] He looks at the work of S. H. Nasr, W. A. Hussaini, A. O. Naseef, Z. Sardar, M. N. Anees, P. Manzoor and Z. R. El-Nejjar.

In this view, one group of scholars believe that the theories of science are in constraint with the metaphysical principles of man and nature and that religious principles should have a role in directing scientific inquiry. Therefore, in this view education play important role and if man changes with education then the gulf between science and religion will disappear.[28]

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27 M.Z. Kirmani, "Islamic Science, Moving towards a New Paradigm" in Z. Sardar (ed.), *An Early Crescent: The Future of Knowledge and the Environment in Islam,* (London: Mansell Pub., 1989), p.144.

28 *Ibid.*, p.145.

The second group believe that Islamic science should be based on the Islamic concept of nature, man and knowledge.[29] In this view, these concepts would give direction to scientific activity, and the *shariah* [30] would fix the needs and priorities of the society in relation to science.

Among these scholars, Nasr refers to the fundamental difference between the principles of *Shariah* and that of Western science, he says, "even if this were to be cultivated, pursued and applied in a society completely dominated and ruled over by *Shariah*, it would not become Islamic, nor would it lose the completely anti-Islamic world-view which forms its background."[31]

He believes that in the context of Islamic science, values must be judged in the light of the *Qur'an*, its teachings about nature and man.

According to Nasr, to create science of Islamic character one needs to know:

> (a) sacredness of *ilm*, (b) hierarchy of knowledge which places the knowledge of God above any science of his creation, (c) interrelatedness of all orders of reality, (d) sacred character of the phenomenon of nature as the signs (*ayat*) of God, (e) nature's participation in the Qur'anic revelation, and (f) the domination of vertical cause or the divine will over all horizontal causes without the negation of these subsidiary cause.[32]

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29 *Ibid*.
30 *Shariah* means the totality of Islamic law, in general it is the normative code of Islam.
31 M.Z. Kirmani, p.152.
32 *Ibid*.

Moreover, Nasr suggests that Muslims must master modern science in depth and also it is necessary for Muslims to understand the nature of modern technology in its relation to modern science.[33] It is obvious that, the interest of governments in the Islamic world is usually in technology rather than in science itself. In this regard, the development of various forms of Western technology and attempts at their adaptation in different Muslim countries is a central importance to governments.

However, an Islamic technology will have to be consistent with the foundations of Islam. Sardar has put forward a set of values that could do this. Sardar believes that there are ten values at the core of Islamic thought: four standing alone, namely *tawheed* (unity), *khilafah* (trusteeship), *ibadah* (workship) and *ilm* (knowledge), plus three opposing pairs. These pairs are *halal* (praiseworthy) vs. *haram* (blameworthy), *adl* (social justice) vs. *zulm* (tyranny), and *istislah* (public interest) vs. *dhiya* (waste).[34]

Therefore, these values and concepts and at the same time dictates of the *Shariah* which apply to technology can incorporate in technological activity in Muslim countries. For example, these values could be put against technical and research programmes to establish whether such programmes fall within the world-view of Islam or not. Questions can be asked as to whether the results of a

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33 S.H. Nasr, "Islam and the Problem of Modern Science" in Z. Sardar (ed.), *op. cit.*, p.132.

34 Z. Sardar, *op. cit.*, p.200. See also; K. Gottstein (ed.), *Islamic Cultural Identity and Scientific - Technological Development*, (W.Germany: Nomos Verlagsgesellschaft, 1986).

particular programme; will lead to a higher measure of social justice or reinforce tyranny, will respect or not the position of trusteeship of man with respect to the world of nature, will promote public interest rather than waste. Such questions would clearly have put certain high technology projects outside of the scene.[35]

If we compare these concepts with the Western scholars activities, we find that to some extent they are in consistent. For example take the concept of appropriate technology and technological self-reliance and self-sufficiency. All ideas of transfer of this technology with regard to indigenous resources, management and renewable energy resources, fall in fact within the Islamic perspective. Moreover, all scientific and technological activities such as medical research to alleviate sickness, agricultural research to fill the gap of hunger, are pursued to promote *haqq* (just, right, true). Environmental conservation and technology assessment is for prevention of *zulm* (tyranny).[36]

Therefore, if we try to assess the activities in science and technology in the West we will find that those theories that aims at self-reliance, community participation and social justice are not in conflict with Islamic values. One of the central concepts in Islam is freedom, notably freedom in thinking, "*ikhtiyar*." Then when we are talking about appropriate technologies and selection of

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[35] For example, high technology agricultural projects such as Gezira scheme in Sudan or the Kufra Oasis development project in Libya should never be started.

[36] The *Qur'an* and the *Shariah* contains numerous concepts, such as these, that should be basic tools for Muslims judgements.

technologies, we may refer to "*ijtihad*" which is the exercise of independent judgement to ascertain the appropriate *Shariah* ruling, and/or to "*aql*" which means "reason."

However, we should take into account that Muslim technology should emphasize harmony, equilibrium and balance with environment and try to make maximum use of human skills and with minimum disturbance of the natural environment. In this way as Nasr has put it: "community can live at peace with its immediate natural environment with the minimum amount of external perturbation and the maximum amount of self-sufficiency."[37]

Moreover, since Islam is a community-based religion, any technological activity should be considered for the benefit of the community. Also, the concepts of *adl* and *istislah* dictate that all the activities done at the community level must be in a such way that the community can understand the technology used, participate in the technological activity and control the processes involved.

Sardar argue that this can be done with the help of the principle of "domesticity," he maintains:

> The guiding principle for the technological activity in the Muslim world should be domesticity. It should be an axiom of technology policy in Muslim countries that local products and raw material, local processes and techniques, local talent and manpower, can provide the best answer to local problems.[38]

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37 S.H. Nasr, *Islamic Science*, (London: World of Islam Festival Pub. 1976), p.233.
38 Z. Sardar, *op. cit.*, p.194.

As is clear, according to him this principle and the associated regional technological isolationism is an essential prerequisite for the evolution of Muslim technology. However, according to him, there are other steps that should be taken to provide basis for the technological independence of the Muslim countries. For example, promotion of traditional technologies, development of multi-purpose plant, introduction of innovations which enhance the notions of self-reliance and self-sufficiency, etc.[39]

Therefore, taking all into considerations we can conclude that, today progress in science and technology within Islamic cultural identity should be objectives of any Islamic community, whether this is a scientific community or an institution or any regional community within the Muslim world.

All activities should be directed towards attaining self-reliance in economy, science and technology (research and development), education as well as planning and decision-making. In this regard, Muslim societies should develop their indigenous capability to deal with technology. Therefore, any meaningful strategy for S & T development should be based on the notions of self-reliance, community participation, social justice and not to be only the imitation of the strategies of the industrialized world.

In these efforts, the basic values of Islam should be guideline for one's behavior in general as well as one's social, cultural and scientific behavior. In this case if Muslims using knowledge for

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39 *Ibid.*, p.195.

application, for the community development, it is *halal* (praiseworthy). Therefore, in this way nobody will work toward destroy the world, but to add value to the world, to the community, to the people and to the human beings.

CHAPTER II

The Status of Science and Technology in the Region

The Middle East, as a part of the developing world, is characterized by the insufficiency and relative failure of technological efforts during the period following the Second World War II. This situation has led the Middle Eastern countries to focus attention on scientific and technological activity and the consequent policy problems. International and regional agencies, national institutions, groups of experts and political leaders have helped to publicize and spread this concern among the population of this area.

However, science and technology in the contemporary Middle East from Morocco to Iran constitutes an extraordinary paradoxial picture. A handful of oil-exporting countries, like Saudi Arabia, Iran, Kuwait, Libya, Algeria, the United Arab Emirates have been annually spending billions of dollars to import state-of-the-art science and technology for military and civilian purposes. Meanwhile the majority of Middle Eastern states, like Turkey, Egypt, Morocco, Sudan, Tunisia, Yemen, Jordan, Syria are struggling to establish national science and technology capabilities.[1]

In this context, the objective of this chapter is to focus on the three dimensions of the status of science and technology in the region which are: transfer, planning and problems. These factors represent development factors which are closely interlinked with the building up of an indigenous technological capacity. The first section looks into the historical background of technology transfer from the Western countries to those of the Middle East, because the experiences of extensive technology exchanges in the region during the 1970s tells us much about the effectiveness of technology transfer. Recognizing the vital role play by national policies and planning in the field of science and technology, the second section examines selected aspects of the S & T policy making in the region. The last section is designed to discuss some of the main problems concerning the building up of a self-sustained scientific and technological capacity in the Middle East.

1-Technology Transfer: Historical Background

Exchange of technology between the countries of West and the Middle East can be traced back at least to the era of Alexander the Great. Many of the roots of early Western science and philosophy

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1 See for example; Z. Sardar, *Science and Technology in the Middle East*, (London: Longman Pub., 1982), which contains a country by country survey of the statues of science and technology in the region.

emerged from the ancient civilizations of the Middle East. Western mathematics, astronomy, medicine, and education all owe a large technological dept to the medieval Islamic empires. Through subsequent centuries, trade and travel still maintained rather continuous flow of technologies and ideas between these two important regions in spite of the turmoil of wars and conquests.[2]

From the nineteenth century and during the first half of the twentieth, this interaction took on an increasingly unidirectional character. The industrial revolution had created the nation-states in Europe, as well as the United States, and brought vast technological and military advantages over the colonized Moslem world. As a result, as pointed out by Ilgen:

> West essentially "gave" what it wished to the Middle East, which in turn had little alternative but to "take" whatever was available on terms that were rarely of its own choosing.[3]

From the late nineteenth century to the early twentieth century, the West was relatively rich and technologically sophisticated, while the Middle East was relatively poor and technologically backward. The West had the ability to provide and the Middle East had the desire to acquire many Western goods and

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2 For a brief history of Islamic technology and transfer of technology from the Islamic world to the West. See; A.Y. Al-Hassan and D.R. Hill, *Islamic Technology: An Illustrated History,* (Cambridge: Cambridge University Press, 1986).

3 T.L. Ilgen and T.J. Pempel, *Trading Technology: Europe and Japan in the Middle East,* (New York: Praeger Pub., 1987), p.26.

services. But Western countries rarely saw much reason to make such transfers, while the Middle Eastern nations lacked both a commitment to technological change and the financial resources to import know-how from abroad.[4]

In the twentieth century, national independence was followed by policy that directed toward industrialization in the region. However, it was the formation of OPEC in 1960 and the increasing of oil prices in 1973 that produced new political and economic influence for oil-rich Middle East countries and their neighbors. This increased the already economic dependence of the industrialized countries on the region. Technological superiority was with the West, but many Islamic countries used their petro-dollars to acquire desired products and technologies in accordance with their own development and modernization plans.[5]

Furthermore, oil dependency and the need to cover higher import costs caused industrialized countries to promote technology transfer to the Middle East. At the beginning of the 1970s, Italy, France and Japan all depended on the region for most of their domestic energy needs, while energy sources were more diversified in the United States, Germany and Britain. These produced a new era between the industrialized countries and the nations of the Middle East in economic exchange in general and in technology

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4 *Ibid.*

5 For the development experiences of the relevant countries in the course of the nineteenth and twentieth centuries. See; C. Issawi, "The Adaptation of Islam to Contemporary Economic Realities" in Y.Y. Haddad, et al. (eds.), *The Islamic Impact*, (New York: Syracuse University Press, 1984), pp.27-45.

transfer in particular. In its broadest terms, the situation approached that of mutual need and capability.[6]

Increased financial strength was combined with a growing desire to utilize Western Know-how in an effort to hasten their own development. Potential suppliers which were mainly United states, Britain, France, Italy, Germany and Japan recognizing the commercial potential and economic importance of the Middle East demonstrated willingness to provide what was desired. During this period (1970-1985), all countries of the Middle East have been involved in various technology transactions on a large scale and over a long period of time (see Table 1).

Most of the industrial technology that was imported in the countries of the region was acquired in association with investment projects to set up major units of industrial production capacity, such as; new steel mills, new cement plants, new petrochemical complexes, major expansions to the capacity of textile mills or tyre factories, and so on. Some foreign technology was also acquired by industrial enterprises independently of such projects, i.e., technology to diversify an existing product range, technology to introduce improvements to existing production facilities, and so on.[7]

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6 T.L. Ilgen and T.J. Pempel, p.28.

7 For evidence see; UN, *The Acquisition of Imported Technology for Industrial Development: Problems of Strategy and Management in the Arab Region*, E/ESCWA/NR/85/16, (New York, 1985).

In spite of such extensive transfers to the Middle East, processes of development of indigenous technology and know-how have not had the same importance. Consequently, the Islamic countries of the Middle East has not obtained the full benefit of the considerable financial investment made over the past two decades. There has been limited absorption of technology despite the repeated transfer of similar capital goods or products. The cost of such transfer of capital goods has been high, particularly when it was unaccompanied by any process of technology absorption.[8]

One of the important factors which should be mentioned here is that, during the past, commercial relations with the Middle East are influenced strongly by political factors, perhaps more than in any other region of non-industrial world. These political factors include the internal political systems of the countries in the region, the Arab-Israeli conflict, and the nature of bilateral relations with major powers. However, the foreign policy positions of the industrial countries toward the region represent the other side of the equation.

All these factors explain the importance of bilateral political and economic relations in technology and trade with the Middle East, and the importance of direct government involvement. This has been one major factor behind a decline in French market share

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8 See; Y.M. Hussein, "Advanced Technology and Development Strategy in the Middle East" in UN, *Technology Assessment for Development*, Reports of the UN Seminar on Technology Assessment for Development, ST/ESA/95, (India: Banglore, 1980), pp.88-95.

in Algeria, and that of the United States in Iran. Overall, the high degree of politicization of trade in the Middle East is a major factor, along with its phenomenal growth as a market, distinguishing it from other regions.[9]

In sum, the Middle East region has been the fastest growing market for Western technology over the past two decade. Oil price increases initiated by OPEC in 1973 and by the Iranian Revolution in 1978-79 created a massive transfer of wealth to the oil-producing nations in the region. This transfer of wealth has allowed these countries to begin fulfilling aspirations of economic development and general modernization of their countries. In this context, ambitious development plans relied on the importation of Western technology and know-how.[10]

Although the character of relations between the two regions over the past shows a deepening in many areas but the role played by individual supplier and recipient countries has been varied. It has been mainly shaped by political circumstances, commercial motivations, and domestic economic strength and weaknesses. However, for most of these countries the base from which they are building their infrastructure, industry, manpower and skill levels was weak and insufficient to absorb the imported technology. One of the reasons for this has been ineffective science and technology policy and infrastructure that could provide the basis for rapid

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9 See; J.J. Emery, et al., *Technology Trade with the Middle East,* (Boulder: Westview Press, 1986), p.4.
10 *Ibid.*, p.1.

modernization and development, which is the subject of the next section.

2-Science and Technology Planning in the Middle East

The discussion of science and technology planning issues might be considered a new trend in the developing countries in comparison with the developed world which experienced this more than half a century ago. The Middle East countries are not exception amongst the developing countries although they might differ in their socio-economic-political structures, i.e., some countries are capital intensive whereas others are labour intensive and so forth. Such differing factors might call for planning of different science and technology policies.

2.1-Relevance to the Past

The foundation of modern science and technology in the Middle East started between 1800 and 1950 when sequence of incidents led to the establishments of institutions aimed to be utilized as centers of scientific learning. However, except in some distinctive cases, no institutionally upheld scientific activity existed prior to 1950.[11]

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[11] Y.Y. Al-Sultan, p.14. See also; A.B. Zahlan, *Science and Science Policy in the Arab World*, (London: Croom Helm, 1980).

The history and trends of academic and research activities in the Middle East differ among these countries due to the country's financial and socio-economic patterns, type of links with the developed world and their colonial status. However, the establishment of higher educational systems and research activities in the Middle East could be divided into two categories:[12]

(i) Countries which were colonized or controlled from the 19th century by France or Britain have started their educational system earlier, with colleges or universities endowed, administered and taught by natives of these countries. At least such colonial and foreign based systems have initiated the foundation of higher educational centers in the region, viz, Egypt in early 20th century, Sudan in 1924, Syria by the end of the 19th century, Iraq and Lebanon in early 20th century, and in the case of Iran first technical college established in 1851.

(ii) Countries who were not explicitly colonized to the same extent as countries in the above categories, have started their higher educational systems in the middle of the 20th century by endowing the most vital colleges needed for their development. This has been achieved by secular and national efforts although they have studied, evaluated and called for the advice and assistance of the educational systems of the other countries, who had valuable experience in such matters.

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[12] See; Y.Y. Al-Sultan, p.14.

As for the Gulf states, the higher educational institutions and research centers were established in the second half of the 20th century. This delay in establishing these activities in the Gulf states might relate to the following causes:[13]

(i) The Gulf states societies were closed, underdeveloped and less exposed to Europe (as compared to other Middle East countries mentioned earlier) and thus would not appreciate the impacts of education and R & D activities on their socio-economic development.

(ii) The unawareness of the policy-makers of the Gulf states of the fundamental importance of scientific research in developing their countries.

(iii) The absence of any sort of communications between the Gulf states societies and the international educational and scientific communications.

The aim of the above explanation is to illustrate the following factors:

(i) Higher educational institutions and R & D centers are important establishments in the development of socio-economic structure of any country.

(ii) Some Middle Eastern countries which were colonized and had contacts with European countries had started their academic and research activities sooner than countries which were in less contacts with these foreign countries.

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13 *Ibid.*, p.16.

(iii) The Gulf states, due to their conservativeness and less-developed societies started their academic and research activities in a later stage. A phenomena which might induce implications to their manpower development and thus delay the establishment of their technical and industrial infrastructures.[14]

The cause of such late start in science and technology research activities would be related to S & T policy, which is the interaction between socio-economic processes and development with scientific and technological application to meet the ambitions and demands of a nation. This interaction involves the analysis of numerous factors related to technology in a nation such as, R & D activities, qualified scientists and engineers, budget allocation, innovation, industrialization, nature of products and trades, manpower development, etc. The extent of these parameters will make a nation, fully technologically independent (self-reliant), fully technologically dependent, or somewhere between these extremes.[15]

2.2-Retrospective Review of Science and Technology Policy During Past Two Decades

It is true that the Middle Eastern countries depend much upon foreign science and technology. Now every government proclaims its commitment to the development of science and technology. Evidence of the wide range and numerous forms of

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14 *Ibid.*, p.17.
15 *Ibid.*, p.18.

scientific and technological dependency can be seen, for example, in the quantity and quality of local scientific textbooks, the number and content of Arab and Persian scientific journals, the number of patents or licences imported or exported, the extent of turn-key arrangements,[16] the heavy dependence on foreign consulting and engineering, the structure of foreign trade and other similarly telling symptoms.[17]

The initial manifestations of this dependency, during the past two decades, was to identify the scientific technological institutions, capabilities and resources that developed countries possessed but less developed countries lacked, their research and development infrastructure, their educational systems and even the relevant policy-making bodies. This was accompanied by an extensive diagnostic studies, at national and regional level, aimed at describing the state of science and technology in the region.

From these initial studies and due to government concern for S & T development, many recommendations emerged from conferences on a ministerial level, and programmes of action were designed by specialized regional agencies.[18] Most of them were

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[16] In the case of turn-key projects, technology is purchased outright and foreign firms come in to build plants or facilities and install the necessary equipment to make them operational. Then, the providing firm or firms depart, with management and operation of the facility left in the hands of local personnel. See; T.L. Ilgen and T.J. Pempel, p.13.

[17] For evidence see; A.B. Zahlan, *op. cit.*, pp.22-33.

[18] See for example; UNESCO, "Science and Technology in the Development of the Arab States"; and UN, *Regional Plan of Action for the Application of Science and Technology to Development in the Middle East*, ST/UNESOB/11, (New York, 1974). See also; UN, *Technology Policies in the Arab States*, E/ESCWA Report, E/ESCWA/NR/86/9, (New York, 1986).

based on some ideal conception of scientific and technological systems and how they might be linked to development. Institutional lacks were identified as well as problems to be overcome and mobilization of available resources and elements of policy and planning were suggested. With such an approach, there was an explicit or implicit adoption of the attitudes prevailing in the developed countries and a neglect of differences in the specific context of Middle Eastern socio-political and economic development.

The main point throughout these recommendations was a rather naive belief in the possibility and effectiveness of government intervention in developing an indigenous scientific and technological base, which would produce technology relevant to need. In this way, general policy recommendations regarding science and technology were designed and superimposed on relatively unknown developmental structures. There, also, emerged a movement that blamed the lack of demand for local science and technology on indiscriminate importation of foreign technology.[19] Therefore, the scientific community began to ask their governments to take measures to regulate such imports, and for the right to participate in selection process of technology. As a result, a very few institutions came into existence and these helped little to reduce the most visible dependency on foreign technology.

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19 For evidence see; Y.M. Hussein, p.89.

Neither approach, i.e., approach of strengthening local capabilities with government intervention or approach of imposing restrictions on the inflow of foreign technology, has so far resulted in orienting available resources towards self-reliant development and has only created an awareness of the need to develop indigenous scientific and technological capabilities.

UNCSTD has evaluated the prevailing assumptions on the relations and interactions between science and technology and development, that started in the region in the seventies, as follows:

> The "Supply push" strategy that had prevailed under the influence of current thinking and examples of success in the industrialized countries has not fulfilled the national and regional expectations for indigenous science and technology capabilities to play an effective role in the development effort.[20]

It is also generally accepted now that the scale and mode of transfer of technological products has suppressed demand for the contributions of those local capabilities.[21] The mechanisms for proper interfacing of "science and technology development" and "national socio-economic development" have yet to be planned and implemented. However, an overall assessment of the status of science and technology planning in the region indicates that none of the countries of the region has science and technology planning,

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20 UNCSTD Report, *Regional Meeting on Progress in Science and Technology for Development in West Asia Region*, (Jordan: Amman, Nov. 1988), p.3.
21 *Ibid.*

until recently. Nevertheless, a definite improvement in science and technology considerations can be seen only from some years ago.

Although several years ago, science and technology planning was totally absent throughout the region, many of today's development plans present a variety and a differentiation in approaches towards science and technology.[22] A number of the countries have adopted (or are intending to adopt) science policy formulation and planning in one form or another as instruments and tools to accelerate and promote development. Most of the these countries are still in a very preliminary stage of science and technology planning and integration.

However, the absence of national science policies and plans is not so much a reflection of the non-existence of a scientific and technological base, but reflection of the fact that such a base is not adequately organized into a institutional framework. At present only some of the Middle Eastern countries have science and technology bodies with one or more national functions related to the promotion of science and technology (see Table 2). Some brief observations on the context of the science and technology policy activity during the past two decade indicate that the creation of an institution or its strengthening figures gathered momentum. Also, it appears that in many countries in the region the multi-purpose

[22] See; ECWA, "The Status of Science and Technology in the Western Asia Region" in A.B. Zahlan (ed.), *Technology Transfer and Change in the Arab World,* (Oxford: Pergamon Press, 1978), pp.51-92.

national institution emerged, while in a number of countries the overall planning function overlooked by a national council.[23] An analysis of the roles and functions of the selected national science and technology institutions, which is given in Appendix I, show their policy approach toward science and technology for development.

In Iran after the Islamic Revolution, for example, the arrangements include a cabinet committee on science and technology supported by a scientific advisory committee to the cabinet. In Syria a national council for science and technology has established. In Egypt a science and technology planning and analysis group is seen. Similar arrangement are going on in other Arab countries like Jordan, Libya, Saudi Arabia, Iraq.[24] Therefore, the importance of co-ordination of science and technology activities is recognized in several countries.

All of these, indicate that there is great improvement in science and technology considerations in recent years, but the net result of all these in terms of research and innovative thinking in science and technology is far from satisfactory. Therefore, it is of great importance for Muslim countries of the Middle East to formulate their own technological planning consistent with their socio-cultural structure. An example is the philosophy of Saudi Arabia's general attitude towards science and technology:

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23 *Ibid.*, p.60.
24 See Appendix I.

> ... the objectives of the national science and technology policy are two fold ... the transformation of society's material conditions through the selection, transfer and management of advanced technology while simultaneously preserving cultural values; and in the development of the country's natural and human resources, the objectives focus on reducing the economy's dependence on foreign power and on depletable hydrocarbon resources.[25]

This is more or less the policy of all Muslim Countries of the Middle East, Arab and non-Arab.

2.3-Regional and International Co-operation in Science and Technology

As is evident from the above, scientific activity is a phenomenon of recent growth. The advantages of regional cooperation in science and technology have been advocated by the Arab League, UNESCO, and other international organizations in the region during the seventies.[26] As a result, the Arab League Educational, Cultural and Scientific Organization (ALESCO) created in 1970. Also, to intensify the scientific and technological activities, the Arab Regional Center for the Transfer and Development of Technology, the Arab Fund for Scientific and Technological Development and the Union of Arab National Research Councils established. There is also the Conference of Ministers of Arab States

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[25] Quoted in C.A. Qadir, *Philosophy and Science in the Islamic World,* (New York: Croom Helm, 1988), p.182.

[26] Regional organizations in the area of S & T has been explained in detail in Z. Sardar, *op. cit.,* pp.83-116.

responsible for the application of Science and Technology to Development (CASTARAB). Its aim is at increasing regional co-operation in various fields of research.[27]

However, the progress towards sharing of research costs and tasks has been slow. The International center for Agricultural Research in Dry Areas in Syria is the only Middle East member of the International Agricultural Research Center Consortium.[28] UNESCO sponsored a major meeting of Middle East Ministries responsible for science and technology in 1976 which generated proposals for regional communication satellites, designated research universities, and research priorities for arid land, ophthalmology, and Islamic medicine.[29] However, political and economic difficulties have blocked most of these proposals.

In addition to the above regional activity and organizations, at the *ummah*[30] level, the Third Summit Conference of the Organization of Islamic Conference (OIC) that held in Saudi Arabia in 1981, recognizing the need for promoting the spirit of scientific enquiry among Muslims, decided to establish a Standing Committee on Science and Technology Co-operation. The main objective of the Committee is to explore the possibilities for

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27 On this subject see; C.A. Qadir, p.185. See also; A. Segal, et al., "The Middle East: What Money can't Buy" in *Learning by Doing: Science and Technology in the Developing World,* (Boulder:Westview Press, 1987), pp.83-105.

28 A. Segal, p.100.

29 *Ibid.*

30 *Ummah* is the totality of the world Muslim community. Sardar has defined as, "Muslim body-politic, the totality of Muslim reality, the ultimate community based on faith." See Z. Sardar, *Islamic Futures: The Shape of Ideas to Come,* p.72.

promoting and strengthening co-operation among Muslim states and drawing up plans to increase the capacities of Muslim countries in scientific and technological field.[31]

In order for the Committee to implement the proposed programmes, the Committee established specialized agencies like the Islamic Educational, Scientific and Cultural Organization (ISESCO) and the Islamic Foundation for Science and Technology for Development (IFSTAD). These bodies are busy suggesting and allocating different scientific and technological projects to different Muslim countries. The world bodies like UNESCO, UNIDO and the World Bank are co-operating with the OIC and assisting it materially and financially for the implementation of its scientific and developmental programmes.[32]

From these conferences and meeting it has emerged that what the Islamic *ummah* needs is: (1) that the capability of Muslim countries be raised by training their manpower in the light of modern developments in science and technology; (2) that institutions be developed so that indigenous resources of Islamic countries be fully utilized for the growth and progress of science and technology; and (3) that *ummah* level institutions in science and technology be set up in areas suitable to research and developmental activities.[33]

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31 C.A. Qadir, p.184.
32 *Ibid.*, p.185.
33 *Ibid.*

To achieve these objectives and to reduce the dependency of *ummah* for science and technology on the West, the committee has identified eight main areas of scientific research.[34] Finance for these projects comes from Muslim countries and from some non-Muslim countries interested in the projects. Among the projects was the establishment of an Islamic Academy of Science and an Islamic Foundation of Research Institutes. Both were initiated in 1984.[35]

3-Obstacles for Science and Technology Development in the Region

Science and technology can only function and grow where there are critical masses of researchers, facilities, flows of information, and sustained funding. Twentieth century science-driven technology depends on large-scales interconnected bureaucracies unlike the one-man labs of 19th century researchers. In this context, science and technology in much of the Middle Eastern countries has no secure home and can barely function.

The lack of effective policy and facilities prompts the most able researchers to emigrate, prevents the training of future researchers at home, and produces results that either published abroad but find no audience at home. The author believes that the lack of support system for research and development is an important contribution

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34 These areas include; manpower training, setting up technological institutions, development of information and documentaries, technology transfer methods, and improved infrastructure for food, energy, higher education and ocean sciences. For more information see; *ibid.*

35 *Ibid.*, p.186.

towards the brain drain in the region. In the last two decades 500,000 Muslims with good qualifications have left their own countries and migrated to the West, which is not only a "brain drain" but also a huge financial loss to the countries concerned.[36]

Therefore, the scarcity of qualified manpower and of scientists (see Table 3) resulted and will result in the Middle Eastern countries remaining almost completely industrially, scientifically and technologically dependent to the advanced countries. For this reason it is essential for a meaningful strategy of any scientific and technological planning to have a clear idea of the implications of technological dependency in relation with the objectives of socio-economic development. The most important points to be taken into account are the following:

(i) The main cause of the failure of the countries of the region in the incorporation of the postwar wave of innovations was not technological dependency, but the well-known fact that the socio-economic strategy applied was not geared to satisfy the needs of the majority, but rather to stimulate a pattern of consumption based on the model of the upper and middle classes of the developed countries, and only accessible to a small minority of the Middle Eastern population.[37] Therefore, the imitative style of development

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36 *Ibid.*, p.180. It should be noted that study by Organization of Islamic Conference on brain drain in the Muslim world has been identified three types of brain drain, "The first is the migration of scientists to industrialized countries. The second is the movement of scientists from the poor countries to capital-rich states. The third type of brain drain is the internal waste caused by the poor use of native talent." See Z. Sardar, *Science and Technology in the Middle East*, p.11.

37 For evidence see; C. Issawi, p.35.

did not create a significant demand on the local R & D systems, and so there was no stimulus for the implementation of an active, systematic policy for science and technology. As a result, the weakness of the local R & D was only a secondary contributing factor, and more a consequence than a cause of the failure.

(ii) Technological dependence is characterized by the degree of dependency. Practically all countries have to import technologies in certain areas or sectors. The difference between the developed and developing countries is not only on the degree of dependency but also, and more important, in the policy they apply to import technology. The developed countries adopt the imported technologies to their own conditions and possibilities. While, as Herrera has emphasized, most developing countries, including Middle East, introduce these technologies to create deformed copies of the societies where the technologies were originated, which in practice results in the socio-economic marginalization of a great part of the population.[38]

(iii) Although only in long-term future, two or three decades, there are possibility for the countries of the region to attain a technological autonomy comparable to that of the advanced countries, they have some degrees of freedom and that, if appropriate policies are implemented, the capacity to take autonomous decisions in the scientific and technological field will

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[38] A.O. Herrera, "A Prospective View of the Social Impact of the New Technologies," Paper presented at the 5th UNU Global Seminar, (Japan:Hakone, Sep. 1989), p.13.

increase continually in the period of transition. Therefore a central task of a strategy should be to organize R & D policies that is based on the socio-economic goals in order to maximize the capacities. In other words, as Herrera has put it: "the problems are not to close the technology gap in absolute terms, but to gradually reduce it as a function of the demand of the socio-economic strategy."[39]

From the above, it is clear that the nature of technological dependence created a range of socio-economic features and problems in the Middle East. These countries carry these problems in different degrees but the among all prevalent problems are:

(1) Predominance of primary commodity production.

(2) Trade structures largely based on imports of technology and export of primary products (see Table 4).

(3) Limited national technology generation, which reflected in low levels of research and development related to technology, as a result few national inventions and low industrial output.

(4) Alien technology management.

(5) Weak technology negotiating capabilities.[40]

(6) The relatively low priority accorded to science and technology as development instruments in the non-oil sectors.

(7) The inadequacy of the existing institutional framework to absorb science and technology manpower.

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39 *Ibid.*, p.14.

40 Items 2,3,4,5 has been also emphasized by Sardar. See; *Science and Technology in the Middle East*, p.3.

(8) The migration of national human resources.[41]

(9) The effectiveness of imported technology, in this regard it should be stressed that the transfer of technology goes beyond mere importation and subsequent application of foreign technology. It requires the conversion of that technology into one appropriate to each country's particular situation. The countries of the region do not have yet national center for technology transfer.[42] Therefore, the absence of a center that carry out R & D related to technology transfer (selection, adaptation, assessment, development) is clear.

(10) The need to develop and improve utilitarian links between industry with R & D institutions and universities.[43]

(11) The absence of a methodology for the popularization of science and technology and their role in the development. Also there are no proper channels of communication with the public to allow their involvement in the choice and utilization of the acquired technology.

(12) Lack of methods to achieve suitable decisions on the technologies due to: (a) non-availability of data and collecting information, (b) absence of sectoral studies and identification of

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41 Items 6,7,8 has brought into focus by UN report in several years ago but, in the author's opinion, still they are applicable in the region. See UN, *op. cit.*, p.8.

42 In some countries of the region, however, National Centers for Science and Technology deal with technology transfer issues, see for example; UNCTAD, "Technology Policies for Development and Selected Issues for Action," Proceedings of a seminar organized by Islamic Development Bank and UNCTAD, UNCTAD/TT/94, (New York, 1988).

43 This point has been emphasized by several authors. See for example; A. Segal, p.96; and, A.B. Zahlan, *op. cit.*, p.18.

their interrelationships and weaknesses, (c) weakness of suitable criteria for selection and transfer mechanisms.[44]

(13) Financing levels for science and technology activities are generally inadequate both at capital expenditure and operating levels (see Table 5).[45]

(14) The absence of plans and schemes to create indigenous know-how and fully to utilise all the accessible national physical and human resources.

Considering all of these obstacles, the need to draw up or improve policies concerned with science and technology in the region become evident. Among all the existing problems those which are related to; weak state of institutionalization, the brain-drain, the poor linkages between researchers and potential users, lack of appropriate support system are of great importance. Also, it is obvious that, concerning technology transfer, the learning process has been generally slow and the countries do not have the capability to analyze, absorb and generate new technologies.

Although obstacles or problems undoubtedly exists, it is not appropriate to consider the development process as a steeplechase, in which one obstacle after the other is being overcome. Studies by the United Nations Research Institute on social development on socio-economic development indicators, and by UNESCO on

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44 Y.M. Hussein, p. 91.

45 This may relate to the maintenance of relatively large armies with huge expenditures which weight heavily upon the finances of all the countries in the Middle East. For example, Syria, Iraq, Jordan, Egypt, Iran, Turkey and Lebanon has allocated unusual amount of resources to national security expenditures.

indicators of scientific and technological development have clearly shown that significant improvements in the development level are not obtained through isolated sequential interventions.[46] Quite the opposite is true: development indicators tend to advance, stagnate or retrogress together. Thus providing strong arguments for an integrated, harmonious approach to growth and development of science and technology.

46 UNESCO, *op. cit.*, p.130.

CHAPTER III

Imported Know-How for Technological Self-Reliance: Towards an Indigenous Generation of Technology

In the last chapter the position and problems for technology development within the region were examined. Taking these problems into considerations, this chapter is an attempt to search for the suitable strategy for effective transfer and generation of technology. Moreover, it focuses on the choice of appropriate technology for the region, its adaptation, utilization, and absorption rather than trend of technology transfer to the Middle East.[1] It argues that without such capabilities no effective transfer and development of indigenous capacities can be said to have occurred.

Technology transfer is more than the supply of equipment and training of people in its operations. Its effect on socio-cultural characteristics of the technology-importing country can be advantageous or disruptive of established attitudes and practices.

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1 This subject has been already studied extensively, see for example; J.J. Emery, et al., and US Congressional Research Service, *Technology Transfer to the Middle East OPEC Nations and Egypt 1970-1975,* (Washington: US Government Pub. 1976); see also T.L. Ilgen and T.J. Pempel.

Therefore, Muslim Countries of the Middle East should only accept a "technology" which consequences would not run into contradictions to their socio-cultural characteristics.

It is in this context that the concept of appropriate technology and its application to the Middle Eastern countries should be considered. It is recommended that technology assessment should apply for any technology selection. There is no reason to believe that the technology assessment should concern only to the industrialized societies. On the contrary, it is developing countries that are more urgently in need of developing their own skills for the selection of suitable technologies in order to meet their economic and social needs.

1-Choice of Appropriate Technology

1.1-The Concept of Appropriate Technology

The critical role of technology in economic development, and especially the importance of technological choice, was first brought into focus by the E. F. Schumacher nearly twenty years ago. In his famous book *Small is Beautiful,* he said:

> In the excitement over the unfolding of his scientific and technical powers, modern man has built a system of production that ravishes nature and a type of society that mutilates man.[2]

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2 E.F. Schumacher, *Small is Beautiful: A Study of Economics as if People Mattered,* (London: Blond & Briggs, 1973), p.272.

Technological choice influence not only production and products, but also the location and conditions where men work and live, the men's relation to their environment and etc. It has been assumed before that the technologies from industrialized countries are appropriate for the development of the developing countries.[3] These technologies typically are capital intensive (labor saving), large scale, and heavily centralized. They require for their efficient operation an elaborate support structure of market, training, raw materials, supplies, spare parts, cheap and efficient communication systems.

Schumacher, observed two basic factors in developing countries: (1) the majority of the populations are in rural area and living in poverty that is characterized by high unemployment and serious underdevelopment, (2) as a result of the above, there is an unavoidable potential for mass migration from the rural areas to the cities, which already many of them face insoluble social, economic, and environmental problems.[4]

Unfortunately, large-scale and capital-intensive technologies amplify those problems. Being capital-intensive and labor-saving they are unable to provide sufficient jobs to cope with the growing supply of labor. Moreover, the kind of goods they produce are generally of the wrong kind to meet the needs of the poor. Also,

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3 Although some Western technology has contributed to economic and social progress but in many developing countries it has been an instrument in increasing the gap not only between the rich and poor, but also in earnings, social status and also produced cultural disruptions.

4 E.F. Schumacher, pp.98-126.

these type of technologies make demands upon special types of infrastructural facilities, they shape educational standards and norms, influence consumption patterns and life-styles, and dictate import-export pattern.[5]

The essence of the argument for appropriate technology is therefore that capital-intensive, centralized, complex, and costly technologies of the rich countries are generally inappropriate for poor countries, and especially for their rural communities.[6] To meet their needs, a new technology must be discovered or devised that lies between the traditional and ultra-modern technologies and unites the two.

Schumacher named such technologies "intermediate" technology and maintained that: "The technologies that are appropriate to developing countries should be people centered".[7] Whatever the name is, the important point is to provide technological choices for people in order to be able to answer their needs among a range of alternatives and at the same time to minimize the harmful effect of transfer of technology from the advanced countries to the importing countries.

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5 See; W. Adams, "Intermediate Technology and Development" in M.J. Betz, et al. (eds.), *Appropriate Technology: Choice and Development*, (Durham: Duke Press Policy Studies, 1984), p.14.

6 The idea of labor-intensive technologies, especially as applied to rural areas, goes back to the colonial era. Village industries were encouraged in India before the 1930s. Gandhi's writings and philosophy were tied to labor-intensive technologies. For more information see; *ibid.*, p.5.

7 E.F. Schumaher, p.162.

However, in insisting on technological choice we must make a clear distinction between science, on the one hand, and technology on the other, i.e., between scientific knowledge and its application. The knowledge of scientific laws is absolute and one could hardly talk of "appropriate" or "intermediate" knowledge or science. But the application of the knowledge can take many different forms and can lead to many different types of technology and modes of operation. It is here that need for the possibility of intelligent choice enters.

Moreover, on a philosophical point of view, appropriate technology relates to the concepts of peace, non-violence and survival and stresses human dignity and the ethics of works. Within the context of planning, the concept puts emphasis on both short and long term policies that will encourage self-reliance, and on decentralization with respect to planning and decision-making within the regional approach.[8] Therefore, appropriate technology is a concept, a set of ideas or a framework within which to think and act for development of a society. The aim of the concept is to provide a basis and a methods for the choice and development of technology.

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8 See, for example; N. Jequier (ed.), *Appropriate Technology: Problems and Promises*, (Paris: OECD Development Center, 1976), pp.98-112.

1.2-Characteristics of Appropriate Technology

In existing literature related to the features of appropriate technology different writers adopt different set of criteria. For example, Eckaus develops the following criteria for appropriate technology: "(1) to maximize product output, (2) to maximize the availability of consumer goods, (3) to maximize the rate of economic growth, (4) to reduce unemployment, (5) to encourage regional development, (6) to reduce balance of payments, (7) to provide greater equity in income distribution, (8) to promote political development, and (9) to improve the quality of life."[9]

However, M. J. Betz adds the following features to the above, although saying that the list is still far from comprehensive: "(10) to reduce the population flow to urban centers, (11) to provide an adequate national food base, (12) to be as consistent as possible with the indigenous social structure, and (13) to build upon and preserve the indigenous cultural continuity and heritage."[10]

It follows that appropriate technology criteria are themselves in conflict.[11] But one strength of appropriate technology is that it can identify negative aspects of a situation as well as those that can be improved. Obviously this strength should lead to more rational

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9 M.J. Betz, et al. (eds.), "What Technology is Appropriate?" in *Appropriate Technology: Choice and Development*, p.3.

10 *Ibid*.

11 For this point see for instance; P.K. Ghosh (ed.), *Appropriate Technology in Third World Development*, (Westport: Greenwood Press, 1984), which contains different criteria for appropriate technologies each in a different context.

decision making since the positive and negative aspects can be compared and optimal solution to implement.

Let us now turn to the type of technology that would meet the goals of the economic principles of Islam. Sardar called these type of technology "indigenous technologies" in order to reflect their local character.[12] He points out some of the major characteristics of indigenous technologies:

"(1) they should be capital-saving and labor-intensive, (2) they will be cottage-scale and small-scale, taking account of the human factor, (3) they should directed towards producing goods and services appropriate for large-scale consumption rather than for individual luxuries, (4) on the whole they would be based on simple processes, where necessary these processes will be adequate modifications of traditional skills like pottery, weaving, etc., (5) they should rely on the use of local material, rather than imported materials, (6) they would be energy saving rather than energy intensive, (7) they would utilize locally available energy resources such as sun, wind, water, and bio-gas, (8) they would promote a symbiotic and mutually reinforcing, rather than parasitic and destructive, dependence of metropolitan city upon the rural population, and finally (9) they would be non-violent, based on rational sustained use, rather than indiscriminate rapid devastation of the environment."[13]

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12 Z. Sardar, *Science, Technology and Development in the Muslim world,* p.132.
13 *Ibid.*

He concluded that small, labor-intensive firms are most suited for Muslim countries. If the technology employed is based on simple processes, it is obvious that the need for complex managerial skill becomes redundant. Also the need for foreign employees, draining away vital foreign currency reserves, evaporates. Moreover, small firms are less dependent on large towns, they can be located in rural areas, thus producing development through the country.[14]

The relevant question, now, is that how to apply the concept of "appropriate technology" to the Middle Eastern countries, is this concept useful, either for imported or indigenous development of technology, in the context of the Middle Eastern countries? To answer this question we should divide these countries into three categories.

One group of the countries of the region is that of small oil-rich countries with super-abundant capital resources and relatively small populations, e.g., the United Arab Emirates, Kuwait, Bahrain, Qatar, Libya, and Saudi Arabia. These countries are experiencing severe skill shortages and have begun to import expatriate technicians of various types on a significant scale.[15] Therefore, open unemployment is not a problem, in part because of government policies to absorb new workers of the labor force into the public

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14 *Ibid.*, p.133.

15 For evidence see; C.G. Baron, "Appropriate Technology, Employment and Basic Needs in Arab Countries with Special Reference to the Food Industries" in A.B. Zahlan (ed.), *Technology Transfer and Change in the Arab World*, p.386.

service. Such countries do not therefore manifest any obvious need for capital-saving, simpler technologies.

However, still there would be a case for selecting industrial technologies for transfer from abroad with some care. The most sophisticated modern technologies can not absorb as much labor as some more appropriate variants of the same technologies which may enable a larger number of people to be trained in the pattern of industrial work and in the use of repair of machines. For the future industrial growth of these countries, skill accumulation in the local population is probably of vital importance and it is not at all certain that most labor-saving technologies can assist the achievement of this objective.

A second group of Middle Eastern countries, including Egypt, Morocco, Yemen, Tunisia, Jordan and in some measure, Algeria, face problems which are more similar to those of developing countries generally. These countries have low land/man ratios, which encourage high rates of migration from the agricultural sector into the towns, and correspondingly significant open unemployment in the latter.[16] Techniques of production which absorb labor have an important role to play in the economies of these countries. Therefore, appropriate technologies of the type of labor-intensive can be suitable choice for development and growth in these countries.

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16 *Ibid.*, p.387.

A third group of countries, notably Iran, Syria, Iraq, Sudan lies somewhere between the first two groups. The land/man ratio is high, so that the key problem is that of generating economic growth from a rural base. However, disguised unemployment is likely to be common in rural areas and simpler technologies for application in small-scale rural industries -- especially those using the products and by-products of the agricultural sector -- may be significant in employment generation and the raising of low rural income.[17]

In sum, Middle Eastern economies vary considerably. Certain categories of skilled manpower are in short supply everywhere, but most countries suffer from an excess supply of labor more or less in the rural and urban areas. However, the general concept of appropriate technology may be demonstrated in a more concrete manner by referring to a specific industry.

It follows that the criteria of a technology's appropriateness presented in this section is not synonymous with labor-intensive and small-scale production, depending upon the circumstances the most appropriate technology could be capital-intensive involving large-scale production. Since the field is relatively new, view points differ as to what constitutes an appropriate technology.[18] However, the author believes that the following criteria is minimum and

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17 *Ibid.*

18 For example, some writers refer to the limitation and barriers of the concept of appropriate technology, for this point see; D.D. Evans, "Appropriate Technology and Its Role in Development" in P.K. Ghosh (ed.), *op. cit.*, pp.47-51.

basic criteria which should apply in any selection of technology whether imported or locally generated:

(1) appropriate technology should be compatible with local cultural and economic conditions, i.e., the human, material, and cultural resources of the community,

(2) the tools and processes should be under the maintenance and operational control of the people,

(3) appropriate technology should use locally available resources,

(4) if imported resources and technology are used, some control must be made available by the community,

(5) appropriate technology should use local energy sources as much as possible,

(6) it should be ecologically and environmentally sound,

(7) it should minimize cultural disruptions,

(8) it should be flexible in order that a community should not lock itself into systems which later prove inefficient and unsuitable,

(9) research and policy action with regard to appropriate technology should be integrated and locally operated in order to ensure the relevance of the research to the welfare of the local people, i.e. the maximization of local creativity, the participation of local inhabitants in technological development[19] and;

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19 This criteria arises from national consensus about the need for development efforts and the relative importance of different policy objectives. Failure to satisfy this condition in a majority of developing countries explains the lack of popular participation that is so crucial to the generation and diffusion of appropriate technologies.

(10) since development in science and technology are greatly dependent on a wide range of domains related to national life, dignity of man, ethics, etc., it is important for any government to promote those sciences and technologies characterized by greater respect for man, better adapted to people and society, and deepening our understanding of nature and man itself.

In practice, it may not be possible to meet all these criteria. However, they do provide general guidelines or goals to which appropriate technology practitioners should consider. Also, it is according to these assumptions that a strategy for indigenous generation and development of technology which is given in the last section become meaningful.

1.3-Technology Assessment for Technological Choices

Technology assessment is relatively a new concept in industrialized countries. It has its origin in the continuing concern for the apparent inability of society to channel technological developments into directions that sufficiently respect the broad range of human needs.

It is often argue that the technology assessment movements is a visible reaction within the developed countries against an almost blind reliance on technological solutions to social, economic and political problems.[20] Should one conclude from these

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[20] See; K. Standke, "Assessing Technology for Technological Choices" in UN, *Technology Assessment for Developmentt*, p.88.

observations that the technology assessment concept is relevant only to those "post-development" countries which are now seeking to control the undesirable and unforeseen consequences of technological application? I do not think so. On the contrary, it is even more crucial for countries with scarce resources and manpowers that technologies be carefully assessed in terms of their efficient use of human and material resources and their over-all implications for development. Moreover, it is possible for developing countries to profit by avoiding the errors of others, if a proper assessment of such errors is conducted.

Technology assessment can be defined in different ways, for example:

> Technology assessment is a process for the systematic analysis, forecasting and evaluation of a broad range of impacts on society pertaining to technological change and choice in order to identify public policy options. It helps to match technological development to national goals.[21]

The concept of technology assessment is a broad one and the above definition is intended to show its domain. Another definition proposed by Arnstein and Chistakis:

> Technology assessment (TA) is a policy-oriented activity, primarily concerned with society's management of technology and not the development or elaboration of technological alternatives. What

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21 This definition adopted by the seminar of the United Nations on *Technology Assessment for Development*, (India: Banglore, 1978), p.6.

> distinguish TA from system analysis is its imposes on the social consequences that are likely to be precipitated through the contemplated innovation and its emphasis on appropriate intervention by policy makers and decision makers.[22]

Both definition shows the particular notion of technology assessment, that is, the interaction between "technology" on one side and "society" on the other, which are both inseparable parts of a socio-technical system. However, in the case of Muslim countries economic and ethical principles of Islam constitute main criteria for assessing any technological choices. Methodologies for technology assessment can be developed according to value system of Islam and on a human base to meet the needs of specific countries. Sardar stress that:

> The techniques currently applied for technology assessment in the Occident are all based on the neo-Apollonian outlook. In this type of assessment all decisions must be justified in terms of "rational factors" and "valid theories" of occidental science and social sciences.[23]

It is obvious that such methodologies incorporate occidental value judgements and only obscure the fact that the categories selected as the basis for analysis already disguise the essential ideological and political elements of the problem under review.[24]

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22 K. Standke, p.36.
23 Z. Sardar, *op. cit.*, p.131.
24 *Ibid*.

Therefore, care should be taken that the analysis in question not to be culturally against the Muslim societies. Technology in Muslim countries should be evaluated with an eye to its promotion of the concept of self-reliance through the use of local human and natural resources, and also assessed with regard to its environmental impacts, as well as to social and cultural effects.

It is clear from above that, technology assessment is a policy tool. Firstly, it would help to identify appropriate technologies and secondly, its major benefit arises from its broad examination of impacts on the society which determine the decisions. In general, TA represent a process for identifying the impacts of both imported and domestically generated technologies on the society, culture, economic and environment. Also, it should be noted that, in the long-run, indirect and unanticipated effects of technology are often more significant than the immediate planned consequences.

Taking into considerations all of the above, the author would like to recommend that the following steps should be taken for any technological choices:[25]

(1) Identification of scope and objectives: for example, formulation of present and future perspectives and identification of the range of utilization and its place in the basic development strategy.

(2) Recognition of technology in detail: for example, placing the technology as to software and hardware.

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[25] For more information see; K. Hoashi, "Capabilities of Technology Assessment in Development" in UN, *op. cit.*, pp.78-83.

(3) Analysis and evaluation of possible impacts, both positive and negative impacts.

(4) Recognition of the interrelation of the effects: for example, interaction of the effects and identification of the casual consequences.

(5) Findings of the measures and alternatives: for example, identification of the alternatives and of possible measures.

(6) Comprehensive evaluation and implementation of the final results.

Therefore, it is very important that technology assessment become a necessary part of establishing new technologies, as well as in transfer of technology. In order to respond to problems that industrialized society faces, technology assessment should be an appropriate policy tool for both technology choice and development. Thus, with the awareness of the importance of TA, the Muslim countries can develop their own methodologies through which they can apply this evaluative tool in their own planning and policy-making.[26]

2-Adaptation and Absorption of Technologies

In order to attain technological self-reliance, technology must be transferred, absorbed, adapted and, in the most favorable cases,

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26 For the role of technology assessment in national planning and decision-making process see; A. Korn, "Technology Assessment in Planning for Development" in V.L. Urquidi (ed.), pp.99-106.

changes to suit to the local conditions. As mentioned earlier the technologies traditionally imported by developing countries are suited to the factor endowments of the rich exporting countries. Adaptation is the process of matching alien technologies to local factor endowments, social customs and values and national development objectives.

Adaptation is therefore an essential element of attempts to foster technological self-reliance. However, in the Middle East generally do not appear to have initiated incentives designed to promote adaptation. In only a few developing countries, such as Brazil, India, the Republic of Korea and Yugoslavia, have consultancy engineering capabilities been created in any significant measure.[27] In several Middle Eastern countries consultancy engineering firms have come into being but their experience and versatility are limited, often confined to local consultants of equipment suppliers or other consultants from abroad.[28]

Since technology adaptation is the means of linking imported technology to national R & D, policies designed to enhance capacities for adaptation and absorption will need to give due consideration to the building-up or enhancement of national R & D capabilities. The adaptation of imported technology may necessitate,

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[27] See; M. S. Kanthi, *A Compendium of Technology Plans and Policies in Selected Developing Countries*, IS.641, (Vienna: UNIDO Pub., 1986).

[28] For example, there are large number engineering and contracting firms in Egypt, Iran, Turkey, Saudi-Arabia which do not have research organizations or capabilities, and are highly dependent on government favors. It is difficult to see them as the agents for adaptation and absorption of foreign technologies unless and until government provide suitable environments and incentives for them.

for example, the scaling down of the technology to the size of the local market, a process that has already been satisfactorily demonstrated in several fields, including bricks and cement, paper, textiles, packaging, sugar and a wide variety of agricultural equipment.

However, as noted earlier, technologies incorporate and reflect value systems and embody social and cognitive structures. They contain intrinsic characteristics that cannot be changed by narrowly defined processes of adaptation. Some of these characteristics such as the degree of complexity of the technology, its scale, spatial extension, energy, material requirements, transformation, skill, manpower and knowledge content have the greatest possibilities for diffusing and absorbing the technology.

The concept of "social carriers" of technology, developed by Edquist and Edqvist, is useful for identifying some of the problems associated with technology absorption.[29] They suggest that effective absorption and diffusion is dependent upon the existence of a social entity or category, so-called a "social carrier," which has an interest in applying that technology. A social carrier could be an individual farmer who changes his pattern of production as a result of the introduction of an improved plough. The carrier can also be an institution. It might be, for example, an enterprise or agricultural

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29 UNIDO, "Technology Self-Reliance of the Developing Countries: Toward Operational Strategies," p.122.

co-operative that can develop and promote the use of new machinery and agro-technologies.

In this view a social carrier must have an objective interest in choosing and applying a specific technology. This objective interest must coincide with a subjective interest, i.e., the objective interest must be consciously felt by the carrier.[30] Therefore, in this way every technology must have a social carrier in order to be absorbed and diffused.

Another opinion presented by Bagchi who argues that there are three major routes for the absorption of technology and its adaptation.[31] The first is the excitation of the profit motive, i.e., when certain products and processes are profitable, economic agents will try to obtain this know-how and implement them in the production process.

Second major routes to absorption of technology is what he called the "associationist route" and mobilization route. Some examples of the "associationist route" have been provided by Piore and Sabel such as the silk industry in Japan in the nineteenth century.[32] This industry mainly consisted of a series of small shops, each specializing in a part of production, but often using common facilities such as steam engines and electric motors. Their work was

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30 *Ibid.*

31 A.K. Bagchi, "Technological Self-Reliance, Dependence and Underdevelopment" in A. Wad (ed.), *Science, Technology and Development*, (Boulder: Westview Press, 1988), p.74.

32 *Ibid.*, p.76.

generally coordinated by merchant-manufacturers and large firms, arranging credit and raw materials and marketing the output.

According to Baghci, third route for absorption of technology is the route of political mobilization. The best examples of such mobilization occur when a country is trying to gear the people up to train themselves, to make the fullest possible use of available resources, and to raise its own productivity. Mobilization of local resources can be a powerful means when the countries concerned were trying to correct major deficiencies in supplier of food and strategic materials, when foreign import and foreign resources were not adequate to fill the needs of the country, for example, when the country is in war.

It is clear, from the above analysis, that for the effective adaptation and absorption of technology, the state of technology within the country and also the existence of conditions to promote such absorption should be assessed. Since the base for adaptation and absorption is provided by qualified manpower it is necessary that long-term policies for the absorption of technology concentrate on human resource development. Also, internal mobility of technical personnel to be considered for immediate absorption and diffusion of technology.[33]

Self-reliance in technology thus requires a system which routinely absorbs and adapts new technology even if it may not be

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33 For a general survey about mobilization of resources from an Islamic perspective see; A.H.M. Sadeg, "Mobilization of Resources for Development" in *The American Journal of Islamic Social Sciences* , Vol.6, No.2, (1982), pp.239-256.

in a position to make genuine innovations. For absorption of a given technology one has to go, at least, through the following steps in the learning of foreign technology; (1) the learning of the technology for operation and installation, (2) the learning of the technology of design, (3) the production of equipment at home based on domestic design, and (4) the development of new designs oriented to actual domestic conditions.[34]

Therefore, it is suggested that countries of the Middle East in seeking to strengthen indigenous capacities for technology adaptation and absorption, should pay particular attention to:

-- Local support systems, such as; financial institutions, local consultants, special government assistance agencies, service companies such as labs, physical infrastructure including roads, water power, etc.

-- Diffusion systems, such as; standard offices, patent offices, professional associations, training organizations, information offices, general publications, etc.

-- Industrial sectors and manufacturing processes.

-- The assimilation of design know-how and related R & D efforts.

-- The further development of technology and its incorporation into the production process.

-- The development of special skills.

-- Educational curricula and policies, which should be directed toward industry and awareness of the students of the technological

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34 For more information see; A.K. Bagchi, p.80.

problems in the country as well as introduction of a vocational training.

3-Technology Transfer for Self-Dependency

In the last two sections the concept of appropriate technology, its choice, diffusion and absorption were examined. Before developing a strategy for generation of appropriate technology it is necessary to analyze terms and nature of technology transfer in order to be able to provide appropriate policy measures for a successful grafting of foreign technology.

Transfer of technology to the Middle East over the past mainly has been imports of technology and capital goods for the establishment of modern infrastructure. For example, in the form of transportation networks, communication systems, basic utilities, etc. In several countries, the process is substantially completed and the emphasis has shifted to industrial development. In others, infrastructure and industrial development have proceeded together.[35]

Perhaps this infrastructure emphasis will decline in the future and will shift toward industrial development. However, the government role which is the principal actor in large-scale industrial development will continue. It is also expected that the activity of smaller-scale private firms will increase. Therefore, at

35 For evidence see; J.J. Emery, et al., p.163.

the moment, it is important for the countries of the Middle East to find out how to manage the transfer of technology and more than that how to utilize science and technology for effective industrial development.

Therefore, the governments should co-ordinate their policies for the selection, acquisition, adaptation, assessment and development of technologies. They should also establish their domestic regulations on industrial property, foreign investments and transnational corporations activities. In this context, in this section cost and benefit of technology transfer has been examined and certain guidelines for action has been proposed in order to strengthen the capacity for policy making, as well as for the selection, assessment, adaptation and assimilation of foreign technologies.

3.1-Cost and Benefit of Technology Transfer

As far as technology is concerned most of the Middle Eastern countries are in an inevitable position. They need to import technology from more advanced countries and it is clear that in this process there are situations in which exporter countries are in a position to dictate terms. Nevertheless, often these difficulties are out-weighted by the increase in production and also when more technology is acquired. As a result, it will be no longer such a rare commodity and therefore becomes more available on more acceptable terms.

Although, the transfer of technology has brought vast changes to the economy of the importing countries, but yet there is no way of calculating the benefits that countries has received by importing technology. Such a means needs to be found.[36]

The transfer of technology is a complicated process that must travel through a number of stages before it is completed. The first of these stages that is the mediation phase, is the stage in which the need for a particular technological items is identified and all possibilities, particularly long-term ones, are investigated. Once these investigations are completed, negotiations are set in practice. This is followed by the information phase, when vital information and material is provided, involving all levels of the work force in both countries. Then comes the implementation phase in which the project is designed, the plans are completed and the plant or whatever is actually transferred to its new location. The installation phase is obviously next, and finally there is the manufacturing stage or rather the training required to enable that technology to increase productivity.[37]

If we analyze the transfer of a piece of equipment or technology to Middle Eastern countries in terms of the above-mentioned stages, then we have a means to measure the benefits

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36 S. G. Hajir has suggested a tool by which the process of modernization in the area could be better understood. According to him indicators used by Western models of development and modernization to describe the region of the Middle East as "transitional" no longer apply. See; S. G. Hajjar (ed.), *The Middle East: From Transition to Development*, (Leiden: E.J. Brill, 1985), pp.1-16.

37 Y.Y. Al-Sultan, p.396.

that are contributed by that particular transfer. To date, the following areas have been received more technology from abroad: electric power generations capacity, telecommunications networks, petrochemicals, energy, shipping, manufacturing, steel industry, port facilities, cement factories, car industry, etc.[38]

It should be mentioned, also, that in some cases preparation of feasibility studies, relevant technological documents, consultation and management of technology, etc., have been assigned to foreign firms and experts (with minimal or no involvement of national personnel).[39] This trend makes the government and other companies pay expatriates high rewards to learn and gain more experience at the expense of local firms and indigenous manpower. It is obvious that this will cause the exporting country to be in powerful and predominant status to control and manage the extent and direction of technology transfer.

As for the concept of "appropriate technology" and its application in the Middle East, it is clear that the concept illustrates that a country should either encourage the design and manufacturing of local technology to meet the demand of the country or that the country should import the technology that produce positive impacts (environment, employment, economy, etc.) for the environment of the local country and also to be suitable for the country's goals and objectives.

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38 For evidence see sources cited in footnote 1.

39 See; A.B. Zahlan, *Science and Science Policy in the Arab World*, p.19.

Considering the first option, as was explained earlier most Middle Eastern countries lack sufficient manpower and physical infrastructures that allow to manufacture all the required technology, and if so, several policies such as educational, industrial etc., have to be revised and reformulated in order to introduce this concept effectively. However, the scientist and engineers involved in the generation of appropriate technology should absorb and/or generate the required preferences, guidelines and paradigms that are essential for the development of the technology.[40]

The second option should provide that the acquired technologies are adopted in accordance to local environment and socio-economic structure. Such technologies should be geared not only to develop and contribute to their development plans but should utilize the available raw materials (gas and oil), to minimize the dependence on expatriates and to be appropriate for the local climates.

Needless to say that adopting the second option, e.g., reliance on acquisition of foreign technologies would increase the technological dependence of the receiving country unless proper policies are proposed and adopted. The policy-makers involved in proposing policies for minimizing technological reliance should realize that technological dependence will have the following negative impacts:

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40 Y.Y. Al-Sultan, p.481.

Cost: There is no easy or direct way to calculate the precise cost countries incurs when importing foreign technology. There are obvious expected costs, e.g., direct payments for purchasing the technology, licences fees, payments of royalties and salaries for accompanied manpower, etc., all of which are further complicated by the system of over and under invoicing tax purposes.[41]

However, there are costs that are difficult to define, e.g., the suppliers insistence that spare parts for the imported technology can and should only be bought from a source they stipulate, though a more competitive purchase could be obtained elsewhere. Often the supplier insists on foreign personnel being employed to use and maintain the technology. Thus strengthening the importers dependence on them. The above two stipulation should not accept by officials in order that at least the country may not pay indirect cost.

Lack of Control: The technological dependence of the country on one supplier might force her to fall in the economic and political orbit of the exporting country. Furthermore, foreign investment might also increase such links. However, it is suggested the importing country, in case of necessity, diversifies her source of importing technologies and when allowing a foreign investment the government stipulates that foreign entrepreneurs shares must

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41 *Ibid.*, p.483. Also for direct and indirect costs of international technology transfer see; F.J. Contractor, *Licensing in International Strategy: A Guide for Planning and Negotiations*, (Westport: Quorum Books, 1985), pp.15-24.

not exceed 49 % to allow control of the venture by importing countries.[42]

Lack of Transfer of Scientific and Innovation Activity (R & D): If foreign engineers and other cadres are required to fit, operate and maintain the imported technology, the receiving country is not learning anything, and is in fact merely increasing her technological reliance. Experiences of previous transfer of technology in the Middle East has illustrated two distinct trends:

(i) Some firms stipulate that their indigenous cadres should be involved in the blue-print process, design and operation of the technology and allow only national cadres to maintain the technology, but do not conduct any innovative or R & D activities on the technology. Such trend plays good role in developing the manpower but calls for more attention to R & D and innovative endeavors.

(ii) Other firms rely heavily on foreign firms to design and construct the technology (turn-key process) and involve local manpower, whenever available, in operating the project. In fact this channel has been dominant in the region during the past.[43]

Therefore, in most cases the R & D activities (equipments and know-how) has not been transferred by the exporting countries. In these cases it is desirable that importing countries call for the

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[42] *Ibid.*, p.483
[43] *Ibid.*, p.484. See also; A.B. Zahlan (ed.), *Technology Transfer and Change in the Arab World*, p.18.

transfer of R & D and subsequent improvement techniques for production and manufacturing methods.

Considering all of the above, then it is possible to maintain that the best approach towards self-dependency concept is to formulate policies which involve the creation and establishment of capabilities of scientific and technical knowledge. This can be done by the development of indigenous infrastructure particularly manpower and also by integration of the scientific and technological infrastructure with institutions and society needs on one hand and with the policy-makers on the other.

3.2-Recommendations

In the countries of the region, the most important obstacle to the acquisition of science and technology is the absence of institutions which can locate, select, absorb, disseminate, analyze and adapt foreign technology. Hence, the establishment of institutional arrangements for these purposes should receive top priority in the region.[44]

Moreover, in order that the countries build up a stronger technology negotiating capability and lesson trade structures which based on imports of technology and increase national technology

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44 See chapter II, it should be also noted that institutional arrangements for the transfer and development of technology has been emphasized in several sources, see for example; UNCTAD, "Possible Mechanisms for the Transfer and Development of Technology" in A.B. Zahlan (ed.), *op. cit*, pp.115-122.

generation, the following recommendations and measures should be analyzed and adopted by the policy and decision-makers:

-- Import of technology, and foreign investment must be permitted selectively only on following conditions: (1) need has been established, (2) technology does not exist within the country, (3) the time taken to generate the technology indigenously would delay the achievement of development targets.

-- Imported technology should: eliminate totally or partially dependence on imports, improve the efficiency of existing production, replace old installations, satisfy environmental legislation and in general brought about a diffusion effect to other sectors and promote exports.

-- In case of licensing it is preferable that the ceiling price for royalties must be set maximum at three percent in the duration of 5 years. This restrictive policy on licensing will increase some local licensees bargaining power and will result in lower prices for mature technologies, which would otherwise should purchase at higher prices.[45]

-- Government should, from time to time, identify and notify such areas of high national priority and promote so-called "strategic" industries (see List A), and also decide which procedure would be

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[45] For example, Korea's policy on licensing of foreign technology was quite restrictive in the 1960s. According to Kim examination of foreign license contract agreements through the end of 1960s shows that all licensors who demanded licensees for above the royalty ceiling have later agreed to that ceiling. See; L. Kim, *Technological Transformation in Korea: Progress Achieved and Problems Ahead*, (Helsinki: WIDER Pub., 1987), p.41.

more appropriate for the acquisition of required technology, for example, licence agreement, technical collaboration agreement, joint-venture, import of equipment, etc.

-- There shall be a firm commitment from the side of government for absorption, adaptation and subsequent development of imported know-how through adequate investment in research and development.

-- Government should encourage the participation of scientists, engineers, technical experts and other key-specialists, in issues related to technology transfer.

-- Government should encourage the direct links between R & D centers, the universities and the vocational institutes and the technology sector.

-- Laws should be formulated, in order that technology transfer agreements may include provision that national manpower will have to be trained (by the transferor), so that the new technology can be handled by themselves. In addition, the transferors should build a prototype in local environment to ensure its performance.[46]

-- Laws should be formed, such that; It involves national consultancy and engineering design offices in the technology transfer processes (design, consultation, maintenance, etc.).

-- A technology transfer specialized body should established to execute the following tasks:

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[46] For example, Kuwait spends intensive capital annually to maintain the imported technologies which were made originally to suit the European and American climates. See Y.Y. Al-Sultan, p.482.

a) documentation of available technology,

b) training supervision,

c) development of production process,

d) transfer and modification of foreign R & D results,

e) licensing agreements and consultancy,

f) to manage the horizontal transfer of technology and to exchange know-how within the local industrial sectors,

g) evaluation of acquired technology and appropriate modification of it,

h) to establish well-equipped industrial and technical information sources,

i) to establish criteria for selecting the appropriate technology for development, and;

j) to monitor the economic, social and technological impact of the imported technology.

In general, the transfer of technology should be regarded as a stimulus to indigenous development of technology. The process of technology transfer should not be viewed as a simple way of overcoming obstacles to the economic expansion of the country, but rather as the acquisition of an input that will be further manipulated and utilized in the process of enabling the country for scientific and technological creation.

4-Indigenous Generation of Appropriate Technologies: Out-Line of a Strategy

In what follows the author suggests an approach to generate indigenous technologies for the Muslim countries of the Middle East.[47] Although, the approach could be applied in any social environment, we refer specifically to the local community sector because it is the most important one in most Middle Eastern countries and its transformation could be the driving force to change the present structural relationship between the two sectors.[48]

As it was described earlier, the technology should be considered "appropriate" when its introduction into community creates a self-reinforcing process internal to the same community, which supports the growth of the local activities and the development of indigenous capabilities. Here "community" means local people with the same culture, language, customs and activities they perform, and environments from which they are surrounded.

A detail analysis about the behavior of the community made by Dr. Chesnut.[49] This analysis shows two feedback loops in the behavior of the community. The first loop related to activities of which the inputs are the three basic resources of each society:

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[47] For the creation of technology see also; A. Emmanuel, *Appropriate or Underdeveloped Technology?*, (Chichester: John Wiley & Sons, 1982), pp.61-72.
[48] See also; A.O. Herrera, "An Approach to the Generation of Technologies Appropriate for Rural Development" in A.B. Zahlan (ed.), *op. cit.*, pp.127-142.
[49] See; V. Pellegrini, "The Problem of Appropriate Technology" in A.D. Clorgio, et al., *Criteria for Selecting Appropriate Technologies under Different Cultural, Technical and Social Conditions*, (Oxford: Pergamon Press, 1980), p.2.

materials, energy and information. The second loop is related to people whose inputs are conditions, expectations and aspiration. Number and capabilities of people as well as their ideas and actions are the transforming factors of the three basic resources of the first loop. The final outputs of both loops are products, services and new ideas, which together influence activities and people environment. This general model helps us to understand better the dynamism of "development" and "growth" within the community.

Before developing a strategy for technology generation within the community the relevant question that one can ask is that what effect changes in local community will have on the present situation of science and technology?

It is well known that the introduction of huge industrial units in the Western style brought about environmental pollution and inevitable results in many Muslim countries.[50] This, however, is not a road which leads to the generation of technologies. The technology needed at this moment is not that of the huge industrial conglomerates on a national scale and the know-how to operate them. But the development of "small decentralized technology" which actually meets the needs of the local community. Although,

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50 As Sardar has stressed: "The impact of borrowed technology on the holy cities of Makkah and Madina and the Hajj environment, in the last decade, has been mercilessly destroyed and delinked from its historical roots, by a brutal technology based on demolition and environmental violence that shows scant regard for cultural values or spiritual concerns." See; Z. Sardar, *Islamic Futures: The Shape of Ideas to Come*, p.182.

the imported technology only for selective and "strategic" industry to be permitted.

From these points of view, the author emphasizes the point that establishment of large number of small-scale industries utilizing local skills and resources is the key solution to the development of industries. Light industries can be more easily oriented towards local needs and requirements, producing what is important and since these industries operate at a low level of technology, they are less dependent on foreign spare parts and easier to manage for the local managers. Therefore, they provide an ideal base for the development and use of local resources, manpower and skills.[51]

4.1-The Facts or Assumptions of the Proposed Approach

One of the main elements of the proposed approach is that the maximum participation of the local people should be ensured. Therefore, in the local community the mechanisms of participation should be created, however, this subject will be discussed later. Besides this assumption the following facts should be considered:[52]

(i) The technologies used by the traditional sector are based greatly on empirical knowledge, which is transmitted mainly by

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51 The importance of small-scale industries has brought into focus by many authors. See for instance; S. Radhakrishna (ed.), *Science, Technology and Global Problems: Views from the Developing World*, (Oxford: Pergamon Press, 1980), p.160. See also; C.J. Hull and B. Hjern, *Helping Small Firms Grow: An Implementation Approach*, (London: Croom Helm, 1987).

52 See also; A.O. Herrera, pp.137-140.

verbal and practical experiences. This knowledge contains useful information about environment, needs and the activity of the community. If this empirical knowledge is coupled with modern science and technology, it will greatly contribute to the solution of many technological problems of the local community.

(ii) Some people within the local community generally tend to reject changes in their way of living, especially when new technologies are introduced, unless they participate in some way in their generation.

(iii) One of the difficulties is that most of the people in the traditional sector ignore the importance and possibility of modern science and technology into their daily life. It is assume that participation of the people will overcome this obstacle.

(iv) In the most countries of the Middle East, the R & D systems have evolved with the modern sector of the economy and are closely similar to the R & D system of the advanced countries. However, it is assumed that this system does not contradict the fact that the R & D system performs some research on the problems of the traditional sector that results in the introduction of a modern technologies.

4.2-The Elements of the Proposed Approach

In this section the main elements of how to approach the local community in order to generate appropriate technology are given.[53] We shall call these technologies "Community technology" or "local corporate technology" in order to reflect their humanistic and corporatist character. In describing the situations in which technology is applied, one can define private, community, and public technologies. In a very simple definition, "private technology" can be considered as a small, domestically owned enterprise which is related to the production of consumer goods and its introduction is largely a decision by the individual.

"Public technologies" are represented by the large industrial firms that produce consumer goods or capital equipment and by the national institutions that supply basic services, such as railway transportation, power generation, telecommunication, etc. However, "community technology" concerns local infrastructure, such as, sewerage systems, health services, community service facilities, and water systems, which affect the citizen profoundly and which require individual co-operation in production and operation. Therefore, in the community technology situation the forms of its organization should be well-defined and the incentive to individual participation should be maximized. Their characteristics will become apparent as we proceed with our discussion.

(i) First of all the general socio-economic characteristics of the selected region should be evaluated, such as; historical background,

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53 Methodology for generating appropriate technology is discussed also in, *ibid.*, p.139. And A. Date, "Understanding Appropriate Technology" in P.K. Ghosh (ed.), *op. cit.*, pp.163-183.

social relationships, forms of production inside the community and economic cycle, etc.

(ii) A general survey of the natural resources of the area should be carried out. This survey should consider specially those resources that can have potential application in the area.

(iii) It is necessary to consider the analysis of those solutions that the local community has traditionally found for their problems. For example, in many rural areas people traditionally use solar energy for their daily life under certain conditions developed through long experience.[54] The central idea in this technology is the utilization of solar radiation. If this is coupled with modern science and technology, it can be not only appropriate technology but also the people will learn how to make use of modern techniques.

(iv) Efforts should be made by scientists and local people to identify the most technological problems within the community and some of them would be chosen for research.

(v) The scientists and technologists who are working on problems that belong to their own economic, social and cultural sectors have a tendency to apply the same criteria to a completely different environment.[55] Therefore, it is necessary for them to ask for example what is the purpose of the technology? What need or

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54 For example, in many rural areas particularly in the tropical regions people preserve meat for long periods of time by exposing it to the solar heat under certain conditions that they know through long experiences.

55 For example, technologists tend to apply their own criteria to the housing problems of the local people. In this regard they only consider the climatic and modern sanitary conditions. However, it is also necessary for other factors such as social, economic, cultural factors to be considered.

needs must it satisfy? Who will really benefit from the solution? Otherwise the result might be unacceptable to the local people even if it is much better from our point of view.

Finally, with the information gathered in the previous stages a set of assumptions will be derived, which will be the frame of reference for the final step of developing the required technology. These information will contain scientific, technical, economic, and social information and will define the frame of reference. Using existing information, the best technological solution should be identified so that it is appropriate to the local community.

4.3-Community Participation

The idea of participation as a basic element for assisting progress, particularly in the community sector, and in designing and implementing measures to improve their own welfare, has existed throughout history.[56]

As has been discussed above, the notions of self-reliance and community technology require active involvement of people in order to manage their affairs, control their environment and enhance their well-being. However, factors such as over-centralised planning, poor delivery of services, lack of effective co-ordination, inappropriate technology and macro-economic government policies

56 See for example; A. Hall, "Community Participation and Development Policy: A Sociological Perspective" in A. Hall and J. Midgley (eds.), *Development Policies: Sociological Perspectives*, (Manchester: Manchester Univ. Press, 1988), p.91.

can be major obstacles in what is essentially needed for a mechanism or instrumental tools for participation.

Therefore, it is important to ask how we can achieve a substantial degree of community participation in the development process in general, and in the process of introduction of new technologies in particular. To answer this question we would like to suggest two possible ways which may increase people's participation.

One way in which the above problem may be solved is the organization of production on a co-operative basis which allows the resources of individual members of the community to be used for the purposes of communal investment in productive equipment, inputs and infrastructural facilities. Hence, co-operatives are one of the tools of community development and a channel for people's participation. The establishment of official co-operatives can be seen as a form of organization which would allow members to exercise a degree of control over production and distribution of product and inputs.

However, we should take into account that co-operatives must not be used to promote government policies and extend state control over the rural sectors. Moreover, co-operatives should not become dominated by rich producers who are able to exercise their economic, political and social influence to monopolize internal management as well as government services such as subsidized credit and technical assistance. Co-operatives should act as agents of change for the benefit of all members of the community. Such formal organizations should bring benefits to the poor and facilitate popular participation in decision-making for the purpose of official development programmes and the introduction of new technologies.

Co-operatives appear to have been successful in a number of countries. It would be a mistake, however, to conclude that co-operatives are a tool for all the difficult problems that are associated with the application of new technologies in community sectors. Particularly in countries without a strong communal ethic, these types of organizations can often be implemented only with considerable difficulty and in many countries they have failed.[57] The most that can therefore be concluded is that co-operatives offer one possible way of relaxing the severe constraints that are imposed by the nature of traditional technologies on the application of emerging technologies to traditional activities and also one possible way for maximizing the participation of people in their affairs.

Another area of community development strategy which permits greater member participation can be the introduction of a "research system" into the community that might have significant impact on improving production techniques within the community and at the same time increasing participation of people in their affairs. Therefore, suitable research systems are needed to provide a more general service to help members of a community in their

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[57] *Ibid.*, p.98.

complex everyday problems. This type of system can play an important role not just in guiding local communities towards proper development of technology but also in the acquisition of information, facts and statistics from the community.

The setting up of such a system in every community district should be the goal for providing access to relevant information in urban and rural areas. They do not need to be big institutions and can be used for collecting data about the range of different problems in a community and how these change. They can also encourage citizen participation and a sense of involvement in community life. This must start as a research method within the community and must involve all members of the community. The research should seek to increase productivity by developing technology and support systems which are fully acceptable to the recipients.

The techniques used by the researchers into community life should reflect accurately the needs of the community. The data collected and recorded must be reliable. It must be organized and analyzed in such a way as to provide policy-makers with accurate and relevant background information for developing their policies. Once the policy is formulated, the same techniques can be used to assess the extent to which the policy actually works, and the extent to which it is affecting the desired changes in the community.

This method is not only to collect necessary information for the development of technology within the community, but also it is a holistic approach which tries to understand the interdependencies and interrelationships between the technical and human elements in the production system. However, this involves developing an understanding of the whole range of constraints -- technical, economic, social and political -- which influence the life of members within the community.

Therefore, an important part of this method is a much closer relation between members of the community and the researcher in order to find out the needs and desires of the community for the application of new technologies in their production system. As far as this method allows for effective feed-back of the views of members of the community and to the extent that this influences subsequent policy-making, this approach can be considered as a participatory strategy.

4.4-The Requirements of Successful Integration

In this section, we describe the requirements for successful integration of emerging technologies at the level of the community. The most meaningful concept of integration could be defined in terms of a fusion of traditional and emerging technologies into a new entity. However, even this type of integration can take a wide variety of forms depending upon the types of technologies in the fusion process.[58]

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58 See also; Bhalla, A.S. and James, J., "New Technology Revolution: Myth or Reality for Developing Countries?" in P. Hall (ed.), *Technology Innovation & Economic Policy*, (Oxford: Philip Allan, 1986), pp.135-171.

For example, in one case the new entity might embody almost entirely the characteristics of the traditional technology and in the other, it might reflect mainly the elements of the new or emerging technologies. However, if integration is to be successful, it should not be of the latter kind; the out-come of the integration process should not be too different from the traditional technologies.

In the case of production within the community it can be assumed that traditional producers are organized along individualistic lines. Moreover, these traditional producers are the dominant group within the community. Therefore, it is necessary to recognize that there are diverse groups of traditional producers within the community whose technologies are in need of upgrading.

In general, the requirements for successful integration in the case of traditional producers derive from their special socio-economic characteristics. Moreover, these producers are usually very poor, often even in relation to average income in the country. Indeed, in some countries of the Middle East traditional producers in the rural areas comprise a relatively high percentage of those living in poverty. In many cases, they are also illiterate and produce mainly for subsistence needs rather than sale in the market.

The importance of the above characteristics of local producers is that they impose highly strict requirements for successful integration of traditional and emerging technologies. One way in which the stringency of the requirements may be relaxed is the organization of production on a co-operative basis which was suggested earlier.

Therefore, for the successful integration of new technologies, firstly the innovation must be close to traditional practice. Secondly, the innovation must not impose a high degree of risk on the members of the community, because they produce mainly for subsistence and earn only a limited amount of cash from market sales. Consequently, the traditional producers are usually reluctant to venture their resources on new techniques of production whose outcome is by no means certain and may involve risks.

Thirdly, the new techniques must be comprehensible to the producers within the community. That is, a new technique must not pre-suppose knowledge that community members do not possess and it must be recognized by them as an understandable technique. This condition is more likely to be satisfied if the innovation fits closely with the prevailing ecological system, for example, the pattern of local resource use, waste collection, etc. Finally, the new technique must not pre-suppose the existence of facilities, e.g. for power, transport, repair and maintenance and so on, that are simply not available to traditional producers.

Therefore, to increase the relevance of the new technologies to the needs of the community there are two broad areas of policy. The first is designed to alter the organization of traditional production in ways that facilitate the adoption of emerging technologies, and the second is to adapt the emerging technologies to the needs of members of the community.

As we have pointed out above, the re-organization of traditional production will need to be based on co-operatives at the level of the community. The other method which can be used is subcontracting relationships with the industrial sector. Therefore, one effective way of applying emerging technologies in the small-scale sector is through subcontracting to the large-scale sector with providing technology, skills and other types of assistance.

For example, the organization of small-scale producers in cluster-type workshops might facilitate an economic use of simple numerically-controlled machine tools in the manufacture of some consumer goods. Also, small firms working in conjunction with larger companies can create appropriate labour-intensive technologies. Therefore, in order to make an efficient production system in the community sector, it is suggested that subcontracting relationships are used, providing greater linkages between large and small firms.

This, of course, will require a policy of active encouragement and considerable protection and assistance to be granted to the many small firms in the community sector and at the same time all discrimination among them should be eliminated. Here, we would like to discuss some of the problems associated with the successful operation of rural co-operatives and small firms at the community level.

Perhaps the main problem that has to be confronted is of a socio-political kind, that is the control of local organizations by the rural political elite. This can result in the inappropriate allocation of the scarce development resources in their favour. In this regard specially when the ownership of land is unequal, it is more likely that rural co-operatives will be dominated or subverted by the elite groups. In such situations, if traditional producers are to be effectively involved through co-operatives organizations, a redistribution of land and political power in their favour would seem to be an essential pre-requisite.

Although, it is possible to argue that such reform is likely to constitute a necessary condition for rural co-operatives to reach the poor, it is not a sufficient condition. We can conclude that what is also essential is the adequate provision to these institutions of inputs, management, know-how, infrastructure, etc.

4.5-Proposed Strategy for Action

In view of the proposed approach described above, what specific measures can be taken to create a conductive environment for the development of indigenous technologies? Furthermore, in which sectors can the idea of "Community technology"[59] be made operational immediately?

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59 We call these technologies, "community technology" in order to emphasize its ideology content or to emphasize a particular set of economic or social variables which should be chosen according to Islamic values and concepts.

In this regard the author would like to propose two main policy measures which can be appropriate tools for development of indigenous technologies.

(i) In order to implement the idea of "community technologies," the author believes that the concept of a regional or provincial science and technology plan can be appropriate tool. The idea here is not simply to decentralize the research system of the government, but to stimulate, by both public and private means, the creation of local systems which are financed, operated and independently controlled by local government authorities and by the local community. This regionalisation of science and technology policies has two advantages.[60]

First, it makes much closer between the real needs of the local community and R & D activities of the scientific establishment. The other is the possibility for the regional system and its sponsors to initiate research in areas which have been neglected by the central government, but which might be of considerable importance to a particular region or community.

This type of decentralized or regionalised technology policy seems to be particularly suitable at least in those countries of the Middle East which have large population and big areas. It is obvious that decentralization and local initiative should not stand in direct opposition to political priorities.

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60 See; N. Jequier (ed.), p.102.

(ii) Government can also function through the promotion of a large number of small-scale entrepreneurs. These entrepreneurs can be a powerful instrument of change. The encouragement might be in the form of providing capital, low-interest financial loans, free consultancy services, establishment of suitable small industries service institutes, etc. In order to do that government should form strong promotion laws for development of small and medium industries. A suitable network linking the local unit with national and regional technology transfer should also established.[61] Moreover, they need to receive assistance from suitable agencies which can provide for them:

(1) the necessary capital, (2) the necessary technology and managerial skills, (3) the required raw material, (4) the necessary plant or manufacturing equipment, (5) the energy or power at reasonable cost, (6) the necessary marketing facilities.

It is also desirable that suitable local national centers to be established by universities, R & D establishments and governments to interact directly with local small-scale industries.

Here it should be state that available studies on small-scale industries in the region indicate that labor in small-scale establishments is less productive than in the medium- and large-scale industries.[62] Also, the medium and large-scale industries

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61 See also; S. Radhakirshna (ed.), p.177.

62 See; A. Segal, pp.83-105. Also UN, *Regional Plan of Action for the Application of Science and Technology to Development in the Middle East,* ST/UNESOB/11, (New York, 1974), p.75.

make higher contribution to output, wages and employment. This may perhaps be due to the fact that less capital and machinery are utilized in the smaller establishments. They also suffer from market limitations and marketing. Therefore, a number of policy measures including measures for expanding the export market should be adopt.

Now let us see among the whole range of human activity, where the new technologies can be introduced. Of course there are a large number of projects that can be undertaken in order to develop indigenous technologies, capacities and local self-sufficiency, here we would like to suggest only some of them:

(1) application of civil engineering to the rural environment, for example, development of low-cost building technology based on local materials,

(2) development and exploitation of locally available energy sources, such as the wind, the sun which is abundant in the Middle Eastern countries, bio-gas and the rational management of fuel sources such as forests,

(3) application of mechanical engineering design for the improvement of agricultural implements and operations, and of rural transport facilities,

(4) application of desalted sea water for flourishing new agricultural areas in the deserts which are lengthy and along the sea shores in the Middle East,

(5) studies and experiments in soil and water conservation, for example, application of the environment and ecological approach to soil, water, grasslands, forests, livestock, wild life and fish. Also, studies on the dynamics of developmental and retrogressive changes concerning desert and development of underground water resources can be very important in the region,

(6) studies and experiments on crop selection and improvement and also on the use of pesticides,

(7) manufacturing dairy products including that of all varieties of local products and at the same time developing and improving the canning, bottling and packaging of food-stuffs in the local area,

(8) studies about the development and growth of genetically improved plants of high protein content and also about increase in protein production from conventional livestock and poultry sources,[63]

(9) studies and research into the recycling of urban sewage and also agricultural wastes efficiently,

(10) studies about utilization of traditional technologies, the purpose here is not to return to the past and also not to rebuild an industry with little future but to help those who have generations of experience behind them make the transition and adapt in an innovative way to the new needs of the community.

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63 Items 5,6,7,8 also proposed by the UN report for the application in the region. Although this report is old and many qualitative changes have taken place since it was written but still contains numerous research proposals which can be appropriate for the region. See *ibid.*, pp.42-104.

These are only some possible measures which could encourage the utilization of indigenous capacities in order to develop local appropriate technologies. However, it seems that for the Muslim countries of the Middle East there is only one choice: to undertake those activities which ensure the flowering of innovation and development of indigenous technological capabilities rather than fully relying on imported technologies.

CHAPTER IV

Technology Development Strategy

> The creativeness of men is judged by the way they are able to translate their thought processes into realities; ... how effectively this transformation of an idea or technology into a practical reality can be achieved depends largely on the sense of commitment, dedication and ingenuity of the people involved in the whole process.[1]

In order to become economically self-reliant, it is essential for any developing country to establish a sound technological base. This is possible through rapid development of industries and the building up of a strong indigenous R & D infrastructure to sustain them. Therefore, the relevance of research and development to needs and the utilization of the technical knowledge generated by R & D in the production of goods is of major importance for any country.

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1 H.S. Rao, *The Commercialization of R & D Results in developing Countries: With Special Reference to the Democratic Republic of the Sudan*, IS. 562, (Vienna: UNIDO Pub., 1985), p.1.

The failure of many developing countries in building and utilizing its scientific and technological base is not so much due to its failure to generate technical knowledge, but it is rather due to the lack of policies and instruments to transmit and utilize existing knowledge in the production of goods and services.[2]

On the other hand, when we consider the relevance of technology vis-a-vis society, we have to take into account all the concerned sectors, i.e., R & D organizations, academicians, industry, consumer, etc. These components with the various sectors of production form up one system with interacting relations among themselves. As was explained throughout the second chapter, such an interaction has not so far been efficient in most Middle Eastern countries.[3]

In this context, the objective of this chapter is to examine effective coupling of different sectors, since nowhere in the Middle East are there effective linkages between researchers and research-users. It is this lack of linkages that intensifies the dependence on imported technology and the failure to learn by doing. First section focuses on the role of science and technology in the social and economic development process from a policy-making point of view. Next section examines linkages of R & D activities with

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[2] For evidence see; F. Daghestani, "Research and Development in Jordan: Policy, Resources and Problems," Paper presented at Seminar on Strengthening Research and Development Capacity and Linkage with the Production Sectors in the Countries of the ESCWA Region, (Jordan: Amman, 1987), p.2.

[3] This point has been state also by A.B. Zahlan, *Science and Science Policy in the Arab World*, p.21.

production sector and the commercialization of innovation activities and finally the last section covers government policy towards promotion of industrial technology and progress of technology.

1-Science and Technology Research and Social Needs: Linkages with Development

There is an explicit need for the policies on science and technology of the various countries of the region that must be integrated with their economic, trade, agricultural and other policies. Although, most of the policy-makers agree that generation, development and diffusion of technology has to be linked with development plans of the nation but yet in many countries there is not such a schemes.[4]

In general, there are two different approaches that relate science and technology policy to development planning.[5] The first approach, which could be called the "implicit science and technology policy," considers that the strengthening of the natural scientific and technological potential comes as a consequence to the practice of the normal social and economic activities that outlined in the natural development plans.

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4 However, attempts to achieve a higher level of integration between science, technology and development plans in the region are under way and can be seen on both the national and regional levels. See *ibid*., p.20.

5 F. Daghestani, *op. cit.*, p.2. See also; IDRC, *Science and Technology Policy Implementation in Less-Developed Countries*, (Canada: Ottawa, 1976).

The second approach, which could be called the "explicit science and technology policy," considers science and technology as an important input to development planning. The general features of those two approaches are given as follows:[6]

The Implicit Science and Technology Policy: This approach, which is practiced by most developing countries, assumes that the national scientific and technological progress comes through the practice of the normal social and economic activities in the various sectors. Therefore, governments give more emphasis to capital, labor, and land than to science and technology as the major inputs to economic growth.

The practice of this approach does not require the formulation of a science and technology policy and therefore does not require the establishment of a government institution to formulate and execute such a policy. The practice of this approach has to some degree succeeded in building a modest scientific and technological base in several developing countries. However, the degree of this success has been proportional to the science and technology elements implicitly present in the social and economic development policies.

Nevertheless, most developing countries adapting this approach have failed to build a sufficient scientific and technological base that is needed for development. Such countries

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6 *Ibid.*, pp.1-6.

suffer from brain drain, high cost of its development projects, high cost of production, and inefficiency of its production system. Therefore, such countries continue to depend on the export of their raw materials and depend greatly on foreign expertise and technology.[7]

Nearly all Middle Eastern countries has adopted this approach of implicit science and technology policy through its development plans.[8]

The Explicit Science and Technology Policy: This approach, which is prevalent in developed countries, considers science and technology as the main input to development planning and considers that other inputs such as capital, labor, and land should be used in order to built a science based economy.[9] Therefore, this approach requires an explicit national science and technology policy and the proper government institution to formulate and execute such a policy.

The basic common elements of any proper explicit science and technology policy are:[10]

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7 *Ibid.*, p.3.

8 Only from recent years some changes can be seen in some countries of the region that trying to adapt explicit S & T policy in their development plans. See for example; UNCTAD, "Technology Policies for Development and Selected Issues for Action."

9 For a brief S & T policy of developed countries, see; OECD, *Science and Technology Policy Outlook 1988*, (Paris, 1988).

10 F. Daghestani, *op. cit.*, p.5.

(i) To increase the national demand for scientific and technological knowledge and to utilize this knowledge in the production of goods and services.

(ii) To built the national capacity for the generation and utilization of scientific and technological knowledge as a supply base for the short and long-term needs.

(iii) To establish methods, procedures, systems, and incentives to utilize the national supply of scientific and technological knowledge for the national demand for this knowledge.

(iv) To make sure that scientific and technological knowledge is transferred to the national base through the import and generation of technology.

Therefore, it is suggested that the countries of the Middle East move towards the direction of establishing an explicit science and technology policy. Since this approach consider science and technology as a comprehensive development sector and call for the establishment of institutions which encourage development of local technological capabilities and help the integration of science and technology programmes with local needs and capabilities.

As it was mentioned earlier, the realization that the problem of development in the Muslim countries of the Middle East is coupled to local flowering of innovation and technological capabilities is very recent indeed. Today, in the Middle East, scientific and technological research should not be separated with development plan. Scientific research can no longer be viewed as an isolated activity of individual scientists but it forms a major area of government responsibility and requires careful planning.

1.1-Research and Development and Social Needs

The challenges of science and technology to address the wide range of social problems have been growing during the past decade. The range of needs can be long, including areas such as food security, water, energy, basic health, housing, urbanization, illiteracy, employment, education, environment, clothing and so on. However, understanding development not only as economic growth but as socio-economic change, we can argue that S & T must be directed at least toward the following means in an Islamic society:[11]

(i) Satisfaction of basic needs that should start from the needs of the neediest in order to reduce inequalities within the country. In an Islamic Country which is committed to realize equality and social justice science and technology should promote them.

(ii) Social participation and control in order to strengthen self-reliance and to prevent concentration of economic and political power and move towards unity.

(iii) Ecological soundness in order to achieve harmony with the environment and make development sustainable over the long run.[12]

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11 For evidence see, Chapter I.

12 For Islamic principles on environmental and ecological issues see; A.A. Kadar, "Islamic Principles for the Conservation of the Natural Environment," IUCN &

Considering priorities, it should be stressed that determining priorities is sometimes a political acts and sometimes a technical one. The priority setting of national goals pertain rather to a political act and is therefore essentially subjective. However, recent regional study about the basic needs for the region identified food security and water as two areas for focus in the future.[13]

Moreover, the same study indicates that two main priorities of the full security are water and management of resources especially land and fisheries, it maintains:

> The land resources could deteriorate to crisis proportion through exhaustion or loss of productivity. The fisheries production could be improved through greater use of science and technology.[14]

In the area of food security, the priority of scientific and technological aspects that need emphasis in the region are:[15]
(a) efficient management of resources, (b) alternate sources of water, (c) better land use, (d) models for forecasting crisis, (e) research on quality aspects, (f) research on farming systems.

In addition to R & D related to the basic needs which is essential, there should be researches which are directed towards the

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MEPA Pub., No.20, (W. Germany: Siegburg, 1983). See also; S.W.A. Husaini, *Islamic Environmental Systems Engineering*, (London: Macmillan Press, 1980), which presents a viewpoint on environmental planning in relation to the social, cultural and moral teachings of Islam.

13 UNCSTD, p.6.

14 *Ibid*.

15 *Ibid*., p.7.

needs of local industry. Here, a major distinction has to be made between research in the context of business enterprises in the private sectors and research done in national scientific institutions. Objectives will be different, being profit-oriented in the private sector but directed to social goals in the public sector. In the government sector some different problems such as emphasis on planning and administration required.

The related questions here are; How are social objectives to be integrated with scientific research? What is an appropriate allocation of resources between organizations and between scientific disciplines? This allocation problem will have to be guided by the overall political and economic objectives of the government such as its emphasis on industrialization or on agricultural development. Within that framework it will be necessary to choose particular objects proposed and this should be done by accurately evaluating the costs and possible economic benefits.

Concerning the first question, Daghestani mentioned that the most successful means for relating R & D to actual needs are: "(1) performance of R & D at research institutions under contractual arrangements with the clients, (2) performance of R & D by units at institutions in the production sector firms."[16] The first method, it seems, is more applicable in the Middle East, because it allows the utilization of existing manpower and facilities at R & D institutions

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16 F. Daghestani, *op. cit.*, p.31.

for the least costs.[17] The second method is more limited, because there are few large firms in the countries of the region that are able to make the heavy investment needed to build and operate R & D units.

Therefore, from the above explanations two important points emerged: First, the co-ordination of the different scientific research centers in their use of available means of research, and second, the linking of their activities to the requirements of the society.

1.2-Recommendations

In order for the scientific and technological research to be practical, relevant and to relate to development plan, the author suggests the following recommendations:

-- Science-policy making bodies (SPMB) should assess, as a science and technology plan, the socio-political-cultural factors of the society and their trends towards R & D activities in order to adopt policy which might produce satisfactory results.

-- SPMB should formulate a research policy in keeping with the needs of the socio-economic-industrial sectors of the country and have priorities oriented according to the national goals rather than ad-hoc or academic based projects.

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[17] For example research contracts, in Japan, on large-scale industrial technology R & D established in 1966, aimed at developing new technology and products in selected advanced technology fields by delegating R & D to the private sector. The research themes, though decided by the government but reflected the needs of the private sector as well.

-- Research institutes should introduce and incorporate technology assessment concepts particularly the environmental and economic impact of their proposed projects.

-- The role of the universities in performing R & D that is more applicable to the needs of the production sector can be greatly enhanced by the expansion of the projects which related to identified problems. In the absence of national R & D priorities and oriented programmes, the choice of the subject is made by the researchers and not by the potential user.[18] This will reduce its chance for its utilization. Also, in most cases, the R & D that is more suitable for utilization has to deal with the various aspects of a practical problem and this requires a multi-disciplinary research team. Therefore, multi-disciplinary research within the university should be encouraged.

-- Although the social need is great, the demand for R & D suitable for utilization in the production sector has been low at both the public and private sectors. This low demand is a consequence of the absence of an explicit science and technology policy and the instruments and resources needed for such a policy. Heavy reliance on foreign expertise and contractors in the execution of many projects in the development plans did not encourage the national institutions to seek and develop sufficient national technical

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18 This is because, normally between industrial sectors which take part in the transfer of technology from abroad and community of science there is no transaction or communication. University professors usually are not informed or consulted. Moreover, their teaching materials have not been modified to reflect the programmes under way.

knowledge which in turn enhances demand for relevant R & D activities.[19]

Therefore, there is strong need to assess the efficiency of productivity in various sectors of the economy and to outline accordingly the related R & D activities. Such an assessment would identify problems. In that case technical knowledge generated through R & D can be helpful in increasing productivity and in reaching objectives.

-- The limited manpower and financial resources allocated to R & D as mentioned in the second chapter indicate the low priority given to R & D as a potential source for needed technical knowledge to accelerate development. The R & D expenditure of the most countries in the region is very small when compared with the minimum of 1 % of GNP recommended for developing countries.[20] Therefore, it is appropriate for governments to increase financial allocations to support research and development and its infrastructure.

-- The research institutes should formulate R & D activities on topics of broad public interests, particularly industry. Also, they should use applied research to modify and transfer technical know-how from abroad.

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19 F. Daghestani, *op. cit.*, p.27.

20 For R & D expenditure as percentage of GNP see; UNESCO, *Statistics on Science and Technology*, (Paris, Oct. 1989), pp.103-104, for example Jordan and Turkey in 1985 respectively 0.2 % and 0.7 % of GNP and Egypt in 1982 only 0.2 % of GNP.

Finally, it should be pointed that in Muslim countries research cannot be funded on the basis of luxuries and fashions. It must be target-oriented, it must endure a system of research which takes account of indigenous needs, requirements and interests as well as promotes the application of research in local industry. It must be related to problems of national urgency. This is the use of science and technology as one of the principal instruments of national development.

2-The Commercialization of Research and Development Results: Linkages with Productive Sector

Although, most Middle Eastern countries to some extent has the technological base and has managed to establish a number of scientific and technological research institutions, it has not yet been able to utilize these institutions effectively.[21] This is largely because of the weak contact between indigenous research and development institutions and the users of their research findings.

This is evident from the fact that while much has been produced in the R & D laboratories over the years, very little has found application in industry. At the same time, there has been a continuous import of technology and often in a repetitive base and a failure to commercialize indigenous technology.

21 As pointed out by Zahlan, *op. cit.*, p.20: "... their activities are circumscribed to a narrow sphere; they persist as impotent instruments kept at a distance from the serious work of planning, designing, evaluating and constructing."

Therefore, one may ask:

-- Why the interaction between the seeker of technology, for example, the entrepreneur, and the creator of technology mainly R & D facilities has not been adequate?

-- Why are there continued preference for imported technologies when similar indigenous technologies exist?

-- Have the incentives for completing the innovation chain in the publicly funded centers been adequate to provide the required motivation to R & D scientists to complete their tasks?

-- Who should undertake the horizontal transfer of technology?[22] For example, R & D laboratories especially in the public sector, consultants, operating plants, etc.

-- Has the management structure and capability of operating enterprises and national research institutes adequate to ensure absorption of technology at R & D levels and develop it internally up to manufacturing scale?

-- Are our scientists engaged in the national laboratories, institutes of technology, universities and other public R & D centers attracted by fundamental research which may be publication oriented rather than dealing with real life problems which may be of immediate use?

-- Would the public R & D institutions be more successful in interacting with entrepreneurs, if they tilted toward small and

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22 From horizontal transfer of technology, we mean transfer of R & D findings from public laboratories and science and technology institutions to industry and economic sectors.

medium scale industry to provide them with technology inputs on a custom made basis?

In finding appropriate answers to these questions, it is strongly recommended that for development of technology any country of the Middle East should build up "an organized institutional mechanism" for holding and exploiting inventions. This can be done through the "national scientific and technological body" which shall be charged with the responsibility of completing the total innovation chain.[23]

Therefore, in what follows specific measures have been suggested such as; sponsored research projects, the need for a central design organization, provision of venture capital, mobility of scientists from R & D centers to industry, patent laws and licensing mechanisms, entrepreneurial development and especially technology delivery systems for carrying technology to remote areas in a manner in which these would easily fit in with the process of development and accelerate the process of technological transformation.[24] In doing this the national S & T body should address itself to the following tasks:

Sponsored Research Projects: It should be arranged a mechanism through which industry, industry-user, associations, user

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23 For national scientific and technological bodies of the selected countries of the region see; Appendix I and Table (2).

24 For more information on this subject see also; A.Z. Idrus, "Utilization, Assimilation and Dissemination of Research Results in Malaysia" in UNCTAD, *op., cit.*, pp.91-97; and H.S. Rao, pp.42-51.

government departments and private entrepreneurs can meet and mutually negotiate on sponsored research programmes of immediate relevance to them.

Therefore, a mechanism should be established through which user and problems will be identified in an organized way. It is necessary also for those research projects which demand high investments to be sponsored by different investors. This can be done, for example, by meeting of research and development scientists in R & D institutions on the one hand and practising entrepreneurs/industrialists on the other, with perhaps the chamber of industries and other relevant departments.

The same meeting could also be used to effectively communicate to entrepreneurs R & D inventions that are appropriate to become commercialized. This kind of meeting can promote effective interaction and initiate a continuing dialogue between R & D scientists and entrepreneurs.

Central Design Organization: The national S & T body should also take the responsibility of establishing a much needed capability that is, a design engineering unit suitably staffed to do both basic and detailed engineering. The function of this unit should be to convert inventions and know-how that generated in R & D into engineered prototypes and produce fabrication drawings ready to be built at the shop-floor level.

The unit can be a key linkage in offering to entrepreneurs R & D process know-how on a turn-key basis or whatever. The central design unit could also be charged with the responsibility of designing pilot plants for laboratory level know-how and further scaling up from pilot plant to the manufacturing level.[25]

Mobility of Scientists: Conveying knowledge and skills developed at the R & D level to the production sectors is not easy. In actual practice it is found that only technical documentation is not adequate. The best way to ensure that horizontal technology transfer will be satisfactory and complete is to develop systems. Under those systems R & D scientists who have come up with commercialisable inventions can be engaged in industry which takes up these processes for commercialization.[26]

This service, for example, can be executed by assigning scientists for a period of two or three years, if necessary, to advise and guide the industry. This movement will not be successful unless appropriate support arrangement exist. Here, the national S & T body can arrange the mobility of scientists from research institutes to industry and back. Moreover, to provide the necessary rules to ensure the success of services.

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25 See for instance; M. Kamenetzky, "The Socio-Economic Iceberg and the Design of Policies for Scientific and Technological Development" in P.K. Ghosh (ed.), *Technology Policy and Development* , p.244.

26 Placement of scientists from the public sector in commercial companies emphasized also in Malaysian new institutional mechanisms, see; A.Z. Idrus, *op. cit.*, p.95.

It is clear that in this way, a strategy for generating a new class of entrepreneurs will emerge. The R & D scientists who take their inventions and processes with themselves to the industry, for ensuring effective transfer of technology, will act as a new class of entrepreneurs.[27]

Venture Capital: Commercialization of indigenous technology by the first entrepreneurs involves a kind of higher risk than by subsequent entrepreneurs. Psychological barriers also exist in the investment of the indigenous technology, as contrasted to imported technology. Therefore, some mechanisms for venture capital assistance need to be formulated.

A suggestion is made that Commercial Banks may offer to the national S & T body, for S & T development, a small proportion of their profits. This money should be given by the body, as an no interest loan, to inventors for materializing their inventions. When the research inventions gets commercialized, the loaned capital can be returned, which will re-invest in other research commercialization ventures, and use the limited fund as a circulating resources.[28]

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27 H.S. Rao, *op. cit.*, p.45.

28 The setting aside of a revolving fund to promote R & D results for commercialization can be observed also in countries such as the Republic of Korea and Japan.

Inventions, Patent law, Licensing: Encouragement of innovation should be one of the main policy tools of any government to develop local technology. This can be achieved by promotion of talent among the individuals and inventors in the country by providing financial assistance for: (1) patenting of ideas and inventions, (2) developing technically feasible and commercially viable ideas to the extent that required for making a prototype of a invention. Also, if there is an invention or even an idea which is not yet patentable, the individual concerned should be able to apply for help in making it patentable.

In the Middle East, Oman, Saudi Arabia, United Arab Emirates and Yemen do not have their own national patent laws. Although some of these countries grant protection through systems of the registration of patents granted abroad. The countries in the Middle East with the exception of Iran, Jordan, Lebanon and Syria have also not signed the Paris Convention.[29]

Therefore, the existing patent legislation of the most countries of the Middle East does not provide adequate protection to indigenous inventions and in fact can be counter productive. In some cases the laws permit that foreign patents to be in force even when the patentee has no intent to manufacture it in the country.[30] This blocks generation of indigenous technology for fear of patent infringement. Thus, measures for compulsory foreign patents

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29 ECWA, p.57.
30 A.S. Rao, *op. cit.*, p.47.

registration should be liberalized, and it shall be the responsibility of the concerned offices to recommend to the government from time to time suitable changes in the patent act. While guaranteeing intellectual property rights, the patent law must be structured to be a dynamic instrument of progress for indigenous technology.

Moreover, the role of patents in technology transfer can not be ignored. Therefore, collection, classification and analysis of patent data should be undertaken systematically and in depth for assessing of the international patents as well as to make use of them as a source of technical information.[31]

It is also possible that all inventions that developed in public sector with government funding will be assigned to the national S & T body and to be the property of this center for licensing. This assignment can be for know-how for technical problems and these may be licensed by the center to entrepreneurs on a selective basis. The income generated from the royalties can be used to further developmental work and also some part of it can be distributed to the inventors to motivate them to continuously improve their inventions.

Therefore, the national S & T body should also promote innovations within the industry as a powerful tool for

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31 It should be emphasized that data collection and analysis are an important aspect of the development of science and technology. They promote the development of specific objectives and mission-oriented research activities.

technological improvement and development.[32] It is obvious that generated innovations within the industry can be easily absorbed by the production line. The philosophy here is that innovations outside industry that generated within a R & D institutions can face problems for commercialization, where as inventions generated within the industry readily accept and receive less resistance to commercialization.

Entrepreneurial Development and Linkages With Consultancy Firms: The national S & T body shall be charged with the responsibility of building up new entrepreneurs with commitment to indigenous technology and establish suitable linkages with educational institutions, R & D centers and financial institutions to come up with a national entrepreneurial development programme.

The center would be the best place to examine and recommend to the controlling authority what special measures should be taken for interest of entrepreneurs who take risk of commercialization of indigenous technology and show preferences for indigenous technology over imported technology. It is also necessary the national S & T body to recognize the importance of consulting firms and to establish an effective linkages with them.[33]

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[32] For the relationship of R & D and patents see; Z. Griliches (ed.), *Research and Development, Patents, and Productivity,* (Chicago: The University of Chicago Press, 1984).

[33] Here we should refer to the experiences of India which rates as a fully institutionalized developing country. India through its "National Research Development Corporation (NRDC)" has devised mechanisms for utilizing extensively consulting engineering firms as a prime role in facilitating technology

Technology Delivery Systems for Carrying Technology to Remote Areas: It shall be one of the functions of the National S & T body to maximize the use of the mass media like radio and especially TV for popularization of technologies that generated indigenously in order to create public awareness and acceptance. The use of vocational and educational institutes is also recommended. Publications and Newsletters about new technologies should be published regularly.

However, the most effective way of promoting technology commercialized in remote areas, those technologies that are appropriate to that area, is through "Demonstration-Training-Replication" centers.[34] It shall be the function of governmental body to set up such centers in collaboration with suitable agencies at selected remote locations. These centers will serve the function of not only demonstrating the new technologies but of training young craftsmen or other talented people in these technologies, so that they may turn into entrepreneurs and then the technological unit may develop further and become as a productivity center.

To conclude; the proposed set of actions arises out of the gaps in the total innovation chain that is necessary to convert an idea into success. A set of questions raised; what is the best structure to bring into operation non S & T agencies like Ministries,

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transfer from domestic R & D laboratories to industry. Therefore, through its long years of experience it developed considerable expertise in the "technology of technology transfer." See; K.V. Swaminathan, "Technology Policies for Development in India" in UNCTAD, *op. cit.*, pp.81-90.

34 H.S. Rao, *op. cit.*, p.49.

Entrepreneurs, Consulting Firms, Financial Institutions, etc., in order to work harmoniously with the existing S & T structures in the country.[35] Indeed, when all the levels are integrated into a production-based and socially-oriented system, we can say that self-reliance is increased.

The proposed measures, should stimulate more meaningful R & D by generating mechanisms for their commercialization and thus will lead to visible results of S & T effort on economic development. However, success in implementation demands a consciously integrated approach covering technology assessment, development, acquisition, absorption, utilization, diffusion, connected aspects of financing, nation interests priorities and hence attainment of the technological goals. The role of government in this integrated system is the subject of the next section.

3-Policies Promoting Industrial Technology

Taking into considerations R & D activities and its linkage with development and production sector, then it needs as a whole, in this section, the role of government and its policies for promoting industrial technology to be examined. Before analyzing how government should influence R & D activity and hence technological progress, let us have a look at why government

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35 For the policy of several developing countries in this regard see; M.S. Kanthi.

support of R & D is necessary. The argument for government support of R & D is usually based on the following three points.[36]

First, the government as the sole supplier of public goods and services such as public health and sanitation, national defense, and so on is responsible for maintaining the quality and controlling costs of these public goods and services. Therefore, government is in a position to assess public wants and to fulfil this role and help in technological materialization of public needs.

Second, it is argue that the government should foster R & D activity where social benefits are more than private benefits. The logic underlying this reasoning that examined by Arrow can be summarized as follows: Arrow views R & D as production of technological knowledge and information.[37] According to him, if R & D activity left to market force, sufficient amounts of funds will not be invested in such activity. Therefore, it leads to an underinvestment of resources in R & D activity.

A third point in which government support is considered to be justified is basic research where low direct economic value of research leads to an underinvestment of resources. However, these arguments are controversial and there is a number of counter argument,[38] but since in the Middle East most of the R & D institutions are governed by the public sector and government plays

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36 See for example; A. Goto and R. Wakasugi, "Technology Policy" in R. Komiya, et al. (eds.), *Industrial Policy of Japan*, (Tokyo: Academic Press, 1988), pp.183-204.
37 *Ibid.*, p.186.
38 For details see; *ibid.*, pp.185-187.

important role in supporting and guiding them, it is assumed that government support of R & D activity is necessary and vital.

In general, the government policies affecting R & D activity can be classified under two broad ranges. First, there are policies that are directly targeted at R & D and technological progress and second, there are policies that are for achieving some other policy objectives but have impact on R & D and technological progress. The former set includes measures that support R & D activity, while the latter cover the macro policies like fiscal and monetary policies, various types of regulations and so on.[39]

Though this section concentrate mainly on the former set of policies, it does not mean that the second group of policies is unimportant. Technological progress demands a suitable environment and the policies included in the latter group also have important role in building an environment for technological progress. Therefore, in what follows focus is on promotion policies in a narrow sense.

The tools of direct technology policy consist mainly of: (1) support of R & D in the form of subsidies, appropriate tax measures, and the supply of low interest funds through government financial institutions, (2) setting up of national and public research institutions, (3) setting up of appropriate technology

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39 According to some writers three stages can be identified in the progress of government action regarding technological development, for details see for instance; H. Kassim, "Technology Transfer System in Malaysia" in UNCTAD, pp.171-182.

research associations, and (4) establishment of the commendation system. These are examined one by one as follows:

Support of Research and Development Activity: Financial support of R & D activity such as low-interest loan, reduction and exemption from tax payments which can be extended by public financial institutions are of measures that government can support directly R & D activities.

In addition to general budget that is allocated for scientific and technological activities government should also use financial support as one of the powerful instruments for R & D incentives. This can be done, for example, by allowing different firms to deduct some percentage of their spending on R & D from their income taxes. This, of course, requires that financial public institutions include in their annual budget a reasonable amount of money to support R & D required by the public and private firms.

Also, low-interest loans is one of the important tool for promotion of R & D by providing public funds at lower interest rates. In short, appropriate financing system will promote R & D activity and will provide incentives.[40]

National and Public Research Institutes: The purpose of establishing institute for scientific and technological research is a very important

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40 For example, in Malaysia the 200 percent tax exemption for R & D expenditure has encouraged private sector research to some extent, see; A.Z. Idrus, p.95.

one. It has a vital role to play in providing foundations for education and research within the country. It also may contribute greatly to all areas of development.[41]

In the Middle East, where there are not so many institutions with the facilities for developing technological methods, creation of appropriate center of education, research and consultation can be very important one. They should closely linked to the universities and should be able to make use of whatever resources the university can offer, for example, manpower, laboratory, etc.

In general, the author believes that these research organizations can contribute to:

(1) Carrying out applied research in areas closely related to industrial technology where universities were unable to help.

(2) Helping the transfer of technology to small and medium-scale firms.

(3) Development of antipollution technology, which is a public necessity and for which private sector could not be relied on to conduct sufficient R & D.

(4) Research concerning the development of standards, quality control and testing methods.

(5) To promote better know-how, innovate products and processes.

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[41] For example, in Japan, approximately half of the government research expenditures have gone to national, public or private (non-profit) research organizations or specially set up public corporation and these organizations contributed effectively in the technological development of the country. See R. Komiya, et al. (eds), p.196.

(6) To disseminate the know-how to the concerned sectors.

(7) To provide technical consultancy, techno-economic studies, manpower training, and,

(8) To assist adapting and selecting available scientific and technological knowledge according to national demand.

It is obvious that, the R & D centers usually consists of institutions, equipment and manpower. Therefore, the extent of the success of performance of such centers depends on the availability of financial resources, trained professional manpower and industrial base in the country.

Hence, the government role is important not only in financing the R & D institutions, but a great effort is required to create links and establish trusts between the industrial sector and R & D institutions and adopt programmes leading to gradual increase of the quality and quantity of indigenous manpower available for these institutions.

Technology Research Associations: The experience of industrialized nations show that there is a system for cooperative industrial research associations that aid the development and dissemination of technology to different firms. This type of associations have a long history in the United Kingdom, West Germany, France but are not as extensive as in Japan.[42]

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[42] J.H. Hollomon, "Policies and Programs of Governments Directed toward Industrial Innovation" in C.T. Hill and J.M. Utterback (eds.), *Technological Innovation for a Dynamic Economy,* (New York: Pergamon Press, 1979), p.307.

Cooperative research associations do not involve themselves in project and innovation which would provide for a firm competitive advantage. Instead, they develop techniques generally applicable to the industrial sector and transfer information and know-how to the firms. For example, in the United Kingdom and West Germany, the government provides a fraction of the support and the industry provides the remainder.[43] While Japan has a few such institutes organized by industrial sectors, each prefecture support a research institute for industrial science and technology for the industry of the region.[44]

In the case of developing countries in general and the Middle East in particular, it is advisable that the government initiates establishment of cooperative research associations particularly for analyzing and teaching modern techniques to small and medium sized firms. As was mentioned throughout this thesis, spreading of technical information and appropriate tools to small and medium industries can play important role in the upgrading of technology in the country.

The Commendation System: Establishing commendation system like the National Award or the science and technology rewards can serve as incentives for researchers and firms to undertake R & D. The certificates or financial rewards can be awarded at a formal way

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43 *Ibid.*
44 *Ibid.*

by a high dignity of the state, so that they gain national statute. Such honors provide enough motivation within the country to keep up the spirit of invention and also may prevent brain drain of qualified scientific talent to foreign countries.

According to one survey, the R & D incentives in Japan that provided by the commendation system in the post-commercialization stage were more than those of subsidies or tax preference measures and were only lower than those which provided by the patent system.[45]

It should be noted that, the selection process for awards sometimes is problematic but the benefits of such a system being greater than the costs involved. Thus, establishing appropriate commendation system by government for promotion of scientific and technological advances needs careful attention.

To summarize, the author would like to emphasize that technological change is a continuous and ongoing process. The knowledge and experience gained from the technology import is an important input, but the mastery gained from the initial import should be used to raise the capability of the country in order to generate subsequent path of technical change. Therefore, the need arises for a policy-framework under which managing the dynamics of technological transformation.

As was discussed throughout this chapter, fiscal and other relevant policies of the government that provide incentives for R &

45 A. Goto and R. Wakasugi, p.200.

D and subsequent absorption and development of technology play important role in promotion and progress of local industry.[46] Appropriate policies regarding innovation activities will increase internal technological capability and subsequently in long run will reduce external technological dependence of the country.

46 For more information about the government policies toward technological innovation see; C. T. Hill and J.M. Utterback (eds.).

CONCLUSION

> ... the future which is the foundation of the hopes and aspirations of the Muslim *Ummah*, as well as its fears and anxieties. The future that depends not just on the past of Muslim societies but also on the policies they pursue today, as well as the vision they nourish of the future.[1]

Science and technology policy-making cannot be confined simply to the application of existing science and technology. It should also be forward-looking with a view to identifying and stimulating new opportunities for R & D and the application of science and technology in the future. Therefore, it is necessary to have some understanding of what lies beyond, what would be the possible outcomes of certain policies. Hence, some understanding of what could happen a few decades from now if the present policies and trends continue, would help our discussions of the right policy for the future.

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1 Z. Sardar, *Science, Technology and Development in the Muslim World*, p.171.

Let us illustrate the point. Considering the case of oil exporting countries of the Middle East, whose economy is based entirely on the sale of oil. However, oil as a source of income cannot last forever. Once it has been pumped it has gone forever. What happens when the oil runs out?[2] Also, the contemporary world recession of oil market is a warning sign for oil exporting countries to develop and encourage alternative sources of income.[3]

With such possible out comes, Muslim policy-makers should realize that the acquisition of scientific and technological knowledge and its indigenous development is of great importance to the economy of their countries and without it the wealth of their country can never develop or increase. Of course, we need to learn to use the value systems of Islam to distinguish between the beneficial and harmful effects of science and technology.

Today, many petroleum exporting countries are attempting to build domestic capabilities through major investments in petrochemicals, natural gas liquefaction, and other petroleum value added technologies.[4] This seems to be very sensible approach that depends on importing sophisticated technologies, relying on highly uncertain future downstream markets, and neglecting research on domestic agriculture, appropriate technologies, small-scale industry and so on. In these countries, therefore, the objective of

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2 See; C.S. Cook, "What Happens When Oil is Gone" in *Bulletin of Atomic Scientists*, (June, 1975), pp.7-9.

3 See; *Financial Times*, (Jan. 1982), p.16.

4 For evidence see; A. Segal, et al., p.19.

technological development should be to build up alternative industrial potential vis-a-vis the petroleum sector.[5]

It is likely that industrialization in the region will continue in the coming decades. As a result, the demand that will generate by the increasing population and higher standard of living on the one hand, and the need to create employment opportunities and export markets on the other hand, will make rate of industrial growth and expansion higher in the 1990s.[6]

The need also to utilize locally available raw material and satisfy the basic needs of the population in food, clothing, medicine, housing, etc., are likely to dominate the direction of structural changes in the industrial sector in every Middle Eastern countries.

Therefore, as we said already throughout this thesis, for any scientific and technological strategy to be successful in the next decades, it is essential that the current unsatisfactory and weak interrelation between the industrial production capacity and local technological capabilities had to be extensively improved. There will have also to be a fundamental change in the perception of the role of technology transfer in the industrial development.[7]

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5 In this regard, several countries of the region have expressed their interest in nuclear power. The interested states maintain publicly that they are taking a long-term view and are preparing for the day when oil supplies are depleted. For more information see; J.J. Emery, et al., pp.112-124.

6 See UNCSTD, p.8.

7 Technology Transfer needs to be seen as a means of achieving domestic capabilities. Therefore, the countries should emphasizing transfers that promote local using and doing rather than elaborate and bureaucratic screening mechanisms.

Scientific and technological self-reliance and sustained industrial development requires continuous accumulation of technical skills and skills in the fields of engineering sciences and management. It requires also technology policies which can help to utilize these skills effectively in the process of transfer of technology, and solving technological problems.

In conclusion we can say that the slowly rising of science and technology policy in the Middle Eastern countries will have to be well integrated or united with national development planning. Science and technology will remain static if there is no good response from the socio-economic planning. In this case there will be much gap between social development and science and technology progress. This will lead to the formation of "two cultures" in the society and obstructing the relation between science and technology and social development. Thus, the development of science and technology policy is the way to exclude the above mentioned implications.[8]

Throughout this study, we have suggested policies and strategies which could be used as tools for technological development. Here, we summarize some of them as a framework for planning, policy making and implementation and as a process towards future change of present situation. Therefore, the future technical and scientific opportunities in the countries concerned lie in the adoption and development of the following activities:

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8 Y.Y. Al-Sultan, p.488.

-- There should be greater emphasis on utilizing locally available raw materials and technological advancement of industrial processes in the areas in which industries will be expanding.

-- Technology policy in the next decades will have to emphasize the role of local science and technology and R & D in meeting the increasing national need for these services.

-- The technological services which require special attention are: standards, quality control, consultancy, engineering, design, information and maintenance.

-- It will be necessary to emphasize the importance of standard and quality control in industrial progress. The institutions concerned should be supported with qualified manpower, equipment and information. Also, regulations should be introduced to apply standard and observe quality control.

-- Local consulting, engineering and design expertise should be effectively strengthened and utilize them in the processes of transfer and generation of technology.

-- National centers for maintenance service will be needed to assist the countries cope with industrial maintenance problems.

-- National industrial information centers need to be established and strengthened. They should be linked with international information centers. In this regard, it should be noted that one of the great challenges of the future is the revolution in information technology to which the Muslim countries must respond. Therefore, there is a need for every Muslim country to develop appropriate infrastructure and institutions which meet the needs of their societies.[9]

-- Regarding R & D, the current policy should be replaced by a more strategically oriented policy which can help the socio-economic development objectives effectively. The R & D programmes should be strongly linked to the transfer of technology. Also, special attention should be given to the development of new technologies that deal with problems which are specific to the region. These include desertification, irrigation, sand movement, housing, etc.

-- There is also a serious need to establish specialized industrial development institutions for specific industries in order to assist the continuous technical change. As such, the relevance of other new technologies should be studied and assessed. For example, the technological changes that are taking place in informatics, micro-electronics, new-materials, energy development and biotechnology are particularly important.[10]

-- R & D in small and medium industries need to be encouraged. As mentioned already, small and medium enterprises can be backbone of a successful economy. They can serve as centers of

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9 For an information strategy for the Muslim world see; Z. Sardar, *Information and the Muslim World: A Strategy for the Twenty-First Century*, (London: Mansell Pub. 1988).

10 In this regard a useful information source available is the ATAS programme of UNCSTD. ATAS is composed of (1) bulletins containing an assessment of technologies of interest, e.g., biotechnology, automation, materials, etc., (2) an interpretation of the national and regional context of the findings of the global technology assessment, and (3) a technology assessment network (TAN) composed of up to 10 international TA organizations, see UNCSTD, p.10.

manufacturing, craftsmanship, and services to larger manufacturers by supplying component parts. They can also bring about technical change and progress in traditional technologies. Therefore, it is necessary for them to utilize science and technology in order to improve their performance and competitiveness. This will promote more closer links between R & D and productive sectors.

-- Our future science and technology policy should enable the private sector to make use of local R & D services that are available. Therefore, the private sector should be assisted to make a better utilization of the local science and technology.

Considering all of the above, then we can emphasize that it is urgent need for Muslim countries of the region to develop their self-sufficiency in local and relevant R & D capabilities in order to attain domestic technological self-reliance. The experiences of the past has shown that reliance on external sources will lead to a new form of dependency and a new form of colonialism.[11] It is thus necessary for Muslim countries to establish indigenous research and development institutions and promote original and relevant pure and applied research in different fields.

In addition, the Muslim scholars should find answer for the question of how do we define a concept of science and technology

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[11] If everything from raw materials to spare parts to managerial skills have to be imported from the Western countries, the developing countries will be reduced to the states of "dependants." It is, therefore, essential that we do not play a passive role in regard to technological supremacy.

which is not secular, materialistic and destructive to the value of the humanity. Moreover, they should determine what type of industrial organization and infrastructure are best suited to the needs of Muslim society and how such institutions should develop and provide incentive for individual participation.

Furthermore, Muslim intellectuals must define, from an Islamic perspective, the elements of technology assessment and intellectual property rights and devise appropriate institutions which can implement these tools for the benefit of Muslim scientific and technological capability. These are the questions that needs further study and research in future. In general, Muslims should find their own answer for their own needs.[12]

As we have emphasized throughout this study, community development within Muslim societies requires concentration on light industries using appropriate technologies and service organizations. Community participation within these industries permits people to develop themselves, their lives and their environment.

Thus in matters such as technology, the community must be given appropriate authority and opportunity. "Community technology," which has been suggested in this thesis, is an example

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12 It should be noted that, in recent years many Muslim scholars turned to the crucial questions facing Muslims today, and attempt to define the epistemology of contemporary Islamic scholarship in science, technology, the social sciences, architecture and the environmental sciences. See for example; Z. Sardar (ed.), *An Early Crescent: The Future of Knowledge and the Environment in Islam,* (London: Mansell Pub. 1989). See also; Z. Sardar, *Islamic Futures: The Shape of Idears to Come.*

in which the active participation of the people within the community will achieve the best results. Community participation then is the process by which individuals, families or communities assume responsibility for their own welfare and develop the capacity to contribute to their own and the community's development.

Finally, it should be noted that the strategies outlined in this study are the minimum that we can hope to fulfil in terms of the S & T development which is needed by the countries concerned.

APPENDIX I

Selected National Scientific and Technological Institutions in the Middle East

1-Iran

In Iran after the Islamic revolution in 1980, the Iranian Research Organization for Science and Technology (IROST) was set-up in order to work toward the scientific and technological development of the country.[1] It is important to note that before the Islamic revolution there was not such an Institution which can support innovative activities. IROST was established to offer expertise and finance to support the inventors, innovators and any other potentially creative people in both public and private sectors, and at the same time to undertake research projects and to assist the transfer of technology from academic institution to industry.

IROST is governed by the representative of minister of culture and higher education, who will be the head of executive and scientific council. The organization is undertaken 11 scientific

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1 See; IROST, *What is IROST*, (Tehran: IROST Pub. Center, n. d.).

department that involve at different fields of scientific activities and joint projects with other institutions. There is also 11 administrative units and four regional offices responsible for research activities in provinces.

The main objectives of IROST can be summerized as follows:

(1) - Development of research activities at different fields of science and technology.

(2) - Promotion of research activities, to facilitate growth and expansion of appropriate technology.

(3) - Offering financial, technical and material support to researchers, innovators, inventors and other potential persons in the field of science and technology within the framework of IROST statute.

(4) - Coordination of research activities carried out by various researchers, universities and other institutions and strenghthening of multi-disciplinary research fields.

(5) - Dissemination of technical knowledge and increasing the research and development capacity of the country by publishing the research findings and their applications to achieve a faster and more dynamic economy, and,

(6) - Collection, systematic processing and disseminating of technological and scientific information.

It should be noted that in addition to IROST, the supreme council of Science and Technology was established, which is responsible for the planning and coordination of scientific and technological activities within the country. It is governed by a council with the president at the head.

2-Syria

In syria, the supreme council of sciences was established in 1958 and attached to the Ministry of higher education. It has the responsibility of the promotion of national scientific activity, coordination and elaboration of scientific policy.[2]

The main body of the council is the supreme committee of sciences which undertakes the final examinations of projects submitted to the council by the competent offices. This committee is headed by the Minister of higher education with representatives of major ministries constituting its membership.

The council's specific functions include: the supervision of scientific activities in government departments and universities; manpower planning and policies of various scientific and technological institutions; the granting of national awards and honors in science; the formulation of science policy and plans for government departments; the publication of scientific works; the preparation of statistical studies; the provision of support to libraries; etc.

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2 See; ECWA, pp.63-65. See also; A.B. Zahlan, *Science and Science Policy in the Arab World*, p.66.

The council is composed of specialized commissions which submit their proposals to the supreme committee. In addition to the commissions, the council also has eight scientific sections. These sections examine scientific problems submitted by the supreme committee, the commissions or the council's secretariate.

Recently, the status of science and technology planning and policy formulation has been the subject of a review by the government. This review has led to the formulation of proposals for setting up of a national science policy council. However, at present the Scientific Studies and Research Center of Syria which established in 1972 is the leading research institution in the country. The center in concentrating its attention on a number of critical technical problems of interest to Syria including Science policy.

3-Egypt

In 1971 the Academy of Scientific Research and Technology (ASRT) established as the responsible body for science and technology in the country with the following functions:[3]

(1) to support scientific research directed towards solving problems of national priority, (2) to encourage the application of modern technology in areas included in national programmes of socio-economic development, (3) to formulate policies that ensure

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[3] See; A.B. Zahlan, *op. cit.*, pp.44-53. Also A. Hebeish, "Country Paper of the Arab Republic of Egypt," UNCTAD, *Technology Policies for Development and Selected Issues for Action*, pp.117-143.

strong linkages at a national level between scientific and technological organizations, (4) to participate in the study of the S & T aspects of major development projects, (5) to encourage basic research, develop human resources, and recommend the establishment of new research institutes, and (6) to support scientific societies.

Policy-making body of ASRT is its council and headed by the president of ASRT. The main functions of the council are to: (1) set policies that mobilize national S & T institutes, (2) take resolutions based on recommendations submitted by the specialized research councils, (3) give state awards, (4) approve budgets and expenditure, (5) consider issues assigned to the council by the Ministrial cabinet or the ASRT president.

ASRT established 11 councils in different fields and developed the first five-year S & T plan (1982-1987) to include programmes and projects that serve the national five-year plan for socio-economic development adopted by the government.

In addition to ASRT, the National Research Center (NRC) which its origins may be traced back to 1950-1 is responsible for multidisciplinary R & D in Egypt and comprises 12 departments. It should be mentioned that, since 1975 the NRC has undergone several attitudinal and organizational changes.

4-Jordan

In Jordan the Royal Scientific Society established in 1970 as an independent non-profit research and development organization. It fuctions under a board of trustees with daily operations taken care of by a Director-General. Its function are:[4]

(1) to follow the latest advances in science and technology; to establish laboratories for scientific research, applications and exprimentation; to conduct research and studies on the feasibility and the launching of pilot industries, (2) to extend technical and consulting services to the government and private organizations for the organization of scientific research, technology development and planning, (3) to mobilize scientists and technologists for work in applied research, (4) to organize scientific library services, and (5) to cooperate with foreign organizations and establishments to strenghthen R & D in Jordan.

Since Jordan used the implicit science policy approach, it did not required until 1987 an institution for formulating and executing an explicit science and technology policy. However, the government of Jordan has in the past established the Scientific Research Council (1961-1976) and the Directorate of Science and Technology at the Ministry of Planning (1980).

The role of these institutions was limited to provide a modest financial support for research and development activities. Recently,

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4 See; ECWA, pp.65-66. Also F. Daghestani.

the government established "the Higher Council for Science and Technology" as a first step towards establishing an explicit national science and technology policy.

5-Iraq

In Iraq the Foundation for Scientific Research was established in 1963 and later on attached to the planning board. The Foundation is the national organization responsible for the planning and coordination of scientific and technological activities and is governed by a council.[5]

It consists of several research departments and also has specialized research institutions affiliated to it. As a national science policy making body its main functions include: (1) the elaboration of a national science policy, (2) the preparation of national plan for research activities, (3) the coordination of research and the promotion of basic and applied research.

Within these objectives, the Foundation has established research centers and laboratories; grants financial supports to researchers; provides consultation to different development sectors; provides scientific information for researchers; etc.

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5 See; ECWA, p.66, and A.B. Zahlan, *op. cit.*, pp.63-65.

6-Saudi Arabia, Kuwait and the Gulf States

Scientific activity in national institutions is recent in Saudi Arabia. It began at the Ministry of Agriculture and also at the college of petroleum and minerals, founded in 1964, which has recently become the University of Petroleum and Minerals. However, a Saudi Arabian National Center for Science and Technology (SANCST) was established in 1978 by a joint US-Saudi Arabia agreement.[6]

SANCST is the central body responsible for promoting and co-ordinating scientific research in the country. It encourages research within the country and seeks the collaboration of foreign agencies for its development programme. In addition to SANCST, Saudi Arabian Basic Industries Corporation (SABIC) was established in 1976 with the task of establishing large-scale basic industries with complicated and advanced technologies.

In Kuwait, Institute for Scientific Research was established in 1967.[7] The main objectves of the Institutes are: to promote scientific and applied research; to advise the government on science policy; to carry out scientific research and studies related to national industry; and to provide scientific and industrial data and information to the government and industry. This organization can be called a R & D

6 See; ECWA, p.67, and A.B. Zahlan, *op. cit.*, pp.65-66.
7 See; A.B. Zahlan, *op. cit.*, pp.56-60, and Y.Y. Al-Sultan, pp.103-161.

institute with promotional and service functions and its functions are carried out through several specialized divisions.

Qatar, United Arab Emirates, Oman, People's Democratic Republic of Yemen, and Yemen Arab Republic have some plans for the setting up of national institutions dealing with overall aspects of science and technology.[8]

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8 For Gulf States see; UNCTAD.

APPENDIX II

TABLE (1)

TECHNOLOGY CONTRACTS AMONG 6 DEVELOPED COUNTRIES AND 15 ISLAMIC COUNTRIES OF THE MIDDLE EAST

<Type of Contract>

Supplier	Technical Services	Equipment Supply	Construction	Total
		(Billions of Dollars)		
Total Amount	$4.4	$10.8	$13.6	$28.8
		(Percentage)		
Six Major Industrial Countries	46.1	69.1	76.1	68.9
Other	23.2	30.3	16.2	22.5
Local and Middle East	30.7	0.6	7.6	8.5
		(Billions of Dollars)		
Six Major Industrial Countries	$2.0	$7.4	$10.3	$19.7
		(Percentage)		
United States	75.5	37.2	43.6	44.4
Japan	3.4	16.5	7.9	10.7
Federal Republic of Germany	2.8	10.2	7.0	7.8
United Kingdom	16.3	11.6	1.5	6.8
Italy	1.9	2.9	9.1	6.1
Total Major Industrial Countries	100	100	100	100

Source: US Congress, *Technology Transfer to the Middle East*, (Washington D.C.: Office of Technology Assessment, Sep. 1984).

-- **Sectors Covered:** Communications, Comercial Aircraft Support Systems, Medical Services and Petrochemical Facilities especially for 1978-1982.

-- Middle Eastern Countries includes: Iran, Saudi Arabia, Algeria, Egypt, Iraq, Kuwait, Libya, United Arab Emirates, Syria, Lebanon, Jordan, Qatar, Yemen Arab Republic, P.D.R. Yemen.

TABLE (2)

NATIONAL SCIENCE AND TECHNOLOGY POLICY-MAKING BODIES IN SELECTED COUNTRIES

Country	Institution	Projects/ Programmes	Staff
Algeria	CNRS	Science policy envisaged	Professional
Iraq	FSR, Science Policy Unit	Science Sectoral science & technology plans, overall plan envisaged	Professional Professional, Technical
Jordan	RSS	Initatives taken for-formulation of national-science policy and plan	Professional, Technical
Kuwait	KISR, Techn-economics Div.	Long-term technological requirements studied	Professional, Technical, Foreign.
Lebanon	NCSR	Science Plan Included in 1972-77 Dev. Plan.	Professional, Technical
Iran	IROST	Science & Technology-Policy envisaged	Professional, Technical
Saudi Arabia	SANCST	National Science & Tech. Plan part of the third-Dev. Plan (1981-85)	Professional, Technical Foreign.
Syria	SCS to be integrated in National Council for science Policy	National Science & Tech. Plan envisaged	Professional, Technical
Turkey	TUBITAK	Sectoral Science & Tech. Plans	Professional, Technical

Source: Aaron Segal, et al., *Learning by Doing: Science and Technology in the Developing World,* (Boulder: Westview Press, 1987), p.93.

-- Information on Iran is according to the IROST Pub.

TABLE (3)

PERSONNEL ENGAGED IN RESEARCH AND EXPERIMENTAL DEVELOPMENT: SELECTED DATA

Country	Year	Total	Scientists & Engineers	Technician	Auxiliary-Personnel
Egypt	1973	...	10655	...	...
	1978	...	18350	5254	...
	1982	46796	19939	6678	20179
	1986	51183	20893	7532	22758
Iran	1970	6432	3007	482	2943
	1972	9865	4896	857	4112
	1985	...	3194	1854	...
Iraq	1970	167	124	43	***
	1971	190	135	55	***
	1972	248	170	78	***
	1973	316	205	111	***
	1974	365	240	125	***
Jordan	1973	...	180	41	...
	1975	...	235	213	...
	1976	417	208	146	63
	1985	...	270	175	...
Kuwait	1980	797	582	125	90
	1982	1864	1013	443	408
	1983	2064	1157	470	437
	1984	2539	1511	561	467
Lebanon	1977	133	133	...	...
	1978	160	160	...	...
	1979	175	170	5	***
	1980	206	180	6	20
Turkey	1984	27007	9914	6284	10809
	1985	29241	11276	7367	10598

Source: UNESCO, *Statistics on Science and Technology*, (Paris, Oct. 1989), pp.77-80.
... Data not available.
*** The figure to the immediate left includes the data for the column(s) in which this symbol appears.
Note: This table is concerned with trends in total personnel and the three types of personnel -- scientists and engineers, technicians and auxiliary personnel -- engaged in Research and Development, and presents selected years, normally between 1970 and 1987.

TABLE (4)

SECTORAL BREAKDOWN OF EXPORTS FROM SIX INDUSTRIAL COUNTRIES TO 15 ISLAMIC COUNTRIES OF THE MIDDLE EAST

Commodity	United States	Japan	Fed.Rep. of Germany	France	United Kingdom	Italy	Total
1982			(Percentage)				($million)
Raw-Materials	31.4	3.5	10.2	19.0	11.2	24.8	7870
Chemicals	15.2	5.4	24.7	20.1	24.3	10.2	3534
Basic-Manu.	13.2	40.5	18.1	14.6	9.6	3.9	12998
Mach. & Equip.	20.3	23.5	22.8	9.4	9.6	14.4	42070
Non-Electric	30.0	21.0	21.6	11.4	13.8	2.2	13945
Electric	15.3	26.0	15.7	11.7	11.7	19.6	10394
Telecomm-unications	13.6	43.5	13.9	13.6	15.3	0.1	2358
Electrical Medical	25.5	10.7	33.1	15.9	9.9	5.0	144
Transport	19.0	29.3	29.3	7.9	6.1	8.4	14523
Road-Vehicles	12.8	36.3	35.3	7.1	5.8	2.7	10819
Aircraft	63.0	0.7	0	13.4	7.7	15.2	1810
Other-Manu.	17.8	23.9	14.7	13.5	13.9	16.1	5120
Prof. Scien. Instruments	22.0	22.9	20.5	14.9	18.3	1.3	895
Other	4.8	1.6	13.7	0.5	25.4	54.0	2223
Total	19.3	22.9	19.9	11.9	11.2	14.8	73813

Source: UNCTAD, "Technology Policies for Development and Selected Issues for Action," Proceedings of a seminar organised by Islamic Development Bank and UNCTAD, UNCTAD/TT/94, (New York, 1988), p. 27.

TABLE (5)

EXPENDITURE FOR RESEARCH AND EXPERIMENTAL DEVELOPMENT: SELECTED DATA

Country	Year	Currency	Expenditure for Research and Development		
			Total	Current-Amount	% of Total
Algeria	1971	Dinar	77500	67500	87.1
	1972		78000	68000	87.2
Egypt	1976	Pound	33440	26686	79.8
	1982		40378	34242	84.8
Iran	1970	Rial	4414595	3966820	89.9
	1971		4856054	4322745	89.0
	1972		3531807	2246789	63.6
	1984		21527000	1584000	53.8
	1985		22010713	12546398	57.0
Iraq	1971	Dinar	1839	1448	78.7
	1972		2361	1794	76.0
	1973		2310	1791	77.5
	1974		3471	2743	79.0
Jordan	1975	Dinar	1540	...	...
	1981		1567	1254	80.0
	1984		3100	2480	80.0
	1985		3560	2848	80.0
Kuwait	1980	Dinar	40459	34504	85.3
	1981		40361	37045	91.8
	1982		43746	40500	92.6
	1983		67250	60616	90.1
	1984		71163	63016	88.6
Turkey	1970	Lira	492000	...	...
	1975		2667951	...	...
	1979		12572229	...	...
	1983		27220500	...	...

Source: UNESCO, *Statistics on Science and Technology*, (Paris, Oct. 1989), pp.88-91.
... Data not available.
Note: This table is a time series of total and current expenditures devoted to Research and Development activities, covers the period from 1970 to 1987. The relationship between current and total expenditures is also shown in percentage form thus indicating any variations in the structure of Research and Development expenditure.

LIST (A)

LIST OF STRATEGIC INDUSTRIES

1. Basic steel and metallurgical plants.
2. Large size machine tool factories (Limit of investment to be determined).
3. Petrochemical industries.
4. Heavy mechanical complexes.
5. Heavy electrical complexes.
6. Heavy foundry works.
7. Defence-based electronic industries.
8. Major vehicle assembling.
9. Ordinance factories.
10. Explosive and sulfuric acid plants.
11. Vehicular tyres and tubes.
12. Locomotives and railway carriage manufacturing plants.
13. Government Mint.
14. Security printing press involved in whole time printing of sensitive documents/currency notes.
15. Power generating and distribution system.
16. Oil storage units.
17. Gas production and distribution system.
18. Oil refineries.
19. Locomotive engines and workshop thereof.

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