WORLD BANK

KNOWLEDGE ECONOMY FOR THE MENA REGION

NATIONAL SYSTEMS OF INNOVATION IN THE MENA REGION

by

Prof. Abdelkader DJEFLAT
Chairman, the MAGTECH Network
Consultant

July 2002
INTRODUCTION

In the eleventh century El Ghazali produced its well-known « treaty of the wise for water management ». The clock-makers of Cordoba and Baghdad mastered the most advanced technologies and the finest know-how of their time. Nine centuries later, and at the outset of the 21st century, the Middle East and North African (MENA) region which was the cradle of breathtaking inventions, suffers from water shortages and fails to run simple water distribution systems and import most of its mechanical products.

Four decades of vain attempts to join the group of advanced countries have brought MENA countries to realise that the task is not easy and they have still a long way to go on this, in comparison with the Science and Technology (S&T) policy experience of the newly industrialising countries (NICs) like Korea and Brazil for example. The efforts in this respect have generally been far from satisfactory. Several factors illustrate this shortfall: the failure of the education system to deliver S&T that is capable of translating into innovation and technological progress, limited public and private initiatives directly aimed at the application of S&T to the process of socio-economic development and a generally backward situation with regards to innovative competition.

Like the rest of the world and the Developing countries (LDCs) in particular, MENA countries will soon face « enhanced competition, vanishing trade barriers, more stringent intellectual property regimes and deeper concern for the environment. » Trends in all these areas are expected to pose serious challenges for fragile components in the socio-economic systems of the Region ». While policy-makers have taken the measures to a large extent of these challenges, S&T policies and strategies, put forward, remain still inadequate, and sometimes immature. Yet, these are essential prerequisites for attaining viable S&T capabilities and innovative capacity and their role cannot be overemphasised.

The situation is of course different from one country to the other, MENA countries being more heterogeneous, than it might seem as a result of resources endowment, history, political regimes etc. In MENA countries, major transitions are therefore needed, and this process would involve a more proactive role of the state aimed at promoting scientific and technological innovation, a well-established market-driven competition, and a more efficient market in allocating resources enhanced with the supply of more and better information. This is of course coupled with a major role of entrepreneurs with the flair for new investment opportunities based on innovation and prepared to face competition of another type. This attitude is far from being firmly established and the emergence of a new enterprise culture, which cannot be expected to occur in a policy vacuum, is one of the key challenges, particularly with regards to integrating successfully the knowledge economy era. There is nonetheless a general consensus that the way forward for MENA countries is through the promotion of innovation and technological progress and an urgent need for adjustment of MENA economies to the rapidly changing trends of the global techno-economic system driven by the fast ICT revolution (Information and Communication Technology). Various factors have played in this respect. On top of the global challenges mentioned above, the failure of old strategies, the emergence of new generations of decision-makers with a significant breakthrough of university graduates, and of course the prospects of a Free Trade Zone with Europe by the Year 2010, have prompted governments to consider more carefully the question of S&T capacity building and the innovation challenges.

As put forward by the World Bank, « A knowledge-based economy (KBE) is defined as one where knowledge (codified and tacit) is created, acquired, transmitted and
used more effectively by enterprises, organisations, individuals and communities for greater economic and social development». One of the four components is pinpointed as being ‘an efficient innovation system’ comprising several institutions and competencies interacting in order to assimilate the growing stock of global knowledge, in order to adapt it to local needs and use it to create new knowledge and technology.

A national system of innovation (NSI) appears thus as one of the prerequisites and one of the key elements for S&T policy to be successful. While this analytical tool has largely been adopted by researchers and policy-makers, in spite of some of the questions it raises in academic circles regarding its relevance, its implementation has not always met favourable conditions in the MENA countries as shown by basic indicators of innovation and the impact on economic development and social welfare. Yet, non-negligible efforts were made in particular by some countries with access to large revenues based on natural resources and which are numerous in the region. At the same time, much less endowed countries, notably in South East Asia, have managed to successfully integrate S&T into their economies, solve major problems such as unemployment through innovative competition and are much better prepared to face global challenges and to take part in the world knowledge economy.

The initiative of the World Bank, which added to others in the region, is timely by helping to raise fundamental issues related to the challenges that the knowledge economy poses for the region as a whole but also the new opportunities that it creates. It helps ask central questions related to the system of innovation, its current situation with its success and its failures and the various obstacles encountered, the various actors involved namely the role of governments and of the public sector, the private investors, domestic and foreign, the new initiatives taken and their impact and more fundamentally, the market-driven approach in terms of capacity building and ultimately growth and social welfare. It raises also the issue of international co-operation in its various forms and its impact on helping to establish on firm grounds innovative capacities and pave the way for knowledge based economic growth.

To tackle these issues and make realistic and workable proposals, we have looked selectively at some of the MENA countries from the Maghreb, namely Algeria, Morocco, and Tunisia, and the Mashrek, Egypt and Jordan. Other illustrative examples are also drawn from Kuwait, Lebanon and Syria. While realising that this approach has necessarily its limitations, we also believe that it gives a large panorama of countries with differences in resources endowment, size, recent history and different political systems. The approaches to S&T has also differed in the past on various grounds and thus help to envisage several possible ways.

Besides looking at published global indicators, which are important to highlight trends and orientations, this study mobilises results of field investigations notably when looking at the Small and Medium Enterprises sector (SMEs). This gives the opportunity to involve the perceptions of actors involved effectively in the implementation of policies, and who can be a good measure of the gap that can sometimes exist between global decisions and concrete implementation.

I. ANALYSIS OF THE NATIONAL SYSTEM OF INNOVATION IN THE MENA REGION: POLICIES AND STRATEGIES

---

1 The other three include an appropriate economic and institutional regime, an educated and entrepreneurial population and a dynamic information infrastructure.

1.1. **Preliminary remarks.** The NSI has benefited from a vast and varied literature in recent years: (Freeman :1972, Von Hippel :1976, Gilles :1978, Mowery and Rosenberg :1979, Nelson :1982 and 1984, Niosi and Faucher :1991). The integrated approach to the NSI was however put forward by Lundvall (1985) and revised in the nineties for LDCs. Three spheres are identified: the productive sphere, the training and education sphere and the research sphere. Co-ordination is essential between these spheres, if the system is to work efficiently. While the NSI constitutes a central component in the process of capacity building, its initial Nation-State base needs to be broadened in the wake of the necessary relationships it mobilises with foreign entities. While the market regulates largely the interaction processes between the various components of the system, social and political institutions and economic policies are important factors orchestrated by the State to guarantee the homogeneity of the system and overcome market failures and optimal use of externalities. Moreover tacit and uncodified knowledge takes a large part in the innovation process and which is of particular interest to the situation we are examining, where the «oral culture» is still highly pregnant in the industrial and administrative interactions. As noted elsewhere (3), NSI has an ex-post and not ex-ante usage and it has been used mostly to describe systems with well-developed institutional and infrastructural support of innovation activities ex-post. It has not been applied to system building, whereas in the South, it needs to be shifted to system-construction in the wake of globalisation. Therefore new issues are raised related to the relationship between globalisation and national/local systems, the importance of well behaved not too conflict provoking, fiscal and monetary policies which are important ingredients for interactive learning and innovation, and a new perspective on a wide set of policies. It raises also the power aspect of development and the conflict over income necessarily connected to the innovation process, and the rent-seeking behaviour (4) that can contribute to freeze or even destroy local competencies. This being said, it remains one of the tools that can help organise our analysis and highlight some of the strengths and the weaknesses of the various components taken separately and of the system as a whole. So far, no MENA country and indeed very few LDCs appear to have sufficiently appreciated the above characteristics in establishing a national Science and Technology-System. We will endeavour to integrate most of the above aspects while analysing NSI in the MENA region and their capability in establishing knowledge economy.

The MENA region appears to show great differences in their NSIs or what may be termed as the ‘National System of Innovation’ being sometimes far remote from what we have described. This should not be a matter of too much concern, bearing in mind that great differences exist also among the countries that successfully established NSIs notably when looking at South East Asian Countries (SEACs). These differences exist with regards to policy option, institutions and infrastructure, mobilised and consequently with regards to problems thus met, although the similarities are numerous.

1.2. **Policy options.** NSI, as we mentioned earlier, are to a large extent dependant on the extent to which a S&T policy is made and effectively implemented. R&D and innovation cannot rest on a vacuum. The experience of MENA countries shows different levels of

---

awareness of the importance of S&T capabilities for development. On the whole most of them have managed to establish some kind of policy, often of an implicit nature. Consequently, there are some components of the NSI. For example: while education and training are found everywhere, R&D institutions or services are found in various fields (agriculture, health, manufacturing and sometimes engineering etc.) in some countries and are absent in others.

Three categories of countries can be identified in the MENA region. A first category (Algeria, Egypt, for example) seem to have made serious attempts to integrate S&T into economic development and have accumulated some non-negligible experience. This experience, considered the richest in terms of technology acquisition, appears to have started laying down the basis for an S&T policy and NSI, though not explicitly, in the early seventies. A study conducted in 1996 under the auspices of the Egyptian Ministry of Scientific Research and funded by the World Bank has identified several strengths of the Egyptian S&T system: Tremendous human resources with a large number of highly educated and specialised personnel, a considerable number of R&D institutions in various disciplines, many examples of success, particularly in agricultural research and other well focused industries, long tradition of S&T and Government commitment towards S&T institutions. The main driving vectors of this policy included: engagement in programmes of scientific research, both fundamental and applied, massive transfer of up to-date technologies from various advanced countries and substantial investments in education and training, locally and abroad.

A second category, more oriented towards market-driven growth and the contribution of foreign capital to industrialisation, (Morocco and Tunisia in the Maghreb, and Jordan and Kuwait in the Mashrek for example) were left with little elbow room to link up S&T policy to economic development policy. The technological decision was to a large extent in the hands of foreign firms, at a time when the industrial base of the country was being laid down. Although these countries have managed to develop local industries of small and medium size type, they were no clear bodies in charge of S&T policy and the level of awareness of the fundamental role of S&T in development was relatively low. Thus the basic ingredient for setting up the basis for NSI was missing.

A third category of countries, (Libya and Mauritania for example), which lack a sufficient industrial base and are small both in terms of population and markets, had S&T policy and its integration into economic policy low on their agenda. Current potential and infrastructure are unlikely to provide the basis for an NSI.

1.3. Institutions and S&T infrastructures. On the whole, MENA countries have built a substantial infrastructural base for S&T institutions, some of it inherited from the two import-substitution era and therefore suffering from poor integration as well as the rest of the economy. The three components of NSI exist: education and training infrastructure, research infrastructure and production units. Their existence does not of course guarantee that NSI is a good working order and producing tangible results.

Education and training: While higher education is often singled out as the most relevant level to scientific research and development, the success or failure of its role rest on a good education and training at the primary and secondary levels. The scientific basis and the right outlook are acquired, according to the specialists, at the level of basic education. Combined

---

school gross enrolments rose from 47% in 1980 to 58% in 1995. In 1992, Arab countries compared favourably with reference countries: 90% for primary enrolment (ref. country 87%) and secondary enrolment 55% (ref. country 51%). The Arab states have established a considerable number of new universities: their number went from 10 in 1950 to 175 in 1995. The number of university colleges also grew from 29 in 1960 to 177 in 1996. Local universities offer training for degrees up to masters’ level in all the three main countries of the Maghreb and in Egypt, Jordan and Lebanon. There are nonetheless considerable variations from country to country concerning enrolment of students, quality of education and its relevance. The total number of students in higher education has steadily increased over the last two decades with a significant increase in women participation. It has been multiplied by 2.5 in all three countries of the Maghreb between 1980 and 1995 with an acceleration for certain countries such as Tunisia. In 1995 it reached more than 3.2 million students i.e.; 11% of the 20 to 24 age group. There were more than 600,000 Arab engineers in 1990. The output of higher education ranges between 10,000 graduates and 30,000 each year. The rate of graduates on average reaches 120 to 220 per thousand for the whole sub-region, compared to France, which scored 246 in 1994 alone. Abroad students from MENA countries follow specialised training or undertake Ph.D. studies. They were present in 45 countries with a big concentration in France regarding the Maghreb (67% of the total), for historical and cultural reasons. A large slice of the Government budget was allocated to education and training reaching as high as 36% of total government expenditure.

Research institutes and centres: MENA countries have built a substantial infrastructural base for all types of S&T institutions and in particular for R&D. Looking at the Arab States, R&D institutions increased from 26 in 1960 to 322 in 1996 at a rate of 8 institution per year. Currently, more than 600 organisations are involved in R&D activity (80% of Arab R&D output is performed in universities). All these units, centres and councils were linked to each other on the macro level and also linked with Economic National Plans. On top of that, inter-sectoral research units, laboratories and research services were set up within academic institutions.

Industry: In spite of the supposedly agriculture-dominated countries, most of the economic development options rested on a sizeable investment in industry and different approaches and models. Whatever the economic choices and policy options were, they all needed massive equipment, know-how and skills and technological services. Many industries established their own research units either at the sector level or within individual enterprises. This is particularly the case for exporting industries. On top of that, inter-sectoral research units, laboratories and research services within the productive sector were set up in some countries, where the interaction between enterprises, branches and sectors and the education system appeared as a core issue in the eyes of policy-makers. The main objective being to get S&T research activities out of the education system and orient them towards the productive system. This has initiated some contacts between industry and academic research though at a minimal level. In some countries co-ordinating bodies were created to this effect, in Egypt, Jordan, Algeria etc.

---

7 ERF Economic Trends in the MENA Region, 2000
9 Zahlan « Science policy for the twenty first century : mobilisation and development » paper given at the EGM on S&T, ESCWA, Beirut, March 1999, 24 pages
10 Quasim, S. « Research and Development in the Arab States : a new commitment » paper given at the EGM on NSTIs, ESCWA, Beirut, March 2000, 23 pages
While suffering from a host of problems and weaknesses, these systems managed to set the basis for some innovation activities.

II. CURRENT MANIFESTATION OF INNOVATION ACTIVITIES IN MENA ECONOMIES: SUCCESS STORIES.

While most studies report the scarcity of innovation in the sub-region and highlight the various shortcomings, very few have examined success stories. This section is designed to highlight some of the achievements in the sub-region.

The literature has, for some years now, consecrated the two concepts related to innovation: radical innovation meaning a breakthrough at the frontier of knowledge and incremental innovation meaning gradual, progressive and cumulative technical change (Dosi, Nelson and Winter, Freeman). While present days advanced countries have progressed through both types of innovation, it is observed that in contrast to the strict OECD definitions for R&D within an innovation protocol, the essential of innovation activities across Asia are concerned with developing incremental innovation, improving products, improving management, installing quality systems and developing marketing strategies. This mode of innovation is recognised as a viable tool to face competition in the absence of radical or breakthrough innovation Asian success and well known economic performances raise some hopes amongst other LDCs and namely in MENA countries. When looking at these latter, a large proportion of innovations, particularly those within the productive sector, appear to be of the incremental type.

The manifestation of innovation varies from one sector to another and from one country to the other. Scarce studies conducted in some MENA countries reveal the existence of successful innovations, particularly in agricultural research and other well-focused industries. Often, in the absence of a systematic survey of the region, it is through the local press (in an anecdotal way), or through some isolated academic work, that diffuses information regarding this phenomenon. Relatively few investigations have tried to measure up precisely the impact of innovation on the economy or at the enterprise level. Only 2 out of 10 innovative enterprises in Tunisia for example have tried to assess the impact of their innovation on their results by calculating their ratio of R&D expenses on turnover. Success stories can be divided into several categories. To give an idea of the range of possible cases met in the MENA region, we shall examine the results of surveys conducted in the region at sector level and specific case studies drawn from both the public and the private sectors.

2.1. Sector studies. Sector studies on innovation performances were conducted in recent years in the MENA region either by government agencies, private consultants, academics or international organisation. Even though, they are relatively scarce and lack a strong information base, they can give an idea of the trends and orientation of innovation in the region. We selected three major studies: a study in the chemical sector conducted by the ministry of science and technology in Tunisia completed by two academics research works.

---

11 Garrett-jones, S. « National Science and Technology Initiatives for ESCWA Member Countries : Lessons from the South and East Region » paper given at the EGM on NSTIs in Escwa member countries, ESCWA, Beirut October 2000, 52 pages
13 BPT (Balance des paiements technologiques) is an indicator measuring the invisible transactions related to the exchange of technical know-how between partners residing in different countries. These transactions must have a commercial character i.e. and be closely linked to the exchange of technology and/or the supply of technological services.
The chemical industries in Tunisia: The SERST (Secrétariat d’Etat à la Recherche Scientifique et Technologique) study in Tunisia examined the 31 enterprises of the chemical sector. 61% appear to have an R&D unit and to have done some incremental modifications of products. Sixty per cent consider that their R&D units have increased their income and turnover through process improvement (69%), through product improvement (46%) or through the creation of new products (54%). These services are relatively recent: 61% have less than 10 years of age and only the third have more. Various motives are put forward for the creation of such units. The bulk of the companies see R&D as a way to consolidate their position in their existing field of activity but they do not try to acquire more competitive positions, which show a certain lack of aggressivity.

Other studies of the most innovative companies in Tunisia in various sectors on a relatively small sample, indicate that successful operations were conducted by R&D departments in several operations: modification of the acquired technological process or products in order to improve their characteristics (80%), developing new products and commercialising them (80%), developing new products without commercialisation (60%). These companies are mostly SMEs. In terms of structure, 60% had a formal de R&D department, and in 20% of the cases, it was in the process of being created while the rest had simply a study desk. All had an engineering office, in charge essentially of feasibility studies of products and equipment. 40% of technical staff perceives the necessity to have an R&D department, which shows some level of awareness of technical personnel and managers of the importance of innovation. Regarding human resources mobilised, they were through, training of personnel on the newly introduced technologies (90%), through recruiting of new personnel for research purposes (50%) and external technical assistance (60%).

As shown by these ratios, several companies in the sample used simultaneously several means to undertake innovative activities. Networking has been used to some extent (50%) mainly to exchange services, information and even undertake joint R&D activities. R&D activities involved most of the functions in 90% of the cases, (with particularly emphasis on research and marketing). Only one company used the sole technical department. Most decisions were taken at top management level showing the perceived importance of R&D and innovation as a competitive tool. This has greatly contributed to set-up the right environment internally. This felt importance of R&D is also shown through the implication of personnel in charge of R&D services in strategic decisions and in defining company policy in most cases (80%). Only one company had a multidisciplinary scientific committee in charge of strategic choices in terms of research and innovation. Finally scientific and technical information seems to have played a central role in the R&D activity. Information sources used were accumulated know-how and internal expertise (100%), customers and suppliers (90%), fairs and exhibitions (80%), training seminars (80%) colloquia and scientific gatherings (60%) and through published information (70%). To a lesser extent were used chambers of commerce (50%) external expertise (40%) professional organisations (50%) market studies (40%), and the participation to meetings of professional scientific and technical associations (30%) like the engineers union, through Internet (30%) data banks (20%) and visits to competitors (20%). It is interesting to note though, that the companies in the sample only used marginally the centres put to this effect by Government such as (CETTEX, CETIME, CNCC...) (30%). This is an indication that

---

14 Secrétariat d’Etat à la Recherche Scientifique et Technologique (SERST), 1996
16 Ten companies were examined
several obstacles exist and that extra effort and funds need to be devoted to popularising these centres and not simply creating them.

In terms of impact, these activities did not necessarily lead to break through innovation: only 2 companies managed to acquire new scientific and technical know-how leading to registered patents (5 patents for the first one and 10 patents for the second one). This latter is now involved in selling its know-how to foreign companies with remittances of 1 million USD annually. A third one managed to put up a new product with an American offshore partner but the innovation was patented under the name of this latter. The number of employees has been constantly on the increase ranging from 120 employees for the smallest one to 4400 employees for the largest one (1996). Turnover reached 4.1 Millions DT for the smallest one and 636 Millions DT for the largest one in the same year.

SMEs in Algeria: They are concentrated in five major sectors counting for 68% of total activity of the country. In 2000 their share of these sectors were 27.6% for Building and public works, 16.34% for commerce, 8.7% for transport and communications, 8.59% for services to households and 7.29% for agro-food industries. We notice that the third of the total are in services. SMEs appear to belong mostly to the two following categories: a first category is able to stand on its own, alongside and irrespective of the prevailing influence of large firms occupying critical market niches; a second category of micro and small enterprises remains rooted in past practices, employing traditional methods and characterised by strong inertia to changing environment and resistant to new technological methods of production. Their investments increased at a remarkable rate in a relatively short time rising from 700 projects in 1994 to 12 300 in 1999, being multiplied by a ratio of more than 17. During the five-year period (1994-1999), 30 106 investments plans were registered. This represents an amount of 37 billion USD and was supposed to generate 1 268 000 jobs. Micro enterprises constitute the highest proportion of these enterprises (97%). Their innovative activities are found in product improvements (48.5% of total investments), capacity stretching, new product fabrication and replacement of old equipment.\(^{17}\)

2.2. Organisation studies. Success stories can also be found within research institutions and public and private enterprises.

Innovation within Research institutions: Institutionalised research has first started in “Centres” and institutions before being a preoccupation in the enterprise in MENA countries. There are few research institutes whose successes are known in the region. We can mention as an illustration: the Kuwait Institute for Scientific Research (KIST). Other examples such the Egyptian Academy of Scientific Research and Technology.(ASRT) will not be examined here.

KIST appears to have registered relatively good records in terms of successful innovation in several fields over the last two decades: in the development of water resources, in the plant tissue culture to support the agricultural sector, and in the field of energy conservation in buildings. As an illustration we shall examine the first of the three areas. In the field of seawater desalination, Kuwait is considered as one of the first countries in the world to have used this method for fresh water supply and certainly the most experienced in the region using he MSF (multistage flash). Current installed capacity is 284 million gallons per day makes it the largest in the world. Research conducted in the Doha Reverse Osmosis Plant (DROP) has lead to many tangible results: adaptation of the reverse osmosis technology to suit the severe climate condition of the country, achieving very high load factor

\(^{17}\) Djeflat, A. & Aït-Habouche « SMEs and Technological Innovation in Algeria » (forthcoming)
(90%). Reduction of capital and operating cost to 20% through a single-stage desalination system locally invented instead of a two-stage system, successful mechanical modification and chemical optimisation of the Reverse Osmosis process, the use of beach wells as well as non-conventional techniques for the treatment of sea water feed, making it more reliable and cost-effective etc. These results are important not only for Kuwait but also for the rest of the countries of the region, since water has been one of the prime preoccupations of MENA governments and because many countries, after long hesitation have opted for seawater desalination, e.g.: Algeria.

While the impact in terms of employment may not be easy to find, the positive effects on the balance of payments and on developing local capabilities are evident. Several ingredients of success can be identified. The long-life of KIST, established since 1972 with the help of Japan, has now thirty years of age. The making up by an appropriate law (1981) that has given a clear mission, in both scientific and applied research. Its orientation towards precise economic goals, considered being priorities of the country, right from the beginning and its role as advisory body to government. Working through five-year strategy programs has given it breadth of vision and continuity with flexibility and adaptive capacity: the fifth strategic plan (2000-2005) is currently on. An evaluation and a peer review for more focused research activities and for optimisation of information technology into the various programs if under way. Human resources development has been one of the main concerns of the institute and its concentrated interdisciplinary approach has helped a great deal. Finally, well thought strategic alliances with local, regional and international research institutions and also international organisation have given it the possibility to have access to state of the art technology, to adapt it to local conditions and modify and improve it18 much like the East Asian model which is taken as a reference model. As a result of its activities, KIST received several awards, the Stockholm Challenge Award given by the City of Stockholm and The European Union in applied information technology in 2000, the GCC prize for the best R&D institution in 2000, etc.

Innovation in Public enterprises: the pharmaceuticals sector in Algeria: a state owned enterprise, SAIDAL, is a good illustration of how in the wake of capital and skills market failures, as well as the failure of the technical support system, government can put a significant effort in channelling funds, information and human resources to build efficient innovative capabilities. SAIDAL, created in 1998 in the pharmaceuticals sector, managed to bring self-sufficiency in many types of drugs. Domestic production has risen from 18% of total need to 40% of the Algerian market. Productivity improvement in 2001 managed to bring the prices down of 2% to 5% and 10 new products were introduced in the market19. Innovation, while not of the radical type has managed to substitute local inputs to imported ones and replace branded products by local generic ones. It received the IOS 9001 and 9002 by the French leading certification institution (AFAQ) for its Head-office, its R&D centre in El Harrach, its anti-biotic unit in Berrouaghia, and its production unit of biotics in Gué de Constantine.

The certification ISO of its R&D centre represents recognition of its research, design and development of new generic drugs (injection, various ointments, pills and syrups) as well as its capability in physical and chemical pharmaceuticals, and in toxicological controlling. Certification of its antibiotic units in Berrouaghia is mainly linked to its capability in fabricating various active drugs. The certification of its head office is a recognition of its capability in putting up «a viable strategy and in managing adequately and according to

19 El Watan, of July 14, 2002, p.2
international standards the design, the production of new pharmaceutical products in the
country ». Its products are now being exported to Iraq, Senegal, Italy and in South Africa
and Sudan in the face of tough competition from various well established names in the
profession. Exports reached 10 Million USD \(^{20}\) and the rate of growth of the firm reached
30% in the first term of 2002 compared to the same period in 2001\(^{21}\). Its position of
leadership is well established at the national level in spite of the existence of private small
firms and imports of drugs from abroad through various channels.

SAIDAL success story is often linked to its R&D department with 120 full time
researchers and its active policy in terms of joint-ventures and partnership with foreign
companies notably with Aventis laboratories, with the Pfizer Group, LAD Pharma for the
design of new products and the Swiss group Medacts for the production of prostheses in
Algeria, with the Jordanian Dar Dawa (ophthalmic drops) and with Somedial (contraceptives
produced and adapted locally). The rather uncommon thing in the region is its partnership in
joint R&D notably with Ely Lily to improve pharmaceutical products and adapt them to
specific environments. With Pfizer, initial investment reached 17 million USD for the co-
production of pills, and gels \(^{22}\).

While being a state owned company, 20% of its capital is owned by private
shareholders mostly local companies and individuals. To support its research activities and
also increase its competitive edge, the company has massively introduced ICTs and launched
an important operation of training personnel in digital communication and Internet directed to
its staff, the SAIDAL ICTs Training Campaign from July to December 2000 targeting more
than 100 trainees.\(^{23}\) While direct links between its innovations and employment may not be
easy to establish, its size nonetheless increased from 2100 to 3500 employees in 2000 and
keeps constantly increasing. The impact on the balance of payments of the country is also
evident

_Innovation in the private sector: The Poulina group in Tunisia._ Born 34 years ago in 1967
as a private initiative with 20 000USD of capital, Poulina has now become a group of
enterprises involved in various fields of industry, agriculture, agro-food and services. In
industry several activities exist: wood, ceramics, steel and printing. It employs more than
7000 employees with 15% of management, 3000 shareholders and an annual growth of 10%.
It is known for its dynamism in the field of technology: it has a proper technology policy that
is rare to find in private concerns in the MENA region. Its achievements include the
adaptation of imported technology and innovations in various fields of agro-food industry. Its
research and development department managed to design and successfully commercialise a
new exhaust pipes to suit the European automobile industry and new automated procurement
and management systems. Similarly, it is one of the few private groups in MENA Countries
to have an R&D department, an important budget and full time employees in this field. It has
also been one of the first ones to introduce intranet to connect its various branches.

_The craftsmen sector in Tunisia:_ Cultural requirements appears to be one of the incentives
to incremental technical change which is not totally different from market requirements, the
two being sometimes closely inter-linked. These requirements play in both ways: imported
products and services can be adapted to suit the requirements of the home market and
consumption habits and pattern, while locally products can be modified and adapted to suit
the tastes, norms values and requirements of foreign markets and consumers. While these

\(^{20}\) El Watan, op. cit.
\(^{21}\) Magazine Santé Economie
\(^{22}\) its manager was elected as one of the 50 top managers of the African continent.
\(^{23}\) IS Promotional activities, Update 2000: Algeria

11
innovations are essentially of the « market pull » type, they can also be the result of « enterprise push » types of incremental changes. Incremental innovations in the region of Sfax, in Tunisia include, the mechanisation of the embroidery sector etc. Similar examples can easily be found in other part of the MENA region. The key to this success were re-engineering, downgrading and substitution with local material. This is reflected through moving from production destined exclusively to the domestic market to exports and the reduction of production costs by 34%. The mixing of tradition and modern requirements and the exploitation of cultural specificities appear to be some of the specific features, and according to the analysts, key elements in the success of the operation. In all cases mentioned, university research was never involved.

These are some of the success stories and there are many more in agriculture, in services, in management and marketing in finance and banking. Other non-conventional categories of and which would need further investigation, have been taking place. These include notably: social innovation, « crisis-prompted innovation », informal innovation etc. Nonetheless, innovations as a whole remain still relatively limited in view of the massive investments made each year, the huge human potential and resource endowment of the region. They remain highly insufficient in the face of market competitiveness and the challenges resulting from the global trends and daunting internal problems.

III. THE SHORTFALLS OF EFFECTIVE INNOVATION AND THE CHALLENGES OF THE GLOBAL TRENDS.

Like the rest of the developing world, MENA countries will have to face major structural changes in the world economy. At the same time, they still face some daunting internal challenges.

3.1. The shortfalls of effective innovation. The performances of scientists are good translation of this difficult situation three main indicator: 1/ Registered patents 2/Scientific production through published articles, and 2/ Participation to International Conferences. In comparison to other countries and in particular to the East Asian ones (South Korea had the same level of development as some MENA countries in the sixties) and to Israel in the Mediterranean Sea, there is a relative scarcity of innovative activities in the classical sense of the word.

Registered patents: If patents can be considered as a viable indicator of innovative R&D activities, the poor yield translates evident weakness of the systems and the important crisis they go through. As an illustration, in the two decades in which major industrial effort was made in Algeria (1966-1986), 7930 patents were registered i.e. an average rate of 397 per year : 97% were held by foreign firms. In Tunisia, the situation improved from 141 registered patents locally in 1995 to 257 in 2000 and fell to 178 in 2001. Morocco reached 325 in 1996 but with a population three times more important. Egypt has registered an annual average of 410 patents since 1951, with only 43 from Egyptians (10.5% of the total). Figures show either declining trends (Algeria) a slight increase (Morocco and Egypt) or an
important increase (Tunisia) of the number of patents registered. Compared to a small
country such as Switzerland or even Turkey, the gap is relatively high. Turkey reached 722
in 1995\textsuperscript{27}. From a sectoral point of view, it appears that the situation differs from one country
to the other, however the most active and efficient sectors in Morocco are medicine &
hygiene (16\%) and chemistry (43\% of all registered patents) probably due to its phosphate
industry.\textsuperscript{28}

Scientific productions through published articles: More than 1,000 organisations publish
one or more publications each year in MENA countries. With a concentration of 30
organisations (mostly universities), which publish 50 or more publications annually\textsuperscript{29}. On the
whole, the number of papers published in refereed and international journals by scientists in
the MENA region has been increasing for the past 30 years at the steady annual rate of
10\%. The total output went from 465 publications in 1967 to 7,000 in 1995. However,
scientific production remains highly insufficient. The Arab world rate of publication, on a per
capita basis, is much lower than that of countries such as Brazil and India.\textsuperscript{30}. In 1995, the
number of publications was for Morocco 597 publications, for Tunisia 342, for Algeria 311,
for Libya 53 and for Mauritania 7. In the same year, Brazil published 6 634 articles for a
population of 156.5 million inhabitants, while South Korea produced 6353 articles for a
population of 44 millions inhabitants. In the more advanced world, Switzerland with a
population of 7.1 million inhabitants published 13 331 articles. Consequently the ratio of
publications to population does not exceed 20.4 for the Maghreb and 26 for the Arab World,
whereas, it reached 42 for Brazil and 144 for Korea during the same period.

However, these publications suffer two major weaknesses: firstly, they are
disconnected from the real engineering and technology sphere. During 1981-86, out of 1229
articles published, only 5.1\% of the articles were concerned with engineering and
technology\textsuperscript{31} a relatively poor performance compared to NICs’ rates. Secondly, they are
rarely done in highly reputable journals: publications in international journals on S&T remain
relatively limited: 0.32\% for MENA as a whole compared to 0.96\% for Latin America and
2.86\% for Asia. Publications are dominant in chemistry and physics.\textsuperscript{32} Most of these were
published in collaboration with foreign counterparts, mainly from France for the Maghreb
(78.2\% for Algeria, 79.8\% for Morocco and 89.2\% for Tunisia) and 46\% for Egypt which
usually high. Mashrek countries collaborate mostly with British and American scientists,
with an unusually high rate of co-authorship, ranging between 25 to 30\%, which is close to
the international average of 25\%. It is argued that countries that have an excessive level of
collaboration reflect poor local subsidy and poor local support for R&D\textsuperscript{33}. Others praise the
merit of this collaboration on the ground that they give privileged access to state of the art
scientific and technical knowledge. A great deal of authors manage to publish either live
outside the region or publish as co-authors with researchers from the North. Maghrebian

\textsuperscript{27} INORPI Tunisia, WIPO Geneva (1998)
\textsuperscript{28} Morocco is the first producer and exporter of phosphates in the world
\textsuperscript{29} The leading centre of research in the Arab world since 1991 has been the University of King Saud in Riyadh.
Cairo University was the leading centre until 1989 when Kuwait University superseded it
\textsuperscript{30} Zahlan, A.B. « The Magheb, Innovation and Globalisation » paper delivered at the 3\textsuperscript{rd}
International Conference Maghtech’98, Sfax (Tunisia), April 1998.
\textsuperscript{31} Alcouffe, A. op. cit.
\textsuperscript{32} Zahlan, A.B. , op. cit. and J. Bouayiour et al. op. cit.
\textsuperscript{33} Zahlan,A.B. ibid
researchers seem to perform better when the discipline are more abstract (physics) than when it is applied sciences (biology, medicine).\textsuperscript{34}

\textit{International Conferences:} It is estimated that some 18,000 conferences were held in 1990 resulting in the publication of conference proceedings during the period 1990-1994. Arab scientists contributed to only about 1% of these 18,000 conferences; the Arab countries hosted only some 0.1% of the world’s conferences.\textsuperscript{35} At the level of MENA and in the 1991-1997 period, Algerian scientists contributed 267 papers to 172 different conferences, Libyan scientists made 23 contributions to 20 conferences, Moroccan scientists made 391 contributions to 168 conference and Tunisians 202 papers to 137 different conferences. Jordanian scientists contributed 116 papers and Egyptians 1130 papers. It must be noted that Morocco has made significant progress in recent years in expanding the scale of scientific research in its national organisations. This is reflected by the increase in its research output, in the range of scientific conferences that were hosted by Morocco and in the substantial participation of Moroccan scientists in international conferences. Morocco is now the third or fourth largest Arab producer of scientific research and the second largest host of scientific conferences. Contributions were mostly in Engineering, Medical Science, Agriculture, Basic Sciences; Geology & Remote Sensing; Renewable Energy; Water; Environment & Radiation Protection.

\subsection*{3.2. Global trends} Global trends are examined both at the international level and domestically.

\textit{At the global international level}, the challenges result from drastic transformations related to the new forms of dissemination of knowledge, namely linked to the ICT revolution. The era of generic technology (biotechnology, genetics and the engineering of materials et al the molecular level) has brought new ways of working and living. Several aspects predominate in these changes: the sheer speed at which these have been occurring which has accelerated the rate at which new technologies are incorporated into systems of production, the much closer links between basic science or pure research and applications (the proliferation of laboratory enterprises), and the new prospects for large applications of generic technologies across many sectors. Computerisation and digitisation require the development of whole sets of new activities, leading to the emergence, perhaps, of a fourth sector to properly harness all these specificities. Major changes occur also in a horizontal manner, in the production function to include more broadly the areas of marketing, new product design, procurements, after sale service, software, branding, logistics and direct marketing showing importance of the new capabilities based on knowledge with limited hardware which can open opportunities for wealth creation and value-added. These changes are accompanied by the exponential growth of service-based economy, which now, more and more, characterises the so-called post-industrial societies. Massive investments are made in R&D, training, education, etc. with the subsequent increase of the need for more knowledge, higher studies and long-life learning. There are new requirements for labour

\begin{footnotesize}
\textsuperscript{34} El Alami, J et al (1992).
\textsuperscript{35} The British Library, Document Supply Centre publishes an annual \textit{Index of Conference Proceedings}. The 1994 Annual Accumulation of this Index gave the figure of 18,000 conferences ending in proceedings.
\end{footnotesize}
mobility, flexible production systems and the mixing of basic knowledge to create complete new products and services.

These characteristics will have, no doubts, important implications for MENA countries: the so-called traditional and once “stagnant” industrial sectors, like textiles, garments production, and food processing, in which they started developing some cost-based comparative advantages, are in the process of being completely transformed as a result of research in new materials, computer automated machines and digital systems of control. The prospects of maintaining comparative advantages are rather slim: automation together with the development of new systems of weaving and spinning equipment have created much more demanding technological conditions.

There is little in the competitive performance of MENA countries to suggest that generic technologies, and the new paradigms and new concepts in policy, management and innovation strategies brought by the era of the new information technology have made sufficient inroads to transform the industrial and technological landscape of a good part of MENA economies. In order to maintain competitiveness, enterprises in MENA countries have soon to come to terms with these more demanding technological and managerial conditions. The new and formidable challenges need to be properly identified, analysed and properly tackled by policy makers and governments.

At the domestic level. Internally, several problems, which we will examine briefly in this paragraph, need particular attention. As a consequence of this pattern of behaviour, the contribution of the $2,500 billion invested in Gross Fixed Capital Formation (GFCF) led to a decline in per capita Arab GDP, despite massive additional investment in education. The level of innovation required by these investments is considerable and represents hundreds missed opportunities for breakthrough innovation by the local NSI in the region. They include:

First of all there is a need to restore sustainable growth which, in spite of the good macro-economic performances, remains sluggish: the region needs to grow at a sustainable rate of 5% to 6% if its unemployment is to be absorbed.

Secondly, there is a need to reduce the still important state stronghold on the economy: a transition for many of them from strong state operated to liberal and private initiative led growth is necessary for both Maghreb and Mashrek economies.

Thirdly, the great majority of industries in the sub-region, suffer from general obsolescence of existing technological capacity: It is widely recognised that on average industrial infrastructure dates back to the seventies when many MENA countries saw their external surplus boosted by the increase of the price of minerals on the international market, large and easy access to borrowing on the financial markets and appreciation of the dollar. Examples can easily be found throughout the region of installed capacity being used at an average rate of 50% notably in the public sector. In the textile sector in Tunisia which employs half of the industrial labour force, 20% of the spinning machines only are fully automated, while the remaining 80% still use traditional mechanical technology largely obsolete

Fourthly, High level of unemployment and particularly graduate unemployment constitutes one of the central preoccupations of MENA countries, particularly in large countries such as Algeria, Morocco, and Egypt. However, there are two categories of unemployed: youth unemployment particularly in the cities and unemployment of graduates. These latter that could constitute a major asset for MENA countries to integrate knowledge economy, are almost totally excluded. This is at the origin of important costs not only as a result of the loss of public spending on education and training, but also as a result of the social and individual unrest and tension particularly on this strata of the population. As an illustration, in Morocco, graduate unemployment increased by 30% in the last two decades, while non-graduate unemployment rate has been on the decline. In 1998, long-term unemployment of graduates reached 87.5% and 77.84% for non-graduates. 30 to 35 per cent of university graduates are said to face the risk of unemployment. This is an indication of major structural imbalances in the economy and the education and training system as a whole. The same phenomenon exists with various levels of severity in Algeria, Tunisia and Egypt. There is no significant evidence that higher education helped to meet industry needs through the production of relevant skills and the provision of R & D support. Education policy is not matched with economic policy, hence possibilities for ‘growth reversal’. The supply of highly skilled manpower in excess of what is warranted by the absorption capacity of the economy becomes effectively redundant. It would often find itself a convenient outlet either by competing with semi-skilled and unskilled labour for available employment opportunities, or by emigrating to skill-deficit economies reinforcing the brain-drain phenomenon that we will look at later. Other problems relate to the people released from state-owned enterprises, due to the over-staffing which occurred under import-substitution era and which is estimated at 15% of total labour force in some countries.

Sixthly, the still important low-wage based and natural resources-based competition. Current dynamics encourages the creation of low-skill jobs and the growing informal sector and a shift from skill-based to low service jobs. Exposure of local investment and production initiatives to a wider regional and international competition, requires for MENA to shift to more productivity, new technology based competition. In Morocco, the pressure of competition in the international market has forced a reduction in real wages to levels 20% to 30% below of what they were in the 1960s and the adoption of a strategy of competition by a continued compression of real wages, child labour, etc. For all that, Morocco has seen its share in all the traditional markets declining, while competitors like South Korea have forged ahead increasing their shares even in carpet making in which Morocco traditionally had a competitive edge. Korea opted for competition by productive gains, and by raising qualification standards of the labour force. Local firms face competition from a relatively weak position in terms of equipment, infrastructure and human resources. Thus in the Tunisian textile sector, mechanical equipment represent 80% of the total while they account

---

38 It is important to observe here that the global data mask the difference between the graduates of university education (except medicine and engineering), for whom the unemployment rate increased from 6.5% in 1984 to 23.3% in 1990, and the graduates of non-university education (Schools, medicine, normal training, etc.) for whom unemployment remained stable for the period at around 1.1%.
39 Lahlou, M. « La problématique de l’emploi et de la pauvreté et le programme d’ajustement structurel au Maroc » Revue CENEAP, N°17 pp. 35-60
41 Djeflat, A. «Technologie et Système Educatif en Algérie » op. cit.
42 Zawdie, G. op. cit.
43 The social clause of GATT, which precludes options for competition by wage compression or exploitation, is invoked by some as the most important clause of the Marrakech Agreement.
for less than 20% in the European Union industry. A transition to service-based, knowledge driven and SMEs dominated production is highly needed.

Finally, the last but not least, the Socio-cultural and societal issues need to be properly understood and tackled in order to create not only a knowledge society but an «innovation society». This requires a framework of creativity across the board for all aspects of life. It is a formidable task to get the social fabric of MENA countries to follow the same road of progress when it comes to social and societal aspects. While being attracted by the facilities and the comfort provided by technology (travel, communication leisure, education, health etc.) and by its processes, fractions of society in the MENA region, oppose its adoption, for what it conveys in symbolic terms and also in the permissiveness it allows and consequently the aggressions to morals, values, traditions and culture. These fraction are also those that have a sufficiently strong will to find the right ways to influence local public opinion and the rest of civil societies. Often their lobbying and contact give them the possibility to curb political decision and choice of programmes.

On top of that, we can add poverty alleviation, the fight against inequalities and the concern for the environment and the concern for the repayment of the debts burden.

IV. MAIN OBSTACLES TO INNOVATION:

While all the necessary ingredients were there for an efficient NSI, a close look at the system unveils several problems and shortcomings. They relate to the poor S&T policies and strategies and their low level of priority and to a general institutional weakness and instability resulting from the political game and clear governance problems. Consequently, several obstacles were met by innovative activities and technological accumulation more generally.

4.1. Workers qualifications. While R&D in its classical sense requires more brain trust than physical force, qualifications are much needed in any NSI. Various examples exist in the electronics and the agricultural machinery sectors in Algeria where shortages of adequate competencies in maintenance for example led to considerable idle capacity and bottlenecks, which seriously hampered burgeoning innovative activities. In Tunisia, under-qualified labour force makes it difficult to conceive and design new products. According to API (Agence pour la Promotion des Investissements), the rate of technical supervision is 0.44% i.e. : four times lower than that of advanced countries. In the textile sector, the needs for technical supervisors are on average 1000 agents per year, while current potential does not exceed 65 per year. In the case of Egypt, productivity of imported capital is lower than the expected one by about 50% due to lower labour skills than those of the country of origin of the capital with the consequent waste of resources. A large proportion of the work force in MENA countries is composed of young people and adults who have completed primary education only. Nonetheless, more than 12 million university graduates are presently employed in the Arab labour market in a labour force of 90 million employees. However this effort is still considered to be below what is required to lead to the building of endogenous capacity in S&T.

---

44 Gouia, R. « Les rapports technologiques CEE/MENA: le cas de la Tunisie », GREP/ University of Tunis III, mimeo, 1990, 44 pages  
45 FENATEX : Fédération Nationale du Textile  
While the issue of shortage of manpower is highly debated\textsuperscript{47}, about two-thirds of the working age population do not have training that would qualify them for employment. It appears that a major factor in this respect is the preponderance of employers, in particular those in the informal sector, who prefer labour force without qualification, and in-house trained recruits. A strong tendency is also observed for industrial firms in Morocco to recruit those with little or no education and to spend little, if at all, on research and technology \textsuperscript{48}.

**4.2. Scientific and technical capabilities.** The size of scientific manpower remains below international standards. The ratio of research personnel to local population is amongst the weakest in the world. In the mid-eighties, only six MENA countries had more than 1000 scientists and engineers per million inhabitants\textsuperscript{49}. A great potential of competencies constituted by women researchers is often totally excluded from the R&D for a variety of reasons including cultural ones.

In Tunisia, 26.3\% of the companies with an R&D department in the chemical sector put forward the lack of qualified people in the scientific field and in the specialised managerial field as one of the major obstacles \textsuperscript{50}. In Morocco, a study conducted by the CNCPST (Centre National de Co-ordination et de Planification de la Recherche Scientifique et Technique) in 1995, reveals the existence of about 910 research units and teams within 118 institutions: 90\% of these belong to the public sector (80\% in universities) while 9\% only are semi-public and only 1\% are in the private sector. The total number of FTE (full time equivalent) researchers in 1996, amounted to 19100 in the whole Arab World, 66.3\% of which, were in government R&D units, 31.6\% in universities and only 2.1\% in the private sector i.e. a relatively low ratio of 0.30. The number of FTE researchers in OECD countries amounted to an average of 4.6 per 100 000 for a total R&D personnel average of 9.4\% with disparities: the highest scores being in USA (7) and Japan (10). Other weaknesses include the imbalance in the R&D technical support personnel (2 support staff to 1 FTE researcher compared to 1 to 1 in OECD) and the slow rate of growth of FTE researchers (7.9\%) per year compared to 11.6\% for universities\textsuperscript{51}. Resources are allocated differently from one sector to the other: the largest share is taken by the agriculture sector in the majority of the Arab countries. In 1996, the share of FTE researchers reached 44.2\% in agriculture while industry had only 8.5\%, basic sciences 8\% and engineering 6.3\%. In universities, personnel involved in academic research does not devote more than 10\% of its time to effective research as a result of increased demographic pressure and teaching loads. Beside the weak numbers, published figures show that the bulk are involved in science research while those involved in real technological research represent between 10\% to 20\% in the countries for which statistical figures are available. This is due to a large extent to the fact that 75\% of researchers are in universities and only 15.7\% of S&T personnel are in Engineering and Technology. Paradoxically, the rate of unemployed engineers and scientific manpower in the region is estimated at 30\% \textsuperscript{52}.

**4.3. Failure of the education system:** Both, the shortage of qualified workers and scientific manpower, can be attributed to a large extent to the failures of the education system, both with regards to basic education and basic training and graduate formation. The

\textsuperscript{47} Zahlan, A.B. \textit{ibid}
\textsuperscript{49} Unesco, book of statistics 1986
\textsuperscript{50} SERST 1996
\textsuperscript{51} Quasim, op. cit.
\textsuperscript{52} Zahlan, \textit{ibid.}
weak educational basis which did not provide firm grounds for building adequate competencies, results from obsolete pedagogical methods which do not encourage awareness and creativity, old curricula, the absence of periodicals and the limited involvement of private initiative in education and training. As an illustration, until the beginning of the 1990s, Morocco devoted on average 7.3% of its GNP to education, a rate higher in many of those countries at the same level of development, and yet achieved relatively poor performances notably an enrolment rate of 40% for the 4 to 23 age group: 55% in the primary school age group and 36% in the secondary school age group. The rate of illiteracy remains one of the highest in the world, at almost 50% of the adult population while it reaches 40% in Algeria and 31% in Tunisia.

Vocational training has long been neglected by most MENA countries due to cultural (low status job) or historical reasons (inherited colonial orientation towards civil servants jobs for Maghreb countries). Yet, in many advanced countries and in NICs, it was given a high priority being considered as the basis for building effective and efficient capabilities for on the job training, for improving of skills, and for accumulation of tacit knowledge. As shown in the case of Egypt, paradoxically, the increase in qualifications did not necessarily improve the possibilities for the development of local capabilities. Rather, it enhanced the propensity to emigrate.  

MENA countries have made large efforts over the years to remedy the situation of shortages of scientific capabilities by several actions, the most important one being the reinforcement of training of graduates in the belief that the higher education level is central to skills formation and creativity, both necessary ingredients for innovation. Nonetheless, graduates in natural sciences and technology remained in a minority situation while those in social sciences, arts and humanities represent between 50% and 60% of the total number of graduates of higher education in the Maghreb as a whole. Comparatively, the rate of graduates per thousand in MENA countries is only half of that of Europe, yet the personnel involved in R&D is on average 10 to 20 times less than in Europe. For all countries of the Maghreb, the number of scientists and engineers involved in R&D is less than 400 per million inhabitants. In the same period Europe had 1735. This results partly from the weakness of the training system: Algeria which trains 39 engineers par 100 0000 inhabitants, Morocco 11, and Tunisia 77 whereas Singapore, for example, trains 360 and Mexico and 358. Moreover, most of these scientists and engineers are either in universities or in ministries and public bodies and not in industry or specialised research centres. Other weaknesses include the relatively low moral and material status of researchers and their marginalisation, low degree of stability and inadequate motivation, bad research conditions and the indigent state of universities forcing them to emigrate.

4.4. Nature and intensity of university-industry interactions. Several studies have stressed the gap between the education and the production system in LDCs.

From the industrial point of view, the isolation of university and its limited and non-institutionalised relationship with the domestic industry is often highlighted. Efforts to link the world of learning to the world of work have been generally limited in scope and

53 Abdellatif, L. op. cit.
54 Bouayiour et al., 1998 op. cit.
55 Bouayiour, op. cit.
56 World Bank report 1993
effectiveness.\textsuperscript{58} The history of their relationship has been that of a series of ‘missed opportunities’ in the MENA region as shown by numerous studies\textsuperscript{59}. ‘Market failure’ and the absence of private initiative, often made worse by the abuse of embodied technology and packaged types of contracts, led to local subcontractors and the education system being completely left out. The firm has consequently been “turning its back” on training and acquisition of advanced knowledge (examples can be found in the Egyptian, Algerian and Moroccan chemical sectors). Linkages with foreign firms, mostly by public enterprises, were not properly used resting often on simple buying of equipment and services. Whenever these ties existed, they had limited spillover effects on universities, research centres etc. Often domestic companies played a simple role of sub-contractors and suppliers of low-skill manpower. Consequently, the learning by doing and accumulated experience, particularly through tacit knowledge, were not given the opportunity to be valorised domestically either in the same branch of activity or in other sectors.

\textit{From the research and innovation point of view:} linkages between university research, R&D Centres and Industry are relatively limited and in some cases totally non-existent\textsuperscript{60}. We have seen earlier that these links were in the past largely episodic and more than often non-existent\textsuperscript{61}. As production kept on using imported “ready-to-use” technology, there was almost no drive for innovation. Eighty per cent of R&D activity is performed in universities. Most of it is of an applied nature: clinical and medical sciences, engineering, agriculture and related areas account for some 90\% of output. Only a small proportion of it involves competencies from industry and the business world. For example, in Tunisia, in the chemical sector, 36.8\% only of the innovative companies has some kinds of links with the local university\textsuperscript{62}. Moreover, most R&D institutions function as academic units rather than technology centres \textsuperscript{63}. Research activities in new fields of science and technology such as information sciences, molecular biology, genetics, informatics or mathematics are still on a limited scale. Lack of linkages capable of triggering off innovation exists also within industry both small and big companies: for 78\% of SMEs in Algeria, relationships rested mostly on the exchange of goods and services and informal interactions and not on exchange of technology-based services. The degree of interaction between the activities of public research centres and the R&D of private firms is relatively unknown but is likely to be relatively limited. In Egypt, in the 90’s, universities were allowed to construct their own technological research centres. These centres were thought to support the technological upgrading of the private manufacturing firms, especially that these firms were reluctant to co-operate with the public technology system (affiliated to the Ministry of Industry or to the Ministry of Scientific Research). Also being in universities and being run by faculty’s members, these centres could make the missing link between the technology upgrading system and the education system. Yet achievements on both sides have been far from satisfactory.

This is attributed to several factors:


\textsuperscript{59}see for Maghreb countries for example Djeflat, A. « Input-Output Analysis and the prospects for innovation in LDCs : the case of Algeria » INNOVATIONS n°3, l’Harmattan, Paris, 1996, pp. 111-133

\textsuperscript{50}Alcouffe A. op. cit.

\textsuperscript{61}Djeflat, A. «Technologie et Système Educatif en Algérie», idem.

\textsuperscript{62}SERST, op.cit.

\textsuperscript{63}Ministry of State for Scientific Research & World Bank study, op. cit.
First, there is a lack of a clear vision regarding the role of the university in the promotion of scientific and technological research. Secondly, there are still relatively limited diffusion and valorisation of research mechanisms. Bodies and institutions linking up national research structures to the users of their results such as ANVAR (Agence Nationale de la Valorisation de la Recherche) in France are relatively rare and ineffective whenever they existed. In Tunisia, for example, the School of Engineering produces approximately 500 student projects, of which 100, at least, can be valorised in industry each year. In the event, only 2 or 3 find effectively their way to industry. Thirdly, the lack of communication blocked new products development in certain sectors, notably in the domain of new technologies (e.g., Biotechnology) where intense communication and proximity are crucial for success. The dissemination of information was not up to requirements leading to insufficient exploitation of the existing scientific and technological potential, which is often badly known. Few complete and reliable record of the accumulated experience within industry, university and research centres are kept with lost opportunities for collective learning exchange and internal co-operation, all vital ingredients for innovation. The cautious attitude of some governments with regards to the handling of information for political reasons contributed a great deal to that. At industry level, for example, some real and effective technology accumulation process has occurred in some leading industries in the MENA region: the national oil companies [with 2 MENA countries world class oil producers]; the phosphate industry [with three countries possessing world class phosphate firms]; the national airline companies (in all MENA countries), electricity production parastatals; etc. Yet, with very few exception, very little is known in precise terms about this amount of learning which occurred and existing capabilities, which can potentially benefit to other sectors. Fourthly, professional societies, whose number remains relatively limited by NICs standards, are disconnected from the economy as indicated by the absence of public debates on the major scientific and technological challenges facing key sectors in MENA countries. Fifthly, lack of mutual trust between university and industry constitutes one of the most important obstacles as shown in the case of SMEs in Tunisia, in the case of petrochemical industry in Algeria and in the technological upgrading programs in Egypt. Consequently, there are no positive externalities or diffusion of technology to benefit universities: firms prefer their internal expertise, or clients, suppliers, fairs and exhibitions and publications or even informal sources rather than university services. In Tunisia, this lack of trust is found even within companies where management clearly shows lack of confidence in the ability of engineers to perform R&D and innovation. Sixth, like in most MENA countries, there was a lack of statute for the industrial researcher. The limited use of national R&D capabilities is also the result of their widely perceived inability to respond to market needs and the needs of the economy as a whole. Out of 10 innovative enterprises, only 5 take part to funding research in public laboratories. (2000 to 20000 DT), they provide training grounds for students and reckon that they have very tenuous relationships with public research. Several reasons are put forward, namely its irrelevance and its too theoretical orientation. Finally, rent-seeking behaviour, found at both at university and industry levels, tend to favour foreign research institutions rather than local ones. This is encouraged by the permissive situation of corruption and low ethical values. In so doing both actors have deprived the home

---

65 Zghal, R. (1994) op. cit.
66 AB Zahlan, op. cit.
67 Djeflat A. unesco/cread, op. cit.
68 Abdellatif, L. _ibid._
economy and society of learning opportunities and all what they convey in terms of innovation, job creation and added income and welfare to the community.

4.5. Regulations and bureaucracy. Any kind of innovation, as a collective action, depends on a variety of relations and transactions between various institutions, and within the framework of clearly defined rules and regulations. While these latter exist to various degrees in MENA countries, inherited practices and methods from import-substitution and protected economies have marked the whole fabric of society and the economy. The belief in central decision-making and the control exercised by bureaucrats not publicly accountable is still highly prevalent in many countries. The measures taken often through government legislation are not always implemented in the correct way to the extent that beneficiaries are discouraged and are prevented from benefiting from incentive measures destined to promote innovative activities. Their effect is a major source of transaction costs, negative externalities and loss of initiative. In Algeria, a new process for the fabrication of paper developed by a university laboratory in biochemistry using local plants since 1985 could never reach full industrial scale, in spite of being patented and successfully tested as a result of enormous paper work and bureaucracy with the obvious lost benefits in terms of employment, income and foreign currency earnings. In Tunisia, ten enterprises of the most innovative ones say they do not expect any help from the State to finance their R&D projects. Nine of them put forward the bureaucratic and lengthy procedures as one of the major obstacles. Often the innovative projects need to be implemented rapidly and cannot suffer unnecessary and sometimes deadly delays in the face of tough competition. Similar studies have revealed that in the chemical sector, where R&D and innovation are vital, only 47% are informed of the existence of incentives for the promotion of R&D and only 10% have effectively benefited from them. One of the reasons put forward is the heavy dossier required which provokes certain reluctance amongst investors. For the same reasons, the support of technical Centres (seven in total) set up by Government is not systematically used to conduct an R&D project. Four out of the ten enterprises have used their services while 6 did not feel the need for them. They are all informed of the incentive measures in favour of R&D such as those provided by the Fonds pour la Promotion et la Maîtrise de la Technologie (FOPROMAT) or the Prime d’investissement à la recherche et développement (PIRD), but only one (10%) has effectively benefited from these funds. This bureaucratic attitude can be found even at the level of private concerns and can prevent from implementing innovation projects.

The slow rhythm of economic reforms, under the various Structural Adjustment Programmes (SAP) indicates the stronghold of this resistance and the complexity of dislodging its main actors. Consequently some SMEs capacity to respond coherently and competently is jeopardised. This results in the loss of considerable accumulated know-how through firms compelled to leave the activity and often turn to trading (in place of manufacturing).

4.5. Obstacles to the creation and growth of enterprises. With economic liberalisation and the wave of innovation throughout the world, MENA big public enterprises and SMEs are required to build new competencies in a relatively short time and develop innovative capabilities. Yet, both the creation and the growth of enterprises meet several obstacles.

Creation of enterprises: In the private sector, the creation of enterprises is a relatively «painstaking » task characterised best in French as the «parcours du combattant » to stress the highly complicated and hazardous task. In Algeria, the rate of birth of SMEs has

---

69 Attia et al., op. cit.
70 Affes, H. op. cit.
accelerated since the start of economic reforms and particularly since 1995, it was multiplied by 2.3 in 1995 and 5.3 in 1996. More than 66% of SMEs were created after 1988, which means that measures taken by the government to promote SMEs have had the expected effect to a certain extent. CALPI (Committee to assist the localisation and the promotion of investment) created in 1994 to provide all the necessary support in particular for the acquisition and the preparation of investment projects showed relatively limited performances. In 5 years of activity, CALPI approved 13 000 projects i.e. an average rate of less than 300 projects per year. ANSEJ, specifically designed to help young entrepreneurs and micro-enterprises namely through the Fund for the Promotion of Youth Employment (FNSEJ) using fiscal and non-fiscal incentives performed also relatively poorly. They suffered from important transaction costs, and the incapacity of the various incentives to promote young entrepreneurs. As an illustration, figures from ANSEJ show that at a global level, 95 928 projects received their agreement but only 31 965 received a bank credit, showing that self financing remains relatively high but also that many projects could not put up a proper financial package, hence the lower number of jobs generated. At a local level, figures from two major ANSEJ investment schemes in Oran, the western capital of the Algeria, show that achievements did not exceed 35% on average regarding number of projects and 21% regarding level of employment. The rate of death of SMEs in MENA countries remains relatively high, particularly in the industrial sector, which has a significant impact on the learning and technological accumulation process. In Morocco, the rate of birth of firms was not enough to compensate the number of lost firms.

**Growth of enterprises:** SMEs witnessed a host of difficulties in most MENA countries making their life trajectory and growth pattern rather chaotic. Economic policy and subsequent reforms have concentrated almost exclusively on macro-economic responses while neglecting the conditions for micro-economic responses. SMEs have meanwhile to find alternative means and rely largely on own savings, not only to grow but also to innovate. Their access to formal financial assistance is limited and hampered by a host of obstacles, which we will look at later. State enterprises in the public sector, which could have played a major role in innovation, considering all the State support they have benefited from for well over three decades, did not perform well as a result of a wave of several reorganisation schemes and major restructuring. They remained permanently in a loss situation, low factors productivity and under-utilised capacities. Capacity utilisation is also linked to the extent to which the local environment provides the necessary ingredients for full capacity utilisation and sound managerial and marketing and information processing are applied.

The hierarchical mode of management adopted by the majority of firms in MENA countries leaves very little room for innovation and initiatives. In Tunisia, in the textile sector (weaving and spinning), hidden costs disfunctioning organisations, and little faith in strategic management are reported as the most important factors that contribute to explain weak innovation performances. In Algeria management procedures and methods used by SMEs appear to be well below what technological capacity building and international competition require. Indeed, management is often highly influenced by the ill conceived and badly implemented management techniques, widely practised by the public sector in the protected economy era. On the other hand, competition pressures do not seem to be perceived strong enough to the extent that they bring decision-makers to undertake the necessary changes. The importance of rent-seeking behaviour and the culture of bureaucracy meant that local

---

71 Conseil Économique et Social - Rapport de Conjoncture, Algiers , CNES 2000
73 El Aoufi, N. op. cit.
74 CNES op. cit. p.89
entrepreneurial attitudes were discouraged and strong resistance to change developed. In Tunisia, resistance to technical change of SMEs is found at top management where conservative and risk averting attitudes exclude all kinds of innovation both technical and organisational. At a lower level, technicians and engineers contribute to this resistance by erecting the standards in « dogma ”, which cannot be altered, safeguarding thus their power position in the organisation. At shop-floor level, technical change and innovation are perceived as threats to their jobs or simply making their work more strenuous and dangerous.  

Innovation suffers also from asymmetrical information, whereby, technicians and engineers think they hold too little information (60.3%) to be innovative (regarding market conditions, technical specifications, availability of spares etc.) and wait for initiatives from the top. Asymmetry of information relating to the return on technological investments, acquisition of new equipment or innovation, exists also between capital owners, managers and shareholders. Moreover, SMEs can be ill informed about the market and their technological environment as such, which is not conducive to innovation and technical change. Thus in our sample, 67% of firms perceive their technological environment as stable, i.e.: where technical progress is slow and does not represent any threat to them. Only 25% perceive it as unstable and subject to important changes without prior warning. This proportion of firms is more inclined towards information seeking, product change and market strategy. In a more precise way, only 25% consider that they are adequately informed with regards to innovation in their own field of activity, while 72% consider their level of information very bad and insufficient.

Often the conventional means to obtain some of the knowledge-building skills from the public domain (for instance journals, expired patents, and attendance of trade fairs among others) are not easily accessible. They are often cost incurring and SMEs, largely of the micro-enterprise type, thus are not prepared to invest in this kind of facilities and events. Even those means that are easily accessible now with access to Internet are not easy to absorb.

**Implications in terms of technology accumulation and innovation:** Consequently, MENA companies, and SMEs in particular, find themselves facing up a double challenge: - the first one is to compete against well endowed and far more experienced firms mostly from developed and newly industrialised countries. -The second one is to cope with a weak, fragmented and still immature technological support system. This highly risky task means that their sole way out is to rely heavily on internal capabilities and their learning potential if not to convert their activity from production to tertiary activities or for some of them to export their capital elsewhere, contributing thus to the flight of resources. Internal technology-capability building and innovation meets several obstacles.

Firstly, most of the newly born enterprises prefer to resort to obsolete technologies rather than « risk it » by adopting the latest ones and ‘take refuge’ in the tertiary sector (commerce and distribution), where the level of technology used domestically is relatively low.

Secondly, we know that learning and the process of capability building take time and are highly dependent partly on the enterprise’s previous history. The relatively high rate of death means that firms leave the activity before they had time to acquire experience and the necessary tacit knowledge without « sufficient history ». In Algeria, 35% of SMEs have less than ten years of age. In Tunisia it is estimated that between 10% and 15% of enterprises will cease operating and will be forced to shut down as the free trade zone with the EU is fully implemented. Often, the loss of firms in LDCs means the loss of organised crews of

---

75 Affes, H. *idem*

76 Figures given during a visit in South Africa on February 3rd, 1999 by the Tunisian minister of foreign affairs.
workers and a significant capital and experience gained through “learning by doing” and accumulated tacit knowledge, thus interfering with the process of endogenous technological progress. The more recent wave of laying off massively of personnel due to inherited over-staffing from previous era raises the same issue of the loss of painfully accumulated technological capabilities. The big challenge facing SMEs is therefore building, without previous accumulated experience and history, adequate competencies to innovate and face up relatively tough competition by adopting new technologies.

Thirdly, the innovation function is not perceived as important: 44% consider it as unimportant and only a small proportion see it as very important. When it comes to implementation, the proportion is even lower. This may also be due to the fact that SMEs employ low-level techniques and depend largely on imported technologies.

Fourthly, most of private manufacturing firms are reluctant to make any technological upgrading or to be involved in programs to upgrade the skills of their labour. Those that are aware of the importance of skill and technology upgrading tend to seek experts from abroad as seen earlier as illustrated by the case of Egyptian SMEs. This is also the result of the fact that SMEs and the private sector in general, were never considered as a viable vehicle of technology acquisition and accumulation in some MENA countries. In several countries, equipment and technological services used were supplied by the major public enterprises. For firms that are to face tough competition both internally and externally, it is clear there is a gross under-awareness of what the threats might be. This is again the result of firmly established protectionist culture and limited information.

4.6. Financing of innovation and technological modernisation. The issue of financing of innovation and technological modernisation has both a macro and a micro-economic dimension.

At macro-economic level, R&D initiatives in MENA countries have always suffered from the lack of adequate financing, resulting from both a limited awareness of the importance of innovation and the weakness of domestic savings and chronic budget deficits. In spite of non-negligible efforts made by countries like Algeria, Tunisia, and Morocco in the Maghreb and Egypt, Jordan and Syria in the Mashrek, R&D expenditures as a percentage of GNP remain insufficient when compared to advanced countries or even to NICs. As a percentage of GDP, R&D expenses did not exceed 0.30% for Tunisia (1997), 0.2% for Morocco (1996), 0.3% for Algeria (1997) and for the Mashrek: 0.22% for Egypt (1996), 0.20% for Syria (1997). OECD countries scored 3.05% for Japan (1996), 2.66% for Germany (1996) and 2.25% for France (1997). R&D expenditures per inhabitant, in MENA countries also compare unfavourably with NICs. This is in spite of the fact that economic demand for new and high technology remains relatively important as shown by the deficit in the technological balance of payments (TBP) which deteriorated from -877 million DT in 1991 to -128 million DT in 1994. All indicators show that MENA Countries invested more funds in higher education (1.3% of GDP) than in R&D, whereas industrialised countries invested 1% to 1.5% of GDP to higher education while investing 2% to 3% to R&D systems in the 90s. There are disparities between the various countries of the region: four countries concentrate 75% of total Arab R&D expenditure in 1996.

Moreover, whenever budgets are allocated to R&D activities, a great proportion of local funds are allocated to wages and salaries of the research institution’s personnel. In

---

77 Abdellatif, L. ibidem
78 SERST (1996)
79 SERST report 1996.
80 Quasim, S. ibidem
Morocco, 95% of the budget goes towards wages. In Egypt for instance, on top of limited financial resources devoted to research for science and technology, 95% are coming from the government with little involvement of the private sector. This is also the dominant trend in the rest of MENA region as a whole. In 1996, the government share of R&D funding amounted to 100% in 7 states, ranged from 67% to 97% of total R&D financing in 11 states. On average, 89% of funds come from government, 8% from abroad and only 3% from industry. Public funding remains thus relatively high compared to South Korea and Japan where it did not exceed 20% to 25%. This is the result of the previous era of government-controlled economies and the exclusion of the private sector. The issue of R&D financing renewed importance in many MENA countries results from several factors, namely the State withdrawal from a certain number of sectors following privatisation, from the devaluation of local currencies and the growing need for external funding to support research (60% of total budget), in the face of competing and more urgent demands. There is also perhaps the fact that private capital shows more readiness for technology transfer than before.

At the enterprise level, the efforts made in the area of R&D remain relatively weak: 10% only of total R&D funds are from enterprises budget. Nonetheless, the trends show that private funding has been growing at a higher rate than public funding. In Tunisia, the share of enterprise funding of R&D went from 6.7% of total funding in 1994 to 10.3% in 1998. This compares unfavourably with OCDE countries such as Japan (72.7%), Belgium (70.4%), Germany (60.5%) or even Turkey (27.6%) and Portugal (27%) Similarly costs of setting up R&D units are found too high: this is the case of 47.4% of the firms in the chemical sector in Tunisia. One of the major impediments is the shy attitude towards the risk factor: 42% see the uncertainty related to the results of R&D and 21.1% the risks involved as major obstacles. This is an indication of the relatively low-risk taking attitude of the private sector and consequently an important deficit in terms of the ‘culture of risk’ linked itself to the so-called crisis of entrepreneurship in the MENA region. As an illustration, the attitudes adopted by SMEs in Tunisia to face up the risks involved are of three types: through getting alliances and partnership with other firms (52.6%) through finding internal solutions (10.6%) and through resorting to university services (36.8%). The lack of capital risk or venture capital constitutes therefore a major handicap in the short and the medium term. There are tens of examples where good innovative products never reached the market as the banking system was not prepared to fund R&D. Resorting to foreign financing would be facilitated by domestic financial reforms, covering organisation and management of financial projects; as illustrated by studies of cases from Morocco and Tunisia and Algerian SMEs.

4.7. Quality of technological services. Technology support systems in each country did not seem to have played the required role as an effective back up to innovation policy, as a result not only of limited availability of technological services but also their poor quality and low competitiveness. Most technological services are imported by industry and professional services imported by MENA countries are equal to or larger than imports of capital goods and yet most of these professional services could have been provided domestically. No single

---

81 Ministry of State of Scientific Research & World Bank, op. cit.
82 Quasem, S. *ibidem*
83 Lahzami, Ch. « Place et conditions de l’innovation technologique dans les pays du Maghreb à l’horizon du XXIe siècle » the 3rd International Conference Maghtech’98, Sfax (Tunisia), April 1998.
84 SERST report 1996
85 SERST 1996
86 SERST 1996, *ibidem*
87 Djeflat, A. & Ait-Habouche, A. « Innovation and the Algerian SMEs » op. cit.
MENA country (except for the GCC countries) possesses the necessary financial resources to sustain unrestricted imports of professional services and spare parts to operate optimally installed capital goods. As a result, SMEs appear more vulnerable to competition likely to intensify gradually until 2010, when the Free Trade Zone agreement with the European Union becomes fully operational. These services include Engineering, R&D services, maintenance, marketing etc. and depend not merely on a single firm at the downstream end of the chain of production, but also on all subcontractor firms upstream.

Engineering services: Apart from building construction and civil works, where the proportion of domestically supplied services, appear to be significant, the rest of the sectors relies heavily on engineering services supplied by foreign firms. Other services such as those likely to enhance engineering, design, quality improvements and standardisation are also missing. In Tunisia engineering represented an average of 15% of total costs of industrial projects (65% related to the equipment, 15% to construction and the rest for installation, licensing etc.) 88. With only 880 man/year (300 engineers and 580 technicians), the local supply of engineering does not exceed 20% of local needs. In 1991, Tunisia suffered a deficit of 2920 man/year i.e.: about 4867 specialists in engineering. Several obstacles hampered the development of engineering. Lack of organisation of the sector, limited financial tools designed to cater for the specific needs of the activity, heavy taxation, lack of guarantees and lack of incentives are the most important problems reported.

R&D support services: which include a whole range of services, from documentation centres to institutions to valorise research results, have received little attention on the part of policy-makers in MENA countries in the past. As seen earlier, the R&D institutional framework (laboratories, sub-contractors etc.) is below requirements. In Algeria, technological support services are still weak and below standards. SMEs resort sometimes to the experience of big public enterprises to test and control the quality of their products, notably enterprises in the oil-processing sector where some significant experience has been accumulated. In recent times, Government has undertaken the creation of specialised research laboratories in all fields of technology through important investments. These are however still too young to be able to respond adequately to the needs of the users.

The limited availability of domestic technical assistance in such skills as procurement and inventory handling, marketing and market studies, etc. had on several occasions hampered innovative projects. We have looked at this quite at length in the hydrocarbons sector in the past 88. With the event of the ISO standards, it has become a main concern of SMEs to reach ISO standards: 72% seem to have integrated some quality control or standardisation procedures, but we do not know to what extent. Only 28% do not seem to have any kind of concern. More and more, this concern for quality standards is the object of wider interest. As shown in the case of Tunisia 89, Tun’cert the official certification body registered 64 ISO 9000 between 1998 and 2001 in all areas of manufacturing which gave non negligible advantage to local firms on the international markets. Trade marks are becoming a common practice showing that the perceived threat from foreign and local competition has become of real concern: 69% of SMEs in Algeria seem to have resorted to trade marks in recent years, and this is relatively new in the local environment. Market study services, remain however relatively weak (26% of SMEs), showing a low concern for this type of services as well as the weakness of these services locally (limited experience,

---

88 Mhedhebi, Ch. « Statistiques Financières Rapports annuels » Banque Centrale de Tunisie, December 1991 pp.45-55
low capacity and quality of internal facilities, insufficient external infrastructure, poor incentive system etc.).

4.8. Intellectual property protection. Property protection rights and institutions are highly underdeveloped within the MENA region. While being looked at unfavourably in some MENA countries, property rights protection constitutes, nonetheless, a significant incentive for foreign investors in general, and TNCs in particular, to transfer technology and generate maximum spill-over effects. The Marrakech agreement in 1995, and TRIP (trade related intellectual property rights) in particular, raised more stringent protection barriers in the face of imitation and the spreading of counterfeit that represents nearly 6% of the world market and a loss estimated at 100 billion US dollars per year. As the provisions of this agreement are implemented, it is believed that higher level and better quality technology is transferred to LDCs and their chances to have access to new and more advanced technology are higher. This position, originally opposed by many, is now more broadly endorsed in MENA countries that realise that they still rely heavily upon TNCs to have access to new and advanced technology$^{91}$.

A *patent protection index* (PPI) can be a good indicator of the chances that FDI is attracted to the country even if its implementation remains relatively difficult. Trade appears also to be closely linked to the level of protection of property rights. Maskus & Penubarti$^{92}$ put forward an IPRI (*intellectual property rights index*) based on the US Chamber of Commerce standards ranging between 0 and 5: an IPRI equal to zero means that there is no Property rights protection while 5 means that the country fulfils the minimum protection standards. The IPRI takes on an ever-growing importance for sensitive sectors (electronics, space and new information technology). While MENA countries do not rate badly, countries such as Morocco (4) and Tunisia (3) are pinpointed as potential centres of counterfeit. High uncertainty is felt in the case of Algeria (3). In comparative terms, Israel is rated 5, Spain 4 and Portugal 4. $^{93}$ These figures of 1984 have slightly changed with the efforts made recently by MENA countries to make their Investment codes most attractive, bearing in mind that this the sole significant criterion. *The IPR Law index* which indicates the strength of law in defending intellectual property locally shows important differences in the MENA region: Morocco scores the highest 8/10 while Egypt and Jordan have medium scores respectively 4 and 5. The worst positions are those of Lebanon (2) Algeria (1) and Tunisia (1).

4.9. Language and Technological culture issues. Cultural impact on technological change and innovation has often been overlooked or given low consideration. At best, it was looked at as a temporary problem of adaptation by the local operatives and users, soon to be overcome. Yet looking at it closely, it is a great deal more fundamental and complex issue. Culture, as we have seen earlier, can be a non-negligible source of creativity and innovation. Ndione (1992), Deleener, Perier, Ndiaye et Jacolin (1994) recognise that cultural specificities in the informal sector have constituted a valuable pool of ways and means for the local population to survive in difficult situations. The rapport to technology of operatives, their representations, their motivations and the values they hold can constitute real assets (Deland 1986). Various components seem to come into play: psychological, cultural, social, and philosophical added to local economic conditions. The cultural factor could be used as a guide, a source of information, a set of psychological and relational assets to be mobilised.

$^{93}$ Maskus-Penubarti and Rapp-Rozek (1984) , op. cit.
Finally, it could be a set of material supports through traditional, and endogenous techniques and know-how sometimes to build upon to engineer new products and processes (Lundvall, 1991). Culture can thus be a mine of creativity and support the idea of bottom up growth. Consequently, a clear idea of the local cultural specificities and their assessment could constitute a first step to harness this potential of culture-based innovative processes. From an economic point of view, culture could be beyond simply a tool of adjusting and adapting an economic offer to a demand to target a market segment. Traditions can constitute specific technological packages and innovative ventures. This positive view of culture has been rarely emphasised by policy-makers. When this issue is raised, it is often in official declarations and documents and remains purely intentional and theoretical. It is more linked to the restoration of ‘identity and culture’ and very seldom preoccupied with its economic significance and more precisely it relationship to knowledge, science, creativity and innovation. In this kind of vacuum, most cultural factors appeared mostly as obstacles and impediment to modernisation and access to advanced S&T. Important issues of culture relate to the language used, to the role and importance of traditions, values and religion, to the impact of oral culture and finally to inherited practices from colonial times notably for Maghreb countries.

Language issue: Communication in the field of S&T remains difficult in the poorly managed arabisation of teaching and administrative life of these countries. Scientific and technical elite in MENA countries has had access to other languages than the native language, with French taking a prime position in the Maghreb and English in the other countries, leading to a ‘two speed society’

Failure to decide on the principal language of instruction for training and apprenticeship, especially in the scientific disciplines, in some countries has made the education system weak and incoherent. The educational process has become a ‘bilingual mishmash’ with its products failing to gain proficiency in scientific and technological disciplines, or mastery of Arabic. On top of the colonial legacy that we need not go into in depth, the failure to properly rehabilitate the local language as an important vehicle for S&T by successive policies contributed a great deal to this situation. The use of the Arabic language as a strong vehicle for rooting S&T deep into society and promoting innovation are relatively rare from policy documents and programmes. East Asian countries, and particularly Japan, put the issue of the national language as one of their priorities. This of course raises a more fundamental issue of whether the Arabic language has sufficiently evolved to be an adequate vehicle for modern and advanced S&T and an efficient tool for innovation.

Local traditions and values are also considered by many analysts, as obstacles to S&T accumulation and innovation in the absence of policy orientation. Taking up the issue in the early eighties, the conference CASTARAB pointed out to the fact that the education and training system played a fundamental role in these negative attitudes. Instead of training people who are rooted in their environment and imbued with all the values of their community, the school functioned in the MENA region and particularly in the Maghreb, as a separate entity creating, in the heart of society, an isolated minority of ‘modern intellectuals’ incapable of understanding the needs of their society, the worth of its accumulated knowledge and the value of its well mastered domestic techniques. Yet this endogenous know-how is worth mobilising as an innovative tool. Several constraints are reported in the textile sector in Tunisia that prevented the usage of local traditions and values to innovation and technical change, while other examples show they were successfully used in the food sector. It is easy to find numerous examples in all MENA countries. Religion, when not

---

properly explored and studied, can also be seen as an obstacle to innovation: very few studies are made on the way the sacred book, the Holy Coran, and its precepts can be misinterpreted to constitute an obstacle to innovation.\textsuperscript{95} and how it can promote science, technology and innovation.

Oral culture (« oralité » in French), which is predominant in the MENA region, appears to be antagonistic with codification, reporting, storing and diffusion of knowledge on a large scale. It does not encourage sustainability inasmuch as diffusion rests on simply the awareness of the need to register one’s experience\textsuperscript{96}. These practices still prevail in administration and industry and produce large ‘spaces of informalities’ in the formal sector. It is easy to understand therefore the difficulty to diffuse know-how and skills and to accumulate experience and valorise it. This is on top of the risks involved when personnel are laid off or simply leave the institution for a variety of reasons. The denial of the innovation function for women or access of women to modern S&T know-how in some countries, partly due to the famous « patriarchal gender contract » and which sets predetermined functions and role in society to individuals according to their sex.

The attraction of civil service and administrative positions and repulsion for manual jobs, the proliferation of engineers “with clean hands” in administrative positions, the marked orientation towards the accumulation of knowledge rather than on development of creativity and the persistent prejudice against vocational training are cultural traits that prevented the rooting of the scientific culture in society and the culture of innovation. With the exception of a small elite, for the majority, a real ‘psychological barriers’ prevent the initiators, inventors and project holders as well as decision-makers from putting their ideas into effects.

This rather bleak picture must not deny however some important factors that could constitute good grounds for rapidly rooting innovation and creativity in the framework of knowledge economy. The most important amongst these are the relatively high proportion of youth with more malleable attitudes, the strong attraction by what may be termed « modernity », and the relative proximity, both geographically and culturally of Europe and the Mediterranean space. The ICT revolution and the rapidly spreading of Internet of course largely facilitate all this.

\textsuperscript{95} Refer to the controversy raised by the word innovation which can be interpreted as « bidâa » and which is frowned upon and « İbdâa » which is on the contrary respectuous and encouraged. It is obvious that those interpreting it as bidâa, are not very keen on innovation and might even raise against it.

\textsuperscript{96} El Kenz, A. « L’Algérie et la modernité » Karthalla-Codesria, Paris 1985, 300pages
V. ROLE OF GOVERNMENTS AND OF THE PUBLIC SECTOR.
While most MENA countries stress the need for innovation and technological progress, not all of them are clear as to what strategies they should adopt to promote innovation and enter the knowledge economy era and to acquire a significant competitive edge. The situation is however different from one country to another. For latecomers like MENA Countries, the experience of NICs, where governments played a key role, appears to be more relevant to their present-day situation than earlier industrialisation in Western Europe. The risks of state interventionism are weighed against the dangers of passivity, given the established fact of market failure in the area of technology capability building and innovation dynamics. While the role of government appears paramount, it is also realized that public-private collaboration remains an important pre-requisite for latecomers to compete in the new technology-based competitive markets. Government role is reflected through mobilisation of innovative potential and the encouragement of new initiatives in S&T capacity building amongst others things.

5.1. Mobilisation. Mobilisation is taking several aspects and following several paths. The first domain is to absorb the institutional deficit MENA countries have accumulated, compared to successful countries such as the NICs. The second one closely linked is a proper regulatory framework, the one inherited from closed economies and import-substitution era being largely obsolete. The third way is the design of a proper incentive system, the existing one having largely failed to trigger on industrial innovation. Several means are mobilised in this respect: besides introducing the innovation issues into formal policy and strategies, making them top priorities, mobilisation is through the elaboration of plans and programmes to build endogenous S&T capabilities and innovation, through sufficient integration of market mechanisms and private initiative, and finally, through the upgrading of their facilities and taking several new initiatives namely in the fear of the impact of greater «digital divide ». The specific situations of some countries may, of course, require other solutions and other devices to be mobilised.

5.2. Measures taken. They include new institutions and bodies, regulatory framework, strategic planning, setting priorities, mobilising human resources, clear budget allocation, and new incentive schemes.

New institutions and bodies: Various bodies were initiated in MENA countries: they include new purpose-made institutions, R&D co-ordinating institutions, and ministries or Ministerial delegates. Most have built S&T policy and some strategies for investment in S&T capacity building. In Algeria, a Ministère délégué à la Recherche Scientifique et Technologique (MDRST) is appointed in 1998. Orientation and co-ordinating bodies include: the CNRST (Conseil National de la Recherche Scientifique) and Inter-sectoral Commissions and sectoral Committees. Several institutions at the operational level are established: the DCR (Research Co-ordination Directorate), the ANDRS (National Agency for Health Research Development) the ANDS (Health Documentation National Agency), and the ANDRU (Agence Nationale pour le Développement de la Recherche Universitaire). In Tunisia, SERST (Secrétariat D’Etat auprès du Premier Ministre chargé de la Recherche Scientifique et Technologique) born in 1998, is in charge of elaborating an S&T policy and plan, while (CNMT) the Commission Nationale pour la Maîtrise de la Technologie and (DMT) the Direction de la Maîtrise de la Technologie et des Mutations Industrielles are in charge of capacity building and innovation policy implementation. Two new institutions complete this institutional set-up: the Institut National de la Normalisation et de la Propriété Industrielle (INNORPI) and the Institut National de la Recherche Scientifique et Technique (INRST) geared towards the upgrading of Tunisian industry and the A.P.I (Agence de
Promotion des Investissements). To provide the necessary technical support and services, several centres were set up: specialised laboratories, a national body for the evaluation of research projects and which provides grants destined to be invested in R&D and directed towards enterprises and various centres namely the Centre Technique des Industries Mécaniques et Electriques (CETIME) (mechanical and electrical industry), the Centre Technique des Matériaux de Construction (CTMECCV) (building materials), the Centre National du Cuir et de la Chaussure (CNCC) (leather and shoes) and finally the Centre Technique du Textile (C.E.T.TEX). These technical centres constitute good indicators of the priority sectors that the country is emphasising. From a financial point of view, several other support institutions were built namely the fund for the promotion of S&T research: F.O.N.A.P.R.A. (agriculture), le F.O.P.R.O.D.I (industry) et F.O.P.R.O.D.E.X (exports). One of their main tasks is to establish links with the users of research results. They could not however perform adequately unlike the French ANVAR, for example, which proved extremely successful in linking up R&D to market needs. A similar institutional architecture can be found in Egypt, Morocco and Jordan.

Regulatory framework: Most MENA countries have promulgated a specific law for the development of science and technology. In Tunisia, new laws were promulgated in the nineties: three of these appear to be directly linked to R&D: the decree n°94-536 of 10 March 1994, the new law of orientation of scientific research and technological development n°96-6 of 31 January 1996 and the Decree n° 99-11 of 4 January 1999. While all this legislation does not explicitly put forward the setting up of an NSI, programmes and actions put forward go implicitly in that direction. According to the 1994 decree, universities are allowed to contract directly with local or foreign institutions for the purpose of undertaking studies, research, consultancy work as well as seminars, training sessions or colloquia, the costs of the services being fixed jointly by the two parties. Parts of the revenues are given to the academic personnel involved (up to 30%). In Algeria, the law promulgated in August 1998 constitutes a real turning point, considering the detailed planning of SRTD (Scientific Research and Technological Development) it sets. It is geared specifically towards enhancing firms’ capability to innovate, including both big public enterprises and private SMEs. The presidential decree status given to the text gives it a greater enforcement power. Thus S&T research is set a national priority activity (art 2) and their aim is the economic, social, cultural and scientific and technological development of the country (art. 3). The novelty in this law is the role given to the private sector as an important actor of the development of S&T, even though, in terms of budget, the state keeps its central position. A new investment code was promulgated in 1993 to give potential investors the best possible conditions for their investment. In Egypt, three Presidential decrees for the restructuring of the scientific research sector were issued in 1998. They include specifying the responsibilities of the Minister of State for Scientific Research, restructuring of the Supreme Council for Research Centres and Institutes. The existence of strong patents, trademarks and copyright protection system as well as the prompt enforcement of the relevant law is believed to improve Egypt’s access to the best available foreign technology and encourage innovation within the country through the attraction of FDI and joint ventures. On top of that, several facilitating measures destined to the private sector, both domestic and foreign, are taken, to make it easier for them to cope with the various administrative procedures. They include:

---

97 To date about 17 private enterprises have benefited from these grants.  
98 Decree, n°94-546 of 26 February 1994  
99 30% of the proceeds are given to the researchers involved.  
100 Law n° 98-11 of 22 August 1998: called ‘law of orientation and Programmes dealing with the five year plan for the development of scientific research and technological development (Loi d’Orientation et de Programme à Projection Quinquennale sur la Recherche Scientifique et le Développement technologique) 1998-2002
training programmes, free counselling and expertise, accompanying measures, provision of sub-contracting opportunities at both national and international levels and public-private partnerships.

Strategic planning for S&T capacity building has made a non-negligible progress in recent years compared to previous decades in most MENA countries. Research and Technology Development (RTD) plans exist in the great majority of them. In Algeria, a five-year SRTD (scientific research and technological development) plan (1998-2002) is drawn giving details of the national SRTD policy. National research programmes involving no less than 30 sectors are set up. As a result of the 1998 law and the orientations of the five year SRTD programme, the Ministry of Higher Education and Research launched 19 National Research Programmes (PNR) in 1999: agriculture and food, water resources, environment, valorisation of raw materials, basic sciences, renewable energies, information technologies and computing, biotechnology, space technologies and their implementation, health, telecommunications, hydrocarbons, regional planning, education and training, national languages, economy history, archaeology and populations and society. The PNR involves no less than 30 sectors. The multi-disciplinary teams are favoured in theses programmes. In Tunisia, a clearer national policy for the development of S&T research with the objectives of technological mastery, research promotion and the strengthening of applied research in priority areas is made explicit. The ninth development plan includes an important ingredient: a clearer and more explicit multi-stage policy to integrate S&T into economic policy in order to increase competitiveness of Tunisian enterprises and the strengthening of the links between university and enterprises. The RTD (Recherche et Developpement Technologique) plan linked to this plan includes several measures regarding future programmes of S&T and research policy development. Other ingredients include subsidies for R&D given to enterprises in the fields of industry agriculture and fishing. In Morocco, a new Five Year plan (1999-2003) made by the State Secretary in charge of Scientific Research includes major policy options for S&T development. In Egypt, several recent programs are put up to solve the problem of incomplete and ineffective national innovation system. One of them is under the supervision of the Private Sector Development Program (PSDP 2001). The program tries to address the technology and knowledge problems on a group or cluster basis.

Setting priorities in the field of S&T policy implementation: One of the outstanding features of past policies and practices in the field of S&T is the lack of clear perception of priority areas. Recent measures are geared towards overcoming this weakness. Most MENA countries have set up priorities that include usually: in the first position industrial competitiveness, socio-economic development and human resources and Environmental protection and management and standard of living in a second position. In terms of specific priorities, all MENA countries have identified the need to upgrade the technological level of their enterprises to bring them to international standards and particularly to the European level in those already in the free trade zones with EU agreement. The approaches differ nonetheless from one country to the other. While Algeria for example put the emphasis on the development of techniques to fight environmental hazards, Morocco emphasises the introduction of clean technologies (technology transfer) and Tunisia gives it an institutional dimension by proposing “the creation of a national

103 IMP is joint program between the Government of Egypt (Ministry of Industry) and the European Union. It is expected to begin its work during the year 2001.
104 ITPS report op. cit. p. 7
Mobilising existing human potential: the issue of human resources for research activities, largely neglected in the past, appears now to be a central preoccupation of policymakers, showing a major change in perceptions and attitudes. The use of foreign technical assistance is not as systematically as in the past. A new approach is adopted to mobilise and reinforce the S&T potential. This is done through the ‘Centres of excellence’ policy planned in several MENA countries notably in the Maghreb: 10 in Morocco, 6 in Algeria and 5 in Tunisia specialising in various fields: advanced technology, energy, environment and water, social sciences, agriculture and life sciences. They mobilise a non-negligible potential of researchers. While discrepancies exist between information sources regarding the number of researchers mobilised, their trend appears increasing in all MENA countries. Algeria indicates the figures of 3870 part-time and 1915 full-time including those in centres of excellence. Tunisia appears to have 6000 academics doing part-time research. In Morocco, there are about 10862 part-time researchers employed in universities, training institutes and high schools, while 2538 doctors and engineers are involved in research activities in public or private institutions. The number of R&D projects rose from 2229 in 1994 to 1700 projects in 1997. On top of these centres, private concerns are proliferating in the field of consulting and engineering in the face of growing demand. In Tunisia, it is estimated at 47 million DT worth of business (1997 data). Two thousand specialists are employed, among whom 900 are licensed engineers technicians. In the nineties, 9534 people were employed in 126 research institutions 19 of which were research centres: 60% came from the Ministry of Higher Education. In Algeria the human resources needed to implement the national SRTD programme (1998-2002) are quite considerable: the total number of researchers is expected to grow at an average rate of 150% in the period to reach a total of 15,915 by the year 2002. This figure includes both part-time and full-time researchers. A considerable effort is thus needed in a relatively short period showing the ambitious character of the plan and the desire of policymakers to rapidly close the gap. However, the most important effort is expected to be made with regards to part-time researchers whose number is expected to be multiplied by 3 in the same period, largely drawn universities. Closer links and strong partnership will need therefore to be established between industry, universities and research laboratories. Personnel is also mobilized within industry both from the private and the public sector. Finally, the novelty is the participation of national competencies living abroad and whose number and capabilities are relatively high. In terms of priorities, the sectors which need more than 1000 researchers are: agriculture & food, Energy & mines, Social sciences & communication, fundamental sciences, Energy & nuclear technology. New incentives in terms salaries, grants, publication, protection of research results are worked out. This emphasis on human resources appears to exist in most MENA countries.

Clear budget allocation for R&D and their increase. Clearer budget seem to be more and more allocated to R&D even if important disparities exist between MENA countries in terms of resources devoted to priority areas. Figures for Algeria show that particular effort is being made to reinforce R&D in priority areas and that the rate of growth of allocated funds can be quite substantial. 0.7% of GDP were devoted to R&D in 2001
out of the 1% targeted for 2002 for SRTD in order to foster firm-level innovation and university-enterprise links. A national SRTD budget is voted each year by the parliament. However, it is not the sole source of funds: contributions are expected from public and private institutions, research contracts and external funding from international funding agencies and co-operation.\textsuperscript{110} In Tunisia, the financing of R&D practically doubled in the 1992-1998 period going from 33 253 DT (Tunisian Dinars) to 65 619 DT. In 1998, public funds share reached 88%, funds from foreign institutions representing only 3.9%.\textsuperscript{111} An important jump is expected from the 8\textsuperscript{th} development plan to the 9\textsuperscript{th} plan from 42 million DT to 151 million DT, an increase of 300\%.\textsuperscript{112} 44% of these funds will be allocated to the establishment belonging to the Secrétariat d’Etat à la Recherche Scientifique et à la Technologie. Like most MENA Countries, Tunisia is aiming at reaching the 1% of GDP. Egypt has upgraded its effort from 0.2% to now 0.6% of GDP and is also aiming at 1% of GDP.\textsuperscript{113}

\textit{New incentive schemes for the promotion of innovation:} Most MENA Governments are putting up incentive schemes to promote innovation and R&D activities. Much of this appears to be done on the basis of the experience of other countries, without much consideration given to the specific conditions of the country. Yet studies have shown that for example R&D taxation concession initiatives appear to be most effective where two basic conditions apply: (1) the concession is targeted towards specific R&D development and sectoral objectives; and (2) the R&D incentive is situated within a consistent package of other incentives that address the role of R&D in the particular national development and innovation context.\textsuperscript{114} In Algeria, the new institutional set up is supposed to give support in the legal, informational, financial, and logistical and land occupation fields. This support includes various tax exemptions, reduction of custom duties for imported equipment, tax reduction of tax for re-invested profits etc. In Tunisia, new incentive schemes\textsuperscript{115} include the PIRD (Prime pour les Investissements en R&D) which is a grant given by government to promote and encourage R&D and the exemption of R&D investments from custom duties and value added taxes notably on imported equipment and those produced locally. The new law of July 2000 bring in more incentives in the field of patenting by giving the possibility for an employee to valorise himself his invention. Several MENA countries prizes and awards were designed as incentives to promote innovation and creativity and most of all implant the innovation spirit. In Algeria, the President prize for Arab Medicine. In Jordan, the El Hassan Bin Tallal Award for Scientific Excellence (1995), the Hisham Hijjawi Prize for Applied Sciences (1991) and the Abdul Hameed Shoman Prize for Young Arab Researchers. In the case of Egypt, The Academy of Scientific Research and Technology (ASRT) give several prizes and awards.

\textbf{5.3. New initiatives.} As mentioned earlier, recent changes in attitude both at the level of policy-makers, political rulers and the scientific and economic communities has set the ground for new initiatives to develop in order to build capacity for S&T, strengthen R&D and Innovation and prepare the grounds for the knowledge economy and the knowledge society. This is also the result of recent experiences, in both the developed and developing countries,

\textsuperscript{110} Hardy, P. & Bontoux, L. op. cit. p. 11
\textsuperscript{111} SERST, 1996.
\textsuperscript{112} La Presse 22 October 1998, p.7 and Ch. Lahzami op. cit. p. 12
\textsuperscript{113} Yousri, M. « Initiatives undertaken to promote dissemination implementation and development of Science and Technology in Egypt: case-study » E/ESCWA/TECH/2000/WG.19, 2000 9 pages
\textsuperscript{114} Garrett-Jones op. cit
\textsuperscript{115} Notably the investment code (1993), the decree of March 1994, the new law of orientation of 1996 and the decree of 1999.
which clearly indicate that achieving sustainable objectives in technological capacity building in today's knowledge-based global economy requires New Science and Technology Initiatives (NSTI) and fresh means for their implementation. While definition problems have risen regarding the diversity of initiatives and their meaning, the action taken in this respect have come to encapsulate more and more «property based initiatives» and include technology incubators, technology cities, corridors and parks, clusters, IT super-highways and 'virtual parks'. We shall examine in this section mostly property-based initiative and look briefly at some of the others.

5.3.1. Property-based initiatives. While Property-based NSTIs within MENA countries appears to be rather limited and still in their early stage. Governments initiate most of them; while a limited number are being implemented with the full support of private initiatives. They take a variety of forms and are closely linked to the dynamism of the national development path of the country and its S&T policy and are therefore strongly context-specific (World Bank 1993)\(^\text{117}\). Property-based NSTIs include usually: technology incubators, parks, cities, corridors, IT super-highways, etc.

_Technology poles and technology parks:_ Algeria was one of the first countries of the MENA region to have opted for industrial poles policy in the late sixties. However they played a relatively limited role in terms of technology diffusion. Currently, Algeria has opted for technology parks; the Sidi Abdellah technological park near Algiers, which was opened in June 2002, is amongst the first ones. Tunisia is striving to create ‘technopoles’ to attract under the status of free zones, high technology investments. The major technology poles are set up around the capital city: physics, chemistry and nuclear technology at Sidi Thabet, a scientific and technological research park in Borj Cedria, and a computer science in Raoued park, in the field of telecommunications, closely linked to training institutions, to cater for innovative start-ups and where half a dozen of enterprises are already active.

In Morocco, the CNR (National Research Council) under the Ministry of Higher Education, Training and Scientific Research has initiated 5 research poles\(^\text{118}\). These poles group all institutions with similar research fields and interests and are supposed to orient research towards common themes, optimise the means, create synergy amongst researchers and promote partnerships between research institutions and national development sectors. The five poles are: the Réseau National des Sciences et Techniques de la Mer (REMER) in charge of Sea Research located at the Faculty of Science of El Djadida and which involves 9 institutes, the pole of competencies in charge of quality (PCQ) involving 11 institutes located at the High School of Technology of Casablanca, the pole of competencies in charge of Biotechnology (PCB) located at the Faculty of Science of Ain Chok in Casablanca, the Network of Universities of Space science and technologies (RUSTE) located at the Ecole Mohammedia des Ingénieurs (EMI) in Rabat involving 4 institutes, and the Network of Universities of Physics and High Energies (RUPHE) located at the Faculty of Sciences of Rabat. There is also the Technopole of Bouznika in the ICTs sector as part of the e-Morocco strategy and National Action Plan. The objective is to reach the level of NICs by 2005 and enter Knowledge Society through the training of 5000 middle et top cadres and the recycling of 10000 bachelors in sciences in ICT sectors. Other public-private initiatives include the Casablanca technopark, launched by the ONA Group and run by the Moroccan Information Technopark, designed as a pole of concentration of competencies and a tool to valorise research results. Other projects currently being envisaged at the Ministry of Higher

\(^{116}\) Garrett-Jone, _ibid_

\(^{117}\) See for example Garrett-Jones _ibidem:_

\(^{118}\) CNCPRST, _op. cit._ p. 4
Education include the creation of an innovation park for SMEs and big enterprises that are particularly known for their innovative dynamism.

**Science Parks or technology parks and Technology valleys.** New initiatives for the creation of science parks and technology valleys were taken recently in Egypt and in Jordan. In Egypt these initiatives include: the Mubarak City for Scientific Research and Technological Applications, the new Egyptian Technological university, the Eastern Suez Technology Valley, the Northern Coast Technology Valley and the « Pyramid Smart Village » project in the fields of communication and information. In Jordan, major initiatives appear to be the result of co-operation agreements with various foreign partners namely from the business world. These initiatives include the Hashemite University Industry and Technology Park, the Jordan University for Science and Technology (JUST) CyberCity, the Irbid Park that houses more than fifty factories and employs about 1100 people.

**Incubators:** as adequate spaces for young and dynamic entrepreneurs appear to attract a great deal of attention on the part of policy-makers in the MENA region. The success registered by ‘early adopters’ of South East Asia (Korea, Malaysia, Singapore etc.) contributes a great deal to that. NSTI have had a significant impact in the Philippines. The ingredients appear to include a well thought out policy framework, sound implementation program, the provision of adequate infrastructure, appropriate skills, management services, and monitoring devices. The Singapore Science Park launched in 1982 started as a location for state of the art R&D, it now the home to more than 2000 multinational corporations and local companies and research institutes. It involves more than 7000 researchers engineers, scientists and support staff. The largest group of companies are in the fields of information technology, followed by electronics. Regarding employees, 52% have a basic degree, 16% have masters and 12% PhDs. The ingredients of success include in this case: a champion to attract and assemble high-tech talents, strong collaborative ties between universities and local industries, a regional network-based industrial system that promote collective learning, venture capital, tolerance of failure, culture of competition and cluster effect. In Tunisia, incubators exist around the city of Sfax and five others are in the process of being set up e.g.: the Nabeul ICT incubator. In Egypt, a full program was adopted known as the Egypt Incubator Program (EIP) designed to foster an entrepreneur supportive environment was launched in 1995. It includes the business incubator at Monsoura and the technology incubator at Helwan. Nine other locations were selected to set up incubators. In parallel, an incubator association (EIA) has been established to act as an implementation agency and to serve as the association representing and servicing the Egyptian incubation industry, nationally and abroad. In Lebanon, the example of BERYTHECH is worth examining. Initiated by the Saint Joseph University (SJU), it pursues several objectives: helping young graduates better integrate the business world, promoting knowledge and creative thinking, helping to valorise research results etc. It takes into account some of the comparative advantages Lebanon has in the region to attract foreign firms: information technology, multimedia and communication, banking and finance, vocational training etc.

---

119 Saleh, N. op. cit.
121 Garrett-Jones, S. *ibidem*
123 Asmar M. & Rahme F. « Berytech, a technology park in Lebanon » E/ESCWA/TECH/2000WG. 1/6 October 2000, 5 pages
5.3.2. Non propriety-based initiatives. These initiatives include renovation of old instruments or/and creating completely new ones. Some of these include Firstly, more open public universities and the emergence of private ones: such as the Egyptian Government initiatives to strengthen the linkages between the Egyptian R&D community in universities, research institutes and the production and services sector through the creation of new services, and business-based, results-oriented, self-financed autonomous and flexible units. More than 300 of these units are now in operation in most Egyptian universities and research institutes. Private universities are growing at a higher rate than public ones: in 1997 and 1998, 12 private universities were established in Egypt, Jordan, UAE, Oman and Yemen compared to only one public university.124 Secondly, new institutions and incentive measures were initiated: Tunisia, for example, created the FITI (Fonds d’incitation aux technologies de l’information et de la communication) geared towards promoting the use of ICTs in industry namely to help enter the age of knowledge economy. Thirdly, broad information to the public through: major information campaigns related to the ICT revolution. As an illustration, the promotional actions program organised throughout the ESIS II period. These actions deal mainly with seminars, conferences and shows rather than publications or written products due to the fact that such actions have more impact on the population: during the ESIS II period, about 60 promotional actions had taken place.125

5.3.3. Impact of these initiatives. Most of these initiatives: techno-parks, incubators and scientific cities are still in their infancy in MENA countries and a full-fledged assessment of their impact would be too premature.

By the experience of other NICs, theses schemes have achieved some success in a relatively short time: on average five years after they had been established. In particular, they have helped set up new firms; facilitate the transfer of technology; and made use of public sector resources previously under utilised. Nonetheless, the direct benefits of any TBI/S&T park scheme appear to be modest in some Asian countries such as the Philippines. As a proportion of all firms, the number of technology ventures that the scheme can initiate must be tiny. It is vital, then, to consider what indirect benefits might also be generated.126

On the basis of the Asian experience, incubators and Parks are likely to meet several challenges in MENA countries notably: regional and political instability, unproven business models, lack of funding in the form of loans and equity injection from banks and other institutions, little knowledge and exposure to the net economy, limited R&D, little government support to SMEs. No up to date legal system and little enforcement of copyright laws, lack of incentives to foreign investors, delay in establishing free zones, little amount of transactions of the local stock exchange, long establishment procedure and red tape.

VI. INFLUENCE OF OPENING UP THE GLOBAL ECONOMY ON TECHNOLOGY TRANSFER AND INNOVATION.

In MENA countries, as in other developing countries, the inward looking, import-substitution based strategy of development has not been able to remove the constraints on growth, mainly because of the protective and costly policies involved. A question at the heart

---

124 Quasim, S. ibidem
126 Macdonald, S. Technology Business Incubators and Science and Technology Parks: Draft Recommendations Report for the National Technology Development and Transfer Plan, Report by the Centre for Research Policy, University of Wollongong, for the Dept. of Science and Technology, the Philippines, October 1995. Macdonald and Joseph in Garett Jones op. cit.
of the transition agenda is how technology transfer practices, which hitherto provided the basis for import substitution, can now be managed to provide the basis for innovation and competitiveness on global scale. While the fears notably at the firm level of opening up abruptly the economy are expressed widely, everybody realizes that old practices have left very little technological capabilities and seldom paved the way towards innovation. Needless to recall the old concerns with monopoly costs, levels of royalty payment, rent taking behaviour and changes in the pattern of production. The concern is more with the fate of ‘traditional’ sectors, like textiles, garments, leather goods, food processing and industries based on local raw materials inputs. Clearly, new ways of technology transfer, new learning processes to initiate within domestic firms and more adapted innovation systems and approaches constitute the ‘kits for survival’ under new competitive conditions, bearing in mind that technological change and innovation have plainly begun to affect all sectors. While competitive pressures are not totally unfamiliar with countries of the MENA region, the changing pattern of competition and relative loss of traditional comparative advantages prompt decision-makers in the region to imagine new alternatives towards technological capability building and innovation.

6.1. Foreign investment and knowledge/technology transfers. Several factors militate in favour of foreign investment in its various forms (FDI, joint-venture, partnership etc.). The vital role that TNCs played as an important medium for the transnational transfer of technology and skills within in the South East Asia and the spillover effect they produced to the rest of the economy, the much needed capital they bring, the benefit of the long accumulated experience and the embedded tacit knowledge in technology and management etc. The measures taken by MENA governments to attract foreign investment in recent years, including the more liberal Investment Codes are a reflection of the ever-growing need for foreign technology to modernise their economies and face international competition in the new era of global economy, even if the enforcement remains a daunting task. In all investment codes, technology transfer and innovation capabilities, the acquisition state of the art technology and spillovers to local firms are mentioned among the long list of expectations from foreign investments.

6.1.1. Foreign Direct Investments. Globally, FDIs have been growing almost exponentially. While LDCs made a significant inroad (30% growth in the nineties), MENA countries still compares poorly with other parts of the world, namely with South East Asia: a mere 7.2 billion USD in 1998 while South East Asia received 77.2 billion USD in the same year. Indonesia, alone received more than half of all FDI to MENA Countries in 1997 (4.6 billion USD) as well as Malaysia (5.1 billion USD). The whole MENA region now attracts only 2.5% of total net foreign investments to LDCs while they reach 83.1% for Asia and 14.4% for Eastern and Central European countries. Many see this as a real ‘eviction’ phenomenon. Taken individually, MENA countries score differently: Egypt has attracted the second largest amount of FDIs (15%) in the region (after Saudi Arabia), half of it directed to the manufacturing sector. Morocco saw its share decrease from 1.1 billion

---

128 Cooper, Ch. op. cit.
129 ERF « Economic Trends in the MENA region », 2000
130 ERF op. cit. p. 11
132 Bellon, B. & Gouia, R.
USD in 1997 to 558 million USD in 1998, namely in industry, services, finance and energy, industry’s share being in minority position. 133. Tunisia doubled its inflow of FDI from 339Mn USD in 1997 to 650 million USD in 1998, mostly directed to the energy sector (developing gas fields and building pipelines) to textiles, shoes and leather, to vehicle parts and to electrical and electronic goods (500 foreign firms are concentrated in the manufacturing sector) 134.

In the face of these poor performances, MENA countries are resorting to joint ventures and partnerships namely with Euro-Mediterranean firms with limited results so far. The Euro-Mediterranean partnership agreements are expected to reinforce Euro-MENA links and boost inflows of European investments. However the competition between MENA countries and the CEECs (Central and Eastern European Countries) appears to be tougher than expected. This is a source of concern for MENA countries: in 1996, the stock of European FDI did not go beyond 1.99 % of GDP (or 8.3 billion USD) in five MENA countries, whereas it reached 5.65 % (or 18 billion USD) in seven CEEC. 135. Several obstacles are put forward by investors to explain the lack of attractiveness: Among these factors are unfriendly macro-economic policy environments, low workers productivity, low skill levels, high transaction costs, and macro and micro-economic inefficiencies. Added to that various perceived risks are associated with the volatility of the exchange rate, bureaucratic stronghold, lack of infrastructures, low property rights protection and security problems in some countries.

**Impact of FDI on technology transfer:** with the limited flows of FDI to the region, it is difficult to expect tremendous positive effects on technology transfer in MENA countries. However, even in countries that attracted a great deal of foreign investments, the results do not appear to be satisfactory. A substantial number of new technologies were introduced in the region over the last three decades, yet most of the innovations required took place outside and not within the region. This is the case for example of the development of new LNG technologies for the export of Algerian gas, the development of new technologies for the export of the Moroccan phosphate industry, the development of engineering technologies for the construction of the Aswan High Dam, the Great Water Distribution in Libya etc. This is perhaps also the reason why some scepticism as to the ability of foreign investment, and particularly of TNCs, to build domestic technological and innovative capabilities still prevails.

Several factors have played the role of impediments to building local technological and innovative capabilities in MENA countries either directly or through spillover effects. On top of the obstacles seen earlier, we can add: the limited will of some MENA governments to get effectively involved in supporting R&D leading to innovation, the reluctance of foreign firms to using locally-supplied technological services limiting thus the spill over effect, and their preference to keep engineering and R&D function within the parent company and outsource low-technology function to domestic firms. 136. In Tunisia, private investment of resident companies is regressing to the benefit of offshore companies as sub-contractors of major textile firms (35% of the total). Innovation capabilities run the risk of being discouraged, the Tunisian manufacturing sector relying more and more on external innovation and less and less on its own capacity. Thus for the sake of speed and

133 Office des Changes, balance of payments of Morocco, 1996
134 The most important ones are French (93), Germans (90) and Belgians (57).
136 Gouia, R. Les rapports technologiques CEE/Maghreb: le cas de la Tunisie » Miméo, GREP, Tunis 1994 p.427
competitive pressures, local firms find it much easier to resort to more easily accessible and ready-to-use, in other words, « off the shelf » new technologies. Looking at registered patents, a substantial share of these is held by non-resident companies: thus in 1995, patents registered by residents represented only 19.7% in Algeria, 23.4% in Morocco and 21.2% in Tunisia. While these figures indicate the limited innovative capacity of domestic firms, what is of more concern is the deterioration of these scores over time. Thus, since 1995, while the stock of FDI has been increasing in relative terms, the share of residents has been steadily decreasing with the exception of 1999: 21.2% (1995), 26.4% (1996), 16.3% (1997), 13.0% (1998), 28% (1999) and 10.9% (2000). Consequently, the increase of foreign investments is not translating in higher innovative performances on the part of domestic firms but rather seems to decrease overtime.

6.1.2. Joint ventures and partnering: they are looked at as preferable alternatives for transferring technology and building local innovative capabilities through spillovers and learning and the quickest way to acquire modern managerial practices by domestic firms. Joint ventures are found in most sectors in the MENA countries. In Tunisia\footnote{Maaref, A. « Management du transfert de technologie dans le cadre de la joint-venture en Tunisie » Mémoire de DEA, Université de Tunis, 20001}, there are 198 joint ventures in the manufacturing and exports sector representing 12.2% of the total number of companies: agro-food (7.7%), electrical & electronics (22.06%), chemicals (24.2%), mechanical and metallurgical industries (11.7%) and paper & cardboard (5.2%). In Algeria, SMEs participation in partnerships with foreign capital remains relatively limited. At the end of 1999, only 297 joint ventures were registered, which represents less than 1% of the total number of investment projects undertaken. In our sample, of Algerian SMEs, only 8% have some kind of long lasting relationship with a foreign partner.

Impact of joint ventures on technology transfer and innovation: Empirical studies on successful operations have highlighted the importance of intangible factors such as trust\footnote{Mansell,R. & Wehn, U. « Information technology for sustainable development » Oxford University Press-UN, New York 1999.}. In MENA countries, that level of trust does not seem to have been established. In the Tunisian case, results indicate that technology transfer occurred in this joint venture but the technology was not state of the art technology. Moreover, the R&D function was not transferred, but remained at head-office level, even though a high level of understanding and no conflict characterised the relationship for more than 50% of the companies investigate. Even the information is not automatically supplied by the partners: 72% of the firms questioned believe that they are badly, if not at all, informed about innovations in their field of activity. In Algeria, it does not seem to constitute a viable means for knowledge and skills flow and technology accumulation for SMEs for the time being. On top of all the difficulties mentioned above, there seems to be a little awareness of the importance of the innovation function on the part of domestic firms: 44% consider it as non important.

6.2. Import-export as incentives/disincentives to innovation. Trade is believed to enhance total factor productivity as well as balance of payments and foreign earnings. It is argued that productive capacities and their knowledge levels are closely linked to the ability of the economy to export and compete internationally. Competitiveness must be understood also as a way of putting into competition total factor productivity, R&D and innovation capabilities, and ultimately National Systems of Innovation and their effectiveness.

6.2.1. Trade and exports of MENA countries. Trade has been growing in recent years in most MENA countries, as a result of access to income, growth of population and the
aspiration of people to a higher standard of living. However, looking at trade of manufactured products, published figures indicate a general trade deficit for all MENA countries and throughout the nineties, even if the total indicates an improvement as global manufacturing trade deficit decreased from -56 048 Million USD in 1992 to -55153 Million USD in 1997. Exports performances of MENA Countries have grown at a satisfactory rhythm, but seem to know a relative slow-down at the end of the nineties. However, it is manufactured exports that indicate the existence and efficient industrial infrastructures. As a percentage of merchandise exports, they represent in the 1996-1998 period, 38.7% for Egypt, 49.5% for Morocco and 80% for Tunisia. Meanwhile South Korea scored 91.2%, Malaysia 77.3%, the Philippines 77.3 and 75.3% for Turkey. With the exception of Tunisia, performances are half of what the Asian countries are scoring. Tunisia adopted measures such as the creation of the National Institute of Standardisation and Industrial Promotion (INNORPI), and the publication of National Plan aimed at promoting the quality of export products. These seem to have given non-negligible advantages to domestic firms on the international markets.

**Technological content of exports:** is the ultimate indicator of the strength of domestic technological capabilities and consequently the relative ease of moving towards innovative competition and knowledge economy. This can be assessed through the exports of capital goods, engineering services and high-technology exports of products and services.

- **capital goods exports**: MENA countries, in general, remain heavily dependent on imports of machinery and transport equipment. The Arab region's ITD (Index of trade dependence) remains high at -85, marking a high import reliance, while exports remain relatively negligible. Algeria, Egypt, Saudi Arabia and Syria are the largest importers of machinery and transport equipment in the Arab region (their collective ITD is in excess of -90). In the case of Tunisia, capital goods imports remained around 65% of total imports in value terms with an average increase of 8.5% per year between 1991 and 1994. Yet looking at the capital goods sector, the installed capacities for producing locally capital goods in MENA countries appear to be non-negligible. The weakness results partly from the low emphasis put by Government policy to promote a capital goods industry. Investment in this sector did not exceed 4% to 6% of total industrial investment even though the domestic demand was relatively important in terms of lorries, diesel engines, metallic frames, trucks, machine tools and computers. Machinery and equipment represented in the 1991-1995 period 8.4% of total manufactured goods in Jordan, 14.4% in Morocco, and 7.4% in Tunisia. In comparative terms, their share of total manufactured output reached 41.4% in Korea and 48% in Malaysia. In qualitative terms, their level of technological content remains relatively low. Nonetheless, a serious attempt was made by some MENA countries to diversify in more technology-intensive products: electronics, computer design and production, pharmaceuticals and chemicals. This is perhaps the reason why their exports increased by 35% over the 1992-97 periods.

- **Engineering services**, which play a key role in innovation, are developed but remained largely in great deficit in terms of ITD. There are however some success stories. In Tunisia, the consulting business is likely to know an important increase to reach 100 million DT of revenues in 2001, according to the industry’s association, the ‘Association Nationale des Bureaux d’Etudes et Ingénieurs-conseils. Exports of engineering services by domestic

---

139 Calculated from WB-WDI database, 2000 in Abdellatif, Libid
140 ITD: The Index of Trade Dependence which measures the extent to which the domestic manufacturing sector is developed and makes a contribution to the balance of payments of the economy in question.
141 Gouia, R. op. cit.
142 In L. Abdellatif (Calculated from UNIDO, ISIC3 database, 1998).
firms are expected to reach more that 20 million DT\textsuperscript{143}. However, the deficit remains still important: La Comète-Tunisie, an engineering firm, resorts to foreign engineering for hydraulics (25%), civil engineering (30%), construction and building (10%). Several other examples can be mentioned. The Arab world as a whole is currently importing some 70 billion USD to 80 billion USD of technological services per year in the construction industry alone.

-**High technology products and services exports:** Global shifts in the structure of demand for manufactured products are working against raw material-based sectors and in favour of technology and knowledge-intensive ones (new materials, telecommunication equipment, electronics, computers and software etc.). MENA countries are still lagging behind in this kind of products. The share of technology-intensive products in the output structure was in 1994 15% for Egypt, 22.5% for Jordan and 24.1% for Tunisia. This compares unfavourably with Korea (41.0%) and Malaysia (50.2%). It is not however too bad, considering that Philippines scores 22.6%, Turkey 19.5% and Thailand 24.6%\textsuperscript{144}. In terms of exports, technology-intensive manufactured exports represented 9.8% of total exports for Egypt, 20.7% for Morocco and 22.8% for Tunisia. This compares unfavourably with Philippines (47.4%), Thailand (48.3%), Malaysia (66.7%), and Korea (65.7%)\textsuperscript{145} and not too unfavourably when compared to Indonesia (22.1%) and China (31.5%).\textsuperscript{146} With regards to world competition, MENA countries are in a less favourable situation than most NICs and technology content in the structure of production are difficult to channel to the export structure. MENA countries appear to specialise in technology-intensive products of the primary type e.g.: chemicals products.

6.2.2. **Problems and prospects for export-driven innovation.** From the above analysis, it appears that imports may be an impediment to innovation while exports have not reached the stage of being a real engine of full-scale innovation in most MENA countries. They suffer from several problems and yet can benefit from certain prospects.

**Problems:** Firstly, MENA countries suffer from a weak industrial base in spite of all the efforts made. With a 26.7% contribution of manufacturing sector to GDP on average during the 1991-1998 period, industrial output is lower than that of Asian NICs where it amounted to about 30% of GDP in each of Korea, Malaysia and Thailand during the same period\textsuperscript{147}. This is the outcome of the high growth rates that the industrial basis in these countries experienced, over many decades. Secondly, their SMEs are more inward looking than those of NICs. Concern is expressed in Tunisian, in Egypt and now in Algeria particularly by SMEs, that in the event of the total free trade zone, several enterprises will find it increasingly difficult to face competition looking at some of the (negative) experience of other parts of the world. Resistance to change is coming mostly from people who have evolved for so long in the protected and concurrence free environment, and are not willing to reconsider their attitudes. The textile and garments sector in Tunisia (50% of total industrial employment) face tough competition from imported cheap garments from Asian countries and second hand markets. As a consequence, it is massively moving to low grade tertiary activities through import of goods they were previously producing and frippery, thus contributing to the dis-industrialisation process and the ‘bazar economy’.

\textsuperscript{141} The North Africa Journal No. 51/ Week Ending January 30th, 1999
\textsuperscript{142} L. Abdellatif : Calculated from UNIDO INDST-4 digit. 1998
\textsuperscript{143} Calculated from PC/TAS database, 1998.
\textsuperscript{144} Both terms : high tech products or technology intensive products are used for the same meaning.
\textsuperscript{145} WB-WDI database, 2000.
Prospects: Firstly, the low labour cost-based export strategy is reaching its limits in most MENA countries. In Egypt, for example, according to the Family Budget Survey of 1996, about 42% of workers in manufacturing (public and private) are below the poverty line. In 1998, more than 70% of workers in private manufacturing are poor. Further salary reduction cannot be envisaged without both hampering the already low labour productivity of manufacturing employees and exacerbating the poverty problem. Consequently, the only way to compete remains the gradual adoption of innovative attitude. Secondly, Incentive and pressures are felt of the free trade zone: Product and process life cycles will be drastically shortened, and thus new capabilities in absorbing continuously new technologies, in innovating constantly are needed for MENA enterprises. This is an incentive for them to upgrade constantly their innovative capabilities to be able to remain competitive, profitable and to survive. Europe, for instance, represents a golden opportunity to expand exports (350 million of consumers) in the face of relatively narrow home markets and the absence of MENA wide market as such. Thirdly, rapid progress is made in ISO certification and the improvement of the quality of the technologies used in most MENA countries, reinforcing the capacity to master technology and in particular to innovate. The race to acquire ISO 9000 label has evident positive effects both upstream and downstream, as shown in the case of Tunisia for example (notably through the creation of INNORPI, and the publication of National Plan aimed at promoting the quality of export products). Fourthly, the catching-up and leap-frogging effects: In Tunisia manufactured exports reached 80% of total exports in relatively short time compared to well established. In 2000, they earned 20% of GDP, growing at a rate of 10% between 1992 and 2000 and making Tunisia the first exporter of manufactured goods in MENA countries. Fifthly, the weight of minerals in export earnings is badly felt by most MENA countries (oil and gas, phosphates, iron ore etc.) both by governments and public opinion. The drive for diversification through S&T capability building and innovation-based competitiveness is therefore relatively strong.

6.3. Brain drain and brain gain. Like many other parts of the developing world, the MENA region suffers an important brain drain. The emigration level of Arab scientific manpower (MSc. and Ph.D. levels) may have attained levels of the order of 80% in many Arab countries, to the benefit of industrialised countries mainly. At least 50% of Arab university professors have been permanently lost, over the last two decades, to the brain drain or to obsolescence, as a result of low pay and limited R&D funding. These are rough estimates, since no MENA country publishes reliable statistics on emigration of scientific manpower. Needless to mention the host of factors that contribute to this phenomenon. Unemployment or under-employment and long tradition of migration (Egypt for example), disparities in the standard of living, and the underlying political instability push many graduates to remain in the country of graduation and professionals to leave whenever an opportunity arises. From their activities and positions, intellectual and scientific workers from MENA countries have, on an individual level, become well integrated into the international scientific community. Regarding Maghreb countries for example, the strong dependence on French culture, drive a scientific and intellectual migration to France but also to Canada, Belgium and other francophone countries.

---

151 The current exchange rate is 72 Algerian Dinars to One US dollar.
152 Zahlan A.B. ibidem
Added to that, an *internal brain waste* can have more damaging effects than the classical brain drain. Thousands of skilled workers, technicians and engineers, deflated from the public sector were either recruited by private sector SMEs or started themselves their own businesses. While this may be seen as a necessary labour mobility and a form of diffusion of valuable accumulated know-how, a significant amount of skills and experience is lost in the process. Many of these technicians and engineers invest in low-grade services (in taxis, shop-keeping etc.) contributing thus to a relative brain-waste. Internal brain waste takes also the form of technical and scientific personnel involved in administrative and office positions or in pluri-activity as a result of low and insufficient wages paid. University professors in large MENA countries are often involved in several activities making the undertaking of research work impossible. Besides, the funding of R&D, the issue of wage policy towards academics is thus of central importance if innovation is to know a new impetus. Finally brain waste can take the form of irrelevant work to local needs, as shown by empirical studies based on a survey of the electronics sector in Algeria.

*Brain gain* (or «reversed brain drain ») i.e.: driving intellectuals and scientists to return home, appears in the current situation relatively difficult for all MENA countries with obvious differences from one country to another. Egypt, Jordan, and Morocco to some extent may be in the most favourable situation while the rest in a less favourable one. Several attempts were made in the past to produce an effective brain gain with very limited results, the same reasons which provoked the brain drain being largely standing nonetheless at policy-making level, very few MENA countries have set up a comprehensive, systematical and coherent plan to benefit from their diasporas living abroad. Yet every body knows at government level and in the public opinion that importance of the intellectual and scientific diasporas in terms of size and quality, and the tremendous role it could play in S&T capability building and innovation if properly involved. Several impediments exist to that. First of all, like the rest of the emigration, it contributes to the valuable inflow of funds for certain countries: Egypt and Morocco, for example, received more than 2 billion USD in 1998, from their migrant community in Europe. Secondly, it faces several obstacles ranging from policy weaknesses and failure, to strong local political opposition, and opposition from rent-seekers. Short of reversing physically the brain drain, limited numbers are invited using different channels: lecturing, research, consulting etc. With the prospects of the ICT revolution, notably internet, this is made easier and MENA brain drain can be more easily reversed into brain gain. A long list of tasks, this huge potential of brain-power can be in charge of and contribute to, can be established.

VII - INFLUENCE OF INTERNATIONAL COOPERATION.

International co-operation can be a valuable tool for S&T capacity building and for setting the basis for knowledge economy. Several attempts and collaborative efforts were made in this respect by a host of international and multilateral organisations in the past. While some non-negligible progress was made, they have not quite succeeded at empowering MENA countries to face up the innovation challenges. The knowledge economy challenges require that fresh initiatives and drastically different approaches to international co-operation

---

154 One of the best known and the most systematically approach being the UNDP Tokten project.
155 More and more gatherings are organised by governments, associations and universities to discuss the topic and the issues involved.
156 ERF, Economic Trends, 2000
157 The Maghtech network initiated by the author has more than 350 members among the research community in the Maghreb.
are undertaken either of the horizontal type (amongst MENA countries) or the vertical one (with the rest of the world and namely Europe).

7.1. Bilateral Co-operation. Bilateral co-operation, as shown in other parts of the world can be a good engine to trigger off innovation.

Bilateral Co-operation within the MENA region, often put forward by political leaders as a means of sharing experiences and accumulated know-how in various fields (oil and gas, agriculture, textiles and garments, chemicals and pharmaceuticals) is at a negligible level, following extremely weak intra-MENA trade links (less than 1% of global trade of the region). Yet, every aspect of S&T policy militates in favour of intra-MENA partnerships from technology acquisition right to R&D and innovation where valuable externalities could be gained through collaborative work. Past experience has shown that rapid progress would have been made if a concerted approach was adopted in fighting for example the palm tree disease (mildiou) which the dates production in several MENA countries was suffering from. Tens of similar examples could be mentioned drawn from the region that indicate the negligible level of scientific co-operation between MENA countries, yet a host of problems in all areas could have tackled jointly. Several international organisations (ALECSO, Association of National Research Councils, IADO etc.) made non-negligible efforts to initiate this co-operation with very limited success. In the scientific field, co-operation is very limited: in 1995, out of the 769 articles co-authored by Maghreb researchers with foreign scientists, for example, only 11 articles involved co-operative work, and joint inter-Arab publications did not exceed 1.7% of total inter-Arab joint papers. On a more positive note, however, there are some success stories of attempts made to undertake joint projects in recent years. As an illustration, research in electricity transportation and the production of cement and machine tools between Algeria and Tunisia have given some positive results. Many more fields, where scientific and technological co-operation is possible, can be envisaged. Arabsat and an adequate usage of TICs give an added opportunity to increase joint research projects.

Bilateral Co-operation with OECD countries: A great deal of co-operation has taken place between MENA and OECD countries. For the Maghreb Countries, the bulk of bilateral co-operation has been with France namely through various promotional schemes aimed at universities (CMEP for Algeria, CMCU for Tunisia and Action Intégrée for Morocco). These programmes helped a great deal the exchange between students and researchers, nonetheless, their scope remained relatively limited and their impact on promoting local innovation non existent. More recently (2001 and 2002) new three-party agreements were signed between the French ANVAR and its counterparts in Morocco ODI (Office du Développement Industriel) and in Tunisia API (Agence de Promotion de l’Investissement) destined to help the valorisation of research results and their diffusion. For the Mashrek, bilateral co-operation is oriented towards British and American institutions and involves Government and private institutions. Government and para-statal institutions include: the British Council, ODA, Friedrich Herbert and Goethe Institute, IDRC and CIDA, Japan Foundation and JAICA etc. In Egypt, a number of private consultant offices acquire their funding from foreign grants namely from USA, Canada, Germany, Denmark, UK and

159 Zahlan, A.B. ibidem
Japan. In Jordan, the Higher Council for Science and Technology has memorandums of Understanding (MoU) with various global partners: the Italian National Research Council, the Development Agency and the Japan International Co-operation (JAICA). The Hashemite University Industrial and Techno Park and the QUIZ have agreements with US companies and Government.

Co-operation with other LDCs: The situation is rapidly changing and new types of co-operation are emerging with LDCs. As an illustration, India is helping set up two Science and Technology Entrepreneurs Parks (STEPs) in Egypt. This is the result of co-operation between the National Research Development Corporation (NRDC), a premier technology transfer government enterprise of Egypt, and the National Telecommunication Institute. STEPS are to help reorient the approach to innovation and entrepreneurship involving education, training, research, finance, management and government.

7.2. Multi-lateral Co-operation.

7.2.1. Co-operation MENA-European Union. MENA countries in general have a strategic and an economic importance for the EU: peace and stability constitute a priority for the EU. Common interests exist: it is in the interest of MENA to attract European investments and it is in the interest of EU countries to have new business opportunities in this huge market and to manage adequately the flows of migrations. MENA geographic proximity to the EU gives it large possibilities to expand its share of the world market through exposure to increased foreign competition and subsequent improvements in technical and economic efficiency. Comparative advantages can be easily gained in the areas of textiles and garments, leather goods, pharmaceuticals, and chemicals. The new dynamics initiated by the Euro-mediterranean conference in Barcelona in November 1995 opened new prospects and raised many hopes that these programme will give a new impetus to European co-operation vis-à-vis its southern Mediterranean partners.

The MEDA I program, beside its bad implementation, was considered highly insufficient to contribute to raising the level of competency of several professionals, university researchers, teachers, journalists etc. Capacity building in technological innovation did not figure high on the priority list. The three previous STD (Science & Technology Development) programs (1983-1994): STD1 (1983-87), STD2 (1987-91), STD3 (1991-1994) and the INCO-DOC (International Co-operation with Developing Countries: 1994-1998) program have left very little technological capacity. Out of the 6000 research teams, the whole Mediterranean had 289 research teams only (11% of total), while Asia and Latino-America had 44% of the total. The most challenging aspect of this relationship remains without doubt the Free Trade Zones Agreement signed so far by Tunisia, Morocco, Algeria and Egypt by the year 2010 and which is aimed at the elimination of trade barriers between the two zones. Bringing domestic industry to European and international level to face innovation-based competition constitutes therefore one of the main concerns of MENA authorities.

European help is badly needed by MENA countries namely in technology transfer and the acquisition of know-how, training, R&D and innovation, this latter being the most complicated task. An important upgrading of the capabilities is needed. EU fund several projects of the private sector consultants’ offices seen earlier (small grants and soft loans).

---

161 N. Saleh op. cit.
162 Businessguide. Com. 21 January 2002
164 Snecma, a jet engine manufacturer belonging to a French state-owned industrial group.
giving preference to development projects. The *mise a niveau program* (corporate upgrading program) negotiated firstly with Tunisia is a full-fledged national program to bring local industry to European level by 2010 and to compete efficiently in the world market. The number of companies allowed into the program has been steadily growing: 63 in 1996, 132 in 1997 and 165 in 1998 showing thus the rising interest of industry in the program. 811 firms took part to the first phase of this program (1997-2000). Its objectives are to restructure the organisation of participating companies. Some 2,000 industrial firms are to be modernised for a combined bill of 2.5 billion DT, according to current estimates. This should normally compensate the declining State revenues resulting from the free trade zone. Other programs include the Industry Modernisation Program (IMP), signed between the Government of Egypt and the EU in 1999, in the field of technology and knowledge upgrading: it is related to the construction of about twenty business resource centres. The main areas of co-operation include: basic science, information technology, conventional and renewable energy, marine science, water, agriculture and agro-food, biotechnology and public health, the protection of the environment (e.g. the Mediterranean sea pollution). MENA countries are also in need of raising their IPR protection capacity, the upgrading of management and marketing skills, communication infrastructures, legal and jurisdictional and social protection systems, the fight against poverty and exclusion etc. The MoCo (Monitoring Committee for Science and Technology) composed of representatives from EU and MENA put the emphasis in 1996, in Cyprus on strengthening R&D of SMEs in South Mediterranean. However, there is still a lack of a clear vision: no clear programs for upgrading R&D and innovative capabilities for instance exists. Internally, foreign funds gained from international co-operation are found to be badly co-ordinated which decreases a great deal from their impact on the scientific community. The MEDA II appears to have made some progress by introducing ingredients of ‘mise à niveau’ in the area of S&T capacity building without properly tackling the delicate issue of the mobility of people between EU and the MENA region. The fear of illegal immigration and international terrorism has relegated these issues to lower priority.

**ICTs and EU-MENA co-operation:** A particular emphasis is to be put on co-operation in the field of ICTs regarding not only the tremendous prospects it offers to MENA countries, but also their fear of a major ‘numerical divide’ between them and Europe. MENA countries expectations to take their fair share of the «Technology for all» program is balanced against the fear that outsourcing resulting from the usage of ICTs, translates into job losses for Europe as some anecdotal stories try to make it out. There are obvious benefits for both MENA and EU to cooperate: a huge and fast-growing market to develop for European ICT industry and massive technological know-how and accumulated experience at the doorsteps of MENA countries to reap. The telecommunication explosion will open new opportunities for investments for European firms to create jobs both in the North and in the South. MENA countries are badly lagging behind in the ICT field and are realising the importance of ICTs for their development and the competitiveness of their enterprises. They realise also that costly telecommunication infrastructures constitute major barriers of entry.

---

165 North Africa weekly review, op. cit.
166 The North Africa Journal, 14 February 1999
167 Abdellatif, L. *ibidem*
168 Hardy, P. & Bontoux, L. op. cit. p. 25
Along with NSTIs, a real strategy needs to be worked out to develop ICTs in MENA countries are needed. Elements of this strategy include 1/ upgrading telecommunication infrastructure, by mobilising domestic capital, expatriates funds and FDI, 2/ training local competencies and upgrading their largely obsolescent knowledge through the uplifting of existing training institutions, the modernisation of training equipment and pedagogical methods 3/ stabilising these competencies locally so as to reduce the brain drain by improving the working environment through the usage of ICTs and internet in particular. 4/ promoting EU standards as a key element between Europe and MENA countries, namely through common research projects and through the access of MENA scientists to the European know-how.

EU could help MENA countries to operate a transition towards a competitive telecommunications. It could use its accumulated experience in extending telecommunication to less favoured European countries (eg: Portugal) or to other territories (Corsica) to promote more balanced grids in MENA countries where the rates of urbanisation are relatively high: 50% of the population live now in cities and towns in these countries. Several means can be used namely: Arabsat, the Arab Ligue satellite, through networking between academics, researchers, SMEs, etc. In this respect, a network called MAGHTECH (Maghreb Technology), started in 1994 has now more than 350 members and researchers from the main MENA countries and from Europe (France and GB in particular), looking at policies and strategies to integrate S&T into development policies. Another initiative now under way and which can contribute to upgrade MENA’s capacity to enter the knowledge economy and reduce the numerical divide is the EUMEDIS programme initiated by EU. Through focal points and intense programs of meetings, fairs, exhibitions, planned in each of the countries, EU is hoping to give a serious lifting in various areas: Health networks, E-commerce, Multimedia access to tourism and cultural heritage, innovation, E-learning etc.

7.2.2. Co-operation MENA/ international organisations. Several international organisations have been active in the field of S&T in MENA countries. Actions could be divided into three major categories: the first one dealt with the improvement of the environment for S&T capability building, the second one dealt with capability building in some components of the S&T system and the third one dealt with the construction of the S&T and innovation system as a whole.

1/ Building a friendly environment or S&T capability building: We have seen through past experience, looking at failures but also at some successes, that often the unfriendly environment for domestic and foreign firms prevented them from contributing to effectively build domestic capabilities and potential for S&T and innovation. The above section on obstacles gives an ample overview of all these problems. Thus, efforts from international organisations, such as the World Bank, to restore a better managed macro-economic regulation can contribute to restore the much needed friendly environment likely to attract foreign investments, encourage domestic investors and give the necessary impetus to learning, creativity and innovation to enterprises but also to all the other actors of society. While several criticisms were put forward arguing that S&T building was very low on the agenda and expressed that the «baby may be thrown with the bath water», everybody admits that S&T capacity building cannot occur in a repulsive environment and no domestic savings can be mobilised nor the access to the international financial market is possible.

170 The world bank estimates this level of funds of the order of 60 billion USD
171 Initiated and currently chaired by the author, it reflects the kind of co-operation that can be put together: it was put together with the help of universities from Europe (the universities of Strathclyde, Lille) and international organisation.
2/ Building components of the NSI: The second set of contributions dealt with components of the system of innovation, notably education and training and industrial development. Institutions such as UNESCO whose efforts in making education systems more effective at all levels have contributed a great deal to a better organisation of the learning process for S&T accumulation, while introducing enough flexibility to guarantee labour mobility, in the face of constantly new market requirements. Several programmes have been set up and implemented in the MENA region: conferences, seminars, training sessions involving policy-makers etc. Institutions for better-managed labour such as ILO and a better-structured industry such as UNIDO have undertaken several projects in most MENA countries. Other institutions have played a non-negligible role and the list can be lengthened.

3/ Strengthening S&T capability building: The third category of contributions, more focused on S&T capability building, were made by through the regional organisations of the United Nations. For MENA countries, important contributions have been made by the ESCWA, (Economic and Social Commission for Western Asia) in raising the level of awareness of the importance of S&T and innovation for the development of their economies. These initiatives have helped create contacts, links, and networks, diffuse information, tackle specific issues and sectors (eg: water desalinisation technology). For the North African part of MENA region, ECA (the Economic Commission for Africa) has conducted several studies related to policy issues in S&T. Here, the World Bank recent initiative known as MDF (The Mediterranean Development Forum) « has provided a rare opportunity for policy leaders and experts to meet and engage dialogue to set the region’s development agenda ». Participants took up several issues related to S&T capability building, the challenges of ICTs etc. While all these projects have contributed a great deal to upgrade the knowledge, awareness and policy instruments and create a more sensitive environment to S&T, they need fresh look to effectively prompt the MENA region to catch up and leap-frog into innovation based-competition and knowledge economy.

7.3. Decentralised co-operation. The bilateral and multilateral model of co-operation met several problems and difficulties. The various evaluations made, particularly in the eighties, have pinpointed its weaknesses, namely its excessive centralisation, slow and irrelevant solutions to the needs of the populations and communities of the South, limited cost-effectiveness, wastage of tax-payers money through lack of accountability, and diversion of funds through corruption. But most of all, it has very seldom made a significant contribution to sustainable development and local capacity building. Thus decentralisation co-operation (DC) became the keyword, not only as a way to overcome these weaknesses but also as a means to involve a host of other actors capable to conduct co-operation at their level of action and decision-making. These are local authorities in their various forms and shapes and Non Governmental Organisations (NGOs) and associations. Several laws and regulations are promulgated in various countries of the world: in France for example the 1992 law which gives the possibility to local authorities, in cities (Mairie) and at district level (Conseil regional), to undertake international co-operation projects and programmes, with their counterparts namely in LDCs. The aim is to achieve co-operation for sustainable development and involve local communities. Different brands of decentralised co-operation are emerging in various countries of Europe (Italy, Spain, Germany) while the EU put more emphasis on NGOs and Associations as main DC actors. Universities are also involved in training the new profiles required in EU in particular.

172 As decentralised co-operation deepens and gains experience, other actors are emerging such as local branches of labour unions, SMEs etc.
173 The author is director of a post-graduate diploma (DESS) in international decentralised co-operation.
Decentralised Co-operation and technological capacity building. As an alternative approach, DC seems as a suitable vehicle for technology transfer, local capacity building and contributing more effectively to knowledge economy. It could help establish and revitalise local innovative capabilities and creativity, often untapped and under-utilised. A great deal of attention has been devoted in the literature as well as in practice to local development, giving way to a whole school of thoughts (the Italian district model of innovation, regional clusters, «milieux innovateurs» etc.). These are presented as more effective and proven ways to enhance innovation. Local communities, well targeted strata of the population, micro enterprises and SMEs can greatly benefit from various supports to their innovative activities through appropriate decentralised funding, the availability of various technical services, training, information diffusion, counselling etc. While full NSIs may be difficult to build by LDCs in particular, at the decentralised level and with appropriate help from counterparts from the North, Regional Systems of Innovation (RSI) can be envisaged, building on the potential of the region. In this respect, SMEs and micro-enterprises and cities can through appropriate schemes help build more effectively the innovation system, e.g.: the compagnonage system in France. In Italy, ENEA that is a parastatal organisation, provides specialised services to local SMEs which have innovative potential and suffer some weaknesses: its action is on the group of SMEs rather than on single ones. It does not provide financial support but other technical services. It has been able to build a consortium made of enterprises, research institutions, banks and local authorities called SPRINT to promote technological innovation in the wool district of the Prato, which has 15000 SMEs employing 68000 workers. Emphasis is put on diffusion of informatics and advanced process technologies. Projects undertaken to improve process technologies for energy saving and environment protection for example have led to whole series of innovations through the combination of existing technology with new advanced technologies. These include CAD (Computer Aided Design) for tri-dimensional projection of materials, printing patterns, robotics in certain stages of spinning, automation of colours in the dying and quality control etc.

Decentralised co-operation for MENA countries: While this approach to co-operation is still relatively rare in MENA countries, they can greatly benefit from it. Current DC projects completed or underway are mostly of the inter-city type. Medium and big cities where half of the population of the region live, suffer from various problems resulting from the relatively high concentration of population and rapid and uncontrolled growth leading to unemployment, sanitation and health risks, delinquency, violence etc. Unlike other parts of the LDC world, (Africa for example) the problems are often due to the weaknesses in technical, organisational and logistical know-how and to a lesser extent to lack of funds. Successful, though relatively limited, DC projects have been conducted between European cities and big MENA cities such as Cairo, Tunis, Algiers, Amman, Beirut and Casablanca. They ranged from training local technical personnel, to re-appraising and reorganising the refuse collecting system, urban transportation, environment protection etc. The inter-city twinning system that served as a basis for that, while giving some results, is now considered as obsolete and needs to be renovated.

DC presents tremendous prospects for building local S&T infrastructure and capabilities, and for setting local innovation systems needs therefore a particular attention on the part of policy-makers. Decisive contributions can be made to employment creation by giving

---

174 Notably contributions from Pegatini, Pecqueur, Courlet in Europe.
175 Lanzavecchia pour le role de l’E.N.E.A. mentionned by A. Asma, op. cit.
hundreds of youth with bright ideas, «the popular genius for finding solutions »\textsuperscript{176}, and the opportunity to put them into practice and start their own businesses. DC can provide that much needed technical support. It can help strengthen NSTIs notably by facilitating the establishment of incubators, which can support new technology-based enterprises.

Experiments are already yielding some results, where DC between Marseilles and cities in the Maghreb include setting up incubators and putting together joint research projects regarding common urban problems\textsuperscript{177}. Initiatives come from local authorities, SMEs and local associations. Success stories exist also in the academic world where university to university co-operation is yielding significant results at the local and regional level: it includes not only training, by the transfer of diplomas from European universities and helping to put up new syllabuses to train new profiles.

\textsuperscript{1}Moursy, M. op cit.

\textsuperscript{176}World Bank, MDF3 Dispatches, March 2000

\textsuperscript{177} These include project like: the compagnonage, Marseille Innovation, Cites Unies France.