SCIENCE AND TECHNOLOGY POLICY AND S&T INDICATORS

Eduardo Martinez *

*****Chief of Section
Science and Technology Studies & Strategic Planning
UNESCO SC/AP Division
1 rue Miollis (B6.33)
75015 Paris, France
Tel. (33) 1-45684075, 4164; Fax (33) 1-4568 5827
e.martinez@unesco.org

I. GLOBAL BACKGROUND

- One of the main causes of the rapid, profound and generalized changes that Mankind has experienced in the last three decades is the closer and organic relationship between scientific development, technological improvements and their application in the production, distribution and consumption of goods and services.

I. GLOBAL BACKGROUND

- In the world economy there is a globalization of markets, characterized by an increasing competition which leads to look for new technologies based on scientific knowledge.
  The incorporation of these technologies to the production system allows to reduce costs, improve quality, save energy and scarce raw materials as well as to increase the productivity of the labour force.

I. GLOBAL BACKGROUND

- In the last decade the international economy has experienced structural changes derived from, *inter alia*, strong waves of technological innovation (with pre-eminence of incremental forms of technological change) as well as organizational and institutional changes.
  The most dynamic sectors of economy are not the traditional ones any more (steel, cement, basic chemistry), but the high-technology ones *(knowledge intensive)*. The current processes of industrial restructuring and of changes in technological patterns revolve around the information industries (microelectronics and telecommunications), and, to a less extent, biotechnology.

II. SCIENCE AND TECHNOLOGY POLICY (STP)

- It is evident that such features impose the need to formulate Science, Technology and Innovation Policy (**STIP**) which is much more linked to the rest of public policies than in the past. Policy loses some of the rhetorical contents it used to have and becomes more practical.

II. SCIENCE AND TECHNOLOGY POLICY (STP)

- It could be argued that in the past 25 years there has been a '**paradigm shift**' concerning the strategies and mechanisms for the institutionalisation of S&T in many LDCs, which is expressed at three levels: strategies and policies, institutional and legal mechanisms, and globalisation and regional integration.

II. SCIENCE AND TECHNOLOGY POLICY (STP)

- **A. Changes and trends in strategies and policies**

1. From the restricted autonomy policies to the modernization policies, from 'Science and technology policy' to 'Innovation policy'.

The State has practically abandoned the pretension of an endogenous scientific and technological development, of relative autonomy, and has replaced it with a modernization policy of the State. At a purely formal level an 'innovation policy' is postulated, although the institutions responsible of implementing it (science and technology councils, industry departments) in general do not have the political weight nor the instruments, and above all, do not have the financial resources which would be required to implement the said policy.

II. SCIENCE AND TECHNOLOGY POLICY (STP)

2. **From the emphasis in R&D supply and social demand to the emphasis in productive firms' market demand (technological research and technical services).**

   Slowly, the institutional, academic and researchers' genuine concern in dealing with research problems of national, social and environmental interest is left behind, replaced by market considerations. Additionally, there has been the pressure of productivity and competitiveness, the 'dynamic duet' (always present in the official discourse), of profitability, of the provision of services, and the short-term concerns (in contradiction with the long-term horizon of research and high-level education).

II. SCIENCE AND TECHNOLOGY POLICY (STP)

3. **From traditional R&D management and the routine assignment of resources, to efficient R&D management, performance evaluation, and links with productive units.**

   Traditionally there was no evaluation and accountability mechanisms, which brought about a high degree of inefficiency and low productivity. Gradually, efficient management, evaluation and quality assurance mechanisms have been introduced, both in R&D centres (and research projects) and in Higher Education programmes.

II. SCIENCE AND TECHNOLOGY POLICY (STP)

4. **From the promotional and participative role of the State in R&D to the illusion of organizing a national innovation system (NIS).**

   Far from a widespread belief, empirical evidence does not show the existence and operation of a NIS in LDCs (specially true for Latin America) Apart from some embryonic signs, it is hard to argue about the functioning of a network of institutions, resources, of interactions and interrelationships, of policy mechanisms and instruments and of scientific and technological activities that promote, co-ordinate and carry out technological innovation and diffusion processes in society.

II. SCIENCE AND TECHNOLOGY POLICY (STP)

5. **From the absence of evaluation and quality control in Higher Education to academic evaluation and accreditation processes.**

   Historically, universities and research activities have not been evaluated, and there has been no ‘evaluation culture’. In recent years an evaluation pattern seems to have emerged in Higher Education institutions, where a shift is starting to take place: from (bureaucratic) planning and programming trends to productivity (performance); from inputs and processes to outputs and results; and from bureaucratic-administrative control to the evaluation of multiple actors.

II. SCIENCE AND TECHNOLOGY POLICY (STP)

- Thus, decision makers require guidelines that enable to assess results, the effectiveness of the adopted policies. If management of organizations and programmes is to be efficient, there needs to be indicators that show the available resources, the processes involved and the results obtained.

  Hence the renewed attention paid to Science and Technology Statistics and Indicators (**STSI**).

III. SCIENCE AND TECHNOLOGY STATISTICS AND INDICATORS (STSI)

- Scientific and technological activities in most LDCs have not arisen from an organic relationship with economic and social processes. Thus, the main goal of the new policies vis-à-vis the future must be to overcome said division, and to be ‘connected’.

III. SCIENCE AND TECHNOLOGY STATISTICS AND INDICATORS (STSI)

- Any effort to formulate and use STSI must take into account that lack of articulation, and other distortions and limitations, such as weak links between R+D and the higher education system on the one hand, and the productive sector, on the other hand, frequently decreasing academic excellence levels and scarce availability of reliable information.

III. SCIENCE AND TECHNOLOGY STATISTICS AND INDICATORS (STSI)

- Although it seems a fact acknowledged by everyone that science and technology are (idealized) economic and social development priorities, several questions should be asked:

  - Given the current limitations, can we appropriately measure scientific and technological activities in LDCs ?
  - Under what theoretical and methodological assumptions should the measurement be made, so that they can be used as a policy and management instrument ?
  - How should the contribution of scientific and technological activities to economic and social development and to production be measured?

III. SCIENCE AND TECHNOLOGY STATISTICS AND INDICATORS (STSI)

- How much money should be invested in science and technology and basically, in what ?
- How to know the capacity of response of science and technology vis-à-vis the demand, and how to evaluate its possible contribution to the fulfilment of society's basic and productive needs ?
- What type of indicators should be used regarding scientific and technological activities (STA) in LDCs :
  - STA input indicators
  - STA output indicators
  - STA innovation indicators
  - STA social impact indicators

III. SCIENCE AND TECHNOLOGY STATISTICS AND INDICATORS (STSI)

- The basic characteristics of traditional approaches are:
  - i. The purpose of simultaneously establishing a national and international (regional) system of science and technology statistics and indicators.
  - ii. The set of statistics and indicators included in those methodologies has a standard structure, a uniform design (in keeping with international norms).
  - iii. Methodologies have been designed according to the scientific and technological problems of industrialized countries (rarely comparable to those of LDCs).
  - iv. Measurable variables mainly refer to:
    - R+D activities
    - STA inputs, measured in terms of human and financial resources (with a basic quantitative orientation and little concern for quality)
    - Innovation activities (more recently)

III. SCIENCE AND TECHNOLOGY STATISTICS AND INDICATORS (STSI)

- Conventional or standard indicators have been basically used in LDCs to make comparisons between the present and the past, or to compare them with industrialized countries (OECD).
  But the international o regional dimension may have important limitations, since the level of scientific and technological activities in each region or country is so heterogeneous, in quantity as well as in quality, that said indicators have a rather limited practical (or theoretical) use.
  Besides, the gap that separates LDCs as a whole from industrialized countries has reached such a magnitude that indicators lose comparative efficiency.

III. SCIENCE AND TECHNOLOGY STATISTICS AND INDICATORS (STSI)

- Indicators that are only based on the experience of industrialized countries risk leading to confusion or to counterproductive policy and management conclusions.
  Their use may not help LDCs to define global or sectoral science and technology objectives, determine and organize priority scientific and technological activities, promote technological innovation processes, or define the most important areas for the training of scientific and technical staff, and the number of professionals to train.

III. SCIENCE AND TECHNOLOGY STATISTICS AND INDICATORS (STSI)

- It seems fair to recognize that, in spite of the above-mentioned limitations, standard methodologies have been used in LDCs in order to analyze or justify the planning, financing and management of scientific and technological activities.
  However, at present there is an urgent need to increase our body of knowledge about the activities and processes of scientific and technological development, due to the great importance they have acquired in the context of the emerging international scenes.

III. SCIENCE AND TECHNOLOGY STATISTICS AND INDICATORS (STSI)

- LDCs need to go beyond conventional input indicators (supply: research centres, researchers, training of scientific and technical staff, financial resources) and output indicators (published articles, index of quotations, licenses, patents, plans and specifications, etc.), and improve the understanding and measurement of their specific scientific and technological capacities.
  To that end, they must develop paradigms that reflect, as specifically as possible, the nature, the distinctive elements, the dynamics and the magnitude of local scientific and technological activities. Analysis and measurement categories must reflect the main problems, and the critical gaps of scientific and technological development.

III. SCIENCE AND TECHNOLOGY STATISTICS AND INDICATORS (STSI)

- At the same time, this may lead to relevant information systems that contribute in an effective way to the analysis of national science and technology problems, to decision making and to the allocation of resources.

III. SCIENCE AND TECHNOLOGY STATISTICS AND INDICATORS (STSI)

- The necessary condition to define science and technology indicators in LDCs is the analysis of their specific situations. The first priority should be the analysis of endogenous scientific research projects and the study of local technological innovation processes and technical capabilities (where, how and when innovation is carried out), directed to the formulation and use of indicators based on tangible interrelationships and products, and on the opinions of specialists (and also to contribute to the development of theoretical formulations).

III. SCIENCE AND TECHNOLOGY STATISTICS AND INDICATORS (STSI)

- Some operational strategy issues that could be taken into account:
  1. There are no paths nor (developed country) role models for LDCs
  2. There is a need to dynamically interact with diverse social systems of knowledge (and data) production and management
  3. The development and use of 'national', relevant, and significant indicators, should not allow for the masking or justification of poor quality, superficial or irrelevant scientific and technological activities; and
  4. LDCs should actively participate in and contribute to the discussion, formulation and establishment of (standard) international science and technology indicators, based on their (rigorous) national experiences.

III. SCIENCE AND TECHNOLOGY STATISTICS AND INDICATORS (STSI)

- Besides, it would important to bear in mind that what is required is not a complex and elaborate system (and process) of STIS (and the corresponding bureaucratic apparatus), but a compact system that is flexible, and reasonably easy to periodically update (approximately every three years). A system that is based on real players, on dynamic institutions, and that efficiently uses the growing (and profitable) opportunities offered by databases and information networks.

IV. STSI: AN EVOLUTIONARY APPROACH (‘POSTERIORITIES’ VRS. PRIORITIES)

1. **Science and Technology Statistics and Indicators for policy, decision-making and resource-allocation (<u>‘families of indicators’</u>), explicitly including R&D, Higher-Education, S&T popularisation activities and the gender dimension**

2. **National and international high quality data collection, dissemination and access**

IV. STSI: AN EVOLUTIONARY APPROACH ('POSTERIORITIES' VRS. PRIORITIES)

3. Technical capacity building, including quality assurance methods
4. Analysis and (subregional/regional) prospective studies
5. Identification of areas regarding methodological development

IV. STSI: AN EVOLUTIONARY APPROACH (‘POSTERIORITIES’ VRS. PRIORITIES)

6. **Establishing/strengthening relationships with S&T top decision-making institutions (national councils for S&T (R&D), university R&D funding departments)**

7. **Strengthening R&D (public and private), engineering and S&T specialized regional (and world) databases, directories and web-pages**

8. **STSI Institutional capacity building: developing regional training programmes on S&T indicators.**

eduardo martinez
chief of section
science and technology
strategic planning

UNESCO

e.martinez@unesco.org
phone: (33) 1-45684075
fax: (33) 1-45685827

1 rue Miollis
75015 paris
france