BUILDING OF S&T INSTITUTIONS FOR SUSTAINABLE DEVELOPMENT

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ABSTRACT

Building S&T capacity for sustainable Development is a more formidable challenge than just building S & T capacity. It implies building a capacity for integrated, problem-driven research on highly complex situations, at the same time as providing the basic general S&T capacity in different fields.

In order for science and Technology to effectively contribute to sustainable development, countries do require scientific capacity. The sustained and enduring investments that developed countries have made in building their educational and science and technological capacity largely explain their success. However, national investments need to be accompanied by responsible and mutually beneficial international partnerships. Experience shows that international scientific cooperation through efforts such as the creation of institutional networks, scientific exchanges and mobility, and the establishment of scientific centers of excellence among nations with weak scientific infrastructures, are excellent strategies for building scientific capacities.

Building and maintaining the qualities of key institutions of learning—especially universities—is critical to long-term capacity-building in S&T. In addition, the establishment of regional sustainable development centers/networks in representative locations, in poverty-stricken areas of the world, are a high priority. Such centers/networks could be linked by effective communication-networks with senior scientists and engineers, serving as advisors and mentors in critical fields. The centers could serve as focal points for capacity-building for students from developing countries and as training centers for visiting volunteer engineers and scientist.

BASIC CONCEPTS

Institution-building is defined as a process of creating capacity within and among organizational sets, to redefine the operating culture, formal and informal rules, conventions and norms of individual and collective work, in response to environmental change. The capacity-building efforts in developing countries must be perceived in the framework of the enormous disparities between the North and the poorly developed South, where 80% of the humanity lives & where only 10% of total outlays for scientific research are spent and only 2% of world patents are registered.

Sustainable development, with faster growth and higher productivity, requires much strong institutions. This is not only true for science and technology, but for all other sectors. The World Development Report, 2002 states;

> *"Without[2] effective institutions, poor people and poor countries are excluded from the benefits of market. The report elaborates that institutions are not immutable. Be prepared to experiment with new institutional arrangements and to modify or abandon those that fail. Learning from the success and failures of other country's experiences in institution-building can provide valuable guidance. But copying institutional models, without considering whether those they are supposed to serve need them, can waste scarce resources"*.

Coming now to components of institution-building, it is necessary to discuss briefly each component, which makes an institution strong. The framework of institutional building consists of six major components[1], which have further sub divisions described below:

1. STRATEGIC LEADERSHIP

Strategic leadership is associated with vision**,** ideas and timely action. It involves developing ways of procuring essential resources, inspiring organization-members and stakeholders to perform in ways that attain the mission, and adapting to or buffering external forces. A strategically led institution will be continuously engaged in the process of changing, adapting and following a path that leads to fulfilling the organizational objectives. The more broadly that constructive leadership is available to the organization, the more vibrant and creative the organization will be.

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2. COMPETENT HUMAN RESOURCES

Human resources of any institution are the most valuable asset. *Professional development* of researchers is necessary for building institutions. Mobilization of expatriate third-world scientists, living and working in the North, to examine critical problems in developing countries together with their colleagues in the South and to assist in building the capacity and excellence of scientific institutions in the developed world that could prove instrumental in transforming the brain-drain into a brain-gain. *Exchange* of scientists & engineers is a proven method of capacity- enhancement. Such exchanges must include a South-North-South dimension.

A *new generation* of scientists is needed, particularly for sustainability needs, with a holistic approach and transdisciplinary resources. Input and work coming from diasporas, or repatriating scientists can be a solution, but nothing replaces the need of developing a home-based scientific capacity. The programmes for Ph.D training must take into accounts the special need for sustainable development, as well as competitive research grants.

3. ADEQUATE CORE-RESOURCES

These resources include infrastructure, technological resources and finance. These are a barometer for an organization's health. As a part of understanding institution-building one has to consider the extent to which inadequate infrastructure interferes with the functioning or the potential functioning of specific S&T institutions. Achieving the critical mass in human resources must be complimented by adequate infrastructure, including modern, well equipped and maintained laboratories, libraries, independent research-funding mechanisms and especially peer-review mechanisms, access to basic communications, including internet, and adequate salaries and career recognition. There is a need to build capacity for carrying out long-term observations and research.

4. GOOD PROGRAMME-MANAGEMENT

The ongoing programs of S &T institutions are its central endeavor and, indeed, its main product. Research-support services and ongoing training should be vital programs within the organization. Program- management is the ability to develop and administer these programs in ways that support the mission. Good program-management sees to it that proper weight is given to each facet of mission-fulfillment. For instance, if producing research and conducting ongoing training are both stated priorities, each should receive commensurate resources. The main effort should be to:

- Identify and assess research needs — their relevance to national plans and priorities and any gaps in existing programs
- Set goals and strategies; identify focus areas and activities
- Develop plans that
  - are consistent with needs, strategies, and areas of focus
  - address constraints and opportunities, and
  - take into account technical and organizational capabilities
- Account for technological, economic, social, and environmental aspects, to ensure applicability of research outputs
- Find/create opportunities for funding that is secure, diversified, and sustainable
- Review, revise, and approve plans/budgets
- Generate and review research proposals; submit to and negotiate with funding agencies, sponsors, and clients
- Assimilate reviewers' comments; approve proposals, activities; allocate resources

a Research-Program Implementation: Research- program implementation should entails the following tasks:

- Implement research-objectives.
- Provide technical, administrative, and logistic support to projects.
- Identify and meet training needs.
- Disseminate/use research results, as appropriate.
- Maintain linkages with policy makers, research disseminators, and other users.

b Research Program-Monitoring and Evaluation: Monitoring and evaluating are

necessary components in the planning cycle. These activities involve:

- Establishing performance-measurement indicators and processes.
- Monitoring technical quality and scientific progress and providing feedback to researchers.
- Administrative and financial monitoring and reporting.
- Reviewing/revising procedures and resources, taking corrective measures or terminating.
- At project completion, evaluating:
  - Objectives — their overall relevance, adequacy, appropriateness, and degree of achievement
  - cost-effectiveness of activities
  - quality of outputs produced (relevance, adequacy, and appropriateness vis-à-vis objectives)
  - activities required to maximize utilization of outputs
  - lessons learned
- Based on the assessment, identifying follow-up courses of action.

c Research-Support Services: Research-supporting services in the organization that must be planned for, implemented, and monitored include:

- External linkages with relevant actors, decision-makers, and policymakers
- Management of Information and materials
- Financial and administrative services
- Field-testing and disseminating research-outputs (farm, community, and commercial trials, patents, marketing)

5. ACCELERATED PROCESS-MANAGEMENT

Taking a vision and making it a reality, through smooth-flowing, daily work in an organization, is largely dependent on the ongoing "processes." These are the internal management systems — the many mechanisms that guide interactions among people, to ensure that ongoing work is accomplished rather than hindered or blocked. They include planning, communication, decision-making, problem-solving, monitoring, and evaluation. If all are working in harmony, the outcome is that the organization is learning and accomplishing a great deal and it is the indicator of a healthy institution. If they are deficient, the organizational direction is often hampered.

Problem solving and *decision-making* are two interacting and mutually reinforcing processes that must function well at every level of an institution. These processes entail the ability to define important problems, gather the data to frame the issues, create a set of alternatives to deal with the problem, decide on solutions, create the conditions to carry out decisions, and monitor these decisions and the problem's progress. Timeliness is a key element in this process: Organizations must be able to identify important issues and act in a timely fashion.

6. EFFECTIVE INTER AND INTRA-INSTITUTIONAL LINKAGE

For S&T institutions engaged in creating and utilizing knowledge, it is vital to cultivate contacts with other institutions and groups of strategic importance to the work. These may be potential collaborators and collegial bodies, potential funders, or key institutions. Formal links with others can result in a healthy exchange of approaches and resources (including knowledge and expertise) and can serve as an important reality check. Keeping up with advances in pertinent fields of research is of crucial importance to S & T institutions. This means having access to wide-ranging sources of up-to-date information within each discipline. New information and technology of importance in the field bear directly on the organization's program-management, from the choice of research topics (to pursue) to the types of training and services the institute will provide. The nature of linkage is as follows:

a. Networks: Networks of scientists or organizations are one of the most important ways of institution- building according to international standards. They provide sharing of produced scientific knowledge, identification of common interests, understanding of impacts, dissemination and gathering of information and support through sharing of facilities. The "Educational Model Network for a global Seminar on Environment[(3)]" organized as a global network of universities (Cornell University as the center and many others from the United States,

Netherlands, Sweden, Melbourne, India & Costa Rica) is a new paradigm of education for sustainable development. It consists in videoconferencing, multiconferencing and satellite-communication systems that focus on problems, with the objective of transforming institutions and empowering global citizens cooperatively to sustain human, environmental and food systems. The global learning concept and theory is constructive, experiential learning, "learning to learn " and uses cognitive psychology

b. Centers of Excellence: These are catalysts of research, they provide capacity-building opportunities and peer revision. Such centers could be linked by effective communication-networks with senior scientists and engineers serving as advisors and mentors in critical fields. The centers could serve as focal points for capacity-building for students from developing countries and as training centers for visiting volunteer engineers and scientists.

c. Collaboration & Cooperation: The "Trieste mode[3]" an idea put forward by Abdus Salam, supported by IAEA and UNESCO, is related to the work of the international Center of Theoretical Physics, the International Center for Genetic Engineering and Biotechnology and the Third World Academy of Sciences. It constitutes a model of international capacity-building. They provide for capacity-building in the biggest sense, contribution to the return of scientists to their countries, and transferring know-how and technologies. It is a perfect example of North/ South and South/ South cooperation.

PAKISTAN'S PERSPECTIVE IN THE BUILDING OF S&T INSTITUTIONS

Keeping in view the importance of institution-building in science and technology, the Government of Pakistan has taken serious action during the last 3 years. During the 2nd meeting of National Commission for Science and Technology in the year 2000 with the Chief Executive, the overall state of S&T institutions had been discussed and it was agreed to critically assess their strengths, weakness, opportunities and threats[4]. Peer Review Committees comprising relevant experts, constituted in each S&T discipline/ subject, have been assigned the task to evaluate R&D organizations and S&T departments of universities. The reviewers had visited physically each of 528 R&D organizations, subordinate institutions, stations, unit, S&T departments of universities, etc. The common observations of the peer review committees are as follows:

i The institutions are disjointed, scattered and, in some cases, duplicating each other's efforts.
ii The institutions are under-funded, under-staffed, poorly equipped, poorly managed and non-productive.
iii Almost 95% of their budgetary allocation meets only the establishment charges.
iv The equipment has become obsolete and has no repair and maintenance facilities.
v The libraries have no modern information-facilities and institutions have poor inter and intra-institutional linkages.
vi Numbers of institution do not have well defined targets and goals and the high-quality but limited manpower working there is under-utilized.
vii Much of the failure is attributed to lack of leadership and R&D managers, who lack the knowledge of whole process of innovation and development.
viii The organization has not been able to build confidence of even local industries to resolve their problems.

a. R&D Organizations

Out of 228 R&D organizations, stations and subordinate institutions, etc, the peer review committees suggested the merger of 33 institutions, closure of 6, re-organization/restructuring of 11,up-gradation of 141 and internal administrative reforms for 22, see Fig-2.

b. S&T Departments of Universitites

As for as 300 S&T departments of universities are concerned, it was noted by the Peer Review Committees that almost 90% are below standard, in respect of input and output. It is not possible, due to limitation of time and space, to discuss in this paper each department individually selectively three main S&T subjects classified under three major disciplines are discussed, viz.

- Mathematics in Basic Sciences
- Veterinary Sciences & Animal Production in Agricultural Sciences
- Electrical Engg/ Electronics in Engineering Sciences

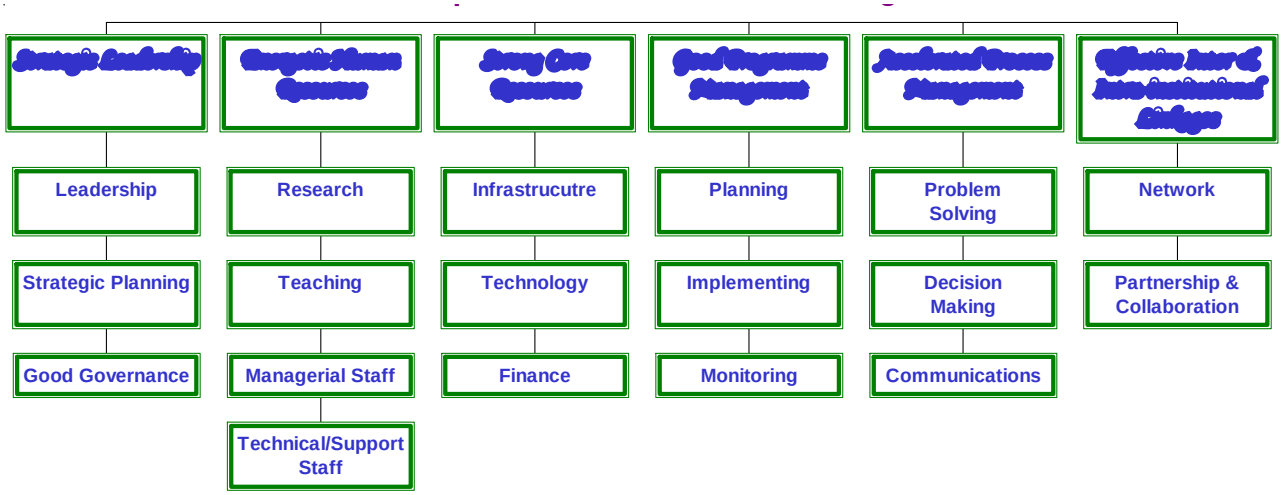


Figure - 1: Component of Institutional Building

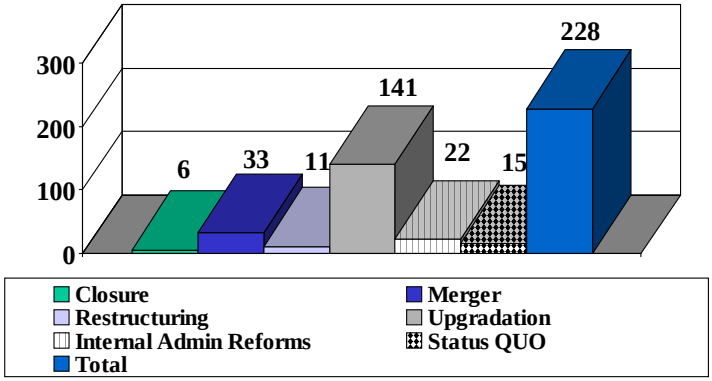
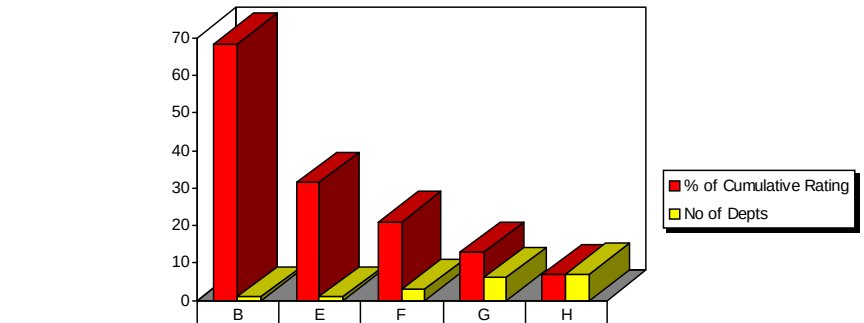
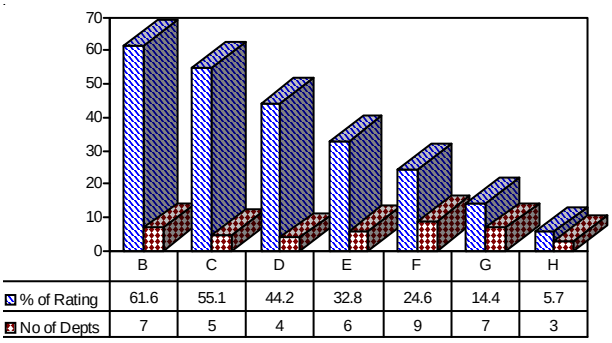


Figure - 2: Recommendations for R&D Institutional Building in Pakistan (2002)



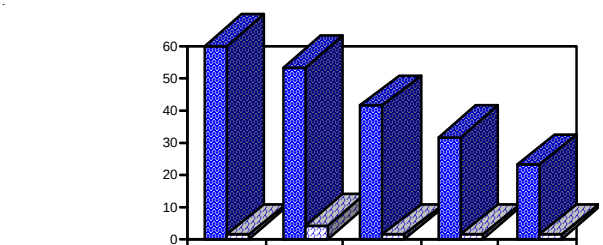
	B	E	F	G	H
% of Cumulative Rating	68.5	31.4	20.9	12.8	6.9
No of Depts	1	1	3	6	7

Figure - 3: Categorization of Mathematical Departments on the basis of cumulative rating



	B	C	D	E	F	G	H
% of Rating	61.6	55.1	44.2	32.8	24.6	14.4	5.7
No of Depts	7	5	4	6	9	7	3

Figure - 4: Categorization of departments of veterinary sciences and animal production on the basis of cumulative rating



	B	C	D	E	F
%of Cumulative Rating	60	53.5	41.4	31.4	22.8
No of Depts	1	4	1	1	1

Figure - 5: Categorization of departments of electrical engineering/electronics on the basis of cumulative rating

The situation of Mathematics is appalling. There is no worthwhile programme in all universities except one. Out of 18 departments, only 1 has been classified in category "B" (see Fig-3) in respect of input and output (scientific and technical merit, contribution towards M.Phil/Ph.D level training, quality of research, linkage/collaboration, ability to win grants & development projects and economic impact of research). There is no more than 90 Ph.D in the nation of 140 million people. There have only been about 35 Ph.Ds produced by the country so far. About 66% of the human resources are non-Ph.D; most of the remaining 33% are likely to retire by the year 2007. It was observed that there is no institutional linkage at national and international level. The libraries have no funds for subscribing journals.

The situation in the Agro-Sciences is summarized below:

1.NWFP Agricultural University, Peshawar	1
2.University of Agriculture, Faisalabad	83
3.University of Veterinary & Animal Sciences, Lahore	8
4.Sindh Agriculture University, Tandojam	2

Only 7 are placed in category "B", see Fig.4

Problem faced by these departments are multifarious, these problems can mainly be grouped into lack of operational funds, the quality of faculty, availability of infrastructure. Some of the departments have the potential to work with local industries, but the mechanism & procedure for joint appointment & research are not fully developed. Thus this interaction is never institutionalized.. [2]

The Electrical Engineering/Electronics departments of eight universities are facing the same difficulties as departments of other subjects. It is noted (see Fig-5) that out of 8 departments only one could attain grade B i.e. satisfactory while rest of 7 are below standard in respect of all those components which make an institution strong.

Let us do something before it is too late. History will not forgive us---the policy makers, science administrators & the managers.

The basic questions relate to the adequacy, effectiveness & relevance of the scientific & technical system in the context of indigenous needs: (i) Whether the growth of the science & technology institutions has been haphazard, or has been linked to the felt needs of the country, (ii) Whether requisite attention has been given to critical elements of institution-building, leadership, doctrine, programmes, resources, internal structure & linkages;(iii) Whether the system is balanced and has all the necessary structures for S&T policy, planning, coordination, education, research, extension & evaluation, and(iv) whether the system has been productive & has contributed to socio-economic development.

REFERENCES

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4. Peer Review of R&D/ S&T Institutions conducted by Pakistan Council for Science and Technology, 2001-2003.