Capacity of the public sector to support creation and application of knowledge, innovation and technology for development*

Jennifer Sisk
Division for Public Economics and Public Administration
Department of Economic and Social Affairs

I. The United Nations Millennium Declaration and knowledge, innovation and technology

Throughout the United Nations Millennium Declaration (General Assembly resolution 55/2) and the report of the Secretary-General on a road map towards its implementation (A/56/326), knowledge, innovation and technology (KIT) feature prominently as key resources that must be marshalled if those laudable goals are to be realized. [1] Although many explicit references are made to those tools, there are many more implicit references and numerous ways in which KIT can be applied to many of the development challenges contained in the Declaration and road map.

Information and Communication Technologies

In the Declaration, the General Assembly resolved to ensure that the benefits of new technologies, especially information and communication technologies (ICTs), are available to all (see General Assembly resolution 55/2, para. 20). With respect to ICTs, the road map describes them as potent instruments for accelerating broad-based growth and sustainable development and for reducing poverty, and within the recommended strategies for moving forward, it cites the need to promote universal and affordable access to ICTs; create ICTs for development strategies; support human resources development and institutional capacity-building; and build partnerships, including with the private sector (see A/56/326, para. 61). Moreover, the suggested reporting theme for 2004 is "Bridging the digital divide". ICTs can be a facilitating tool in almost every area of the Declaration, improving the quality, reach and timeliness of many development solutions and generally enhancing information and knowledge flows, collaboration and capacity building.

Transforming government and governance

Since government is a central player in realizing each of the goals contained in the Declaration, developing its capabilities and effectiveness cannot be stressed enough. There are repeated references in the Declaration and road map to good governance and democracy, including improved capacity for public service delivery of basic social services, public administration reform, integrated planning, increased citizen participation in decision-making, decentralization, transparency, accountability and combating corruption. Although technologies are not specifically mentioned, there are calls for

* A version of this paper was issued as a background document to the 2002 meeting of the United Nations Committee of Experts on Public Administration (E/C.16/2002/5). The author would like to thank Mr. Anthony Bartzokas for background contributions made to this paper.

innovation and new mechanisms for achieving the above. Foremost among those innovative tools and means for realizing improved capabilities are ICTs and the pursuit of e-government. E-government has tremendous transformative potential if used in support of good governance objectives, and can significantly change the way in which government approaches its mandate, solves development problems and interacts with other government agents, citizens and business. It can give rise to a new paradigm of governance: one that places citizens at its centre, responds to their needs and expectations, and is based on the tenets of transparency, accountability and participation.

There are numerous rewards in the social, economic and government arenas, as well as multiple challenges, associated with e-governance initiatives. However, one of the benefits to be derived from the strategic application of ICTs in government is of particular importance and has multiple impacts, namely, increased transparency through the provision of information and knowledge.[2] E-government allows for greater transparency of government activities, processes and decision-making, and can reduce corruption, a significant barrier to development. Transparency can also engender greater trust in government and a willingness of citizens to participate in the processes of governance, thereby improving the prospects for democratic governance. E-government also provides additional channels for interaction and participation. Moreover, greater ICT-enabled transparency opens governments to public scrutiny, allows citizens to assess their performance and provides a mechanism for accountability.[3] Those aspects of transparency can in turn help to ensure the relevancy and effectiveness of public service delivery. The greater provision of information, as well as knowledge, also enables the policy maker and the citizen to make more informed and judicious decisions. Such redistribution of information flows and the elimination of asymmetries can have considerable impact on decentralization, overall power relations and the empowerment of civil society.[4] Concerning knowledge as a key to the functioning of a participatory and effective democracy, the road map also emphasizes the need for better access to state information, and for greater freedom for the media and channels to receive and impart information. E-government strategies consider those issues as well.

Economic development and poverty alleviation

Within the context of poverty alleviation, the road map calls for capacity building in technology and in upgrading and diversifying export capabilities (including in the area of food production), and in improving nutrition. Also, the relationship between technology transfer and trade regimes is emphasized. Technology — a basis for increased productivity — lies at the heart of long-term economic development and can accelerate poverty alleviation. Moreover, globalization has fuelled a knowledge-intensive economy and has enhanced the value of ideas, intellectual capital and the ability to innovate, which can offer important opportunities for developing countries to upgrade and reshape traditional industries by establishing linkages with a wider set of knowledge inputs, including the local knowledge base.[5] Technology, innovation and knowledge serve as key drivers of productivity and give a competitive edge to firms. They can embody improved capital goods, innovation in processes and efficiency gains, or result in a more productive worker who has access to better health care or more nutritious food. Ultimately, increased

productivity and technological possibilities can lead to growth of entirely new sectors (from small and medium-sized enterprises (SMEs) to industry level) and improvements in traditional sectors, which may lead, in turn, to real income growth, increased employment opportunities, and, if equitably distributed, improvements in the quality of life society-wide. In that sense, KIT may offer increased possibilities for youth employment, one of the goals of the Declaration. Additionally, ICTs and knowledge-based service industries offer considerable possibilities for the economic development of small island States and landlocked countries, also key goals of the Declaration.

Sectoral applications

Health care and the challenges of infectious and other diseases are of major concern in the Declaration and road map. Technology and knowledge are particularly critical inputs to that area of development. The road map points to the need for greater access to affordable medicine and drugs while supporting the process of innovation, and particularly welcomed national efforts to promote innovation and the development of domestic pharmaceutical industries to ensure medicine for all; increased research and development on advanced medicines for those diseases that primarily affect developing countries and other technologies for the poor; enhanced immunization and vaccination programmes; general strengthening of health-care systems; access to technologies related to HIV/AIDS; and the dissemination of knowledge and research. There are a range of technologies and innovative approaches available to meet those goals, as well as tools for their management, particularly ICTs.

There are several references to technology within the Declaration's provisions concerning the environment, including environmentally sound technologies and the utilization of pollution abatement technology. The Declaration also cites the need for the World Summit on Sustainable Development, to be held in Johannesburg in 2002, to address new technologies and fully consider the impact of the revolutions in technology, biology and communication. Moreover, the road map decidedly states that all should share equally in the benefits arising from genetic resources and should carefully assess biosafety issues, particularly with regard to genetically modified living organisms. In the field of disaster management, the Road Map refers to the increased application of science and technology designed to reduce the impact of natural disasters and related technological and environmental phenomena, as well as technology transfer and training. Beyond that list of technological interventions, knowledge and technology related to water management, the prevention of land degradation and several other environmental issues contained in the Declaration can be aided by KIT practices (e.g., geographic information systems for environmental management).

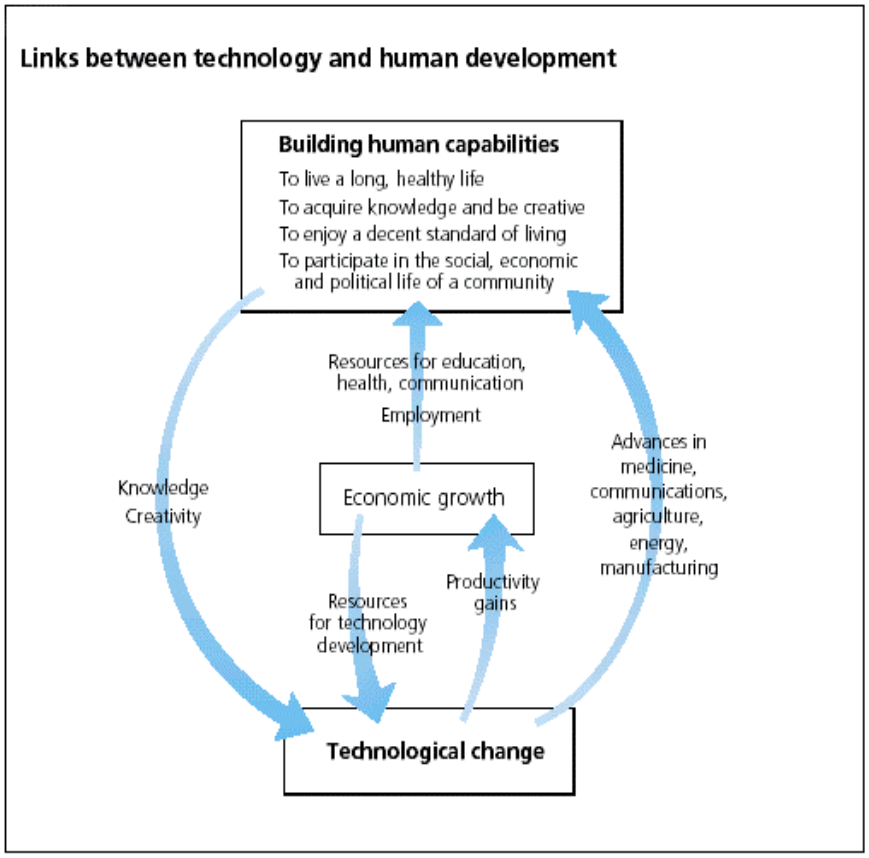
At the cross-sectoral level, in addition to ICTs there are a number of other KIT systems that reach across multiple millennium development goals, including biotechnology and basic scientific research. For example, scientific knowledge underlies the understanding of mineral, land, forest and marine resources and their sustainable use, and is critical in identifying the problems which development efforts must address, such as epidemiological knowledge of the patterns and causes of human and animal disease and

hydrological knowledge of the patterns and causes of pollution.[6] As regards biotechnology, the emerging science of genomics, indeed much of modern genetics, signals a paradigm shift that is taking place at the heart of modern science, with profound implications for developed and developing countries alike. Biotechnology solutions are being developed in health care, in the environment (such as genetic engineering of crops for improved pest resistance) and in adding value to economic development (such as the use of enzyme technology for improving the quality of textiles[7]). Finally, innovation is not limited to technical issues but should be encouraged in a social context as well. Innovation should apply to creative policy solutions, technical or otherwise, across all aspects of development and by all members of society.

KIT and development

An examination of the broader relationship between knowledge, innovation and technology and development supports the Declaration's emphasis on those tools, and presents the more complex linkages between those fields.

The dynamics between development and KIT are complex and mutually reinforcing. As noted in the 2001 Human Development Report, technology is not a reward of development but is a tool for growth and development, much like education. (at p.27) Nor should it be presented as a dichotomous choice: either technology or development. Indeed, many policy makers and development experts agree that building science and technology capacity helps developing countries to create the social capital necessary for development, particularly in a globalizing world. (Rand p.5) Moreover, there is now greater emphasis on knowledge and creative wealth as the heart of society and of development. The chart partially illustrates the dynamics between KIT and development.



Source: 2001 UNDP Human Development Report
Note: In addition to the elements in the present chart, there are other conditions within society that will affect successful technology diffusion and use, namely ancillary development and the socio-economic and political climate. Technology and knowledge are often only partial solutions to what are often not only technical problems but also socio-political problems with a technical component. For example, excellent local knowledge about farming techniques, coupled with new variants of seeds being diffused throughout society, may be powerful KIT tools for improving crop productivity or nutrition. However, unless the gender dimensions of appropriation are understood, or at a higher level, political stability or basic physical infrastructure of the country are in place, food security may still be hindered, no matter how promising the technology. In other cases, knowledge and innovation can have truly transformative effects, and those impacts on society should also be understood.

Both the benefits of KIT and the risks associated with exclusion will have even greater implications for developing countries today than in the past given the confluence of several factors, including the “information revolution”, the exponential pace of developments in other scientific and technological applications, the forces of globalization and the increasing pressures faced by developing countries (such as epidemic diseases, the depletion of natural resources, the demography of young populations or continued access gaps in mature technologies). Therefore, the concerns of

the Declaration and road map about KIT access, transfer and capacity-building are of special importance.

Ultimately, knowledge, innovation and technology are not luxuries for developing countries. This is evident from the Declaration's reference to these tools in the context of aiding Least Developed Countries (LDCs), and within many of the Millennium Development Goals. All developing countries, even LDCs, should develop a basic level of KIT capacity - not necessarily at the forefront of technology innovation - so as to be better positioned to promote development and competitiveness, exploit internal resources and adapt external ones, solve development problems from a place of empowerment, and implement existing commitments as contained in a number of international conventions, action plans and strategies. While not a panacea, technology, knowledge and innovation, as appropriately applied to development, can have a transformative effect and governments should seek to unlock this potential.

II. Knowledge, innovation and technology systems

Features and advantages

Realizing the full potential of KIT for development cannot be achieved solely on an initiative by initiative basis. Nor is it a matter of merely importing new technologies, knowledge and innovative practices from abroad. The same emphasis must be placed on the processes and relationships surrounding KIT and on basic foundational issues, as is placed on the technologies themselves. The effective elevation, enhancement and harnessing of KIT by public administration and the rest of society should be addressed in the context of a society's ability to produce, acquire, adapt, diffuse and appropriate KIT, whether existing, new or emerging and whether indigenous or exogenous. That involves a number of substantive goals, processes, actors, activities, and structures. The internal dynamics — including dependencies and complementarities — of those components are complex. For example, the fostering of medical research and development to address some of the most prevalent diseases affecting the poor will be less effective if not accompanied by concurrent efforts to strengthen national health systems and channels of delivery.[8] One cannot address the issue of environmentally sound technologies in isolation from economic policy and trade-related technology transfer. Moreover, innovation policy will have less impact if local learning processes are not in place. Therefore, capacity-building and KIT development should be based on an approach which examines and attempts to address the systemic linkages between those components.

A host of UN agencies, regional bodies, national governments, academics and practitioners have examined the issue of the Knowledge, Innovation and Technology System (KITS), variations thereof, and their sub-components. However, there is no one size fits all model, nor a blueprint that can readily be adopted. Each country may have different combinations of priorities, needs and capacity issues that will determine the look and feel of their own KITS. However, there are some common features that can be identified.

Infrastructure

Underlying KIT is its infrastructure, which comprises, inter alia, institutions and actors, such as government science and technology councils, public and private research institutes, academia, professional associations, firms and industry, NGOs, local communities, and the fluid relationships between them; physical infrastructure, such as communication, rural health-care clinics, transportation and electricity; policy instruments and legal/regulatory frameworks, including intellectual property rights, standards, contract laws, privacy issues, trade policy and global policy regimes, such as the World Intellectual Property Organization (WIPO), the World Trade Organization (WTO) and other standard-setting bodies; risk management capability, such as biosafety issues and monitoring; research and development by both the public and private sectors; and human capacity, such as primary education (general and science and math skills), tertiary education, specialized capacity, vocational training, general technological literacy and the quality of learning. In addition, ancillary support structures and their dynamics with KIT should be fully understood.

Processes

KIT is not only about static products and goods but also about their associated processes. At the highest level is the overall process of catching up, getting ahead and leapfrogging with regard to KIT development. At the next level are the processes of KIT acquisition, generation, adaptation, diffusion and appropriation. Within those levels, there are multiple sub-processes taking place, including learning cycles which generally come with fairly high transaction costs, require learning by doing and temporal stages, and involve putting new KIT systems into productive use.

Sectoral applications

A KIT system considers the strategic development of sectoral applications, policy and capacity (such as biotechnology, ICT, energy and health care), and identifies synergies between sectors and cross-sectoral applications. KIT should be integrated within and should also take into account other development sectors, such as economic development, environment and agriculture.

Society

KIT systems are not objective, nor are they inherently good or bad, but instead are embedded in social, cultural, political and economic structures, and embody the values of the society in which they are created and applied. They should also be situated in the context of globalization, changing capital markets and new societal and developmental challenges. An understanding of those interactions is critical to ensuring that KIT is relevant and successful in meeting human needs and the millennium development goals. Who is taking decisions on KIT and what are their priorities and interests? Do those decisions reflect the development interests of society? When examining the appropriation

of KIT, the impact of new knowledge and innovations on social and cultural practices should not be ignored.

Advantages of KITS

A primary advantage of the KITS approach is its treatment of the complexity and the many multidisciplinary aspects of technology in a more holistic fashion. It acknowledges that the integration of the many KIT components, with attention to the resulting dynamics, will reduce the chance of failed policies and initiatives. A KITS can provide an integrated approach for moving forward and positioning developing countries so that they gain more control over the shape and direction of their collective national intellectual, creative and technological resources, as well as the ability to better determine what, when and in what form they adopt and adapt external intellectual and technological resources. In this same vein, a KITS can also allow for greater flexibility and the ability to respond quickly to new opportunities and a changing environment. Finally, a KITS appropriately formulated, can serve as a foundation for meeting society's needs and allowing societies to "work smarter" within, and add value to, not only economic activities, but also within a broad range of social, cultural and political activities. Not all aspects of a KITS need be in place for benefits to be realized. However, the larger the number of components and effective processes in place and working together, the greater the potential for maximizing those benefits.

A KITS can provide an integrated approach for moving forward and positioning developing countries so that they gain more control over the shape and direction of their collective national intellectual, creative and technological resources, as well as the ability to better determine what, when and in what form they adopt and adapt external intellectual and technological resources. In this same vein, a KITS can also allow for greater flexibility and the ability to respond quickly to new opportunities and a changing environment. This will be critically important given the rapid pace of new technological developments and the profound changes often associated with them.

Finally, a KITS appropriately formulated, can provide a framework for the application of knowledge, innovation and technology to human development. Ultimately, they should not be about technology per se, but about the ends towards which they are directed. A KITS must serve as a foundation for meeting society's needs and allow societies to "work smarter" within, and add value to, not only economic activities, but also within a broad range of social, cultural and political activities.

Current Landscape of KITS in Developing Countries

The Special Adviser to the Secretary-General on the millennium development goals has stated that income inequalities across the globe are actually exceeded by the inequalities of scientific output and technological innovation.[9] Indeed, despite specialized pockets of excellence that can be seen in some developing countries, most fare poorly on the global ratings of innovative and technological capacity.

There exist a number of measurements and indicators to assess where countries stand in terms of scientific, technological and innovative capacity. They traditionally rate countries according to, for example, number of patents; enrolment in primary, secondary and tertiary education; gender enrolment, number of scientists and engineers; high-technology exports; number of computers, Internet hosts and telephone lines; public and private research and development; foreign direct investment (FDI); or diffusion of agricultural and manufacturing technologies. In terms of many of those benchmarks, developing countries are lagging significantly behind. So as not to reproduce voluminous tables, only the following general statistics are offered:

(a) Some 22 nations in the world (all developed countries) account for 90-95 per cent of all research and development spending, including both public and private spending;[10]

(b) Some 15 per cent of the world's population provides nearly all the world's technology innovations, while perhaps half the world's population is able to adopt those technologies and the remaining third of the world's population is technologically disconnected;[11]

(c) Some 37 countries can be considered technological leaders or potential leaders, a handful of which are developing countries; 26 developing countries make up the dynamic adopters, while the remaining 95 developing countries fall into the marginalized or other category (for which sufficient data was not available — itself a meaningful indicator).[12]

While they add up to a fairly gloomy picture, many of the above figures do not capture the local or informal knowledge and innovation that exists at the individual and community levels, much of which is relevant, important and could be better tapped. Neither do they capture the qualitative aspects of a developing country's KIT systems. However, those statistics and those found in more detailed accounts are indicative of the challenges facing developing countries. Given this overall landscape, the question remains as to how to proceed towards overcoming obstacles and making progress in putting a KITS in place and moving developing countries off the sidelines. The one certain answer to this question is that the government and public sector will be instrumental in achieving these goals.

III. National knowledge, innovation and technology systems: role of the public sector

Governments have traditionally had a hand in the evolution of science and technology capabilities, both in the development of underlying knowledge bases and in the provision of the physical and policy infrastructures on which technological progress depends. They must similarly play an active part in developing and strengthening KIT. The precise role of the public sector, and especially at the intersection of KITS and the Millennium Development Goals, will depend upon a number of factors including the level of development, existing capacities in certain areas (e.g. where there is a limited private sector the degree of government action will be higher), location factors (geography, regional priorities and niches), development priorities (e.g. pressing public goods and strategic competitiveness) and whether the state is a direct provider of public goods (KIT or development related) or contracts this function out to the private sector.

An essential function of government is correcting market failures, and the degree to which they exist in a developing country will also determine the level of government activism in KIT development. Market failures pose a significant challenge to the ability of developing countries to use KIT systems to meet basic human needs on the whole and many of the goals of the Declaration in particular. Indeed, developing countries are often beset with dynamic market imperfections associated with learning, as well as static ones, such as those associated with regulating competition.[13] Moreover, there are considerable barriers to the application of technology to public goods, resulting in serious underprovision. For example, there is currently underinvestment in many infectious and other developing country diseases because the private sector does not see commercial gain to be had for research and development investments due to, inter alia, the inability of beneficiaries to pay for treatment. Moreover, often the size of a developing country's market is not sufficient to warrant investment in specific aspects of KIT, which depend on a critical mass of ideas and technology.[14] Finally, it must be made clear that products developed in northern countries cannot merely be transplanted to developing countries. It has been pointed out that not only are developing countries poorer but their markets are qualitatively different. Indeed, they can face entirely different demographic and geographic conditions which affect the adoption of knowledge and technologies.[15] Therefore, a viable KIT system may rely on government to overcome some of those market barriers through supply, as well as to facilitate the enhancement of markets and respond to demand. On the other hand, there are also many areas where the markets function well and should be encouraged to operate without government intervention. An effective private sector and civil society free from excessive control will also be critical to KIT development.

On the whole the public sector should not be cast in an interventionist or non-interventionist role. Without an approach that acknowledges the imperfections of both the market and the state, a balanced and realistic view of such a complex issue as KITS development cannot be reached.[16] The state should rather be seen as playing a facilitating role, intervening where necessary - especially where public sector goals are not being met by private actors - and otherwise creating an enabling environment conducive to KIT generation and utilization across all levels of society and in support of human development.

Consistent with this role, there are three overarching functions which can be assigned to the public sector in the development of a KITS: (a) Strategic framework and policy formulation and implementation; (b) Value-added activities; (c). Infrastructural capacity building.[17]

Strategic frameworks and policy connected to development

A primary role of government in supporting the development of KIT systems is its function with regard to policy development and implementation, which can take several

forms, including national strategies, enabling environments, and sectoral strategies and measures. Within each of those, there is a need for more sophisticated policy frameworks that will respond to the complex processes that have been discussed in the previous section.

Government action can have a major impact by setting an overall strategy and action plan related to a country's KIT systems. It can provide the impetus for KIT development by formulating a vision and serving as a leader. It can play a key role in setting substantive priorities and goals and coordinating the development of a broad conceptual framework that is based on a systems approach. To that end, government can initiate a participatory process which brings together multiple stakeholders and results in a holistic and people-centred KIT strategy.[18] As part of that process, it can also help to ensure that there is public interest and understanding through awareness-raising and deliberative discussions, which entails highlighting the promises but also being realistic about their delivery and honest about the risks. Moreover, in fulfilling its public service obligations, government should attempt to understand the dynamics between KIT and development and place them both squarely on the country's agenda. In the process, government can also define the possibilities for the utilization of KIT in the public sector, for instance in e-government. The objective of the strategy and action plan should be to think and act strategically and in a way that suits local demands and contexts, resisting any impulses to introduce technology anywhere and everywhere or to put in place imitative frameworks.

In the implementation stage, government can also lead the effort to take stock of existing technological and institutional capacity at the national, enterprise and community levels, which might extend to key sectors as well, such as ICT and e-readiness assessments. However, all of those exercises should be part of a regular assessment process and not a one-time exercise, and should be done when government is prepared to act on the findings. Government should also devise, in concert with other stakeholders, a realistic action plan (with the traditional attributes, such as benchmarks and monitoring and evaluation). The proper timing and sequencing of policy instruments, as well as the design of appropriate incentive structures and institutions so that both credible pre-commitments and feasible implementation and enforcement devices are in place, should also be carefully considered.[19] Moreover, while KIT systems can take up to a generation to be put into place, the implementation plan should consider immediate and targeted interventions that can make a difference in the short and medium terms.

Ultimately, though led by government, this should not be a "top down" exercise. The organic activities at the community level and smaller scale initiatives throughout the nation should be recognized and built upon and should complement strategies and policies being developed at the central level.

Creating an enabling legal and regulatory framework

A second key aspect of policy development is the creation of an overall enabling environment that will allow not only government but other key actors, such as civil society, academia and the private sector, to benefit from and contribute to the

development of a national KIT framework, which might include a transparent legal and regulatory system; trade policy; setting the conditions for attracting FDI; developing a balanced intellectual property rights regime that combines incentives and better protection of developing country assets with fair use and recognition of the interests of the poor; telecommunications policy; security and privacy policy; commercial policy; and environmental, biosafety and health regulations.[20]

Sectoral Policy

Beyond a national strategy, government should develop and strengthen sectoral technology strategies and/or policies consistent with the KIT framework and national goals. For example, in the case of ICT, sectoral policies can build upon and complement KIT by focusing specifically on e-literacy, ICT private sector development and entrepreneurship, connectivity and the applications of ICTs to development, among others. Moreover, the KIT framework should also mainstream and integrate scientific and technological policy and understanding into non-technical sectors, such as the environment, where it can help to ensure that reciprocal contingencies are addressed, such as the importance of the basic rule of law and good governance for effective technology transfer through FDI or the integration of KIT into poverty reduction strategies and economic policy. All of which implies a certain amount of cross-disciplinary thinking and an integrated approach to problem solving by all actors involved.

IV. Value-added activities

In addition to setting overall strategic and policy frameworks and identifying general action plans, a second mandate of the government is to provide strategic investments and value added activities in support of a KITS and to ensure that public goods are being delivered and the needs of the poor met. These can take many forms and again will depend on local context. Some examples of value added activities by government include:

Research and development and strategic technology or knowledge development

Innovation and knowledge have strong public good properties, which hinder the attainment of optimum levels of investment in technology by the private sector.[21] Since it is difficult for private firms to capture all the benefits of such investments, total research and development spending, if left only to private sources, will result in underinvestment and the loss of many potential social benefits, especially in such areas as the environment, health care and other public service-related activities. Therefore, government-sponsored research and development is generally considered to be a public good.[22] Research and development constitutes fundamental research from which many scientific and technological innovations arise often by chance or in other cases through deliberate design. It is also a step in the process of adaptation of external or internal knowledge and technologies to local or differing conditions. Ultimately, government-

sponsored research and development and technology development can be instrumental in ensuring that KIT is meeting the needs of the poor. As highlighted earlier, much global research and development is focused on northern needs, and to the extent that the poor face distinctive challenges from the rich, science and technology must be directed purposefully towards them.[23]

There are several challenges associated with public research and development, in addition to basic resource barriers. One is to better link inputs from the grass-roots level and traditional knowledge to research and development. Another is to better connect the outputs of research and development to actual products and services (commercial or social, e.g. new medicines), through linkages with research labs, industry and SMEs and others. Another challenge is to promote competition and avoid crowding out the private sector, where viable. To that end, government can also encourage private-sector research and development and technology development, especially if it focuses on the needs of the poor, through a variety of incentives, including fiscal measures, such as loans, research grants, subsidies and matching funds.

IV.2. Partnerships

There are many attendant benefits to the establishment, or fostering, of partnerships by government at the national and supra-national level and between public and private actors from the north and south. They can positively contribute to overcoming capacity gaps through transfer of capital, ideas, methodologies, experience, and collaboration, and through pooling of resources, generating economies of scale and increasing market access. Furthermore, partnerships can distribute risks and avoid duplication of efforts. For the purpose of targeting transboundary issues or public goods where there are considerable market failures, the creation of national or regional niches or cluster partnerships can make a decisive difference. However, there are many conditions that determine whether a partnership will succeed and they must therefore be carefully constructed and not seen as a panacea. There are also challenges in ensuring equity in the relationships between actors and the distribution of benefits, and dealing with the aspect of competition with regard to research or product development with commercial potential. Specific tools available to government in encouraging partnerships include establishing a networking infrastructure; designing a regulatory framework to ensure that the rights and obligations of partners are respected; providing a forum for the exchange of information and discussion; promoting funding, research and development projects; and promoting basic absorptive capacity.[24]

Government as knowledge broker

As one of the biggest producers and consumers of information and knowledge and given both its policy-making role and its interest in promoting knowledge for development, government can act as a knowledge broker in support of KIT.[25] There are several ways in which it can effectively execute its brokerage role.

Making available its own information/knowledge

On the whole, government information and knowledge can serve as key inputs into many development goals and can be crucial in overcoming coordination failures across many sectors. The instrumental role played by government in so many facets of society and our daily lives affords it access to and control over national knowledge resources from the central to the local level and offers the advantage of economies of scale. But although much government information exists in the public domain, much of it is dispersed, unorganized and inaccessible.[26] Therefore, the challenge to government lies in how to extract, codify and deploy its information and knowledge in a meaningful way. That can be done through a variety of devices, such as one-stop-shop portals, databases, web sites, networks and traditional technologies (such as print, radio and television), and through intermediaries at the local level. It also requires addressing issues of trust, privacy, timeliness, quality, relevance and the increasing complexity in providing data, information and explicit or tacit knowledge.

Promoting diversity and pluralism of knowledge and sources of information/knowledge

Although government is an important source of information and knowledge, it is not the only one. Therefore, in the interest of promoting knowledge for development, government should also seek to promote a diversity and pluralism of knowledge, which entails greater recognition of different and valuable knowledge systems by society, including traditional and local knowledge and innovation systems which contain extremely rich experience and insights across a range of development issues and should be utilized and protected. Government, through its extension workers and local offices, can actively tap and promote those resources. Other forms of knowledge can also be promoted by encouraging debate within society and soliciting input from citizens on public policy issues. Where important knowledge is privatized, government may wish to purchase or engage in creative partnerships that makes private knowledge more readily available to society. Government can also facilitate the development of the national content industry, including broadcast, film, publishing; software and information services. The active role of public universities and libraries in making diverse sources of knowledge available and designing education policy will also be critical in enhancing the intellectual and creative capacity of society.

Promoting the capacity of government and non-State actors to disseminate/utilize/ integrate new knowledge and to convert information into knowledge

Without the capacity and mechanisms for society to absorb information and knowledge, their full impact will not be felt. Absorptive capacity will depend on many of the issues outlined earlier, including learning cycles, basic levels of education and technological literacy. Cultural issues surrounding the social appropriation of new knowledge must also be addressed by government in its policies and capacity-building activities: these include traditional practices, gender dynamics and factors of control. Within government, the sharing and utilization of new knowledge may require incentives and rewards, as well as the portrayal of those activities as a means of enhancing power and relevance, rather than

as giving up power or admitting ignorance. Moreover, a culture of innovation should be encouraged.

E-government and enabling policy:

Sharing government information and knowledge, as well as the other exchanges described above, will necessitate the development of e-government strategies.[27] E-government strategies should address the overall enabling policy and regulatory environment. Information policy, such as laws on access to information, privacy and security, regulation of media and freedom of speech, and intellectual property rights, is of particular importance. Furthermore, e-government policies can facilitate access to information infrastructure by promoting connectivity and networking. Finally, they can address critical organizational, cultural and knowledge management issues within government and generally highlight the importance of technology for development.

Building KITS infrastructural capacity for public administration and society

In addition to the above activities, government should seek to build key capabilities, both for itself and for the rest of society. These include human, institutional, infrastructural and financial capacities, among others.

Human resource development

A long-term strategy for human resource development and continuous investment in a country's education system are of the utmost importance. General enrolment, especially that of girls, in primary and secondary education is a key goal for any government and is a goal of the Declaration as well. However, higher enrolment rates should be coupled with improved quality of education and curriculum development, a greater focus on basic mathematics and science skills and technological literacy, and the facilitation of creative learning and learning-by-doing. Given the challenge of demographic trends in developing countries and the goal of the Declaration that focuses on youth employment, targeting the next generation of innovative and intellectual skills will be essential. Beyond primary and secondary education, government can fund or provide incentives for more specialized tertiary education and vocational or apprentice schemes and skill development. For all countries, especially least developed countries, an understanding of and building capacity for local learning cycles related to KIT is of special relevance. At the broader level, government support of FDI and partnerships can also facilitate practical learning. Policy measures and practical activities to minimize brain drain of science, technology and knowledge workers and the intellectual capital of society, as well as to take advantage of diaspora population through partnerships and collaboration should also constitute a value added activity by government. All of these actions are particularly critical to the generation of new knowledge and improving the creative wealth of society.

Public administration

At the level of public administration, policy makers and public officials must have themselves or have at their disposal those with a basic capacity to understand KIT-related issues, including an understanding of the possibilities of technology as an input to a development solution, the suitability of alternative technologies (both indigenous and external), trade-offs and risks, the technological implications of policy decisions, and the ability to assess contradictory scientific evidence. Scientific and technological decision-making, whether in a pure technology sector or a non-technology sector, is key to problem-solving and long-term planning processes.[28] An understanding of KIT and its sub-components is particularly important when looking at the capacity of policy makers on the international stage and their ability to affect or influence international policy regimes whose impacts are considerable. Moreover, the technological and innovative skills of extension workers and agency officials working on the front line are equally critical. Yet, for all those actors, skills and understanding will have to shift with the ever-changing landscape and new developments in technology. Therefore, skills may have to be adapted over time.

Physical infrastructure

The physical infrastructure which supports KIT, including communication, transport and electricity, will depend in part on direct government interventions and resources, in addition to related policy measures, which are traditional areas for government investment. The public sector should specifically address infrastructure issues which cannot be established and operated by individual firms or by individuals or communities. (Aherns p.12). Some direct government interventions might include the direct purchase or maintenance of equipment or establishing rural health-care clinics, and ensuring that there is connectivity to rural areas and poor populations (in cooperation with the private sector). Especially with regard to e-governance, connectivity is a prerequisite.

Institutional infrastructure

The necessary institutional infrastructure can also be supported by government, including the establishment of public institutions, such as national KIT councils, science and technology regulatory bodies, research institutes, national centres of excellence and community-level entities, which can all serve to create and diffuse knowledge and technology and act as a node in innovation networks.[29] Moreover, those government institutions can, in some cases, act as a signal in pioneering new technologies and promoting innovation from within publicly owned industry, where appropriate. Although public institutions are critical, so too are private institutions and actors. The private sector is a key participant in the innovation process and in technology transfer, generation and diffusion, as well as in turning research and development into useful products and services. Government should stimulate the private sector, particularly where it is in its nascent phase, through such mechanisms as fostering entrepreneurship (in particular SMEs), strengthening ties to universities and industry, identifying sources of venture capital, establishing technology parks and partnerships (contingent upon their benefits being linked back into broader social and economic development) and encouraging the

development of professional or research associations. Moreover, it can back up private firms by providing standards, information, scientific knowledge and facilities.

With regard to public institutional development, it is difficult to identify a basic minimum capacity. Bureaucratic and other institutions will change with policy and KIT development and will vary across sectors (e.g., bodies that monitor safety are more important with regard to biotechnology than ICTs). Therefore, public institutional development needs to be interpreted as being subject to a dynamic process. However, the establishment or strengthening of a KIT (or equivalent) ministry or body within government and identification of KIT advisers are first steps in building the institutional capacity of public administration and possibly in establishing a decision-support system, the need for which was outlined above.

Cultural and organizational issues

Cultural and organizational issues must be addressed by the public sector. The systems approach, as well as the demands of e-governance, imply greater complexity and will require considerable change management, re-engineering of processes and conceptual reorientation within government, which may involve creating change agents, a supportive climate for innovation, better knowledge management, awareness-raising and basic training. It should also be made clear that the systems approach to knowledge and innovation is not driven by the technologies per se but the end goal of working substantively across agencies and with multiple actors to achieve a common development objective through joint planning and programming. Therefore, whether looking at KIT as a whole or e-government in particular, integration should be justified on the grounds of more effective development (and not merely in the context of technological or financial convenience and efficiency), which implies a different way of approaching development.

Financial issues

There are clear and very large financial implications for all of the above. Government can attempt to rationalize and in some cases reallocate resources, gain efficiency and savings through the systems-based approach and e-government, increase potential for resource mobilization through
e-government, establish partnerships and pooling of resources, attract FDI and affect global and national policy regimes, such as trade and intellectual property rights, that have very real financial and debt consequences for developing countries. The international community must also support the mobilization of resources for developing countries to build long-term KIT capacity, as well as short-term capacity to meet the most pressing knowledge, innovation and technology needs as outlined in the Millennium Declaration and the road map. However, sustainability should underlie efforts by all actors in resource mobilization and funding.

Ultimately, there are considerable challenges to be faced when tackling the implementation of KIT for development. But there is no other choice but to proceed with capacity-building towards that end, which means that developing and developed

countries will have to play their parts and on an expedited time frame if the millennium development goals are to be wholly or partially realized by 2015.

VI. Conclusions and recommendations

A relatively complex but still incomplete and only partially nuanced picture has been presented of the relationship between the Millennium Declaration, KIT, the systems approach to KIT and the role of the public sector in its development. A few overall recommendations can be extracted from the above discussion, as follows:

(a) Governments should put in place a KIT framework that is highly contextualized, responsive to local needs and linked to human development. Developing countries should keep an eye on long-term capacity-building; while also acting incrementally and strategically in the medium term and focusing on key millennium development goals and building targeted capacity to address them in the short term. For some, that may mean more advanced and high-technology innovation and economic development, while for others it may mean focusing primarily on the various aspects of human capacity and learning;

(b) Since government is only one player in KIT, it must work actively to create an enabling environment for academia, civil society, private sectors and communities to develop and benefit from KIT. Moreover, it should concentrate on value-added activities where there are market failures related to the delivery of KIT public goods and services;

(c) As government embarks on KIT for development, it should start with its own operations and examine how they can benefit from knowledge, innovation and technology. Therefore,
e-government strategies, policies and activities should be pursued, among other interventions;

(d) As national-level KIT systems are influenced by global policy regimes, developing countries should build partnerships to collectively advocate at the international level. Partnerships should also be established to address market failures and build capacity;

(e) Finally, there is a great need for the sharing of information, knowledge and comparative experiences on KIT and its sub-components, particularly among developing countries. More work is needed to determine not only what needs to be done but also how to go about doing it and overcome bottlenecks: this is critical. In addition, there is a need for better indicators and benchmarks and materials that move from anecdote to analysis and focus on the evaluation of what works and what doesn't and why.

Resources

Accenture, “eGovernment Leadership: Rhetoric vs Reality – Closing the Gap”, 2001.

Aherns, J., “Governance and the Implementation of Technology Policy in Less Developed Countries”, UNU-INTECH Workshop on the Political Economy of Technology in Developing Countries, UK, October 1999.

Akthar, Shahid, et al., “Transparency, Accountability and Good Governance – Role of New Information and Communication Technologies and the Mass Media”, International Journal on Media Management, 124-132, Vol2. No.3-4, 2000.

Aryeetey, Ernest, “RTD in Ghana”, One World Research and Technology For Development Think Tank, August 2000.

Backus, Michiel, “E-Governance and Developing Countries: Introduction and Examples”, IICD, 2001.

Bartzokas, Anthony, “Policy Relevance and Theory Development in Innovation Studies”, UNU/INTECH, October 2000.

Bartzokas, Anthony, private correspondence, April 2002 (on file with the author).

Bartzokas, Anthony and Teubal, Morris, “A Framework for Policy-Oriented Innovation Studies in Industrializing Countries”, UNU/INTECH, Sept. 2001.

Bartzokas, Anthony and Teubal, Morris, “The Political Economy of Technology Policy in Developing Countries: introduction to a special issue of the Journal of the Economics of Innovation and New Technology”, June 2000, <http://www.intech.unu.edu/publications/conference-workshop-reports/sussex/instruction.pdf>.

Berting, Jan, Technological Impacts on Human Rights: Models of Development, Science and Technology, and Human Rights, The Impact of Technology on Human Rights: Global Case Studies, C.G. Weeramantry (ed.), 13, Tokyo: UNU Press (1993)

Corell, Robert, “A Progress Report on a Series of Regional Workshops Around the World Designed to Broaden and Deepen an Agenda for Science and Technology for Sustainability”, Presentation at the Science and Technology for a Transition Toward Sustainability Symposium, American Association for the Advancement of Science Annual Meeting. 17 February 2002.

Daly, John A., "Building Science and Technology Capacity in Developing Countries", Sustainable Development International, February 2002, <http://www.sustdev.org/industry.news/022002/Sdi-web.pdf>.

Digital Governance, www.digitalgovernance.org

Goulven, Katell and Kaul, Inge, "Global Public Goods: Making the Concept Operational", UNDP, 2002, <www.undp.org/worddocs/concept-operational.doc>.

Hamdi, Mongi, Correspondence, April 2002.

Heeks, Richard, "Understanding e-Governance for Development", Institute for Development Policy and Management", 2001.

Herrera, Amilcar, Science, Technology and Human Rights: A Prospective View, Human Rights and Scientific and Technological Development, C.G. Weeramantry (ed.), 19, Tokyo: UNU Press (1990)

IDRC/UNCTAD, An Assault on Poverty: Basic Needs, Science and Technology, Geneva: UNCTAD (1997).

Kalathil, Shanthi and Boas, Taylor, "The Internet and State Control in Authoritarian Regimes: China, Cuba and the Counterrevolution", Carnegie Endowment, 2001

Kaul, Inge, "Public Goods in the 21st Century", UNDP, 2002, <http://www.undp.org/ods/worddocs/publicgoods.doc>.

Juma, Calestous and Konde, Victor, "Technical Change and Sustainable Development: Developing Country Perspecitves", American Association for the Advancement of Science Annual Meeting and Science Innovation Exposition, February 2002.

Lewontin, R.C., Biology as Ideology, NY: Harper Perennial (1992)

Mansell, Robin and Wehn, Uta, Knowledge Societies: Information Technologies for Sustainable Development, NY: Oxford University Press (1998).

Mytelka, Lynn, "Promoting Scientific and technological Knowledge for Sustainable Development", Third UN Conference on LDCs, Round Table: "Education for All and Sustainable Development in LDCs", 16 May 2001.

Nath, Vikas, "E-Governance and an Intolerable Civil Society, Communication to GKD list serve, 12 February 2002.

Njoroge, James "New Forum to Lobby for Genomics in Africa", SciDev.Net, 2002.

Niosi, Jorge, "National Systems of Innovation are "x-efficient" (and x-effective): Why Some are Slow Learners", Research Policy, 31 (2002) 291-302.

OCED, "Policy Brief: Science, Technology and Innovation in the New Economy", 2000.

(a) OECD, "Brazil, China and India Share Knowledge Strategies", 2001.

(b) OECD, "Policy Brief: Engaging Citizens in Policy-Making: Information, Consultation and Public Participation", 2001

(c) OECD, "E-Government: Analysis Framework and Methodology", PUMA (2001) 16/ANN/REV1, 2001

One World Research and Technology For Development Think Tank, "About this Think Tank", <http://www.oneworld.org/thinktank/rtd/about_en.htm>.

Second Italian Conference on E-government, "Overview of E-Governance Agenda", 2001, <http://www.globalforum.it/htm/frame/inglese/sessioni_ing.htm>.

PANOS, "Perspective Paper: Information, Knowledge and Development", October 1998.

Reilly, Katherine, "Government, ICT and Civil Society in Central America, Working Paper 3: Defining E-Governance and E-Democracy in Central America for Action", Fundacion Acceso, 2002.

Sachs, Jeffrey, "A New Map of the World", Economist, 2000. www.economist.com

Sachs, Jeffrey, "Helping the World's Poorest", 14 August 1999, <http://www.cid.harvard.edu/cidinthenews/articles/sf9108.html>.

SciDev.Net, "Genomics and the New 'Science and Development' Paradigm", 2002 www.scidev.net

Sclove, Richard E., Democracy and Technology, NY: Guilford Press (1995)

Stiglitz, Joseph, et al., "The Role of Government in a Digital Age", Computer and Communications Industry Association, October 2000.

Stiglitz, Joseph, "Knowledge as a Global Public Good" p.308-325, Global Public Goods: International Cooperation in the 21st Century. Kaul, Inge et al ed, NY: UNDP (1999).

UN Millennium Declaration, G.A Res. 55/2 of 8 September 2000.

UN, "Road Map Towards the Implementation of the United Nations Millennium Declaration", A/56/326

UNCTAD, Report of the Preparatory Panel Meeting on the New Substantive Themes of the CSTD: Technology Development and Capacity Building for Competitiveness in a Digital Society", Commission for Science and Technology for Development, Geneva 2001.

(a) UNCTAD, "A Framework for a Common Vision for the Future Contribution of Science and Technology for Development: Elements of Change and Possible Responses", Commission on Science and Technology for Development, E/CN.16/1999/Misc.4, Geneva, 7 May 1999.

(b) UNCTAD, "Expert Group Meeting on a Common Visions for the Future Contribution of Science and Technology for Development", Commission on Science and Technology for Development, E/CN.16/1999/Misc.1, 17, Geneva, May 1999.

(c) UNCTAD, Working Groups on Science and Technology: Partnerships and Networking for National Capacity Building, Commission for Science and Technology for Development, E/CN.16/1999/2, Geneva 1999.

UNDESA, Open Plan of Action on E-government for Development, April 2002.

UNDP, Digital Opportunity Initiative Report: Creating a Development Dynamic, 2001.

UNDP, 2001 Human Development Report: Making New Technologies Work for Development, NY: Oxford University Press (2001).

UNIFEM, "Women Making a Difference in Science and Technology", 1999.

Van Der Velden, Maya, "Knowledge Facts, Knowledge Fiction: The Role of ICTs in Knowledge Management for Development", Journal of International Development 14, 2002, pp. 25-37.

Venturelli, Shalini, "Inventing E-Regulation in the US, EU and East Asia: Conflicting Social Visions of the Internet and the Information Society", Forthcoming in Telematics & Informatics: An International Journal on Telecommunications and Information Technology, 2001.

Wagner, Caroline, et al, "Science and Technology Collaboration: Building Capacity in Developing Countries?" RAND, 2001.

Whyte, Angus and Macintosh, Ann, "Transparency and Teledemocracy: Issues from an 'E-consultation'", Journal of Information Science 27(4), 2001, pp.187-198.

[1] Technology should be read to include scientific research and discovery; technological applications or the physical objects of human design; techniques, practices, methodologies and know-how to use technological artefacts; mature and traditional technologies, whether new or emerging, basic or advanced. (Berting, pp.13-16) Knowledge and

innovation include bodies of knowledge and intellectual capital, both tacit and codifiable, and the ideas produced by society.

[2] Other benefits include improved efficiencies and cost savings; more effective service delivery (reach, relevance and timeliness); decentralization; mechanisms for coordination; complementary channels for participation; income generation; and other economic, social and governance benefits.

[3] Akhtar, OECD 2001c, Backus.

[4] Nath.

[5] Hamdi.

[6] Daly, p.1.

[7] SciDev, Juma.

[8] Goulven, p.8.

[9] Sachs 1999 p.3.

[10] Rand. In developed countries, biotechnology may be focused on creating more attractive foods, while in developing countries the need is to create hardier crops resistant to drought and pests. Furthermore, there is considerable need for research and development for tropical foodstuffs where tropical countries face poor nutrition and cannot pay for food imports, Sachs 99 p. 6-7.

[11] Sachs 2000.

[12] HDR TAI.

[13] Bartzokas, correspondence.

[14] Sachs 2000 p.3.

[15] Ibid., p.4.

[16] Bartzokas, correspondence.

[17] They will be discussed broadly and should not be seen as the sum total or comprehensive account of government intervention with regard to the many features of KITS that were discussed in the section above. Rather, this presents a sample of activities which may be undertaken by government.

[18] HDR p.80.

[19] Aherns p.15-16.

[20] Sachs 2000 p.8, HDR.

[21] Hamdi.

[22] Rand p. 4.

[23] Sachs 1999 p.2.

[24] UNCTAD 1999c p.9.

[25] It is useful to distinguish between data, information and knowledge. Data and information are relatively self-contained and easier to transfer, whereas knowledge tends to reside in the individual, is based on experience and is much more difficult to transmit. Tacit knowledge is more important in the long run, but how to turn tacit knowledge into explicit or codifiable knowledge without stripping it of its context is more challenging. Yet context is key to development and to many of the goals of the Millennium Declaration because it reflects gender, race and culture, and influences how people value, share, use, create or interpret knowledge, and convert information into knowledge. (Velden p.29 and PANOS) Those distinctions and requirements should not be lost on policy makers and government officials. These distinctions and requirements should not be lost on policy makers and government officials.

[26] Kaul p.8.

[27] For more information on e-government strategies see the Government of Italy and UNDESA Action Plan for E-Government, as well as discussions on national ICT strategies, and Annex.

[28] Mytelka p.5.

[29] OECD 2000 p.11.