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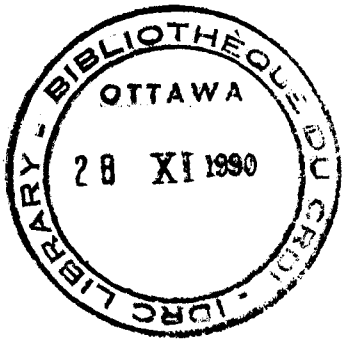
CHALLENGES FOR DEVELOPMENT IN THE ASIA-PACIFIC REGION: THE INFORMATION SECTOR, KOREA AND THE PHILIPPINES



BY KIERAN P. BROADBENT,

ASSOCIATE DIRECTOR
SCIENCE AND TECHNOLOGY INFORMATION
INFORMATION SCIENCES DIVISION
I.D.R.C. OTTAWA

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ABSTRACT

Economic Development is based on the creation of new infrastructure and a service sector capable of giving support to national economies to allow society to consolidate and grow. The newly industrialized countries (NICs) of the Asia-Pacific region are good examples of countries on the move. In the rapidly changing economies of these countries, the information sector has gained new prominence alongside other sectors. In recent years NICs have been able not only to absorb new information technologies from outside the region but also have been able to consolidate, improve and create whole new industries around them. Such countries have been termed "information societies" because they have been able to manipulate new advances in information-communication to develop their economic base. Not all countries in the region have been able to do this. This paper, therefore, will examine some of the successes in the information sector, discuss some of the problems experienced by other countries and attempt to provide some answers as to what should be done to improve their chances to keep on the cutting edge of technological change.

CHALLENGES FOR DEVELOPMENT IN THE ASIA-PACIFIC REGION: THE INFORMATION SECTOR, KOREA AND THE PHILIPPINES

BY

KIERAN P. BROADBENT

INTRODUCTION

A great deal has been written about the critical role that the spread of scientific knowledge has played in the processes of development, but less tends to be known about the all-important factor - the information function. The purpose of this paper is to try to explore the role of information in the development of some area economies and explore the reasons for their success or failure. Particular emphasis will be placed on S. Korea and the Philippines.

Modern development has been attributed partly to the rapid spread of knowledge and the ability of countries to utilize research results. In this day and age the dissemination of scientific information and the utilization of research results have become key factors in economic growth. Specialists in economic analysis have placed great emphasis on the role of technology transfer to explain why some economies grow and others do not. However, it should also be pointed out that such theories are controversial and some sociologists have questioned the role of technology transfer in economic growth. When one considers developing countries, conventional theories cannot be supported because of the wide variation in culture, and socio-economic conditions.

Nevertheless, history teaches us that major industrial countries in the past, such as Great Britain and Germany (Japan, and S. Korea in more recent times), all placed great importance in laying the necessary socio-economic infrastructures to enable development

to take place in a balanced manner. A key factor was the development and management of human resources who were encouraged to use their indigenous capacities to devise technical solutions to local problems, both by way of adapting and improving imported knowledge and equipment to suit the local environment. Many of these early industrialized countries possessed the combination of factors capable of capturing and utilizing domestic technological advances that yielded a steady flow of technical change. It was this steady stream of change that created the source of rises in productivity that lead in turn to increases in living standards. Many developing countries have been unable to successfully copy the driving forces of dynamic economic development, even from close neighbours. South East Asia is a good example where there is wide variation between country performance.

Changing Global Economy

Empirical research on technical change has shown underlying changes continuously shaping the global economy. One of the causes of these changes is the new information technologies. These technical changes in the way we handle information accentuate the technical and competitive advantage of industrialized countries over less developed countries and, at the same time, they add to the disequilibrium in international trade.1 The present structural crisis of the global economy is gradually leading to a new world order - a technological society based on information-intensive products, processes, systems and services. Just as the structural crises of the 1920s and 1930s led the move to mass production of commodities - exemplified by the Ford Motor Company - the present structural crisis is driving us towards the mass production of knowledge. We have now systemized the production of scientific information and this knowledge has become the driving force of society.2 Such changes as we are presently witnessing tend to destabilize society, and emphasize the uneven development of the global economy, placing developing countries in a vulnerable position. Shifts in the international division of labour occur and countries lacking the essential components of modernization - education, research,

1 C. Freeman, **Technology, Policy and Economic Performance: Lessons from Japan** (Falmer, U.K.: University of Sussex, 1987), p. 21.

2 J. Naisbett, **Megatrends** (N.Y.: Warner Books, 1982), p. 7.

management, and innovative capabilities - become even more isolated in international markets. The growth of electronic communication in science and commerce is disadvantageous for countries outside the information-exchange loop. New information technologies permit multinational corporations and other foreign competitors better access to local markets and local suppliers, further disadvantaging developing countries, and new information technologies are increasing the mobility of the macro service sector further facilitating the trading in services between countries. The effect on employment will increasingly be a decisive factor in the relocation of industry closer to clientele in richer countries. There is, therefore, significant evidence of the widening gap between richer and poorer countries and a growing dependent relationship of the poorer on the richer for new knowledge.

It is only in recent times that much thought has been given to the conditions for economic growth. Although heavy industries, such as those in chemical and electrical engineering which exist only because of fundamental discoveries in chemistry and physics, have arisen to change the structure of industry, economists have paid little attention to technology. It had been assumed that new processes and new products arose spontaneously in response to market forces. While this was true during periods of intense innovation, it is decreasingly so as innovation is divorced more and more from systematic scientific investigation. It was only in the 1960s that the role of R&D in economic growth became a subject of serious economic study. It was shown, for instance, that of the economic growth of the United States during the first half of this century, only about 40% could be explained by traditional factors of production, the remaining 60% was assumed to be due to technology improvements, management, and higher levels of education and training.3

3 C.G. Heden and A. King (eds), **Social Innovations for Development** (Oxford: Pergammon Press, 1984).

The Newly Industrialized Countries

This ability to create new infrastructure and service sectors to provide support to growing national economies is exemplified by the newly industrialized countries (NICs) of the Asia Pacific region: Japan, S. Korea, Taiwan, Singapore. In these countries the information sector has gained a high profile alongside other sectors of the economy and has been able to expand, and in doing so has created the means for a range of changes that have enabled the economy to consolidate its modernization through repeated application of new knowledge.

In recent years, the NICs have not only been able to absorb new information technologies and use them to launch economic growth, but also they have been able to improve on them and create whole new industries around them. Such countries have been termed "information societies" because of their ability to manipulate new advances in information-communication technologies to develop their economic base. But not all countries in the Asia-Pacific region have been able to follow suit. Some have been able to benefit from the spin-offs, others have lagged behind. Nevertheless, it is felt that all developing countries can devise policies that can both foster and create conditions that allow effective deployment of domestic resource capabilities to solve local problems.

This form of economic development ideally will be founded on the formation of new infrastructure and the development of a service sector that is capable of providing the type of supportive features that allows new information technologies to survive and grow. In the NICs the information sector is such a key sector that it has been given prominence in the national economies. This has been described as the primary information sector4 and it includes not only goods and services that provide information or are related to the collection, processing and dissemination of information but also established markets. These will include not only the micro-electronics industry, communications, media, education and training establishments, but also a wide variety of goods and services which spring up as a result of these industries and flourish because of them. The music and entertainment fields

4 M. Porat, **The Information Economy, Definition, and Measurement** (Washington, D.C.: Dept of Commerce, Office of the Treasurer, Special Publication 77-12(1)).

are a good example. There is also a secondary information sector which includes various in-house information activities: private industry databases, government information services, etc... which are not transacted on established markets but which, nevertheless, are important and are consistent with the rapid needs of economic growth.

Countries which are described as NICs have been able not only to absorb new technologies, but consolidate and adapt them, creating whole new industries around the original structures. An example of this has been the information sector in the Republic of Korea. The information sector there has been growing at a faster rate than other sectors of the economy. For instance, a study in 1987 using shift-share analysis, initially developed for use in OECD countries where the rapid growth in the amount of resources given to information dissemination in industrialized countries is already well recorded,5 was applied to the Korean economy for the period 1975-1980 - a period of intense economic growth. The results revealed that the information sector recorded the highest rate of employment expansion of any macro sector. Moreover, employment in non-information related activities was found to increase at less than half the rate than was experienced in the information sector.6 As economies grow the role of information becomes more intense and draws more of the labour force into its ranks, through direct employment and assorted, preferential industries. The primary output being processed is information. The size of the labour force engaged in information-related activities has been used as an economic indicator before (OECD 1981) and economists, such as Kaplinsky (1982) and Cole (1986) amongst others, have drawn attention to the critical role of information in economic development. Because modern methods of information processing in dissemination are crucial to a growing

5 OECD, **Information Activities, Electronics, and Telecommunications Technologies, vol 1: Input on Employment, Growth, and Trade** (Paris: OECD, 1981).

6 H.J. Engelbrecht, "An information sector perspective of employment in the Republic of Korea, 1975-1980", **Developing Economies** 25, 1 (1987), 26.

economy, it is possible to detect it and note it as an early indicator of economic progress. The Republic of Korea, Taiwan, and Singapore have all experienced this same growth feature and have well established information sectors amongst other macro sectors of their economies.

Indicators of Technical Capacity

It has been argued that the growth in information services is a significant factor underlying the economic well-being of countries and, therefore, also a major indicator of success or failure of the economies of developing countries.7 Whereas, it would be foolhardy to accept completely this hypothesis on the grounds that economic development in developing countries is far too complex, there is, nevertheless, sufficient evidence to consider it as a factor in a country's capacity to add value to the factors of production. The problem lies in a complete understanding of the processes of development. Why, for instance, would the NICs fit so well into this theory but other less developed neighbours would not? The Philippines has developed an information sector but has not the infrastructure in place with marketability and human resources, and the economy lags behind other Pacific Rim countries in terms of economic performance. Certain sectors have been well served in terms of information, e.g. agriculture. Other sectors have been less well served, e.g. industry and technology. Rapid growth in employment in information industries is not so well marked, and Information services have remained focused on the capital, Manila.

Economic theory presumes that alternative ways of producing something are known. What is known in detail are production processes in use. Less tends to be known about alternatives. These differences in degrees of information are critical because the degrees of information are the important components needed to fill the gaps in the production function. It is a case of the saying: "A little learning is a bad thing", there being a basic amount of knowledge less than which cannot be reasonably acted upon. The onus is on the recipient as the receiver of an item of information. If the recipients know very little and have little ability, they can do little even with basic knowledge because it is difficult to

7 UNCSTD, "Towards an Information Technology Resource Strategy in Development"; **ATAS Bulletin** 3 (1986), 163-165.

generate the complex detail required to complete the whole skill in a new technique. On the other hand, if recipients know a lot they can deal with complex detail; then, from just a small amount of information, they are able to create. That is why it is easy to transfer technology to Korea and Taiwan but not so easy to do so to other less developed countries.

Moreover, in every economy markets are imperfect. This is even more true in less developed countries. There will be gaps in value-added factors of production, defined in this context as information and motivation. This is where entrepreneurs come in. They are energetic gap-fillers and are major players in providing information in putting science to work. Activities at this level involve precise skills because not all aspects of information processing are easily assimilated, adapted, or used with the same degree of ease. Five criteria can be isolated in the transfer process, arranged in order from the easiest to the most difficult:

equipment
services
skills
motivation
management

Developing countries having the least competence, who lack experience and infrastructure, would need to consider this list in reverse order to be most successful. In industrialized countries, entrepreneurship, government commitment to research and education, and greater private involvement in R&D, as well as competitive spirit, are also major determinants of success.8

Large differences also exist between countries in the same region in terms of technical capacity. This is accentuated among countries in the Pacific Rim. Emphasis is required on investment and science policy. In absolute terms, the human and financial capacities of developing advantages for more efficient adoption of new technologies are investment in local R&D, education, and service sectors,(Table 1). Less developed countries remain weak

8 S. Wall, "Growth data of the information sector". In OECD, **Information Activities, Electronics, and Telecommunications Technologies, vol 2: Background Reports** (Paris: OECD, 1981) p. 15.

because the need to absorb new technology requires a greater proportion of effort in the form of funds for training and other start-up costs. This is clearly demonstrated by looking at the differences between an industrialized country and a developing country investment levels in R&D and education.

TABLE 1
INDICATORS OF TECHNICAL CAPACITY

INDICATOR (% OF WORLD TOTAL)	INDUSTRIAL COUNTRIES	DEVELOPING COUNTRIES ASIA	AFRICA	LATIN AMERICA
R&D Scientists	55.4	1.2	1.4	2.0
R&D Expenditures	66.5	0.31	1.60	0.94
Share of exports of capital goods	86.9	0.04	2.6	0.68
Developing Country Imports	90.3	0.1	5.1	0.53

Source: UNCTAD Handbook of International Trade & Development Statistics 1986 supp. UN Geneva. World Bank Development Reports.

In order to increase absorptive capacity for the efficient transfer of technology, it is necessary to put in place the means, the staff and the services to apply the technology. This is why donor aid is most important as seed money, but no amount of aid will substitute for poor state infrastructure, and lack of ongoing national financial commitment. Growth in labour employed in information is also an important indicator of economic development. Recent studies using production function analysis to examine two inputs in manufacturing - labour and purchased information services - to estimate the degree of use and underuse in comparison to other factors of production have tentatively revealed use increases in line with the state of development.9

9 H.J. Engelbrecht, "A comparative analysis of the use of information inputs in the manufacturing sectors of Korea and Japan", World Development 1 (1990), 77-89.

In addition, where empirical estimates of substitution elasticities between information and non-information inputs have been analyzed, there is evidence that employment policies also impact on the level of participation of resources given to information workers. There is a tendency to display greater expansion in employment as the economy grows. This rate is faster in Korea than in the Philippines.

Further factors to be considered in the economic progress of countries is the innate ability to accept and adapt innovations and be creative. Analysis of long-term cycles of development (Kondratieff (1925), Schrumpter (1912)), have focused these issues at national, regional and international levels.10 In this sense, one can look to the innovative potential of a country as one way of determining its prospects for growth. Adoption of innovations, however, cannot in any sense stand alone as a qualifier for success or failure but must be viewed together with other macro sectors and especially be connected to public, science and information policies in order to enhance R&D.

Role of Regional Bodies

There is also strong evidence that suggests that neighbouring countries learn from each other. This process can be enhanced when systems are in place for countries to exchange science and technology information in key subjects. The role of regional bodies in supporting information infrastructure in the Asia- Pacific region is important. UNESCO's Information Programme and Service for the Exchange of Information and Experience in Science and Technology in Asia and the Pacific (ASTINFO) is the core of UNESCO's Science Information Programmes in the region. It was established in 1983 as a result of the recommendation of the Second Conference of the Science Ministers and Economic Planning Bodies in the Asia and Pacific Region (CASTASIA II) held in Manila in 1982. Its activities are directed towards establishing and strengthening regional information infrastructures within existing structures to permit a more balanced and obstacle-free flow of technology and know-how. ASTINFO places emphasis on strategies that create within existing structures more effective co-ordinating mechanisms at national regional levels and

10 M. Olsen, **The Rise And Decline of Nations** (New Haven: Yale University Press, 1982).

allow researchers and research institutions to have better access to information and resource centres. A specific example would be its specialized information service - ISORIP (The Information System on Research in Progress) - which helps avoid regional duplication of research efforts. Another example is ASTINFO's emphasis on regional information networks, such as the Regional Network for Micro Biology in Southeast Asia, the Asian Physics Education Networks (ASPEN) to enhance science curricular development, and the Regional Network for Instrumentation and Process Control which aims to cooperate in the areas of maintenance and operation, microprocessors in instrumentation, applications of microcomputers, instrument fabrication, metrology and precision measurement.

The Case of the Republic of Korea

Korea has actively participated in such networks and has vigorously pursued policies of its own to develop its economy through use of science and technology information. The recent technological information policy of Korea officially stated in the Sixth Five-Year Economic and Social Development Plan, 1987-1991, to help the existing technological information supply services based on KIET evolve into a more effective nation-wide technological information network, and establish standards in the field of technological information services. In 1982, the Korean government merged Korea Scientific and Technological Information Centre (KORSTIC) and Korea International Economics Institute into KIET so that it could concentrate on industrial research and the dissemination of technological information. Following the establishment of Korea Institute of Science and Technology (KIST) in 1966, eight other specialised research institutes were established in such areas as machinery, electronics, chemistry, etc... to meet the increasing demand for higher technologies and to complement the functions of KIST. Each of these research institutes has a busy Technical Information Department engaged in the handling of technological information to provide information services. In compliance with the national information policy, the Korean government approved the Proposal to Design the National Technological Information System submitted by KIET, which was implemented in 1985.

The National Technological Information System is now operating with a centralized database to provide one-stop service.11 The Korea Advanced Institute of Science and Technology (KAIST) has also played a leading role in the formation of national policy since 1967.

Evidence of Korea's technical skills in information handling culminated recently at the 24th Olympic Games, held in Seoul, 1988. All aspects pertaining to the games - recording results, time, individual identification, logistics of all kinds - was handled by computer. For the first time, electronic measurement removed human error in time and record management. An E mail system with Bulletin Boards kept athletes in contact and enabled them to obtain special information, as well as providing information on a wide range of related topics. The Wide Information Network Service (aptly abbreviated to WINS) was a winner itself giving athletes and others connected with the Games an efficient means to manipulate information. In a sense, it represented the scale of technical achievement Korea had reached for since the 1960s, largely as a result of a committed nationwide drive to put and keep Korea on the cutting edge of new information technologies. In a sense, also, the Games were an indication of the planning that had involved a very precise information infrastructure under an overall national S&T policy that had come to fruition. Korea has moved steadily from under-development into a leadership position, not only for electronics in Asia, but as a model for creation rather than imitation in other hi-tech areas. It has been a policy involving a joint partnership between government and private industry. A key ingredient in its success has been entrepreneurship. Long-term plans call for pushing Korea into the same group of industrialized countries as Japan, Europe, and North America by early next century. In order to achieve this goal, Korea plans to construct 16 major dynamic RAM semi-conductor chips as the basis for an electronic leadership position in the information industry. This plan, in conjunction with other macro sectors of Korea's economy, will only work if all relevant parts of national infrastructure are in place. Accordingly, emphasis is placed on scientific and technical education both at the secondary

11 S.J. Choi, **Review of Industrialized Information Policies Existing in Developing Countries.** (Paper presented at FID/CAO Meeting, Seoul, (1990)), p. 5.

and tertiary levels. It aims to raise the number of scientists from 11 in every 10,000 population in 1986 to 18 in every 10,000 by the end of 1991. In addition, private entrepreneurship will be activated to refine and market information products. Such information products will be successfully launched through a buoyant domestic market, the formula successfully operated by Japan. The dramatic increase in Korea's labour force employed in information handling underlies this commitment to consolidate new markets. During the period 1975-1980 the labour percentage engaged in broad information work grew by some 47.5 percent, with routine information work accounting for the largest category (72 percent) in absolute terms.12

Geographical Concentration of Information Services

The information intensity of new technologies has also given rise to another phenomenon - concentration of the information sector. There has been more attention paid to this aspect of the tendency toward geographic clustering of information, a characteristic that first occurred in North America and Europe, e.g.: Columbus, Ohio, Palo Alto, California, Cambridge, UK, etc. Skilled labour tends to congregate and grow around these areas. There is now a significant body of literature on the subject.13 The ability to facilitate networking around nodal points, obtain economies of scale and minimize risk facilitate this process. These features and characteristics appear in NICs such as Korea, as well as in less developed countries in the region, e.g. Philippines. In the Philippines, information centres conform to the uniform features noted elsewhere. The concentration is around Metro Manila and Los Banos but there is less spatial correlation between the geographic pattern of information centres and other sectors of the economy, as noted in some other countries. A feature of information centres that has become common is that Universities are the focus for the development of new industries, as well as being the trap to entice new ones. The university aids recruitment, provides information employees with the benefits of attending

12 H.J. Engelbrecht (1990), op cit., p. 80.

13 P. Nijkamp, "Information Centre Policy in a Spatial Development Perspective", **Economic Development and Cultural Change**, 37, 1 (1988) 173-193. Also, E.M. Roger and J.K. Larsen, **Silicon Valley Fever** (New York: Free Press, 1984).

extramural courses in related fields easily. The interface between new knowledge and its application is facilitated by universities. The role of information centres may, therefore, be assumed crucial to regional development strategies because of the potential for developing underdeveloped areas through the creation of scientific information centres and science parks. The question will be open, however, as to the extent that the presence of information centres are potential stimulators of innovation.14

The Case of the Philippines

In the Philippines there is, at present, no articulated national information policy such as has been the case in Korea. However, there are a few activities taking place in the country which augur well for its articulation in the near future. Activities tend to cluster around Metro Manila and the Los Banos academic community. There is a great deal of activity, as evidenced by the following:

The National Information System for Science and Technology (NISST) links together all S&T related information systems in the country into one big integrated database, specifically those of the sectoral planning councils and affiliated centres. Poor coordination within the various S&T sectors is noted. However, each of the councils (e.g.: Philippine Council for Health Resources Development (PCHRD) which represents the medicinal sciences complex, and Philippine Council for Agriculture Resources Research and Development (PCARRD) for the agricultural sciences) have set about putting up their own systems with quite successful results.

The Department of Science and Technology (DOST) is the national coordinating centre for the UNESCO-sponsored Regional Network for the Exchange of Information and Experience in Science and Technology in Asia and the Pacific (ASTINFO). As such, all activities of the network are focused through DOST again making it a key institution insofar as information activities in the Philippines are concerned.

The Agricultural Information Bank for Asia (AIBA), Los Banos began automated services to the Asian region in the mid-seventies.

14 Nijkamp, op.cit., p. 183.

On another plain, the National Information Technology Program (NITP) for the Philippines is being spearheaded by the National Computer Centre. The program envisions the use of information technology to hasten national development. It promises far-reaching impact once it is fully implemented.

There is also a move to radically overhaul existing library science curricula to be able to train scientific information specialists responsive to the needs of S&T for development.

The Los Banos Science Community (LBSC) is particularly interesting as one of its major components is information-sharing, through such mechanisms as library resource-sharing. However, those with developed collections, like the University and the International Rice Research Institute (IRRI) libraries, refused to join the program due to lopsided benefits that will surely ensue in favour of the smaller libraries. This snag has yet to be threshed out.

As conceived, this community is expected to create an environment conducive to productive scientific endeavours and maximum interaction among their member institutions. Provision of housing and other social amenities for their staff is envisioned. Furthermore, it is designed to promote sharing of facilities and resources, such as libraries, computer services, development services and laboratories, between and among the members irrespective of their department affiliation.

The Los Banos Science Community is a group of agencies with the University of Los Banos as its nucleus. Its members are agencies under the umbrella of the Department of Science and Technology (DOST), Department of Environment and Natural Resources (DENR), and Department of Agriculture (DA), one international organization, one Southeast Asian centre, a national institute, and a fisheries school.

The main thrust of the community is to accelerate rural development. This involves the generation, verification, packaging, and dissemination of technologies and information to promote agricultural and natural resources development.

The Philippines Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) serves as the DOST coordinating council of the community.

Mere physical proximity to a university, however, is not enough. The strength of R&D and organizational links are what ultimately matter. Another prominent feature of successful complexes such as this is that they should function as components in larger systems of interface, rather than isolated phenomenon.15

Thus, the LBSC tries to emulate this and functions as an agent of technological and social change and development, drawing its framework from national development goals. Excellence, cooperation and relevance are its guiding concepts in implementing the following functions and services:

- To formulate programs and strategies for agriculture, forestry and natural resources research and development.
- To generate practical and productive technologies for rural development at the regional and national levels.
- To promote public welfare and development of Los Banos and surrounding communities through technical expertise and consultancy service for various development programs at all levels.
- To supply the qualitative and quantitative needs of the country for high-level manpower in agriculture, forestry, and rural development fields.
- To pool and efficiently organize efforts of institutions, decision makers and researchers towards more systematic and effective program formulation and implementation.
- To conduct basic policy researches and develop or help develop an effective machinery for policy formulation and implementation.
- To institutionalize management capabilities in the national research system, particularly in agriculture, forestry, and natural resources.
- To humanize science and technology through human-oriented integrated programs emphasizing use of appropriate technologies and opportunities ultimately aimed at enhancing people's welfare and quality of life and environment.
- To conduct joint information system planning and regular conduct of meetings to coordinate information management activities and develop LBSC-wide programs on information sharing and exchange.
- To generate funds from external sources through solicitations and sponsorships of projects as additional sources of funds for the community.

There has been a cutback in funds flowing into various institutions in the Philippines as a result of the slide of the economy in the late eighties. Nevertheless, the country has shown a modest upsurge in information activities although less well pronounced than Korea. The

15 R. Stankiewicz, "Science Parks", **ATAS Bulletin** 2 (1985), 115.

growth in labour employed in information has grown significantly during the period 1975-1990. Although firm figures are not available, estimates by DOST, the Development Academy of the Philippines (DAP) and outside data reveal a swing to employment in information since the mid-1970s.

TABLE 2
LABOUR ENGAGED IN PHILIPPINES
INFORMATION INDUSTRIES, SYSTEMS AND SERVICES

YEAR	TOTALS ('000)	PERCENT
1975	15.300	3.0
1985	19.801	6.8
1988	22.345	10.4

Source: Economist Intelligence Unit Country Profiles. DOST, Manila. DAP.

The Limitations of Information Technology Development

Constraints on widespread use of Information Technology require careful attention. Some constraints are financial and technical, others are behavioral and institutional. Financial and technical constraints can be overcome with some effort even though, in the case of the Philippines, they can be considered chronic. Behavioral and institutional constraints are more difficult to resolve and focus on access, learning, attitudes, and management.

In the Philippines, with regard to access, the problem has been hardware and software acquisition. Network access is also limited. Recent attempts to solve this have focused on geographical concentration, but communication with distant scientific colleagues outside of the computer-enhanced complexes is limited because of internal communication problems and local geography. Solving the software issue is more acute. This is especially so in science where special programme needs are not met as opposed to commerce where a wider range of programmes are usually available.16

16 D.N. Langenberg, "Information Technology and the Conduct of Research. The Users View". **Report of the Panel on Information Technology and the Conduct of Research** (Washington, D.C.: National Academy of Sciences, 1989), p. 48.

What appears lacking most are the institutional means for solving problems, as well as the inability to maintain appropriate software. This is critical in the Philippines but is not the case in Korea. Training in new information technology requires specialized skills, time and money. Local help is often not available. Little incentive to learn and adapt new skills may be available locally. Unless expatriate help is forthcoming, local help may be poorly trained themselves. A more serious constraint is management of information and all the generic issues therein. This, coupled with attitudes of staff to adoption of innovations, presents a formidable barrier to development of the information sector unless a coherent, consistent approach is taken at the significant levels of entry, maintenance, and development.

The character of the information infrastructure is, therefore, shaped in large measure by the close relationship between technology and the economy. S&T influences the character of information infrastructure in several ways. Science expands the dimensions of what is known and knowledgeable and in application it can also promote a positive attitude towards knowledge. Technology can be understood as a means for applying information to human and national resources and for transforming them into intermediate and final products of added value. In order to do this it is now important to consider other factors, such as, Management Information Systems (MIS) which are an essential component for restructuring the macro sector in developing countries. Electronic Industries are also needed to bolster local demand for information. Worldwide the electronics industry accounts for about 10 percent of manufacturing and in 1987 electronics ranked the fourth largest industry in the world. R&D expenditures in information technology industries are the biggest among all manufacturers in industrialized countries, accounting for almost 1/3 total R&D. The growth of electronic industries in NICs is also significant. Korea has moved in less than a decade to become the world's third largest manufacturer of semi-conductors. Both Korea and the Philippines, recognizing the strategic potential of domestic semi-conductor industries because they offer value-added services, input-substitution and a multiplier effect, have moved quickly to develop their production capacity.

TABLE 3
INFORMATION TECHNOLOGY EXPORTS
(IN $ MILLION)

	1983	1984	1985	1986	1987
Korea	880.6	1337.5	1137.5	1610.8	——
Philippines	901	910	711	539	605

Source: Economist Intelligence Unit. Country Profile Korea and Philippines 1989/90.

But rather than focusing on the electronics needs as a whole as Korea has done, the Philippines has tended to be more selective and has tended to broaden their involvement as capabilities increase. However, as a national policy for information development evolves, developing countries like the Philippines who are relative latecomers to the information revolution and have, therefore, missed the boat on export-led growth of information technologies like Korea, can still take heart. The experience of the NICs was that they first built up a progressive, strong domestic market based on satisfaction of user needs. At present, the world market for knowledge-based industries seems unsatiable. But in order to obtain their market share the Philippines will need more effective policies to foster and regulate R&D. In this respect, a national information policy is essential. Future growth will to a large extent depend on efficient information infrastructure being put in place.

CONCLUSION

The rapid changes taking place in information handling has major implications for developing countries. More important, in the short to medium term future is the rapid changes brought about by more enhanced software capabilities. Some countries in the Asia-Pacific region are particularly well placed to take advantage of the situation, others can expect to see their position deteriorate without massive support programmes. Nevertheless, all countries can expect to gain some advantage from the technical changes. For example, new Management Information Systems and pilot projects to use national economic databases for planning in the Philippines are bound to have a spin-off effect for the economy as a whole. Moreover, new information technologies offer new and improved means for raising research managerial capacity in developing countries -hitherto a key

source of weakness in both public and private sector development. Korea has moved decisively since the late sixties to build national infrastructure and is thus at an advantage at the present time to take a leadership role. For the Philippines to exploit its potential, attention needs to be paid to management, information policy, training, (especially training of trainers), and technical support to serve local needs. In this respect, further decentralization of information services outside of the Metro-Manila-Los Banos complex is needed. Developing countries like the Philippines cannot afford to ignore the "information revolution". The time is now to complete their infrastructural plan.

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