BUILDING TECHNOLOGICAL CAPABILITY IN DEVLOPING COUNTRIES: **THE CASE FOR A TECHNOLOGY POLICY**

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Abstract.

The paper offers some reflections on technological capability building in the context of low-income developing countries. The relevant literature strongly focuses on technological learning (enabling technical change to take place), the two important components of which are the development of human capital, and research and development (R&D). The issue is of particular concern, especially in an economic climate of liberalisation hostile to direct state intervention, at a time when the less developed countries are struggling to compete. While the literature on technology transfer that developed in the 1970s and early 1980s has been critcised for its static approach, in the recent past there appears to have developed a consensus regarding the need for improving the ability of a developing country to operate imported technology efficiently and effectively, thus enabling it to compete in the international market. After briefly reviewing the relevant theoretical background the paper surveys the state of technology policy in three countries of the Indian sub-continent -India, Bangladesh and Nepal – in order to draw some lessons. The externalities and market imperfections involved in technology development are so substantial that, if left to market forces without a technology policy, there seems little prospect of the successful building of technological capability by low-income developing countries. This does not necessarily imply direct public production of R&D; given the experience of government failures in implementing efficient resource allocation in developing countries, the specific role of the government requires careful consideration.

I. INTRODUCTION

The objective of this paper is to reflect on technological capability building (TCB) with a view to understanding some issues which are of particular relevance to low-income developing countries.

In an age when the liberalisation strategy is being followed by most developing countries, often pushed by the World Bank and the IMF, it is apparent that the ability to compete effectively at home and in international markets will largely determine the survival of a production venture. Being borrowers (or say imitators) of technology rather than innovators leaves the developing countries at a distinct disadvantage since they are unable to derive monopoly profit in any of their production activities. In fact, most of the manufactured goods exported by low-income developing countries are low-technology manufactures being produced long after the technology employed was

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invented, the main production consideration being to take advantage of the cheap labour available in these countries. Other advantages in using such a technology are that it is widely known and so is often available from many sources, and that such technology can be bought at competitive prices so long as there are no obligations in respect of suppliers' credit or tied foreign aid. On the negative side, there are a number of disadvantages. Firstly, as borrowers of technology these developing countries are heavily dependent on technology suppliers. Secondly, as the products are made using unsophisticated technology, there exists fierce competition not only among the developing countries, but also within these countries (for example, in carpet and garments manufacturing one finds thousands of firms engaged in the same line of production in a particular country). The intensive competition is an important factor in keeping prices down, causing deterioration in the net barter terms of trade of developing countries even for their manufactured exports. Thirdly, in relation to the first point, there are cases where even if a low-income developing country can manage to move to medium and high level technologies, it has to depend heavily on technology suppliers for the necessary support in plant design and installation, and also for future product and process improvements because of lack of local R&D.

Furthermore, at a time when the liberalisation strategy is strongly in fashion, direct involvement by the state may be frowned upon. Neoclassical economists may be particularly critical of any state involvement as they believe that government intervention in the trade flows of developing countries (a strategy which many developing countries followed vigorously with little success for a number of decades from the 1950s onwards) has done serious damage to resource allocation. They are, therefore, keen to see a return to the days when *laissez faire* had prevailed with a minimal government role.

Given the vigour with which the liberalisation strategy is being pursued, one might be tempted to draw conclusions such as those below:

(a) Technological capability building should be left to market forces, thus enabling it to develop efficiently without any government intervention;

(b) With regard to the first point, in the free enterprise mode of development as pursued by the industrialised countries, technological capability building does not need any government intervention.

Nevertheless, it is the contention of this paper that neither the theoretical arguments, nor the available empirical evidence, support orthodox liberal propositions such as these.

The next section (Section 2) will briefly provide some theoretical background to technology capability building (TCB). Section 3 will present a brief survey of the state of technology policy in three countries of the Indian sub-continent. In Section 4, we discuss whether low-income developing countries should have a policy with regard to the promotion of TCB, thus enabling us to draw some conclusions. Finally, in Section 5, we draw some conclusions.

II. A BRIEF THEORETICAL BACKGROUND

Since the1980s, there has been a healthy debate on the subject of technological capability building (TCB) with particular emphasis on some of the dynamic aspects (see, e.g. Enos and Park, 1988; Lall, 1987 and 1992; Huq et al., 1992 and 1993; and Bell and Pavitt, 1992). Some of the initial technology transfer studies which took place in the mid-1970s (at Strathclyde University, see e.g. Pickett and Robson, 1981, and Huq and Aragaw, 1981) were rightly criticised for focusing on the static cost-minimising approach. At the time when the studies were carried out the wastage of capital which went along with the import of large-scale capital intensive technologies by most developing countries was a matter of serious concern and, understandably, these studies tried to draw attention to the proposal that by careful selection a developing country could easily go for a better technological alternative than the one adopted. (See, e.g., Huq and Aragaw, 1981.) However, this approach was found to have exaggerated the scope for substituting labour-intensive for capital-intensive techniques, while at the same time ignoring the dynamic factors of technology assimilation, diffusion and innovation.

Thus a need was felt for a closer understanding of technology capability building, defining that concept to comprehend capabilities of selecting, assimilating, using, maintaining, adapting, designing, and even creating technology – capabilities required for the development of products and processes in response to a changing economic environment. (See Huq, 1996.) The literature which has been developing in this area since the mid-1980s has been of great help in, to a large extent, clarifying our understanding (see e.g. Enos and Park, 1987; Dahlman et al., 1987; Lall, 1987 and 1992; Huq et al., 1992 and 1993; Hikino and Amsden, 1994; and Bell and Pavitt, 1997). An important feature of this approach is that the development of technological capability is viewed as a process of learning, enabling technological change to take place. The learning process involves a number of components including (a) development of human capital, and (b) research and development (R&D).

Development of Human Capital. An important prerequisite of technology capability building is a labour force which can select, install, maintain, assimilate, design, manufacture and even create the technology. The workers do not need to be the inventors, but must have the ability to absorb borrowed technologies successfully. The mass educational development which took place in South Korea (and also in Singapore, Taiwan and Hong Kong) preceding their success in industrialization is often cited as a model of appropriate preparation.

R&D. This is considered to be the core of technology capability building. Freeman (1987) associates R&D with the national system of innovation and describes it as the decisive factor. The ease of absorbing new technologies in agriculture, thanks largely to the successful R&D carried out in Asian and South American countries, has greatly contributed to the success of the Green Revolution. There is a very high social rate of return from R&D in agriculture, typically exceeding 20% and often higher than 40% (Khan and Akbari, 1986). Unfortunately, however, investment in R&D in the manufacturing sector is negligible in most low-income developing countries.

As may be seen from Table 1, even the high-income developing countries such as Malaysia, Mexico and Brazil are fairing badly when it comes to investment in R&D and also the number of scientists and engineers engaged in R&D.

There is, however, a positive correlation of GNP per capita with R&D variables, the lower the per capita income the lower is the investment in R&D as a percentage of GDP. A similar relationship is also observed between GNP per capita and the number of scientists and engineers in R&D, the correlation coefficient being stronger here (0.8740, n = 19) than in the former relationship (0.7142, n = 19).

Table 1: Investment in R&D and the Availability of Scientists and Engineers in R&D in Selected Developed and Developing Countries

Country (*GNP per capita 1995, US$*)	Research and Development: Year	As % of GDP	R&D per capita (US$)	Number of Scientists and Engineers in R&D (1987-1997) (per million people)
Developed Countries				
UK (*18,700*)	*1996*	2.04 (1.4)	384	2,448
Canada (*19,380*)	*1997*	1.66 (n.a.)	315	2,719
France (*24,990*)	*1997*	2.25 (1.5)	545	2659
USA (*26,980*)	*1996*	2.64 (1.7)	655	3,676
Germany (*27,510*)	*1998*	2.41 (1.5)	675	2,831
Japan (*39,640*)	*1996*	2.8 (1.9)	1,226	4,909
Developing Countries				
Bangladesh (*240*)	*1995*	0.03 (n.a.)	0.1	52
India (*340*)	*1994*	0.73 (0.22)	2.4	149
Pakistan (*460*)	*1997*	0.90 (0.0)	4.4	72
China (*620*)	*1995*	0.61 (n.a)	3.8	454
Indonesia (*980*)	*1994*	0.07 (0.04)	1.0	182
Thailand (*2,740*)	*1996*	0.13 (0.04	4	103
South Africa (*3,160*)	*1993*	0.7 (n.a.)	21	1,031
Mexico	*1995*	0.24 (0.17)	11	93

(3,320)				
Brazil *(3,640)*	*1996*	0.81 (n.a.)	37	168
Malaysia *(3,890)*	*1996*	0.24 (0.17)	11	93
South Korea *(9,700)*	*1994*	2.6 (2.0)	271	2,193
Taiwan (12,400)	*1993*	1.7 (0.8)	180	n.a.
Hong Kong (*22,990*)	*1995*	0.1 (n.a.)	23	98*
Singapore *(26,730)*	*1995*	1.13 (0.6)	300	2,318

Notes: *Figures in brackets show: in col. (1) GNP per capita in US$ and in col. (3) R&D expenditures incurred by industry.*
* *Data for Hong Kong for the number of Scientists and Engineers refer to the period 1985-95.*
Figures have been rounded off.

Sources: Given the difficulty of obtaining the relevant data, especially for developing countries, we have depended on various sources and in some cases there may be some slight discrepancies, e.g., the year of data relating to the percentage of R&D in the industrial sector may not exactly match with that of R&D expenditure as % of GDP. However, the discrepancies are not of a magnitude as to provide any misleading information. The sources of data are UNESCO, *Statistical Yearbook* (various issues); World Bank, *World Development Report* (various issues); and OECD, *The Future of Asia in the World Economy* (edited by Foy et al).

III. THE STATE OF TECHNOLOGY POLICY IN THREE COUNTRIES OF THE INDIAN SUB-CONTINENT

Studies available on technology policy for some middle and high-income developing countries have helped us to see the importance of S&T infrastructure (including R&D) for technological capability building, particularly in Latin American and East Asian Newly Industrialised Countries (NICs). Such evidence is apparent from the studies made by Dahlman and Westphal (1981) and Katz (1987) on Latin American NICs, and those by Kim (1980, 1990), Enos and Park (1988), Hobday (1991), Kim and Dahlman (1992), Chen and Sewell (1996), and Lall (1997) on East Asian NICs. As observed by Lall (1997): "Technology development faces a number of market failures, and governments need to mount interventions to overcome them and promote technology deepening and diversification." (p.103). However, for the low-income developing countries there are not many studies similar to the ones on NICs. From the limited information available, we present below a brief portrayal of technology capability building as attempted in the cases of three countries of the Indian sub-continent - India, Bangladesh and Nepal.

India.[1] India is perhaps an exception in the group of low-income countries, in that it recognised the importance of S&T as a crucial factor of industrial and economic development even before the independence of the country in 1947. The two decades, the 1950s and the 1960s, following independence could be described as the period when the basic infrastructure was built. Currently there are over 200 specialized research institutions in the country, apart from over 1,200 R&D units which are managed by the public and private sectors.

As early as 1947, the importance of S&T was recognised, science as a necessary input in achieving industrial growth. Under the chairmanship of Jawaharlal Nehru, the first Prime Minister of India, planned development of S&T began with the setting up of an Advisory Committee for Coordinating Scientific Work in 1948. This was followed by the setting up of the Ministry of Natural Resources and Scientific Research. However, the Indian Government's major commitment to science came through the Scientific Policy Revolution (SPR) in 1958 with the aim of fostering, promoting and strengthening scientific research, thus helping to ensure supply of high quality scientists in adequate numbers and also secure the benefits as derived by acquiring and applying scientific knowledge. It was emphasised that national prosperity depended heavily on an effective combined role of three factors, technology, raw materials and capital, of which the key element was technology.

The supportive political environment helped the scientists to establish one of the largest infrastructures of S&T institutions in the Third World. Some of the major S&T organisations which were set up included the Department of Atomic Energy, the Council of Scientific and Industrial Research (CSIR), the Defence Research and Development Organisation, the Indian Council of Agricultural Research (ICAR), and the Indian Council for Medical Research. According to Sandhya and Jain (2002): "While India's policy on science came through the SPR in 1958, concerns for industry were reflected initially through the Industrial Policy Resolution of 1948 (subsequently revised five times). The Revised Industrial Policy (1956) stressed accelerating the rate of economic growth and speeding up industrialisation."

However, since the 1980s attention has been given to the various components of innovation, from invention to diffusion. The Technology Policy Statement, announced in 1983, placed emphasis on development of indigenous technology and efficient absorption and adaptation of imported technology.

The post-1985 economic reforms in India witnessed the opening up of the economy. In 1991, a New Economic Policy (NEP) was announced which contained liberal options for industrial licensing, foreign investment, foreign technology agreements, public sector policy, and the Monopolies and Restrictive Practices Act. However, the commitment to the development and utilisation of indigenous capabilities in technologies through investments in R&D has been maintained, although the methodology of achieving this was not clearly spelt out.

In 1993, the New Technology Policy (NTP) was announced, which aimed to give a renewed sense of purpose to indigenous technology for its accelerated development and use in the context of the 1991 NEP. A key feature of the NTP is the focus on human skill development, especially as it emphasises the training and retraining role for Research Development & Engineering (RD&E) relating to development of indigenous technology, acquisition, adaptation and absorption of foreign technology. Emphasis has also been given to the role of RD&E in technology acquisition, export promotion, and the improvement of linkages between the R&D system, universities and industry.

For promoting R&D in the industrial sector the Indian government has taken various initiatives, as for example, support measures such as income tax relief, weighted tax deduction for sponsored research, customs duty exemption for science and industrial research organisations, accelerated depreciation allowance on plant and machinery based on indigenous technology, and financial support for R&D programmes. The government-sponsored PATSER (Programme Aimed at Technological Self-Reliance) has also supported the development and absorption of technology by industry, through financial help. In the new economic environment of liberalisation, it is realised that the CSIR can play a very important role. As is reflected in CSIR's vision statement for 2001, it aims to provide scientific industrial R&D that maximises the economic, environmental and social benefits for the people of India. Moreover, CSIR is also entering into agreements of understanding with industry associations for foreign strategy alliances.

The above, however, provides a brief account from the vast range of initiatives taken by the Indian government to encourage indigenous R&D, to strengthen linkages between industry and institutions, and to reorganise and restructure R&D institutions. However, the failure of India to achieve a breakthrough in economic development is a matter of concern, obviously felt by the economists and scientists, among others. Writing in the late 1980s in the context of industrialisation in India, Lall (1987, 240-41) observed that "developing countries cannot 'leave it all to the market': they must create the supply of technical manpower to assimilate technological development, and they must set the right environment for their industries to develop the requisite capabilities and employ them in local and foreign markets. Much more is needed than adopting an outward-looking trade regime: specific policies have to be implemented on the extent of protection, domestic competition, imports of technology, the S&T infrastructure, and all the other things that influence learning and productive efficiency."

Similar concerns have been expressed by Sandhya and Jain (2002): "Although a few initiatives have been taken by the Indian government to encourage indigenous R&D, to strengthen linkages between industry and institutions and to recognise and restructure R&D institutions, what is missing is an integrated approach to link the supply and the demand sides of technology." They are particularly critical that the demand side of technology is still not taken care of by the policy pronouncements. There is failure to appreciate that the Indian success of sectors such as space, defence and atomic energy can be attributed to the clarity of mandate of their goals and sustenance of their functions over a long period of time along with integration of R&D generation and its use. Both the demand and supply sides of technology have been taken care of within the system. Substantial funds have also been made available to implement the strategies developed by them.

Bangladesh.[2] Since the independence of the country in 1971, the policy makers of Bangladesh and, in particular, the planners, have shown their awareness of the need for promoting technological capability by institution building, by motivating the entrepreneurs to introduce new products and new processes, and by collaboration between entrepreneurs and institutions with R&D facilities. Even though the *First Five-Year Plan (1973-78)* was very much concerned with the rapid rehabilitation of the war-devastated economy, it offered a clear vision of sound industrial development.

For example, its programme of development included a 'centralised research institute for all chemical industries' (p.234); in its investment allocation, separate funds were set aside for R & D, such as Tk 10.24 million for the iron and steel industry programme, Tk 6 million for sugar, Tk 3 million for leather, Tk 1.6 million for food and allied products and Tk 10.8 million for mineral industries. As far as engineering and shipbuilding are concerned the Plan proposed the establishment of an 'institute of industrial technology to secure, develop and foster proper growth of this sector'. The Plan also proposed the establishment of a 'centre for research and product development' for the food and allied industries (p.241). Indeed, it had a clear vision of institution-building for industrial development (pp.245-9). However, during the middle of the Plan period the country went through a major political change and the direction of the Plan changed.

The *First Five-Year Plan* was followed by a *Two-Year Plan (TYP 1978-80)* which aimed to: (a) consolidate and further strengthen and develop the local base for science and technology to make optimal use of natural resources and raw materials of the country through indigenous R&D and also to improve capability for effective transfer and use of imported technology; and (b) to make an effort to reduce the information and communications gap in advanced science and technology between Bangladesh and developed countries (TYP p. 196-97). Like the first Plan, the good intentions were unfulfilled. The *Second Five-Year Plan (1980-85)* envisaged that "a comprehensive approach will be made for the development of the skilled manpower, acquisition and adaptation of foreign technologies and development of technologies suitable to the condition of the country."[3] Similarly, in the *Third Five-Year Plan (1985-90)* high goals were set as shown below: "The prime mover of planned development will be the improvement of their productivity through technological and manpower development."[4]

The *Fourth Five-Year Plan (1990-95)* also remained strong in its goals for technology achievement: for example, on the macro front the fourth Plan aimed to promote 'technology transfer, adaptation and upgradation as elements of building competitiveness' (p.vi-4). The Plan aimed to achieve 'scientific and technological development for different sectors … (through) proper S&T planning and activities and institutional and human resources development' (p.XIX-4). The *Fifth Five-Year Plan (1997–2002)* continues the quest of the fourth Plan by aiming to strengthen the 'technology base'.[5] It is argued within the Plan that to obtain 'socio-economic prosperity' within a country, 'science and technology is a crucial area where development is essential' (p.531). The Plan argues that if emphasis is placed on the 'advancement of S&T research and innovations by adopting imported improved technology', by developing indigenous technology and by re-orientating R&D activities towards specific goals of national importance, self-reliance could be achieved 'within the shortest possible time'. The aims of the fifth Plan seem to mirror the aims of earlier plans; the exception being that this plan claims that R&D work up to now has been uncoordinated, hindering substantial development.

However, the declarations made in the various planning documents in most cases remain unfulfilled, although in recent years the government's intention was very clear as far as it wanted the private sector to play a key role in technological innovations and improvements. Moreover, a collaborative role was envisaged with existing R & D facilities in institutions such as the BCSIR (Bangladesh Council of Science and

Industrial Research), BAEC (Bangladesh Atomic Energy Commission) and BUET (Bangladesh University of Science and Technology), even though this remains far from being implemented.

It is apparent that a serious national commitment to technology promotion has been missing. Although the need for centralised research institutions was emphasised as early as 1973, the country still does not have any such facility in the industrial sector, the agriculture sector perhaps being the only exception with an active centralised research body. The first attempt towards the formulation of a state policy for science and technology was made in 1980. However, due to over-ambitious organisational constraints the draft could not be approved. In January 1985 the Science and Technology Division circulated another National Science and Technology Policy (NSTP) document. This draft was subsequently approved by the National Committee for Science and Technology (later renamed the National Council for Science and Technology) in the beginning of 1986. The NSTP recognizes that the integration of scientific and technological considerations into the overall development strategy of the country should be a national priority. One sub-section of the NSTP deals with the "(E)stablishment of a national capability for development of indigenous technology and attainment of a national capacity for the assessment, selection, acquisition, adoption and adaptation of foreign technology."

The formulation of the above National Science and Technology Policy was considered to be a major step in the right direction, however the progress in terms of its implementation has been rather unsatisfactory, as is apparent from the following observation in *The Task Force Report on Technology* (Mahmud, 1991, p.264): "Good intentions are of no use if they are not implemented. A Technology Policy for the country cuts across many policy areas and development sectors. Absence of any mechanism for (the) implementation and obligatory obedience to the policy by different sectors plays a vital role in not implementing the National Science and Technology Policy." The *Task Force Report* also found that a Committee was constituted named the 'Consultative Committee on Transfer of Technology' in 1987 for the implementation of the National Science and Technology Policy, which "suggested a number of action programmes and indicated the institutional arrangements for implementing those programmes. However, nothing has been implemented as yet." (Mahmud, 1991, p.264).

The authors of the National Science and Policy document were, however, aware of the various conditions which needed to be fulfilled for a successful implementation of the Science and Technology Policy, as is apparent from their following observation (GOB, 1986, p.15): 'Implementation of the policies will require a commitment on the part of the Government to undertake the much needed organisational and managerial reforms not only in agencies and institutions which generate science and technology but also in all public and private enterprises which use science and technology. In fact, the effectiveness of Science and Technology Policy would depend upon the strength of the linkage between the political and scientific/technological systems.'

The failure of the country to utilise the opportunity it had to gain technological capability is perhaps particularly striking in the fertiliser manufacturing sub-sector, which has been developed for over a period of four decades since the late 1950s, and in which the government has invested heavily during the course of establishing as many as seven large plants. (See Huq and Islam, 2002.) The studies on leather and garments manufacturing carried out during the mid-1990s also demonstrate that, as in the past, there is hardly any effort to engage in developing local R&D, although Bangladesh is keen to compete in the international market, depending heavily on imported technology. (See Huq, 2000b and Bhattacharya, 2000.)

Thus, Bangladesh's S&T infrastructure is fragmented. The amount spent on R&D is negligible, and the limited activity that exists is focused on fundamental research. Furthermore, there is hardly any R&D activity undertaken by the private sector, including the FDI sector.

Nepal.[6] The National Council for Science and Technology, formed in 1976, is the major body of the Government of Nepal; the formulation of a national science and technology policy is one of its major objectives. Its other duties include promotion and co-ordination of research activities and dissemination of S&T information. However, in the history of development of S&T in Nepal one comes across a number of apex bodies, two of which are mentioned below. The first of these is the Research Centre for Applied Science and Technology, established in 1977 (by reforming the Institute of Applied S&T which was established in 1973); its objectives include the development and adoption of appropriate technology, and improvement of traditional technology. The second apex institution which perhaps can be singled out is the Royal Nepal Academy of Science and Technology, and its objectives include the advancement of S&T for all-round development of the nation; improvement and promotion of indigenous technologies; promotion of research in S&T; and identification and facilitation of appropriate technology transfer.

As in the case of Bangladesh, the policy makers of Nepal have been trying to give a lead for technological capability building, and it was the Seventh Five-Year Plan (1985-90) which provided the Science & Technology (S&T) with a sectoral status, a position which has been continued in the Eighth Five Year Plan (1990-95). Realising the vital role of S&T, the Ministry of Science and Technology (MOST) was established in 1996 with the following objectives:

- to formulate and execute policies, plans and programmes in S&T;
- to develop and promote programmes on S&T;
- to organise research works and carry out analysis on scientific and technological development;
- to produce, supply and manage scientific and technological resources;
- to collect data and to carry out surveys on ultra-modern technologies;
- to organise national, regional and international conventions, seminars and workshops on S&T;
- to enter into bilateral and multilateral agreements and conventions;
- to develop contact and to co-ordinate with international organisations relating to S&T.

Research undertaken by Chitrakar (1994, 1999) enables us to get an understanding of some of the relevant aspects of TCB, including the state of S&T infrastructure and R&D expenditure. While Chitrakar's original studies related to FDI, subsequently he studied closely the S&T infrastructure and its effectiveness in technological capability building. A number of important findings emerge from Chitrakar's studies:

* There is no local R&D in FDI, although they are found to have contributed in investment and employment growth and also have demonstration and spillover effects.

* S&T infrastructure is fragmented.

* Hardly any private R&D, although in recent years one or two NGOs are carrying out R&D.

* Existing R&D activities, particularly at the university-level, are more orientated towards fundamental research.

A number of the findings of Chitrakar are also substantiated by a research on technology development in the micro-micro hydro sector of Nepal, carried out by Shakya (1999). She finds that R&D is almost non-existent and the S&T infrastructure needs rapid development and suitable coordination. However, by focusing on a particular sector, micro hydro, she has been able to see the technological development by examining the technology manufacturers and users. Thus viewed, she finds that the sector has some glimmer of hope. Balaju Yantra Shala (BYS), a pioneering engineering firm, started to promote the technology in collaboration with non-profit making foreign organizations. Some of the skilled hands left BYS to start their own firms and in the recent past there were in total nine industrial units producing turbines and other necessary equipment (the amount of units is now eight); working with the users of this particular technology, they have improved the efficiency of the turbines based on in-house experimentation, in effect R&D. However, there is a serious lack of coordination in the research that is being undertaken and little collaboration with the Government Research Organizations and Universities.

It is apparent that in Nepal technological capability building is still at its early stages as evidenced from a report recently submitted by a Committee on '*Policy Formulation for Institutional Strengthening and Feasibility for Establishing Multidisciplinary Science and Technology Research Centre*' (CEDA 1999). Resource constraints pose a significant obstacle, and financing for R&D in science in technology is still greatly lacking. However, the uncoordinated and fragmented nature of the entire technology system is found to be a serious problem in building technological capability in the country. The institutions exist but the progress so far is limited. Thus, a consistent and concerted approach to policy formulation and implementation is urgently required for improving the situation.

IV. CASE FOR TECHNOLOGY POLICY

It needs to be mentioned that before one can draw firm conclusions on technological capability building not only should one carry out more country case studies than has been possible here but much more in-depth analysis is also necessary. However, the brief theoretical overview and the limited empirical observations do provide us with some insights into technological capability building in low-income developing countries. Given the positive correlation between per capita income and R&D, the normal expectation is that not only will there be a low R&D share of GDP but also, compared to developed countries, much fewer numbers of scientists and engineers in R&D. Only when strong commitment is shown, as in the case of India, can one expect for technology promotion, however such commitment needs to be clearly demonstrated through strong and coordinated state action. As Sandhya and Jain found, the policy is expected to succeed only when both the demand and supply sides of technology are taken care of within the system. Bangladesh and Nepal are perhaps typical of most low-income developing countries, with a fragmented S&T infrastructure, and the amount spent on R&D is negligible. They also provide examples where technology policy has not yet been taken as an *explicit variable*. An appropriate recognition in this regard will "make it easy to consider how a technology policy will cut across various other policy areas including industrial policy, credit policy, education policy, export and import policy and tariff policy." (Huq, 2000a, p.218)

In the light of the preceding discussions, let us now try to pose the question which, we believe, needs to be answered: whether low-income developing countries should adopt a technology policy? The question is relevant in the sense that the liberalisation strategy appears to be successful in attacking rent-seeking which was rampant in the import substituting industrialisation (ISI) phase of development. The liberalisation strategy has also been found helpful in forcing investors to be competitive.

However, a distinction needs to be made between trade policy and technological policy. The liberalisation strategy which has now become almost the conventional wisdom in most countries of the world is a policy prescription more in the context of trade policy. In the case of technological capability building, market failures will remain a permanent feature in many areas, including human capital development and R&D with two obvious features:

(a) The market rate of return will be lower than the social rate of return, thus causing underproduction; and

(b) There is likely to be a lack of co-ordination between the various agents participating in the activities.

It is, therefore, not difficult to answer the question in a positive manner, that the state will need to be involved in technological capability building. The externalities and market imperfections involved in technology development are so substantial that, if left to market forces without a technology policy, there seems little prospect of the successful building of technological capability by low-income developing countries. In fact, given the very low level of R&D in most of these countries they will have to abandon the hope of technology capability building if they decide to take the liberalisation stand. This does not, however, necessarily imply direct public production of R&D. In an age where the private sector is being promoted actively, there is an obvious case for encouraging private participation in R& D, which will be directly market-orientated.

Moreover, by introducing market failure into technological capability building one should not ignore the point that government failure has been strongly associated with industrial policy in most developing countries. One therefore needs to focus on promoting the involvement of the private sector in technological capability building, while recognising the fact that the government will be required to co-ordinate the direction of research, taking its distribution and content into consideration in the interests of the economy as a whole. The experience of South Korea is particularly revealing within this context. While the government has helped in building the training and skill base and in providing some useful S&T institutions (e.g. MOST and KIST), R&D development in the private sector has been strongly pushed. The Government of South Korea took the responsibility of promoting indigenous technological development by establishing the necessary S&T infrastructure, providing its own fund for R&D and at the same time strongly encouraging private firms to undertake R&D. (See Chen and Sewell, 1996.)

Thus, while state participation is needed to correct underproduction in the required R&D, it does not follow that the state will necessarily have to engage itself in production. It is, however, essential that the S&T infrastructure needs to be significantly strengthened by coordinating the activities of the existing institutions and also by adding, as required, some new ones according to the planning and promotion programmes. The main objective is to make the production sectors competitive by acquiring various abilities - to select, assimilate, design, maintain, innovate and even create new technologies - to introduce processes and products into competitive markets. In the form of some concluding remarks, it may be mentioned that the approach suggested in this paper, fortunately, does not completely clash with the World Bank's recent thinking on the issue. In the *World Development Report* (1998/99), the World Bank suggests that action to improve information failures in developing countries should be taken.

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[1] This section depends heavily on Sandhya and Jain (2002, forthcoming).
[2] Taken largely from Huq (2000a).
[3] *The Second Five-Year Plan* (1980-85), as quoted in the *Task Force Report on 'Technology'*. (Mahmud 1991, p.262.)
[4] *The Third Five-Year Plan* (1985-90), as quoted in the *Task Force Report on 'Technology'*. (Mahmud, 1991, p. 262.)
[5] 'Introduction' to *The Fifth Five-Year Plan* (1997-2002), The Planning Commission, Government of the People's Republic of Bangladesh.
[6] Depends heavily on Manhandhar and Ranjit (2002, forthcoming).