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Development of Technological Capabilities: Success Story of India and South Korea

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INTRODUCTION

To start the process of industrialization a developing country must first acquire technology. Many developing countries, setting up new production units, have tended to purchase the latest in technology, which has been usually provided their firms with the means of transformation, but have left them ignorant about how the technology functions. Thus, technology has become a *black box,* supplied to them by outsiders. The implications of this has been serious, as it has affected the firms' ability to adapt technology to local conditions, operate it efficiently, upgrade and further adapt it once it is operating.

MECHANISMS OF TECHNOLOGY TRANSFER

Technology transfer, as generally called the acquisition of technology, can be divided into two sets:

- Technology transfer mediated formally, through the market or informally, outside the market.

- Active or passive role of foreigners in the transfer process. In the absence of former delayed and latter activised.

Under these two sets there are four different categories of technology transfers.

Formal Market Transfer With Foreigner Taking Active Part

In this case foreigner will influence the quality and quantity of the knowledge and skill involved in the transfer. He will also be able to set conditions for the use of the technology and be in a strong position while setting the price of the technology. Examples of transfer in this grouping are direct foreign investment, joint venture, turnkey project, and licensing.

Formal Transfer With a Relative Passive Role of Foreigner

This type of transfer limits foreigner's control over the use of the knowledge embodied in the technology transferred. The main example in this category of transfer is machinery purchase.

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Informal Transfer of Knowledge With an Active Role of Foreigner

This covers transfer of knowledge such as active feedback from foreigner on the shortcomings of export, and specifications for new product. This is a form of learning-by-exporting which is usually be regarded as a costless method of transfer, and it is informal in the way that the knowledge is not sold in a market.

Transfer That is Non-market Mediated and Where Foreigner Plays a Relatively Passive Role:

Examples of this type of transfer are imitation, scientific exchange and the distribution of trade journals. Here foreigner does not initiate or takes active part in the transfer, nevertheless knowledge is transferred to developing countries at a low cost.

From the experience of the newly industrialized countries, it is learnt that the development of technological capability is necessary, but not sufficient for economic growth. Often, the fastest, cheapest and most efficient way for developing countries to acquire technology is to import it. However, it is vital that this process of technology transfer instills a certain level of knowledge which will allow this technology to be absorbed by the host country and diffuse throughout its economy. It is therefore crucial that in choosing the technology and negotiating the transfer the host country and in particular the government, should be mindful of its appropriateness to the need of the country and of its dynamic potential as a source not only of output, but also of the assimilation of skills and procedures which can be linked to other firms and new activities.

DEVELOPMENT OF TECHNOLOGICAL CAPABILITIES

Besides the main activities involved in the setting up and efficiently operating a manufacturing firm, industries in the LDCs must acquire the capabilities needed for mastering them. Knowledge and skill can only be acquired through a long process of learning. This process can be both extremely complex and varied, depending on a firm's ability, its competitive environment, development in its input and output markets, their accumulated base of technological knowledge and experience, direct investment in the creation of new knowledge and skill, and the availability of imported technological knowledge from abroad. Thus, knowledge and skill involved, can be grouped into three broad categories; investment, production and innovation.

There are three types of technological capability which help in establishing, maintaining and operating industries efficiently in the Third World.

Production Capability

Encompassing the skill which is required for production, maintenance and upgrading, where production management, production engineering, repair, maintenance, and the identification of uses and markets for outputs are the main activities. The learning process involved in developing this capability can be accelerated by studying the production process and providing training and practice for the employees, in advance

of the start up of production. Other includes systematic effort of gathering and analyzing information from similar domestic production and from abroad, undertaking experiment in the adaptation and modification of technology, acquiring technological knowledge from supplier, customer and other source, and keeping record of all such new information.

Investment Capability

The ability to undertake activity independently in the development process of a firm, includes: project management, project engineering (including detail study, and engineering for providing core and peripheral technology), procurement of technology, organizational structuring and planning, ability to embody technology into physical capital, and the skill to start up production through which firm attains predetermined standards. In addition, skill in searching for and analyzing various technological alternatives prior to the investment decision, and skill in manpower training are required if a firm is to have an independent investment capability.

Innovation Capability

The ability to carry out small and large change in existing technology, the invention of new device, in product and process, and making commercial use of which are must. Previous experience in production and investment activities is, generally required for the development of this, since the development of new technology requires knowledge about the nature of change in current technology that is needed, what process and product change are technically feasible, and knowledge of means by which technology can be developed. It is important to note that the development of this capability is dependent on the explicit allocation of money and human resource because of uncertainty involved in producing and marketing new technology.

LIMIT TO THE DEVELOPMENT OF TECHNOLOGICAL CAPABILITY IN A FIRM

The most obvious restraint on the development of technological capability in a Third World manufacturing firm arises from :

- Limited resources in terms of human and financial capital, including foreign exchange.
- Nature of the technology in terms of its complexity, speed of change, required scale, interaction with different technological disciplines and the external environment that confine the technological activities of a firm.
- Government policy affect, directly or indirectly the direction, speed and depth of technological effort.
- A limitation of local human capital explicitly in entrepreneurs' ability to correctly identify technological need and existing condition in the operating

environment, such as the supply of capital, energy, skilled labour and other necessary inputs.

- The interest and objective of the owner and manager of a firm that limit a firm's technological effort, especially when there is divergence between private and social costs and market and industry structures are uncompetitive.

NATIONAL TECHNOLOGICAL CAPABILITY

The national technological capability of a country is reflected in :

- Achievement of a country in acquiring technological skill and knowledge in production, investment and innovation, across old and new industries.

- Competitiveness of its manufacturing firms in the international market.

These, in addition will depend on structural factors and incentives and pressures operating in the national economy. The industrial sector of a country might have been built up, or has the potential to build up, and has considerable experience and expertise in production, investment and innovation activities. However, when faced with outside competition it can fall short and be unable to make use of its real potential, because of restrictions imposed upon it by forces in its operating environment. These forces may be of: structural factors; incentives; constraints imposed on industry by trade polices; functioning of factory; product market; efficiency of institution set up to support the functioning of the market; provision of infrastructure, especially with respect to education, transport, communication, and Political tradition.

PROMOTION OF TECHNOLOGICAL CAPABILITY IN INDIA AND SOUTH KOREA

With an outline of the main issues mentioned, it may be useful to examine the way in which two newly industrializing countries - India and South Korea have approached the task of developing technological capabilities, and with what success.

In both countries there has been very active government participation in the process of development of technological capability, although quite different policies have been pursued by them. Table 1 shows the evolving structure of industrial activity. It indicates the success of the two countries in moving away from relatively simple low value added activities to more skill based and capital intensive ones. Their economic performance (Table 2) since 1970s, shows a growth without precedent, achieving from 1965 to 1989, an average annual growth rate of GNP per capita of 7.0 percent. During this period it can be seen how both these countries have changed the pattern of industriés after initial encouragement of only labour intensive light industries.

Table 1
Structure of Industry in India and South Korea
(percent of moving away from simple value added activity MVA)

Country	Food Beverages & Tobacco		Textile Clothing		Machinery & Transport Equipment		Chemicals		Others	
	1970	1988	1970	1988	1970	1980	1970	1980	1970	1980
India	13	10	21	13	20	27	14	17	32	33
South Korea	26	11	17	15	11	32	11	9	36	33

Source: World Bank, *World Development Report 1991*.

Table 2
Gross Domestic Product and Gross National Product Per Capita Growth Rate of India and South Korea

Country	GDP Millions of US Dollar		Average Annual Growth Rate of GDP (percent)		GNP 1965-89	
	1965-80	1980-89	1965-80*	1980-89	per capita 1989 US Dollar	Average Annual Growth Rate (percent)
India	50530	235220	3.6	5.3	340	1.8
South Korea	3000	211880	9.9	9.7	4400	7.8

* For South Korea statistics refer for the period 1970-80.
Source : Same as of Table 1.

The two major factors contributing to this growth are :

- Soaring export (an average rate of 23.2 percent per year especially during 1970s) (WDR, 1992) and
- Very high investment; 12. 7 percent during 1970s (WDR, 1992).

ROLE OF GOVERNMENT POLICIES

South Korea was established as a separate state in 1948. Initially the government focused upon building up production and export capacities encouraging labour intensive light manufacturing industries.

In 1970 a change in industrial policy took place. Since then the Korean government has actively pursued a vigorous industrial and technological development policy. Large scale, synchronized development of industries, with linkages, has been attained within a system of Five Year Plans. In moving into these industries, including

steel, machinery and petrochemical (industries being new to Korea), a precise system of requirement was stipulated and incentive outlined for acquiring the necessary technological capability.

As an incentive for investment in new industry by Korean and foreign firms, the following steps were taken :

- National Investment Fund was established to provide loan for capital project at less than the market rate.
- Tax privileges were also granted under the Foreign Investment Scheme.
- Infrastructure was provided for new investment project.
- Imported technologies were screened under the Foreign Capital Inducement Law and categorized in order of preference as following:
  - technology with high export - expansion potential i.e, technologies essential for producing components for Korean capital goods industry and
  - technology which would be costly to develop domestically and technology with potential for cost reduction and productivity increase.
- Strict terms on payment made for technology and on the right to export goods and to have access to improvement and development in the technology during the contract period, were imposed. The government generally has managed to agree terms with suppliers of technology that have allowed Koreans to absorb the technology rapidly, enabling high rate of output productivity increase and cost reduction rapidly.

It has also played a crucial role in the development of skill and human capital which accelerated technological development, employing 46.5 scientists and technicians per 1000 people in 1980-1988. The government also insists that companies must spent atleast 5 to 6 percent of their total budget on education and training programs, and the proportion of GDP spent on research and development in South Korea was 2 to 3 percent in 1988 and is planned to reach 5 percent by the Year 2000.

India gained its independence in 1947 and introduced its Industrial Policy Resolution in 1948. The policy undertook the following steps :

- Limited role for private sector.
- Direction of industrial development and investment in Five Year Plans.

Direct control over national investment by Licensing Authority controlling the activity of the manufacturing firms, which includes product kind, scale of firm, type of technology, source of inputs, payment to workers, price of finished goods.

- Encouragement to growth of small scale industries;
- Control of production and price of essential commodities.
- Enforcement of high excise duty on luxury goods.

These steps resulted in foreign exchange constraint and export pessimism.

In 1950s India embarked upon nationalistic import- substitution strategy with self reliance in almost all sectors, as a goal. This had serious implication on export import paving the way for protection of local manufacturers. The government set up state run science and technology infrastructure, provided incentives to set up and strengthen in-house R & D effort of manufacturing industries. Furthermore, the government actively aimed its education policy at providing industry with large base of skilled technological manpower.

After late half of 1970s, import restriction was eased slightly to allow the upgrading of technology by introducing some competition, with mixed results. In general the regime created high cost and inefficiencies, with growth being arrested in many sectors. Restricted access to the latest foreign technology, together with reduced need to develop marketing skills, limited incentive and infrastructural constraint become the general characteristics of the Indian industrial sector.

Some of the positive achievement in Indian technology adaptation including, adaptation of capital goods to meet local customer need, transmission of technology to subcontractor, new product development and diversification in response to international competition, and some cost - saving measures are distinct.

ACQUISITION OF KNOWLEDGE AND SKILL

Investment in human resource in terms of formal education and training has been recognized as an important factor in the process of economic development. Supply of skilled workers and entrepreneurs is very important to any industrializing country. Required eduction and training increase with complexity of technology and level of industrialization complex. Table 3 presents a comparable data on educational attainment for the two countries and some other industrialized countries.

Table 3
Education Enrollment in Selected Countries (percent of age group)

Country	Primary		Secondary		Higher	
	1965	1988	1965	1988	1965	1988
India	74	99	27	41	5	9
South Korea	101	104	35	87	6	37
Japan	100	102	82	95	13	30
UK	92	107	66	83	12	23
USA	100	100	n.a.	98	40	60

Source : World Bank,*World Development Report 1988 and 1991.*

Extent of vocational education in India and South Korea is shown in Table 4. It gives an indication of the spread up of basic skill and available supply of skilled labour in the industry.

Table 4
Tertiary Level Students in Technical Fields in India and South Korea

	India (1980)		South Korea (1987)	
Area	No. in '000	Percent to the total enrollment	No. in '000	Percent to the total enrollment
General Science & Engineering	1443.0	0.21	585.8	1.46
Natural Science, Maths & Compulsory English	1269.9	0.19	320.6	0.76
Engineering only	397.0	0.06	227.6	0.54
Total	3109.9	0.46	1133.6	2.76

Source : UNESCO, *Statistics on Science and Technology 1987.*

The measure of production capability is well depicted by the high rise in the increase of exporting firms and their recognition abroad in Table 5 and 6.

Table 5
Industrial Project Export, Consultancy Export of India and Direct Foreign Investment in India

(in Percentage)

	Manufacturing	Non-manufacturing	Total
Cumulative Industrial Project Export (Mid 1982)	91.7	8.3	100.0
Consultancy Export (1978-79)	63.1	36.9	100.0
Foreign Direct Investment (Aug.1980)	81.7	18.3	100.0

Source : Lall, *Building Industrial Competitiveness in Developing Countries 1992.*

Table 6
Licensed Project-related Export of South Korea by Industry Sector

(in Unit)

	Manufacturing	Social Overhead	Services	Total
Overseas Construction	2055	41777	121	43953
Plant Export	472	2098	-	2570
Direct Investment Project	67	35	-	102
Disembodied Technology Export	-	85	93	178

Source : South Korean National Bureau of Statistics, *Industrial Census Report 1990,* South Korea.

The investment in research and development (R & D) related with industry gives a good picture of the rise in the interest and capability of the two countries in the innovation of industry. This is well reflected in Table 7.

Table 7
Research and Development Expenditure in India and South Korea

	India (1984)	South Korea (1986)
R & D Expenditure percent of GDP	0.9	1.6
Percentage of R & D in Productive Sector	26.0 (0.2)	67.1 (1.2)
Percent R & D in Productive Sector Finance by Enterprises	13.0 (0.1)	80.9 (1.5)
Scientists in R & D in '000 number	100.1	47.1
Engineers in R & D in '000 number	132.0	1133.0

Note : Figures in parenthesis indicate percentage of GNP.
Source : Same as of Table 5.

CONCLUSION

The success of South Korea in developing a relatively high technological capability is revealed in : technology export, education structure and absorption capability of foreign technology.

The factors which have contributed to this success are: entry into capital goods and chemical industries, build up technological capability, substitution of imported goods, comprehensive planning by government and industry, ensuring necessary resources, development of adequate infrastructure and support institution for industry, serious and uncompromising negotiation with all potential foreign technology transfers, including manpower training and right to future access, domestic improvements in the transferred technology, adaptation of transferred technologies, emphasis on production and export of capital and high value added consumer durables and built up of forward and backward linkages in the economy.

Although Indian industrial development is less impressive compared to South Korea yet, it is worthy of admiration when compared to other LDCs. Despite the pitfalls, her success, has been determined by : acquisition of advanced technological knowledge and skill, pursuit of nationalistic goal, self reliance objective and heavily regulated domestic environment.

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