Strategic Technology Management and International Competition in Developing Countries — The Need for a Dynamic Approach

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The present scenario of free trade, globalization and intense international competition calls for a strategic development of technology management particularly in the developing country enterprises to enable them to quicken technology capability building and compete in the international market. The present paper explores the need and measures to adopt such a strategy and build up technology innovation systems to leap-frog and meet the above objectives taking a few examples from Indian scenario. It is argued that the ITC of a country is the sum total of TM capabilities of the firms in that country. Moreover, both TM and ITC are cumulative, incremental and are therefore evolutionary in nature. It is necessary, therefore, to talk about dynamic indicators of ITC. Such dynamic indicators are captured best in the mechanisms of selections — of choices and preferences on structures of incentives and strategies. We argue that national indicators of ITC are the same as the firm level indicators of dynamic TM; and indicators of dynamic TM are the indicators of choices and preferences on structures of incentives and strategies.

Introduction

Rapid industrialization is an imperative for the developing countries. In this context the subject of technology development and its management is crucial. In the present scenario of globalization and international competition, an additional significance for the developing countries is the thrust now needed to be given to the strategic development of technology management (TM). Indigenous technology capability building in these countries can effectively enable them to compete in the international market. Technological development has not usually flourished in the developing countries in the absence of building up of sufficient Indigenous Technological Capabilities (ITC). Ishikawa, in his study on role of import of technology on ITC, stresses that a proper mix of foreign technology(tf) and indigenous technology(td) is necessary for raising the total level of indigenous technological capability (TD). Once this level of TD is raised, the system is capable of importing more advanced technologies(tf). Successful absorption and adaptation of a technology in a system raises its level of ITC which, in turn, determines the sophistication of the technology it can further import. Thus, ITC is the product of continuous amalgamation of indigenous R&D and imported technologies. The present paper is about the indicators of ITC. The kind of technologies a country can assimilate and disseminate largely depends upon the level of its existing ITC. If the gap in the technology imported and existing ITC of the recipient country is too large, then there is every possibility that the technology may not get assimilated fully in a short span of time. The result of this is that the technology gets outdated and the recipient country may have to depend on import of the “improved versions” of the same technology repeatedly. The differential of ITCs between the donors and recipients, i.e. the “technology gap” determines the mode of technology transactions which, in turn, affects the building of ITC in the recipient country. Further, this ITC of a country is a total multiple effect of the ITC’s built up at the firm level through the process of technological management and change. Countries with successful experience in TM have come to realize that a minimum level of technological competence is required, not only to modify and adapt foreign technology to local needs, but also to provide the basis to an intelligent selection from out of the wide range of potential supplies. The proper selection from the alternative technologies available from abroad requires a considerable amount of technical knowledge which is difficult to acquire in the absence of any domestic experience. It has been acknowledged that creating Strategic
Technology Management (TM) as a main factor of technological capability is of vital importance to the developing countries.

The technology management problems of the developing countries can be broadly summarized in a few questions. How can the technology and technological capability of a developing country be developed? How to use the technology it possesses? Which products should it manufacture now and which later? What capabilities does it need for production, both now and later? Which agents should supply those capabilities at the various stages of its technological development process? What technological changes are needed to bring in competitive advantage? These problems of choices and preferences set their own parameters, and we argue that such parameters constitute the indicators of technological capability — both current and potential, and the indicators of technology management at the macro level. It is argued that the ITC of a country is the sum total of TM capabilities of the firms in that country. Moreover, both TM and ITC are cumulative, incremental and are therefore evolutionary in nature. It is necessary, therefore, to talk about dynamic indicators of ITC. Such dynamic indicators are captured best in the mechanisms of selections — of choices and preferences on structures of incentives and strategies. We argue that national indicators of ITC are the same as the firm level indicators of dynamic TM; and indicators of dynamic TM are the indicators of choices and preferences on structures of incentives and strategies. The paper discusses in the subsequent section, the importance of strategic TM, followed by issues on strategic technological innovation. The section following addresses issues of competitive advantage, followed by a discussion on approaches to technology strategy including dynamic aspects. Case studies are taken up thereafter, followed by a discussion on the issues raised by the cases. A brief conclusion follows.

Need for Strategic Technology Management

Support of Technological Change (TC) process by the top management is primary to the success1 of TM. Recent studies on Indian firms also reveal that the top leadership has been mainly responsible in raising the indigenous content of TC2. This is in harmony with Schumpeterian3, thinking which regards entrepreneur as an important figure. Detailed micro studies carried by Mascarenhas4, pointed out that in improving quality of production of the Hindustan Machine Tool (HMT) its top leadership had been a positive factor of importance. King5, regards that only having technical environment is not a sufficient stimulant to independent technological activity. Entrepreneurial activity of the top management, as a vital non-cognitive aspect of ITC, helps technical environment bringings effective TC in a given enterprise.

A technology developed in one country can only be partially transferred to another country. A recipient country needs to learn both the transferable parts, as well as the parts which cannot be transferred. In order to overcome the untransferrable, it is necessary to have learning at the shop floor level to fully absorb and adopt the technology and then to build upon it through incremental innovations and technological change. Lack of sufficient will at the level of top management and ‘learning by doing’ coupled with in-house R&D, have been the main factors that, in spite of the massive flow of foreign technologies, stopped most the developing countries from developing a strong ITC. One of the major issues raised by several workers has been the lack of TM and TC to absorb imported technology6. Through TM, the enterprise and its associates can properly integrate and manage the interdependence between technological innovations and other types of innovation (related to organizational structure, systems, strategy, finance and management aspects). Thus, TM is now at the core of the strategies of successful industrial firms of any size in any country.

Strategic Technological Innovation for Leap-frogging

Incremental innovations are so widely adopted that they have been mistaken as the recipe for enterprise competitiveness by the entrepreneurs of most developing countries. Therefore, what most organizations call innovation is actually confined entirely to incremental innovation. Without demeaning their relative importance for short-term gains in productivity, quality and profitability, and for providing both rapid credibility for change processes and building change management capability, incremental innovations by themselves do not contribute significantly to the enterprises’ sustainable competitiveness. When managed effectively, these incremental innovations result in quality and productivity gains which increase profitability and customer satisfaction. Furthermore, they set the stage for the enterprise’s adoption of a culture for change. These innovations, in the main, rely on imitation of what the best companies are doing but technological imitation alone can neither provide the
market differentiation required for competitiveness nor the knowledge-breakthroughs required by the New Industrial Revolution. As a consequence, technology transfer by itself has lost significance. Any potentially significant source of differentiation — cost structures, internal logistics, distribution channels, flexibility of delivery and others — should be targeted for strategic technological innovations and change.

Strategic Innovations are ongoing processes in which a company synthesizes industry and technology foresight with the market place. As a result, it can strategically posture itself to produce the breakthrough new technologies, products and businesses, required by the New Industrial Revolution. In order to harness the power of strategic innovation, a company must act on foresight (into the future) and on insight into current and future customers’ needs. The leveraging of foresight and insight allow it to conceptualize a desired future and to create new products and businesses required to materialize such a future in a productive way. Therefore, breakthrough strategic innovations require prospective analysis of technologies prioritized by their impact on existing and future competitive factors, the detection of opportunities and threats to existing and new businesses created by market and technology discontinuities it involves, the precise identification and leveraging of the enterprises core competencies, diagnosis of the respective risks of technological strategies, balanced project portfolios and innovation partner’s roles. Technological Leap-Frogging is beset with the lack of capability of the developing country enterprises to effectively perform strategic technological innovations. The enterprises are necessarily the main actors involved. Accordingly, the starting point is inevitably to create a capacity for strategic TM in the enterprise.

Competitive Advantage
Smith’s, dictum on new divisions of labour and new improvements, Schumpeter’s also inco, emphases on competition from the new commodity, the new technology, the new source of supply, and the new type of organization have provided us the view that competition is the driving force behind technological and institutional change. The same has been recently reiterated by Porter, as the four broad attributes that are determinants of competitive advantage: (i) factor conditions (skills, infrastructure, etc.); (ii) demand conditions; (iii) related and supporting industries; and (iv) firm strategy, structure, and rivalry. These attributes form a mutually reinforcing system in which the effect of one depends on the state of the others. Technological competitiveness, thus, can be achieved in three different ways:

1. Performing better than competitors on an already existing dimension of competition,
2. Establishing a new dimension on which to compete, and

The creation of a competitive advantage is actually related to a process of continuous innovation and technological change. The creation of a competitive advantage, thus, is the result of continuous innovation activity of enterprise. The sustainability of a competitive advantage is strongly related to the appropriability and exploitability of the underlying innovations. These, in turn, are linked with two main factors — know-how and timing. In fact, innovation and technological change create a comparative advantage when a gap is created between the innovating enterprise and its competitors. This is essentially a knowledge and know-how gap. The appropriability of an innovation can be measured by the effort that competitors make to narrow the knowledge gap. When the knowledge gap is wide, competitors should make great efforts to fill it, and this takes time and resource investments. The longer the time required, the larger the investments required, the more sustainable is the comparative advantage. If the knowledge gap can be narrowed down in short duration, the innovator can make profits from the innovations on short term basis. This shows that other way to exploit innovation is timing, which relies on the ability for continuous innovation.

Traditional Approaches to the Formulation of a Technology Strategy
Strategic management of technological innovation for linking technology and business strategies has been paid increasing attention over the last several years. Hax and Majluf, proposed, the Strategic Technical Unit (STU) as a unit, defined as the technologies embodied in a product and in its process of production. Later, as the technologies become sophisticated, this STU also incorporates the skills and disciplines that are applied to a particular product or process, in order to gain technological advantage. The process of evaluation of technology strategy starts with the technology environment scan and the internal technology scrutiny. Technology environment
scan identifies technological opportunities and threats and assesses the attractiveness of each STU. The internal technology scrutiny recognizes strengths and weaknesses associated with each STU and determines the specific technological competencies which can be acquired to gain competitiveness. This is effecting choices and preferences. STU can be considered as the dynamic carrier of ITC indicators. Defining and evaluating specific R&D projects and budgeting therefore follows this effecting of choices, the latter carried out in the stage of strategic programming.

Conceptually, this approach to technology strategy assumes that technology has to relate to a conventional generic strategic framework and support a selected market positioning. At the center of a technology strategy, there is competitive advantage which an enterprise is trying to achieve. It begins with the specific industry where a firm is competing or will compete; and the unit of analysis is the technology embodied in the product. This model focuses on how a strategic decision affects or is affected by the change in technology, on how to embody technology in the strategy formulation process, on how a technology programme can support a given strategy and finally, on how to gain competitiveness through change in the technological solution for a certain product. However, this approach can be criticized, if applied to dynamic competition which implies continuous innovation and technological change in high technological areas with high knowledge content. The main criticism concerns the unit of analysis that remains static and limited to the product and its constituent technologies.

Towards a Framework of Dynamic Technology Strategy

Enterprises faced with the dynamics, need continuity and coherence in terms of the skills and knowledge used for product application. The nature of technological development is, therefore, cumulative, and an enterprise innovation capability is strongly related to the resources and competencies developed over time through accumulating tacit knowledge and experience. Further, the role of learning-by-doing process in improving technological competencies and continuous upgradation of the knowledge domain is also crucial. A technology management strategy formulates this ‘trajectory’ by which technological resources are accumulated, and used. An enterprise needs to find a continuity which is not related to the stability of the product paradigm but is related to the stability of the resource (knowledge) accumulation process.

Three Indian Firms: Combining Business with Technology

Some efforts in this direction to combine technological approach with business approach have been pursued by many Indian firms. Following three examples drawn from Indian scenario conform to the above approach.

The example of TELCO, a large Indian firm in the automobile sector is a case in point. The strategy of TELCO has been to develop design competence and blend it with the required engineering and manufacturing competence. From 1954-64, TELCO had only one collaboration with Daimler-Benz AG, West Germany. By the time collaboration ended in 1969, at the end of 15 years, TELCO had completely indigenized the product and process technologies mainly through in house R&D. The main reason for the success of the strategy of TELCO has been the integration of technology into the business growth. As a result of Government of India’s broad banding policy for automobiles in 1985, TELCO moved into the Light Commercial Vehicle (LCV) segment without much time lag and produced completely indigenized LCV in 1986. The seventies and eighties thus, saw the intensive development of in-house R&D at TELCO. Because of the competition from Japanese designed Light Commercial Vehicles (LCVs) (From 1985 onwards), the company entered into several manufacturing processes agreements to modernize its operations and to introduce new products through its own design efforts. During 1990s, TELCO increased the design and manufacturing integration. The progressive integration of design and manufacturing has been possible because of the co-location of R&D and production.

The use of a common design data base across the manufacturing, engineering and design functions along with standardization has been one of the major technology management strategies adopted by TELCO for introducing many products at short intervals. By 1991, TELCO introduced several indigenously designed vehicles including multi utility vehicles like Tata Sierra and Tata Estate. Till 1994-95, TELCO has produced approximately 1.4 m vehicles and of this 1.2 m vehicles have been produced after 1969 under ‘Tata’ brand-name. With the result, TELCO at present is the largest commercial vehicle manufacturer in India with 70 per cent
market and it has been able to compete based on its own combined commercial and technical strength.

Another example is that of Samtel Group in electronics industry for the manufacture of black and white picture tubes. The Teletube Electronics was the first company in India to manufacture picture tubes in the private sector without any collaboration. Its Managing Director, before returning to India in 1972, had worked in the US for six months with a TV picture tube manufacturer. He learnt the basic technology for its batch production. It started with an initial installed capacity of 40,000 units in 1975 at Ghaziabad, Uttar Pradesh(UP), India. Up to 1983 the tubes were totally imported. In 1984, it established a Sister Company ‘Samtel India’ to assemble the three glass components of the bulb, viz. the panel, the funnel and the neck locally. Further, in 1983-84 the firm was importing complete electron guns. In 1985 the group set up another Company at Ghaziabad, to assemble electron guns indigenously and by 1986, seven assembled components were being imported in the form of Semi Knock Down (SKD) kits. These were then fitted together locally to form the electron gun. In 1988-89, it started importing Completely Knocked Down (CKD) kits, under which electron gun was imported in the form of twentythree components to be assembled locally.

The indigenization process was facilitated when the Government of India introduced favorable fiscal measures in the form of reduced customs duty on import of components. For example, when the whole electron gun was imported, the import duty was 60 per cent; for SKD components imported the duty was 40 per cent. Of the 23 components the three most important were cathodes, heaters, and stems. All these were indigenized later. By 1991 the electron gun was being completely manufactured for B&W and color televisions and monitors for personal computers. In the complete TV picture tube, there are 40 components, of which only 20 components continued to be imported in 1990, whereas in 1982 all these components were imported. Cost-wise, the extent of indigenization is 85 per cent. In 1988, about 60 per cent of the raw materials were imported. In 1990, the cost of these imports was reduced to 16 per cent only. Presently, high grade phosphor, lacquer, and barium oxide getter are the only raw materials which are still being imported. It is observed that, in the manufacture of picture tubes at Samtel Group, indigenization and technological change have been brought about mainly through the strategy of “learning-by-doing” process and design engineering and is characterized by the substitution of imported technologies. Technologies have been picked up from various sources, put together and adapted. Expansion of the production capacity along with diversification of the products show that entrepreneurial capabilities played a vital role in building of technological capabilities at the firm level.

Third example is that of Defence Research Laboratory (DRL), Hyderabad, which is one of the top three pharmaceutical companies in India. It was founded by Dr Anji Reddy in 1984 and since then it has grown into a fully integrated pharmaceutical company. Along with other group firms, it has an annual turnover of over US $100 m. It consists of three organizations namely, Dr Reddy’s Research Foundation; Cheminor Drugs; and Dr Reddy’s Laboratories Ltd. These three units have become multinational players. By the end of 1997, Dr Reddy’s Group has filed for 18 international patents. DRL uses strategic alliances for competence building, and for creating competitive advantage. For example, it entered into alliance with the well known world leader Novo Nordisk; Debiopharm of Switzerland; Center for Cellular and Molecular Biology(CCMB), Hyderabad; Biomed of Russia; and Organics of Israel for collaborative drug development and manufacturing. The main strategy has been systematic planning and tight coupling between R&D and business. This appears to be responsible for the high R&D productivity at DRL. Their R&D portfolio approach has reduced the drug development cycle time and ensured that a regular stream of drugs are introduced every year. This rapid growth rate has mainly come through dovetailing R&D strategy with business strategy and its major research strategy has been to continuously launch new products into the market. Since 1990, it has been launching a new product every year. Its R&D expenditure has risen from 1.53 per cent of sales turn over in 1989 to 9.54 per cent in 1995-96. This has been made possible through balanced mixing of:

- Innovation.
- Entrepreneurial capabilities.
- Long-term vision.
- Competence in drug regulatory processes.
- New products R&D planning.

Discussion

We can thus conclude that these firms have been quite successful in combining technology strategy with busi-
ness strategy to capture the market. This is evident from the fact that these firms have been able to capture a large share of the Indian and the export market. However, this is not the case with a large number of other Indian firms. At present, technological changes in the developing countries are restricted to products, manufacturing processes, and related equipment. Given the imperatives of market differentiation and the broad scope for applying the new generic technologies, technological changes should, in principle, be targeted at all activities valued by clients, including external logistics, commercialization channels, and services. In many businesses, technological innovations conferring flexibility or reliability of delivery, for instance, often prove more effective for differentiation and competitiveness than attempting further gains only through bringing changes in product quality and price. Technological innovations dramatically affect, both price and non-price factors. Effective technological decisions and actions are actually at the core of effective business restructuring, enterprise reengineering, and the application of total quality management processes. They are the bedrock for seizing the new business opportunities that stem from technological and market discontinuities and for establishing the required global partnerships to bring about their materialization.

Most of the Small and Medium Enterprises (SMEs) in the developing countries lack the technological requirements for sustainable competitiveness. Usually, their technological needs relate only to gradual improvements in product quality and productivity or machinery up-grading. This inhibits strategic breakthrough innovations and renders these companies blind to new business opportunities presented by market and technological discontinuities. The related capability required to diagnose the technological competitive position of the company, to define technological strategies and to effectively implement related technological innovation projects do not exist in the great majority of enterprises. In the scenario of globalized markets and increased international competition, these enterprises require more and more TM skills and external support for both R&D and technology transfer projects. In this direction, a recent move by the PHD Chamber of Commerce and Industry (PHDCCI) is worth mentioning, which has mooted a proposal for formulating a “country-Technology-Matrix” for strategic management of indigenous technologies with a view to helping Indian industry build a global and long term technological competitiveness.

Conclusions

We have argued that the ITC of a country is the sum total of TM capabilities of the firms in that country. Moreover, both TM and ITC are cumulative, incremental, and are therefore evolutionary in nature. It is necessary, therefore, to talk about dynamic indicators of ITC. Such dynamic indicators are captured best in the mechanisms of selections — of choices and preferences on structures of incentives and strategies. We argue that national indicators of ITC are the same as the firm level indicators of dynamic TM; and indicators of dynamic TM are the indicators of choices and preferences on structures of incentives and strategies. The current widespread need to compete through market differentiation, brought about by globalisation and trade liberalisation, has placed technological innovation and its effective management at the core of successful enterprises strategies. In order to achieve this, the developing countries enterprises have to be capable of effectively managing the strategic technological innovations, through adoption of a dynamic technology strategy, to generate constantly the new technologies, new products, and services that characterize the highly knowledge intensive New Industrial Revolution.

References


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