COMMERCIALIZATION OF NEW TECHNOLOGIES IN INDIA: THRUST AND CHALLENGES

By

VIMAL KUMAR

DEPARTMENT OF MANAGEMENT STUDIES

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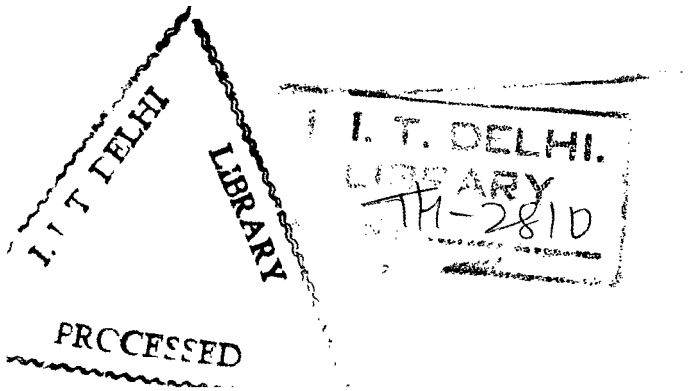
Dedicated to unknowns

who

Serve humanity through Innovation



CERTIFICATE

This is to certify that the thesis entitled **COMMERCIALIZATION OF NEW TECHNOLOGIES IN INDIA: THRUST AND CHALLENGES** being submitted by Mr. Vimal Kumar to the Indian Institute of Technology, Delhi, India, for the award of the **DOCTOR OF PHILOSOPHY** is a record of bonafide research carried out by him under my guidance and supervision. He has fulfilled the requirements for the submission of the thesis which has attained standard required for a Ph.D degree of the Institute. The results presented in this thesis have not been submitted in part or full to any other university or institution for award of degree or diploma.

PROF. P K JAIN
Department of Management Studies
Indian Institute of Technology
New Delhi – 110 016
INDIA

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25th January 2001

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VIMAL KUMAR

ABSTRACT

'The key to national prosperity, apart from the spirit of the people, lies in the modern age, in the effective combination of three factors, technology, raw materials and capital, of which the first, is perhaps the most important, since the creation and adoption of new scientific techniques can, in fact, make up for a deficiency in natural resources, and reduce, the demands on capital'.

— First Scientific Policy Resolution of India enacted in 1958.

The importance of technology as well as its vital role for the well being of a national economy, *inter-alia*, international competitiveness, corporate profitability and growth has been well documented. Germany which was technologically backward, during 1830s, as compared not only to United Kingdom but also to France and Belgium, transformed itself into an industrialized country through technology innovations. Special institutions were established, new technology risks were accepted and the task to industrialize Germany through technology was declared as 'National Mission'. Thereafter 'development through innovation' spread to many other countries. There is an eloquent testimony available in literature that commercialization of technological innovations has imparted growth and leadership in industrialized world especially since late nineteenth century.

The management of technology development and commercialization process, *vis-à-vis,* financing and market development, etc. has always posed a challenge to scientists, technologists, entrepreneurs and the policy-makers.

The initial part of technology life cycle pertaining to evolution of radical innovation from a scientific invention and its further development to meet the market requirements is characterised by unexplored scientific, engineering and commercial aspects. The process of technology upscaling, proving and market development has associated uncertainties as well as risks. It is the first commercialization effort of a new technology that takes the dent of (I) resolving uncertainties, (ii) optimising operating parameters and (iii) developing market, etc.

Financing of new technology commercialization ventures (NTCVs), by virtue of associated uncertainties and the risks, is quite different than financing a regular business venture based on proven technology. The traditional financial institutions, namely, commercial banks and industrial development finance corporations / bodies deter from financing a NTCV. Financial functions are of course the *raison d'etre* of financial institutions but financing or supporting NTCVs does not find any place in their charter of duties / functions. There is a basic conflict between their role as a financial intermediary and unrecognized role as technology facilitator. This conflict stems from the opposition between the necessary financial prudence of the banker and the risks involved in technology commercialization. In developed countries special

banks / mechanisms were set up, during late nineteenth and early twentieth century, to support technology development and commercialization. Subsequently, venture capital funds (VCFs) have also been established. To meet the financing requirements of NTCVs (having uncertainties, risks and longer gestation periods), support of financial institutions / special mechanisms is necessary. It is the mobilisation and allocation of financial resources between research and development as well as technology exploitation efforts that provides a lead to technological capability building. However, due to the economic conditions in most of the developing countries, the creation of industrial base as well as development of science and technology infrastructure are being attempted simultaneously.

Recognizing the importance of technology, India incorporated it (technology) as a key factor in the first Scientific Policy Resolution of India enacted in 1958 and also in Technology Policy Statement (1983). Initially, the emphasis was laid on development of scientific know-how and infrastructure base and subsequently since eighties, technology development and commercialization has also been in focus. Setting up of venture capital funds during 1980's, Research and Development Cess Act (1986), formulation of Technology Information, Forecasting and Assessment Council (TIFAC) in 1988, starting of Home Grown Technology (HGT) activity under TIFAC in 1993, Programme Aimed at Technological Self Reliance (PATSER) under Department of Scientific and Industrial Research (DSIR) in 1993, Technology Development Board (TDB) in 1995 and Technopreneur Promotion Programme (TePP) in 1999 jointly by DSIR and TIFAC are the focussed specific policy measures and facilitation actions

taken by Indian Government to nurture and harness the technological capabilities to innovate and commercialize.

In spite of above mentioned initiatives, the desired impact has not been made by new technologies; only a beginning has been made in a modest way. Over the time, majority of venture capital funds have drifted away from their primary responsibility of financing new technologies and have positioned themselves in risk-free operation zones. The design and implementation of other mechanisms and special schemes commissioned to promote commercialization of new technologies have also not fully met with the satisfaction of the clientele.

The present study makes a modest attempt to fill in the void; it is holistic in nature and presents analysis of commercialization of new technologies in India from the perspective of major stakeholder groups, viz, industrial firms, financial institutions, technology institutions and policy makers and facilitators to bring to the fore the thrust areas in terms of issues involved, their importance and hierarchical positioning, and the challenges in terms of actions required for the furtherance of this very important subject of nation building.

Towards the said objectives, the study analyses (a) parameters that govern the decision to commercialize a new technology vis-à-vis their relative importance, (b) parameters and their relative importance, that contribute to the success of NTCV, (c) new technology risk assessment practices (d) the mechanisms and schemes of financing, supporting or facilitating commercialization of new technologies from the point of their efficacy and effectiveness.

Two broad sectors of industry, namely (i) metal, metallurgy and mechanical engineering related and (ii) chemical and pharmaceuticals related; and 10 case studies (5 each of the successful and not so successful new technology based ventures); as well as the status and mechanisms of similar activities in a few other countries of Asian region and also of developed countries to draw lessons for India, form the main basis of study.

The thesis is broadly divided in five parts spread over ten chapters. The first part dealing with the background provides information on aspects such as problem identification, main issues / hypotheses, scope of the research, literature survey and the research methodology used. The second part deals with the aggregative analysis of practices of four major stakeholder groups (spread in 4 chapters). Ten case studies, five of successful ventures and five of failures, are discussed and analysed in part three. While, the part four of the study delineates experiences and practices of other countries to derive lessons for India, the part five (concluding observations) presents main findings, recommendations and suggestions for future research alongwith the limitations of the present study.

The survey brings to fore that (i) there is consensus that new technologies have higher risks (technology, market and financial) as compared to proven technologies; (ii) use of techniques of higher levels of rigour are recommended to strengthen the existing practices of risk evaluation. Regarding financial risks assessment, the financial parameters that have the capacity to take in account

the uncertainties and the risk aspects of NTCVs are trailing in application practice, however, their use has been recommended for future. The recommended techniques are: sensitivity analysis for risky projects and probability distribution for cash flows, etc.

Further, the two major parameters that govern the preferred choice of technology for commercialization are (i) technology: source, status and available back-up support and (ii) market: needs and potential including fiscal and import-export policies of Government affecting the market. Capital financing aspects are not given significant importance at this stage; however, it is rated at rank one (of the three most important parameters) that govern the degree of success of new technology commercialization venture (NTCV). Other important parameters for the success of NTCVs are : (i) firm related: commitment and sincerity of entrepreneur / industrial firm, (ii) technology related: in-advance completion of plant and equipment design and the technical support available from technology supplier and (iii) concurrent engineering: product engineering to market needs.

Other notable finding of study is that policy-makers and facilitating agencies themselves rate the existing facilitation and special financing mechanisms as 'in-sufficient' and, hence 'not making desired impact'. In addition various measures required to be initiated at policy level have been delineated which include doubling the number of special funding mechanisms from existing 8 to atleast 15, increasing available funds from about Rs.1,000 million/year to Rs. 10,000 million / year and drastic improvement in operating norms as well as criteria, currently

being applied to evaluate the NTCV proposals. In addition, venture capital funds need to honour their *raison d'etre*.

To strengthen the commercialization of new technologies in the country, other notable suggestions made are: industrial firms should have (i) broader perspective of research and development activities as an investment for future, (ii) more sponsored projects with research and development laboratories and to work with them for upscaling of technologies to pilot / demonstration plant level; and risk sharing, and low cost funds on soft terms are required to be made available, easily and on time, to NTCVs. Further, financial institutions should extend overall support rather than being merely a financier and government to provide priority sector status to 'commercialization of new technology' activity by extending fiscal and policy concessions as well as patronizing new technology products.

Thus, the research study has helped to develop an in-depth understanding of process of new technology commercialization and various affecting parameters. It has also provided in-depth analysis from the point of view of major stakeholder groups that could help each of them to better their respective tasks, *inter-alia*, national growth through commercialization of innovations.

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