2006

What drives technology collaboration in India: perceptions and practices

Arijit Sikdar
University of Wollongong, arijitsikdar@uowdubai.ac.ae

What Drives Technology Collaboration in India – Perceptions and Practices

Dr. Arijit Sikdar, University of Wollongong in Dubai, UAE

ABSTRACT

The growth of the Indian economy is presenting immense opportunities for development of new technologies to fuel this growth. However, developing new technologies by Indian firms is costly and risk as most of them do not posses the necessary technological capabilities. With the increasing cost and risk of technology development, it has come to be recognized that external sourcing of technology through collaborative technology development provides strategic advantage by providing faster access to new technology and markets through complementing resources and risks between partners. On the other hand, collaborative technology development also faces problems due to fear of opportunistic behaviour of partners. The balance of benefits and risks related to collaborative technology development is contingent on the nature of industry and technological characteristics surrounding the collaboration. The failure of collaborative technology development is due to the fact that partners do not have adequate understanding of context. Therefore it is important to understand the context and especially in the Indian context, where collaborative technology development is a new phenomenon and there is little understanding regarding the perception and practice of it.

To understand the perception and practice of collaborative technology development in the Indian context, a study was conducted across three industrial sectors- electronics & IT, chemicals & pharmaceuticals, and engineering. The choice of these sectors was influenced by the fact that these sectors experience greater technology based competition so the necessity for upgradation of technology would be a relatively important concern. Data on collaborative technology development practice was collected through a questionnaire from 119 respondent firms representing the identified sectors. The results of the study show that different industries have different perception regarding the importance they attach to different modes of collaborative technology development which is influenced by the technological environment. Across the sectors, the perception is that collaborative technology development modes that provide greater control for the firm to monitor partner opportunistic behaviour are considered more effective than others. The motivation to undertake collaborative technology development is influenced by the benefits accruing from access to new technology and markets to maintain their competitive position as compared to benefits of collaboration like risk sharing or establishing common industry standards or technology cartelization. On the other hand, conflicts between partners that would be seen to give rise to opportunistic behaviour are considered a major obstacle for collaborative technology development across the industries. Overall, the strong obstacles to undertaking collaborative technology development as perceived by the different sectors are those that are perceived to give rise to the fear of loss of control on proprietary technical knowledge. Based on the findings, implications could be drawn regarding what needs to be done while entering into technology collaboration with Indian firms so as to ensure that the collaborative venture is successful and long lasting.

INTRODUCTION

The process of liberalization that started in the early 90s has transformed the Indian economy that today it is considered one of the fastest growing economies of the world. As it evinces a lot of interest from businesses around the world to invest in India, there is increasing collaboration between Indian and foreign firms on technological development and upgradation. For example, TELCO worked with IDEO, Italy for design of the indigenous car, Indica. Similarly, Ranbaxy Laboratories had developed a drug delivery system for Novo Nordisk, Denmark. However, this is a new found phenomenon in the technological domain of the Indian industry as prior to liberalization, policy and regulation forced Indian industry to

indigenize technology development rather than seek outside support. It is predicted that opportunities for technological collaboration would increase further as it presents foreign companies with the opportunity to tie up with Indian companies to enter hitherto unknown markets, as technological needs of Indian markets are vastly different. Similarly, for Indian companies, the opportunity lies in getting faster access to technology that would have been costly and risky to develop on one's own abilities.

However for any collaboration to succeed, it would require that goals and concerns of the participating parties are addressed within the collaboration framework. This is possible when each member is aware of the goals and concerns of the other collaborating partners. This may be true in the context of collaboration between companies in the developed world where alliances have been found to be frequently playing a dominant role in technology development (Shan, 1990). However, as Indian industry has not participated in collaborative technology developments extensively, it is unknown what the goals and concerns are of Indian industry regarding collaborative technology development and therefore collaborative technology development with Indian industry could be fraught with risks. Past experiences of similar collaboration between Indian and foreign companies like LML- Piaggio (Shirisha & Dutta, 2002), TVS- Suzuki (Mukund & Shubhadra, 2002), etc. have shown this to be true. In this backdrop this study assumes significance as it tries to uncover the mind of the Indian industry regarding collaborative technology development.

COLLABORATIVE TECHNOLOGY DEVELOPMENT

In the mid eighties, a marked shift was noted towards the increased use of external sources of technology as against internal R&D in technology development (Graham, 1985) and since then, the importance of external sources of technology as a source of strategic advantage has come to be recognised widely. The potential benefits of collaborative technology development could be summarised as (1) gaining faster access to new technologies or markets; (2) accessing technological expertise located beyond the boundaries of the firm; (3) leveraging the comparative advantage of each partner; (4) increasing the firm's openness to its environment and stimulate internal innovativeness; and (5) sharing the risks of R&D beyond the resources of any one firm (Powell, 1987). According to Hagedoorn (1993) these set of benefits could be related to three major motivations viz. (1) technology complementarity, (2) faster development of innovation, and (3) improved market access.

While benefits of collaborative technology development cannot be disputed, collaborative technology development had its share of problems and that has prevented effective collaboration between firms. Studies by McKinsey and Coopers & Lybrand suggest 7 out of 10 R&D collaborations fail to meet the expectations and had to be dissolved (Achrol, Sheer & Stern, 1989). Some of the major sources of problems/ obstacles related to collaborative technology development that have been identified are (a) conflicting objectives among members, (b) difference in value, concept and attitude among members, (c) conflict in distributing and sharing results, (d) difficulties for individual members to maintain autonomy and control, (e) difficulties in deciding the ownership of R&D results, (f) difficulty in exploitation of intellectual property rights, (g) confidentiality, and (h) unwillingness to let top level personnel participate in collaborative effort (Dodgson, 1992; Tan & Lung, 1997). These obstacles are a result of the participating firm in collaborative technology development network being exposed to a variety of risks such as (1) loss of proprietary control over technology, (2) loss of proprietary access to markets, (3) exposure to opportunistic behaviour of partners, (4) unintended leakage of technical information to partners, and (5) poaching of technical experts by partners.

Thus, the success or failure of collaborative technology development is to a large extent dependent on the perception of the risks associated vis-à-vis the intended benefits. This is an outcome of the motivators and obstacles for collaboration as perceived and is influenced by the context of the firm and its environment .For example, when individual members are not willing to negotiate on their individual objectives, which is reflection of the firm's vision/ philosophy, conflicting objectives amongst members would arise and give rise to increased obstacle in collaboration. Similarly, when the legal environment is not strong enough to protect firm-specific knowledge or the nature of the technology is such that knowledge cannot be kept proprietary or when there is a high degree of rivalry within the industry, all these

create fear and chance of illegal appropriation thereby increasing the perception of risk in undertaking technology collaboration and thus give rise to obstacle for collaboration success.

At the same time the nature of the collaborative arrangement could affect the perception of risk and benefits and thus affect the overall success of the collaboration. From the transaction cost perspective (Williamson, 1985), collaborative technology development involve transactions that give rise to (1) asset specificity, (2) behavioural uncertainty, and (3) market uncertainty (Robertson & Gatignon, 1998). If the nature of the collaborative arrangement chosen is not able to address the uncertainty, it gives rise to increased perception of risk leading to ultimate failure of the collaboration.

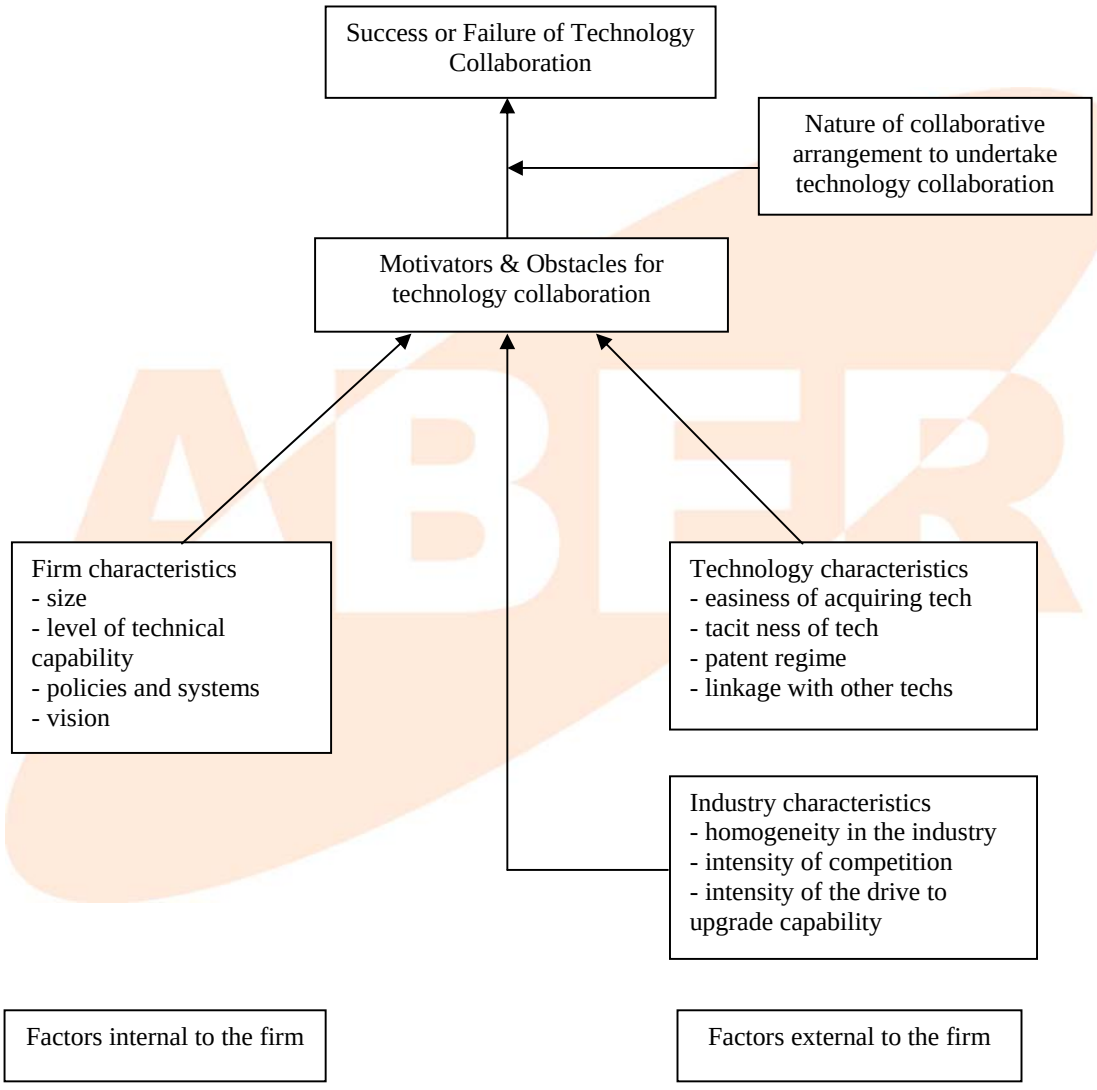

Figure 1: Framework for Collaborative Technology Development

As collaborative technology development is a new phenomenon in the Indian context, not much is known how the above model would work out in Indian context. In this backdrop, it was sought to understand what Indian industry's perception is regarding risks and benefits associated with collaborative

technology development. Possibly, such an understanding would help in evolving collaborative arrangements that could ensure greater success of technology collaboration in the Indian context.

RESEARCH METHODOLOGY

As the context of the study is related to collaborative technology development, firms where technology plays a critical role in driving competition are more likely to be concerned with technology development and be more aware of the phenomena. Thus it was decided to focus on industries that are technologically intensive i.e. where technology plays a major role in driving competition. Based on the above criteria, three industrial sectors were chosen as target- Electronics & Information Technology (EIT), Pharmaceuticals & Chemicals (P&C) and Engineering (ENGG). In the Indian context, these industrial sectors are technologically more dynamic as measured by R&D expenditure, employment of technical resources, number of technological advancement- major & minor, etc. as compared to the other industrial sectors. Thus it could be assumed that their awareness and interest towards collaborative technology development would be strongest as compared to other industrial sectors.

For the purpose of this study, collaborative technology development was defined as firms engaged in any of the following forms of collaborative technology development arrangements as listed below

A. Pre- competitive stage technology development
- -University based collaborative R&D projects financed by firms in universities.
- -Government-industry collaborative R&D projects in firms as well as public institutions
- -Private sector R&D joint ventures

B. Downstream technology development
- -Shared venture capital investment by firms
- -Project specific based collaborative R&D between firms
- -Cross licensing or other agreements to share independently developed technologies

C. The manufacturing and/or marketing co-operation based technology development
- -Comprehensive R&D, manufacturing and marketing collaboration between a number of partners formed with the aim of creating, testing, producing and commercializing a product all the way from R&D to the final market
- -Customer-supplier partnerships based on either equity or exclusive relationships between firms providing a mechanism for leveraging critical technical resources of the partners.

As the purpose of the study was to present the status of collaborative technology development, it was decided to have a survey of a wider representation of firms to be conducted using a questionnaire to be administered to firms from the target industries as identified. The initial questionnaire developed was pilot tested and based on the feedback the questionnaire was modified and finalized. Approximately 600 firms across the chosen industrial sectors were contacted for responses out of which 119 responses were obtained. The break up of the responses was as follows- 36 responses were from the EIT, 35 responses from P&C and 48 responses from ENGG. Statistical analysis of the data was carried out to derive empirical results.

FINDINGS

Collaborative Arrangements

Regarding choice of collaborative technology development modes for acquiring technology (Table 1), consortia is considered the least preferable as compared to directly collaborating with another firm or research institution by all the three sectors. The difference is that in consortia the presence of many partners makes it difficult to monitor progress and control and could give rise to free-rider problem which is not so the case in direct collaboration. This shows that firms in Indian industry would like to have direct control

over the technology development they are participating in. This also explains why all three sectors rate comprehensive technology development collaboration involving multiple partners as one of the least effective modes (Table 2).

Table 1: Importance attached to methods of acquiring new technical knowledge
(Proportion of population assigning top two ranks)

		EIT	P&C	ENGG
1	Funding technology development through research institutions/ universities	0.23	0.36	0.34
2	Working jointly with another firm in the industry	0.35	0.43	0.17
3	Contract R&D	0.35	0.27	0.15
4	Consortium R&D	0.16	0.16	0

However, regarding the effectiveness of different collaborative modes, the technological context plays a significant role (Table 2). In the EIT sector, project specific based collaborative technology development is considered significantly more effective vis-à-vis P&C and ENGG sectors. This difference could be attributed to the nature of the technological development in the industry. In the EIT sector, the technology is more systemic/ architectural - a conjunction of multiple technologies, rather than standardized and stand-alone. This means any specific technology development would need to interact/ integrate with other technologies throughout the development cycle and in such context of increased interaction, project specific based collaborative technology development would be more effective to facilitate the interaction sought. Moreover, the life cycle of EIT technology is short a compared to P&C and ENGG sectors so it makes more sense to invest in short-term project specific based technology development collaboration. Similarly, EIT sector attaches high effectiveness for technology development through venture capital investment in start-ups. This could be attributed to the fact that technology development in the EIT sector across the world has been driven by start-ups (example the Silicon Valley experiment) and Indian firms also see start-ups as an effective source of technology development in which to collaborate.

Table 2: Effectiveness of collaborative technology development modes ***(5- most effective; 1-least effective)***

		E IT	P&C	ENGG	F- value
1	Venture capital investment by firms in start-up companies	3.41	2.75	1.78	13.73 **
2	Project specific based collaborative technology development between firms	3.86	2.96	2.40	11.27 **
3	University based collaborative technology development projects financed by firms in universities	2.46	3.15	2.68	
4	Cross licensing or other agreements to share independently developed technologies	3.00	3.6	2.30	6.55 **
5	Comprehensive R&D, manufacturing and marketing collaboration between a number of partners formed with the aim of commercializing a product	2.82	2.8	2.25	

Note: ** statistically significant at 1 %

On the other hand, P&C sector attach higher effectiveness to university based collaboration projects financed by firms as compared to the other two sectors. This difference could be attributed to the

availability of well recognized institution in the field of P&C as compared to the other two sectors in India. Moreover, the nature of technology in P&C sector is more driven by fundamental knowledge, whose source could be from the institutions rather than firms. This would mean that firms in P&C sector are looking at longer term technology development.

An interesting finding is that firms in P&C sector consider cross-licensing to share independently developed technologies as significantly more effective than the other two sectors. This could mean that Indian P&C firms have independently developed technological capabilities that could be exchanged through collaboration. Another possible explanation is that the nature of technology developed in P&C is more fundamental in nature and therefore can be cross licensed without sacrificing any firm specific technical capabilities.

Motivators and Obstacles

For the Indian industry, the most important motivators for collaborative technology development are those that lead to increased technological capabilities through acceleration of product and process innovation and helping acquire state of the art technology (Table 3). This is well understood given that Indian industry is technologically backward. At the same time, Indian firms are motivated by the need to meet competitive priorities and which is reflected in the high score for cost sharing & saving and responding to international competition. On the other hand, going for technology collaboration so as to encourage exchange of information or preventing the non-member peers from acquiring technology or to establish common industry standards are the least important motivators. This shows that firms in Indian industry are looking for tangible gains that accrue to the firm directly through technology collaboration rather than intangible gains.

Table 3: Motivators for collaborative technology development (*5- strong motivator; 1-weak motivator)*

	Motivators	EIT	P&C	ENGG
1	Cost sharing and cost saving	4.14	4.00	4.44
2	Accelerating product and process innovation	4.36	4.18	4.56
3	Risk sharing	2.93	3.93	3.26
4	Establishing common industry standard	3.71	3.15	3.73
5	Responding to international competition	4.21	3.86	4.29
6	Acquiring start of the art knowledge and technology	4.25	4.04	4.12
7	Encouraging exchange of knowledge and information	3.39	3.50	3.63
8	Incentive offered from the government	2.77	3.29	3.20
9	Preventing the non member peers from acquiring technology	2.61	3.18	2.85

However, there are industry specific differences in the case of motivators. In case of P&C sector, firms are motivated to go for collaborative technology development that could share the risk. This could be explained by the fact that technology development in the P&C sector has to clear a number of hurdles

related to multiple stages (lab to pilot plant to commercial) of development and clinical/ regulatory trials before commercialization thereby increasing the risks and costs. However, risk sharing is a weak motivator in the Indian context as technology development in India more incremental nature to warrant high risk of cost or failure.

Difficulty in getting a suitable partner whose values, concepts, etc, do not conflict is a significantly strong obstacle for firms across all the sectors (Table 4). These are stronger obstacle for firms in EIT and P&C sectors as compared to ENGG sector. On the other hand, across all the three sectors, difficulties in communication and coordination or lack of information and channel to establish contact or unwillingness to let top notch personnel participate in collaborative effort are relatively not strong enough reasons for not undertaking collaborative technology development. Thus it could be concluded that the major obstacles that appear in undertaking collaborative technology development are related at the initial stage of forming the collaboration rather than at the later stage of running the collaboration.

Table 4: Obstacles for collaborative technology development *(5- strong obstacle; 1-weak obstacle)*

	Obstacles	EIT	P&C	ENGG	F- value
1	Conflicting objectives among members	3.86	4.04	3.63	
2	Difference in value, concept and altitude among members	3.96	4.00	3.65	
3	Difficulties for individual member to maintain autonomy and control	3.50	3.54	3.80	
4	Not enough resources to support the necessary investment	3.96	3.68	3.23	3.16 *
5	Difficulties in communication and coordination	2.86	2.89	2.83	
6	Difficulties in deciding the ownership of the R&D result	3.54	3.71	3.46	
7	Lack of information and channel to establish contact	3.00	3.32	3.20	
8	Confidentiality	3.82	4.11	4.08	
9	Unwillingness to let top notch personnel participate in collaborative effort	3.46	3.21	3.23	

Note: * statistically significant at 5 %

However for the firms in the EIT sector, having not enough resources is a significant obstacle for not willing to undertake collaborative technology development as compared to the other two sectors. The possible explanation for this could be the fact that EIT firms being younger than P&C and ENGG firms do not have deep pockets to support necessary investments. Similarly, for both the P&C and ENGG sectors, confidentiality is a relatively major concern for undertaking collaborative technology development while it is not so for the EIT sector. Confidentiality being a concern is expected given the nature of appropriability regime that exists in India and the fact that technological spillovers are high in all the industries which compounds the fear that collaborative technology development would lead to loss of technical knowledge. Confidentiality being a lesser concern for electronics industry could be possibly explained by the fact that one of the prime strategies for technology development in this industry internationally has been based on open standards and second sourcing. This reduces the fear of technology getting stolen if it is not kept confidential as in the first place it has been decided to share the technology and thus reduces the concern regarding confidentiality.

CONCLUSIONS

Based on the findings of this study some implications can be drawn that could be useful to understand collaborative technology development in the Indian context. Firstly, this study has been able to throw some light on the perception of Indian firms regarding collaborative technology development which was hitherto an unknown phenomenon. For example, the study has shown that there is clear preference by Indian firms towards direct one-to-one form of collaborative arrangement rather than consortium based collaborative arrangement. Thus it is clear to any potential technology collaborator that entering into technology collaboration with Indian firms would work best where it involves one to one relationship rather than involving multiple partners in the collaboration framework.

Secondly, the study points out that Indian firm are motivated by the tangible gains of technology collaboration rather than intangible gains. Though it may be understood that benefits of technology collaboration is multifarious, some tangible and some intangible, but technology collaboration with Indian firms would require that the potential collaborator need to bring forth the tangible gains more strongly otherwise the chance of the Indian firm getting into collaboration could be less.

Thirdly, it is intuitive to think based on experience that most collaboration would fail at the later stage when the partners are not able to sort out the differences. However, the study points out that the major obstacle for undertaking technology collaboration by Indian firms lies not because of differences in sharing gains at the later stage but at the initial stage wherein they are not address the conflicting objectives and differences in values between partners. The implication of this for the potential collaborator is the fact that given an equal chance between two potential collaborators, one whose values and objectives do not match with the Indian partner would seem to lose out in being selected as a collaborating partner.

Fourthly, the study also point out that while the above three may be like hygiene factors whose absence could jeopardize the collaboration, but the success of collaboration from then onwards would depend on meeting specific factors, driven by industry specific conditions, which increase the benefits vis-à-vis the risks of technology collaboration.

Finally, the validity of the research findings is limited by design of the study and sample size. This could provide direction for future studies to include more variety of industries and larger sample size so that more generalized findings could be drawn. Moreover, future studies could look at case studies of managing successful technology collaboration of Indian firms that could throw light on understanding the dynamic process of managing technology collaborations.

REFERENCES

Achrol, R.S., Scheer, L.K., and Stern, L.W. (1989). Transorganizational systems: a framework for analysing strategic alliance behaviour and performance. Working Paper, Marketing Science Institute, Cambridge, MA.

Dodgson, M. (1992). Technology Collaboration: Problems and Pitfalls. In: Technology Analysis and Strategic Management. Vol. 4(1), 83-88.

Graham, M. (1985). Corporate research and development: the latest transformation. Technology in Society, 7, 179-196.

Hagedoorn, J. (1993).Understanding the rationale of strategic technology partnering: interorganizational modes of cooperation and sectoral differences. Strategic Management Journal, 14, 371-385.

Mukund, A., and Shubhadra, K. (2002). The TVS- Suzuki Break-up. Case No. 302-085-1, ICFAI Centre for Management Research.

Powell, W.W. (1987). Hybrid organizational arrangements: new form or transitional development. California Management Review, 30(Summer), 67-87.

Robertson, T.S., and Gatignon, H. (1998). Technology development mode: a transaction cost conceptualization. Strategic Management Journal, 19, 515-531.

Shan, W. (1990). An empirical analysis of organizational strategies by entrepreneurial high-technology firms. Strategic Management Journal, 11, 129-139.

Shirisha, D., and Dutta, S. (2002). The LML-Piaggio Break-up. Case No. 202-015-1, ICFAI Centre for Management Research.

Tan, R.R., and Lung, S.S.C. (1997). Promoting collaborative R&D in Taiwan: an empirical study focused on the information processing component of the decision making process, International Journal of Technology Management: Special Issue on R&D Management, 13, 762-795.

Williamson, O.E. (1985). The Economic Institutions of Capitalism. Free Press, New York