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Technological Competitiveness of Telecommunication Industry in India

Glimpse of Reality, Opportunities and Challenges

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Abstract

There has been unprecedented growth in the telecommunication sector in India in the new millennium. This boom has led to a revolution in the telecom service industry across the country and hefty gains are made by the telecom operators. With newer innovative services being launched by the operators continually, subscribers feel benefiting like never before. However, few seem aware about the flip side of imbalances in the trade, technology ownership, and overall competitiveness aspects. Despite the ambitious vision, significant technological and managerial capabilities in industrial houses, PSUs to SMEs and huge young skill base, the country seems to be close to worst points in trade and technological competitiveness.

The paper aims to understand the problems in the Indian telecom sector about the lagging technological competitiveness and to find out whether the Indian telecom product development firms can leapfrog, though being latecomers. The causes of the low technological competitiveness of the Indian telecom product development firms emanate from the whole ecosystem of the Indian telecom sector consisting of the government, operating firms, industry associations, product development firms and the research & academic institutes. An effort has been made to identify the root cause of the problem supplemented by studying what has happened in a similar international scenario by taking a case of Huawei (China).

Keywords: *Telecommunication, Technological Competitiveness, R&D, Innovation, Leapfrog, Strategy*

1. Introduction

Driven by urban users, the telecommunication sector in India has grown exponentially in the new millennium and is likely to sustain growth through rural penetration and value-added services. Yet, while Indian telecom subscriber base is

around 450 million, the same for China is around 950 million. It is expected that the Indian scenario is going to be a repeat of the Chinese one and it may even be more aggressive. India has extremely low geographical mobile coverage. India's call charges per minute are the lowest in the world and the ARPU is also amongst the lowest. Yet, the operators are able to make healthy profits. As per TRAI study Paper (2005), estimates are that even at a monthly ARPU of US$5, wireless operators can make money. Thus operators can profitably expand into non-covered and rural areas. India has high consumer durable penetration in rural areas and thus the telecommunication penetration could just be waiting to explode.

Real benefits of such growth in the long run accrue to players that can differentiate. Technological competitiveness can be a differentiator, but few firms of Indian origin (FIOs) seem keen to leverage it. The telecom sector is heavily dominated by the technology. However, the Indian operators have a heavy dependency on the foreign technology and the real benefit of the boom in the Indian telecom sector is going to the foreign technology developers. The long term business advantage could only be driven by the technology ownership. The technology ownership not only provides the bargaining power, but also the handle for technological innovations, which could often be translated into hefty cost advantage, service differentiation and business creation.

With the business advantage of going global, most of the foreign technology developing companies are having a global footprint, thereby tapping the cheaper and skilled resources of the countries like India. In essence, in many of the cases, the technology is really developed by Indians for the foreign companies to be sold back to the Indian operators, resulting in huge arbitrage. Further, with the growing globalization, most of the multi-national companies have R&D setup in a number of countries. However the latent aspect is that most of the strategic and key R&D is carried out in their own countries and the knowledge is not available to the other countries.

Further, with the focus only on the telecom services and not on the technology generation, the strength in the Indian innovative product development in the telecom area may slowly erode, which may affect the country in the long run. New product development firms face a huge challenge to deploy their products in the network. If there are operators' investments/alliances with the development firms, there is better chance for the newly developed products to be deployed. Moreover since the products may be tailor made to offer differentiating services, operators may be rather keen to deploy them.

Now that the Indian telecom R&D is on a low, a concerted effort needs to be done towards catching up with the world and having leapfrog strategies. Since the telecom sector is highly technology dependent and technology, per se, provides chances to leapfrog, it is definitely feasible. The question remains, "Can Indian telecom product development firms leapfrog?" The answer may obviously be yes, but details such as by whom, where (e.g. niche / segment), when and how, remain fuzzy. The paper aims at developing the context from years of practical experiences, literature review, analysis of systems and a case study.

2. Brief Literature Review

While there is exponential growth happening in the Indian telecom services sector, it is important to identify the regulatory, economic, and market forces which

are driving the growth – and the profit opportunities that are opening for operators and vendors (Shosteck Group's white paper, 2004). Due to huge momentum in telecom and mobile penetration, privatization, liberalization and loose regulation are normally adopted. But in this process, the local technology R&D and innovation starts taking back seat, technology strategy is put aside and local system of innovation starts to show signs of depression (Cassiolato et al, 2002) and starts dispersing its technological capabilities and more serious impact is that this is irreversible (Szapiro, 2000). The existence of an efficient national system of innovation is important to couple the strong national science base to innovative, competitive and often large firms (Patel and Pavitt, 1999). By themselves, foreign corporations are unlikely to create new world-class centers of technological activity. Minin and Palmberg (2006), have highlighted that despite the globalized nature of the wireless telecommunications industry by the face of it, the R&D and inventive activity relating to the technological core of this industry still is very home-bound. Multi-National Enterprises (MNEs) are undertaking abroad a growing share of their R&D; however, many MNEs are barely interested in researching in foreign locations and many of the world's countries lack the features that appeal to foreign laboratories (Rama, 2007). The host countries obtain the maximum benefits from FII only when some conditions are met: 1) affiliates import foreign technology, 2) purchase their inputs in the host country, 3) relate directly to domestic suppliers and 4) enjoy product and technological autonomy vis-à-vis the parent. Further, for nurturing the innovation, it is essential that innovative products are successfully deployed. Its success depends on the patterns of cooperation among the R&D, marketing and the operations (Olson et al, 2001). Curwen and Whalley (2001) have focused on alliance and joint venture formation in two different yet related parts of the telecommunications industry: operating companies and vendor companies. The ecology between operators and product developers is not merely for the supply chain reasons, rather there is a significant role of the knowledge sharing among the two. Grant and Baden-Fuller (2004), point out that the knowledge based view of the firm offers new insight into the causes and management of inter-firm alliances. The basic motives of collaboration between two firms are market and technology related (Hagedoorn, 1993). Interfirm new product development partnership dynamic capabilities are significantly related to two critical success outcomes – measured as the proportion of new products becoming commercial successes and superior commercialization (Ettlie and Pavlou, 2006). High technology partnerships outperform low technology partnerships in both profits and superior commercialization hit rate. The discontinuous processes have extremely high degree of technological and market uncertainty and are under influence of additional constraint and challenges (Veryzer, 1998). Initiating and driving forces and strong visionary is a must. The traditional benefits of concurrent development, like cost savings, time to market and improved manufacturability do not accrue for them (Mcdermott and Handfield, 2000). In ICT industry, Voice over IP is an important example for discontinuous change (Wirtz et al, 2007). Product differentiation, image differentiation, focus, proactiveness, replication, reconfiguration and cooperation are constructs for strategy in high velocity environments, which has both market and resource based views. Effective firms in innovation do handle paradoxes: Seek risk & innovation but execute safe& incremental; Make decisions carefully but decide and move quickly; Have powerful CEO as well as top management team (Bourgeois and Eisenhardt, 1988). Local firms can compete against MNEs by developing strong manufacturing capabilities only when barriers to appropriability are high (Gao et al, 2007). In the turbulent global competitive environment, innovation management

needs to be done in a comprehensive manner based on Total Innovation Management (TIM) model (Li, 2007). For the laggards in the innovation, crisis of design technology is a push factor for leapfrogging, arrival of new techno-economic paradigm can serve as a pull factor for leapfrogging (Lee, 2005). For leapfrogging, ownership of the firms is important. FDI can't be relied upon for the technological development of the late-comer countries. For late-comer's technological catch-up, the role of the government is important. One example is that of facilitating the adoption of specific standards and thereby influencing the formation of markets at the right times. Mittal (2003) has enlisted, how can the government, being the main policy and regulatory authority, act in different ways to facilitate R&D in the Indian telecom sector. The search of business model reinvention in today's world is an important and continuous process (Voelpel et al, 2004). Path-creating catching-up is more likely to happen by public-private collaboration where the involved technology is more fluid and the risk is high with bigger capital requirements (Lee and Lim, 2001). Leapfrogging is typically in the technological sense; however it must be integrated with the social context and the stakeholders (Davison et al, 2000). Leapfrogging is a continuous event, rather than an ad hoc kind of activity, and so resources need to be available in the long term.

Critical success factors in improving national technological competitiveness may reside in the competitiveness process of nurturing emerging industries, particularly creating enabling environment, collaborative advantages, strong commercialization capabilities, infrastructure creation, mass awareness and attract global resources through alliances (Momaya, 2008). Another aspect of enhancing technological competitiveness is pursuing cooperative strategies and while the governments can facilitate the cooperation, the real cooperation has to be driven by companies and industrial houses for win-win business benefits to both sides (Momaya and Kuroda, 2008). The other broad issues in the area of management of technology are, strategic management of technology, technology planning and forecasting, technology transfer and acquisition, development and innovation management, technology and organization issues, adoption and implementation of new technologies (Husain and Sushil, 1997). One of the overall generic aspects of the strategy is the management of strategic change and flexibility (Sushil, 2005; 1994).

3. Analysis of Technological Competitiveness of Indian Telecom Sector

To analyze the low technological competitiveness, two techniques, viz., Cause and Effect Analysis; and Systemic View are applied which are detailed below: -

3.1 Cause and Effect Analysis

As a result of enormous demand boom in the Indian telecom sector and the tremendous future demand potential, the telecom operators have reasons to quickly deploy the networks and satisfy the demand and in turn reap the profits. In the absence of any significant domestic technology/ products, such network deployment is being carried out with the help of import of the telecom products based on the foreign technology. This has led to highly negative export of the telecom technology and products for our country. Further this has led to very low Indian competitiveness in the telecom technology and products area. These are the two problem areas which need to be addressed. Figure 1 shows this broad cause and effect diagram.

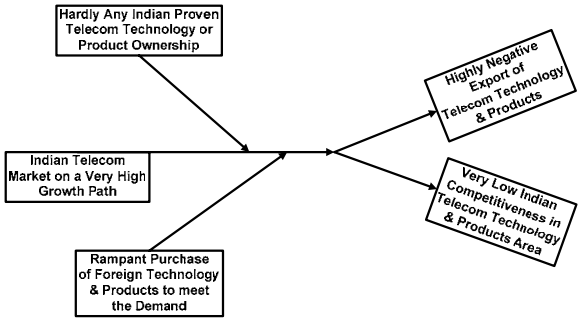


Figure 1 : Broad Cause and Effect Diagram – Low Technology Competitiveness

These problems are rather more complex and are contributed by a number of factors related to multiple players in the Indian telecom sector, like, Indian Development Firms, Operating Firms, Foreign Development Firms, Government, Industry Associations and Research & Academic Institutions. This detailed cause and effect diagram is shown in Figure 2. The factors related to the Indian development firms are, viz.; No established proven products; New products facing rejection from the telecom operators due to non-proven clause; Objectives of quick gains leading to focus only on consultancy and project work and not on more grinding option of product/ technology development and deployment; Low hardware manufacturing capabilities and weak semiconductor component industry; Short term vision; Poor technology appreciation and corresponding vision; No importance to meaningful participation in the international standardization; Poor leadership; Only small incremental investments; Lack of risk appetite; Low accountability. The factors related to Indian operating firms are, viz.; Hyper competition; Huge growth in demand; Focus on market acquisition only; Insistence on proven products and technologies only; Tougher SLAs; Lack of risk appetite; Short term vision; Poor leadership; Quick revenue earning opportunities. The factors related to foreign development firms are, viz.; At least a few proven products making them eligible for their new product deployment; Ability to push their products in India; Strong influence on Indian telecom operators and the government; Huge support within their home countries; Huge financial muscle; Easy product/ technology sourcing option for Indian operators; Ability to have global strategy for the R&D work; Strong R&D backup and support back home. The factors related to the government are, viz.; Focus on licensing and regulatory aspects only; Lack of support for deployment of indigenous products; Lack of incentives to firms for R&D investments; No guidelines for technology standardization; No meaningful environment for protecting intellectual property.

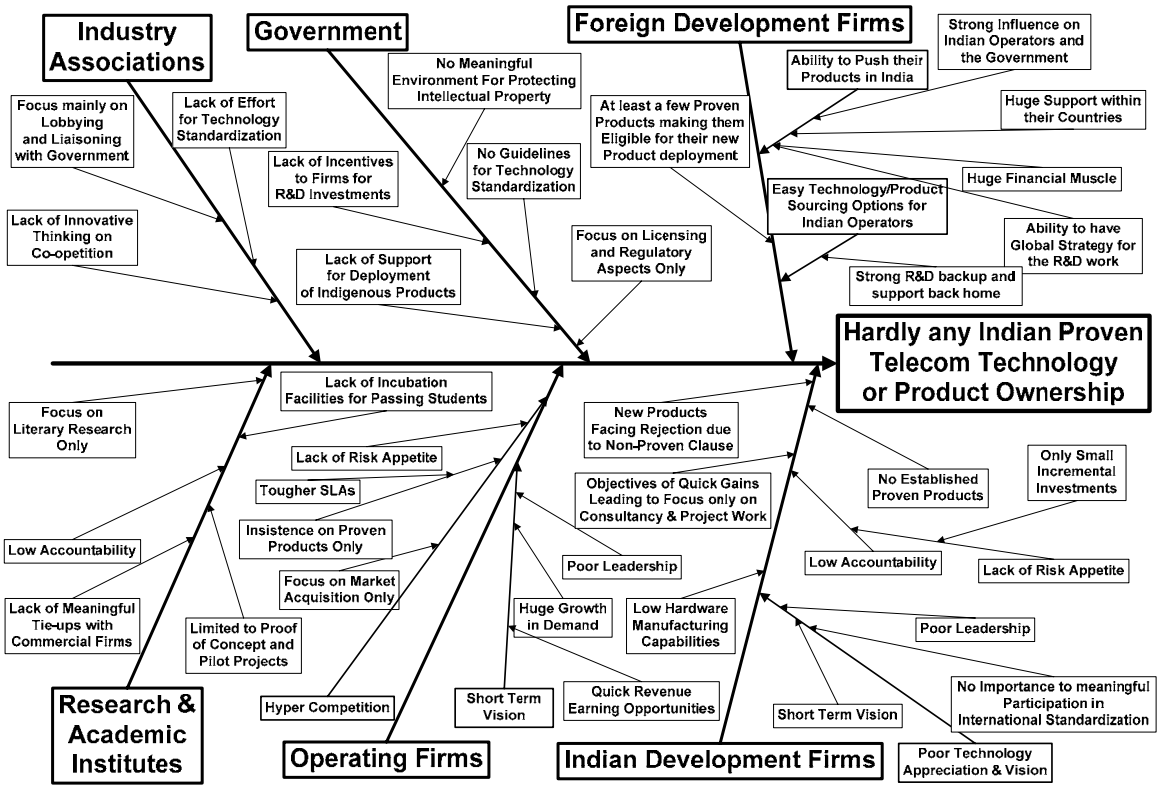


Figure 2: Detailed Cause and Effect Diagram – Low Technology Competitiveness

The factors related to the industry associations are, viz.; Focus mainly on lobbying and liasoning with government; Lack of innovative thinking on co-opetition; Lack of effort for technology standardization. The factors related to the academic and research institutes are, viz.; Lack of meaningful tie-ups with the commercial firms; Low accountability; Focus on literary research only; Lack of incubation facilities for passing students; Efforts limited to proof of concept and pilot projects.

Thus it could be seen that there is a general lack of the innovative product development environment in the country and that is why there is hardly any Indian proven telecom technology or product ownership. The lack of the innovative product development environment is being contributed by almost all the players in the sector, viz., the government, the operating firms, industry associations, development firm and the research & academic institutes. The detailed cause and effect diagram helps to identify the associated problems with the players, but is unable to figure out why the problem is sustaining and is not able to cure itself. To explain this sustenance, the systemic view is developed in the next section.

3.2 Systemic View

Since the problem of lower technological competitiveness of Indian telecom industry is now sustaining for long, it is important to understand the various components/variables/parameters associated with the industry and their interplay. This is better depicted with systems view. To develop the systems view, a number of interdependent and measurable variables are identified in Table 1 as follows: -

Table 1: Interdependent and Measurable Variables for Systems View

S.No.	Variable Name	Variability Dimensions	Measures
1.	Unserviced Telecom Demand	• Urban • Semi Urban • Semi Rural • Rural	• Subscriber Growth Rate • No. of unserviced areas • Idle capacity of operators' networks
2.	Serviced Telecom Demand	• Urban • Semi Urban • Semi Rural • Rural	• No. of commissioned subscribers • Subscriber Growth Rate
3.	Telecom Infrastructure Investments	• Urban • Semi Urban • Semi Rural • Rural	• Telecom Infrastructure Investments
4.	Telecom Technology/ Infrastructure Import	• Urban • Semi Urban • Semi Rural • Rural	• Telecom Technology/ Infrastructure Import
5.	Overall Economic Growth	• Urban • Semi Urban • Semi Rural • Rural	• Growth Rate, • Per Capita Income, • Average Urban and Rural Expenditure and Savings Profile
6.	Technology Leapfrogging in Telecom	• PSTN • Mobile • IP/Broadband • 4G/NGN	• Operators' Investments in the technology introducing discontinuity/leapfrogging
7.	Demand for New Telecom Services	• PSTN • Mobile • IP/Broadband • 4G/NGN	• No. of Innovative Services successfully launched and popularized
8.	Government's Telecom Policies	• Licensing • Regulation • Liberalization • Privatization	• No. of Licenses • Amount of Spectrum Allocation • Allowed FDI • Actual FDI

		• Technology Ownership	• Consolidation Allowed • No. of Indian Patents Registered • No. of Indian Standards in the Advanced Telecom Technologies
9.	No. of Operators	• Independent Operations • Circles	• No. of Operators • No. of Circles • Extent of Cross Holdings among operators
10.	Successful Operations	• Growth • Profitability • Services • Customer Satisfaction	• Revenue Growth • Subscriber Growth • ROI/ROCE • No. of Innovative Services successfully launched and popularized
11.	Indigenous R&D Investments	• Investments/ Facilitations from Government • Investments/ Facilitations from Operators • Independent Investments from Indian Business Houses • Investments from Venture Capitalists/ Incubation Investments	• Direct Government R&D funding • Direct Operators' investments in R&D • Operators' Strategic Alliances with R&D firms • Core Telecom R&D investments from Indian Business Houses • Core Telecom R&D incubation investments
12.	Indigenous R&D Accountability	• Government Funded • Private Sector	• Technology/Product worth created per unit investment
13.	Indigenous Technology/ Products Availability	• Domestic Market • International Market	• Extent of successfully deployed technologies/ Products
14.	Service Competitiveness	• Domestic Market • International Market	• Service Competitiveness
15.	Technology Competitiveness	• Domestic Market • International Market	• Technology Competitiveness

3.2.1 Basic Positively Influenced Systemic View

The relations among these interdependent variables are captured in Figure 3, which shows the positive influence systemic view. As shown in the figure, the boom in the telecom sector is marked with burgeoning unserviced demand which also gets positively influenced by the overall country's economic growth. This unserviced

demand is met with the telecom infrastructure deployments by the operators based on either the technology/products import or the indigenous technology/products. The serviced telecom demand in turn helps the overall country's economic growth to some extent, thereby creating the demand further. In case the unserviced demand is enormous, it may not be possible for one or two operators to invest enough in the infrastructure and meet the demand. The government thus could liberalize and privatize the sector and introduce more number of operators and thereby influencing large infrastructure investments to meet the demand. The government could also regulate these operators so as to facilitate the efficient services and successful operations. The successful operations in turn influence the operators to invest more in the telecom infrastructure thereby further meeting the unserviced demand. The serviced demand thereby increases the service competitiveness of the country. Further, the unserviced demand could motivate the indigenous R&D investments and with embedded accountability of these investments, more and more indigenous technology/ products get available for deployment. This deployment serves as import substitution and also increases the technology competitiveness of the country. In the meanwhile there could be a technology leapfrog introducing a number of new services at cheaper prices and easy deployments. This could fuel the demand further and with operators using newer technology, the success of the operation could be enhanced. The government also realizes the need of newer policies to meet the new propositions posed by the technology leapfrog. Thus the newer rules of the game are written and the positively influenced systemic loop sustains.

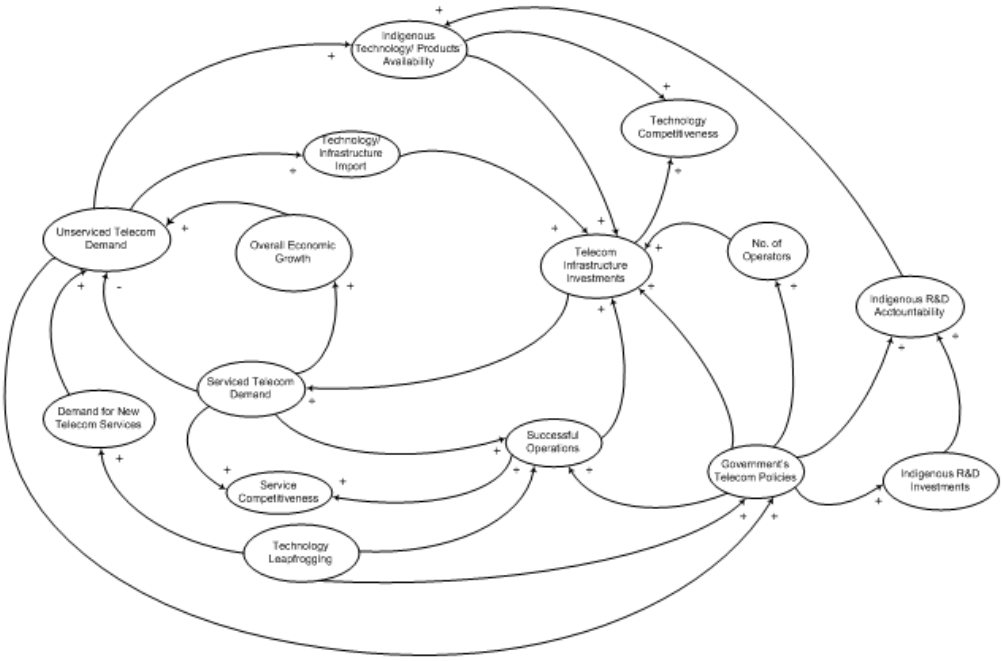


Figure 3 : Positively Influenced Systemic View of Telecom Sector

3.2.2 Systemic Sub-Loops

A holistic look to the systemic view suggests that there are essentially four sub-loops which may be independently self sustaining (at least for a while). These sub-loops could be identified as shown in Figure 4 and are described below: -

a) Dampened Growth Sub-Loop

In the Indian context, this sub-loop marks the pre-liberalization era where in spite of the huge unserviced telecom demand, there were not enough technology infrastructure investments. This was mainly due to the government's monopoly in the telecom operations with no private players involved. Since the government had limited funds at its disposal, the corresponding telecom infrastructure investments were also limited and there was only a dampened growth in the sector. Further although there were some facilitation and funding from the government for the indigenous R&D, but due to lack of much accountability, there were only a few indigenous technologies/products available for deployment. As a result there was not even much import substitution. As example to the indigenous technology/product developed and manufactured at that time was the rural exchange (RAX) developed by the government funded Center for Development of Telematics (C-DOT) and manufactured by public sector undertaking, Indian Telephone Industries (ITI). However this effort was also limited and later could not sustain much.

b) Free Market - Growing Economy Sub-Loop

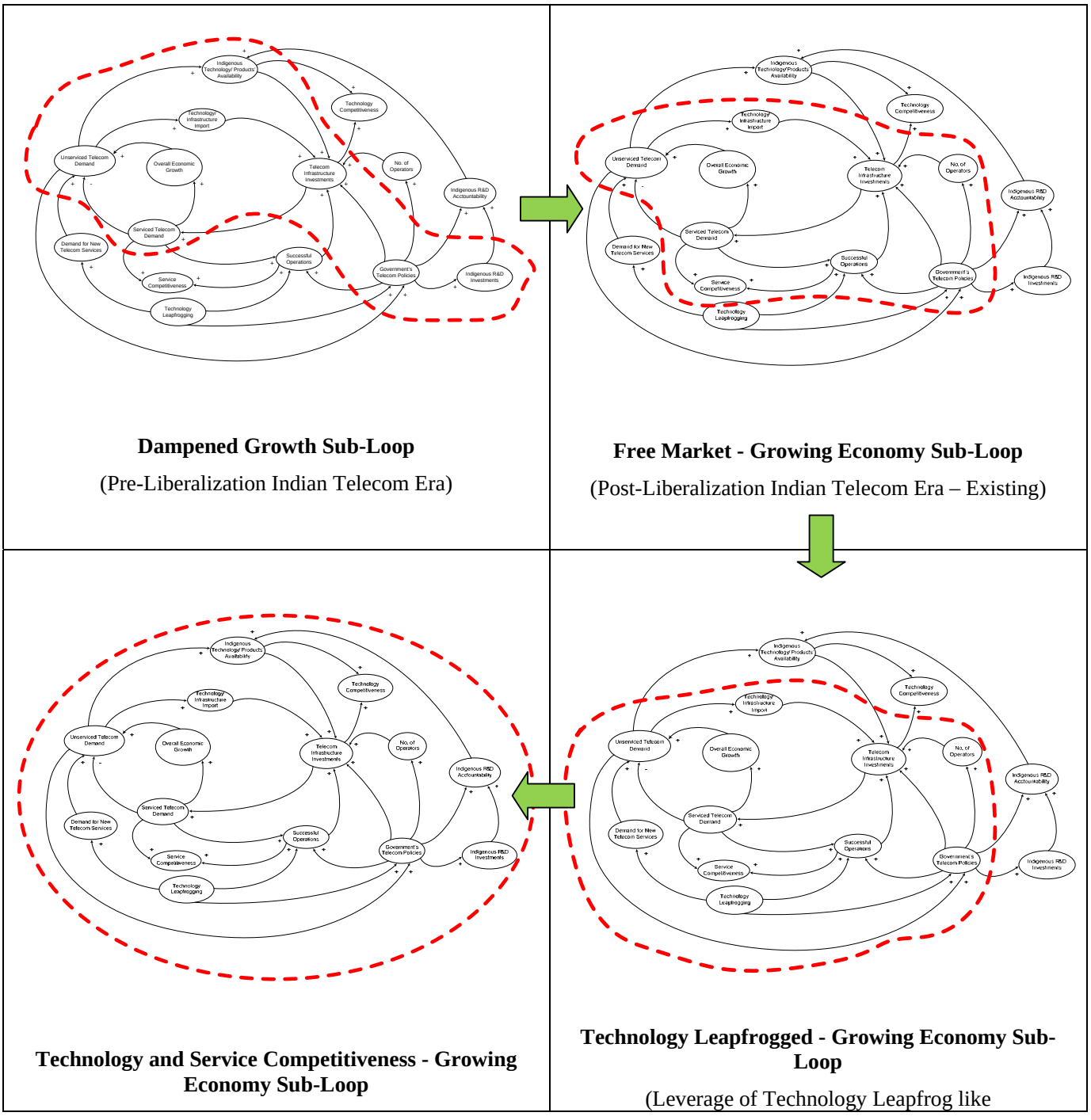
Again in Indian context, this is the post-liberalization era. Almost one and a half decade ago the government understood the problem of lack of funds for telecom infrastructure investments and took steps in terms of the liberalization and privatization of the telecom sector and introduction of the mobile technology. This was to meet the huge unserviced telecom demand without much hindrance in broadly a free market condition. Subsequently the periodic corrections in the regulation and licensing policies helped meeting the demands further. As a result the phenomenal growth in the sector has become self sustaining without much interference from the government. This is also the current phase in the Indian telecom sector where the exponential growth is freely happening. Newer services are also being launched everyday and there is a significant gain in the service competitiveness in the sector.

However an important point in this era is that there is hardly any serious facilitation towards indigenous R&D investments; neither from the government nor from the private sector. As a result there is a virtual absence of the indigenous technologies/products availability for deployment. The complete growth is happening at the expense of the precious foreign exchange and the real benefit of the boom in the telecom sector is going to the foreign technology/product firms. Even though there are a number of new services being launched everyday in the current 2G/2.5G technologies, a technology leapfrog in terms of IP/Broadband/3G/4G/NGN is waiting to happen which may change the dimensions of the growth again. In spite of all the growth, the sustenance of the whole systemic sub-loop depends upon the assumption that India is a huge market and the unserviced demand will keep on growing along with the growing economy. In case of any slowdown, this growth sustenance of the sub-loop is questionable and may crash. Even the slowdown in the import of technology/ infrastructure due to foreign economy slowdown (even though Indian economy grows) may crash this growth sustenance sub-loop.

c) Technology Leapfrogged - Growing Economy Sub-Loop

This represents an era waiting to happen in terms of the launch and diffusion of the IP/Broadband/3G/4G/NGN network services. While the launch of these network and services depends much on the government's policies about Voice over IP and the spectrum allocation, the diffusion of the these services depends upon the

commercialization of the innovative newer services by the operators. There is a sufficient technology leapfrog push to the government for early finalization of the policies. Moreover as the newer innovative services are launched, there is going to be a new leg of explosive demand growth. This way the whole systemic loop is taken to a new dimension of growth and this further increases the service competitiveness. Again, any possibility of slowdown in the economy or the unserviced demand, could lead to the crash of this growth sustenance sub-loop. And again, even the slowdown in the import of technology/ infrastructure due to foreign economy slowdown (even though Indian economy grows) may crash this growth sustenance sub-loop.



Dampened Growth Sub-Loop

(Pre-Liberalization Indian Telecom Era)

Free Market - Growing Economy Sub-Loop

(Post-Liberalization Indian Telecom Era – Existing)

Technology and Service Competitiveness - Growing Economy Sub-Loop

Technology Leapfrogged - Growing Economy Sub-Loop

(Leverage of Technology Leapfrog like

(Desired State for Technology and Service Competitiveness)	IP/Broadband/4G/NGN) etc.

Figure 4: Transitions of Various Systemic Sub-Loops of Indian Telecom Sector

d) Technology and Service Competitiveness - Growing Economy Sub-Loop

In spite of the systemic loop sustaining new growth, the real problem is the lack of technology competitiveness. The lack of technological self reliance poses a huge risk to the growth sustenance. This sub-loop is thus the desired one and includes the serious R&D investment well facilitated by the government as well as the private sector with due accountability. This brings more and more indigenous deployable technologies/products on the anvil and thereby facilitating import substitution. This not only saves the foreign exchange but also increases technology self reliance as well as technology competitiveness.

Thus a growth in the demand is equally met with the indigenous technologies/products. Any slowdown in the foreign economies thus may not affect the supply of infrastructure. Moreover in case of a domestic slowdown the technology command can act as a savior. Including the technology competitiveness would lead to a desirable situation of the technology and service competitiveness growing economy sub-loop.

4. Case Study – Huawei Technologies

While the whole telecom technological competitiveness scenario in India looks to be grim, the same for China is reasonably healthy with a lot of contribution from Huawei Technologies, which is one of the leading product development firms and has shown the successful leapfrog in the telecom technology area. The company focuses on the future telecom network needs and has a focused IP based technology strategy. In just 18 years, Huawei has grown from a corporate midget into a mighty global contender, with offices in 41 countries. Guangping (2007) points out that as a private owned enterprise, Huawei realized great-leap-forward development through "independent R&D" and "walk-out" strategy. Simons (2006) described various other factors affecting the performance of Huawei. These factors are categorized in the three views of strategy and performance, viz., Industry based view, Resource based view and Institution based view (Peng, 2006).

Looking from the industry based view, Huawei has benefited from being in a strategic industry. Over the past 20 years, there has been a massive release of pent-up demand in China for better communications. Huawei grabbed this opportunity with both hands and grew unhindered. When Huawei began selling fixed-line hardware in 1988, China had only about 3 million land-line phones as compared to the current combined numbers of 950 million land-line and mobile.

Looking from the resource based view, Huawei has been meticulously handling the aspects of R&D investments; IPR and patents; global R&D setup; upgrading R&D setup to world class standards, driving international standardization; leapfrog strategies of "independent R&D" with IPRs and "walk out" aggressively to global arena. Huawei has kept investing funds around 10 percent of sales revenue in R&D every year. Up to the end of 2006, Huawei had possessed 2,575 patents. It submitted a total of 575 international patent applications in 2006, going beyond Cisco Systems. Huawei has set up R&D facilities in Dalas and Sillicon Valley of the US, Bangalore of India, Stockholm of Sweden, and in Mosco, as well as a research institute in Europe. Huawei has spent more than $500 million hiring foreign firms like PriceWaterhouseCoopers and Hay Group (which specializes in human resources) to modernize the company's business practices including accounting, pay packages and leadership training for corporate executives. It has joined 75 countries' standard organizations, and has had 300 personnel involved in the formulation of international standards. Although the internationalization of hi-tech firms from developing countries is harder than those companies from developed countries (Wu and Zhao, 2007), Huawei adopted internationalization strategy, which has been testified as a correct choice by the fact. Now the company's overseas revenue accounts for more than a half of its total revenues. Huawei also formed a number of alliances with firms like Marconi, Siemens, 3Com, Matsushita (Panasonic), NEC, Motorola etc.

Looking from the institutions based view, market forces are not the only catalyst for Huawei's growth and Beijing has taken a very active role. Huawei has received a slew of advantages, from government R&D funding to tax breaks and export credits. The R&D operations of some Chinese firms are partially funded by the government, and Huawei has received more than $9 million in research funding from Beijing since 2003. Another important aspect is the easy line of bank financing Huawei received. In 2004, Huawei got a $10 billion credit line from the state-owned China Development Bank and $600 million from the Export-Import Bank of China to fund its global expansion. That helped Huawei undercut competitors' bids by as much as 70 percent and offer vendor-financed loans. In April, Nigeria received $200 million in loans from the China Development Bank to buy Huawei equipment. The Chinese government kept the view that Chinese high-tech firms are weak compared with larger Western corporations and so they needed the government's help. Beijing has been pouring money into science education. Chinese universities are graduating more engineers than the United States by a factor of three to five, a trend that has helped Chinese companies improve not only in manufacturing but in research and development. At Huawei headquarters, scientists and engineers (half of them with master's degrees or Ph.D.s) churned out 2,300 new patent applications last year, with much lower pay packets. Further, China decided to develop its own technical standards, so it can stop paying royalties to foreign firms. However, while the government's support was the baseline reason initially for the company's leapfrog, it also proved to be a matter for suspicion for the company. For example, a some orders to Huawei were blocked by India due to security reasons. Similarly UK raised

reservation about bidding by Huawei. Globally, analysts were apprehensive about the real intent behind Huawei's efforts (similar to China National Offshore Oil Corporation, Lenovo, Haier and other Chinese firms) in terms of whether it a security menace bent on doing Beijing's bidding, a legitimate international telecom competitor, or a corporate house of cards, all market share and PR releases but no profits. Opaque bookkeeping has also frightened analysts. Huawei has also been dogged by accusations of intellectual-property theft and corporate espionage. There are persistent rumors that the firm is actually run by the People's Liberation Army. The company denies that, and has long claimed it no longer has any ties to the government. The firm has two short-term aims--to reduce product prices further by cutting profit margins and to increase R&D spending. Huawei might do both, with or without Beijing's help.

The case study of Huawei clearly indicates a very significant role of the government towards its success. The important aspect is that the government's role has been that of facilitator rather than mere protector. The government supported in terms of direct funding, cheap financing, local technology standardization, ensuring the deployment of the products conforming to these standards, supporting the research and academic institute as a complementary strategy to nurture local talent, influencing and even arranging finances for the international buyers to buy Huawei's products etc. Thus with these kinds of influences a high degree of motivation and accountability was embedded into the R&D efforts of Huawei. Complemented with the matching resource and capability strategies of focused R&D and internationalization and the boom in the telecom sector, Huawei could come up with a number of products deployed in various national and international telecom networks and achieve leapfrog. Even though dogged with some negativity, Huawei is constantly working towards the upgrade of the working environments and generating self sustaining revenues and profits, with the world class business processes & practices.

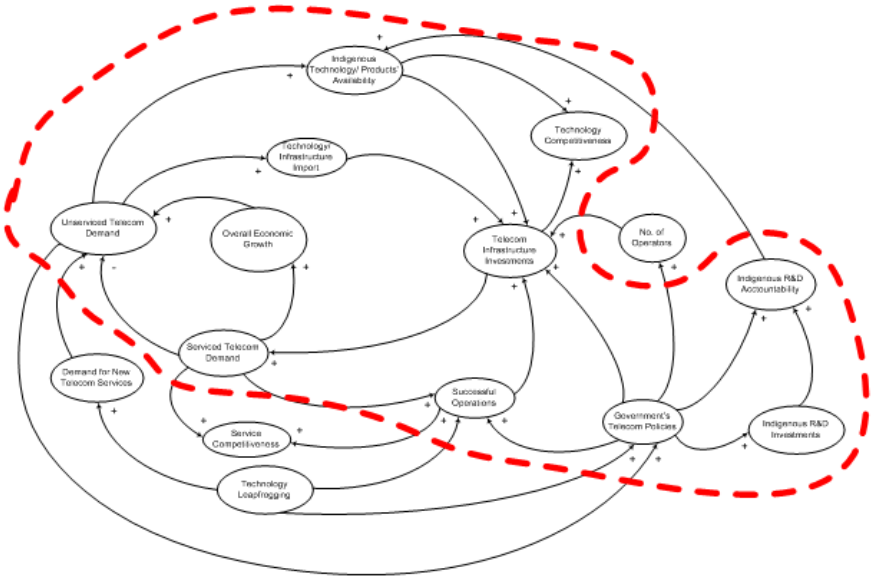


Figure 5: Positively Influenced Systemic Loop with Technological Competitiveness

The synchronized and visionary efforts of the government and the development firm (Huawei) led to a successful combination in terms of the telecom technologies/products ownership. The products have not only been widely deployed in the domestic markets but are deployed well across the international boundaries. How this successful model is sustaining (in context of these Chinese market), is shown in the systemic view in Figure 6 (encircled dotted portion). Although the figure shows only the domestic Chinese market, but the growth and stability of the R&D efforts of Huawei have been a lot due to the intensive internationalization of its products. The systemic loop in this case banks largely on the indigenous successful R&D products and thereby generating technology competitiveness for the firm and the country.

5. Conclusion

Due to unprecedented growth in Indian telecom services market, heavy investments in the telecom infrastructure are happening. However, there is a heavy dependence of operators on the foreign technology since there are weaknesses in innovative product development processes and effective strategies in Indian R&D firms and low facilitating effort from the government to nurture the indigenous R&D efforts in an accountable manner. The operators also don't consider the technology ownership as their forte and are busy in fulfilling the explosive consumer demand, largely through imported technology. Indian development firms do not see any assured deployment scenario of their products and thus consider it very risky to invest aggressively in the R&D. The industry associations are overwhelmed by the operators only and thus do not consider technology ownership as an important issue. The academic institutions don't have any significant tie up with commercial firms to take their innovative ideas to the field. This whole problem, if seen in a systemic view, is growing because of existence of a sustaining loop. However this loop is generating only the service competitiveness and not the technological competitiveness and thus may not be long lasting due to imbalances.

The Huawei case study has shown that there has been a clear difference in the Indian and the Chinese technological outlook. The Indian government has followed almost a free market approach with not much clarity about technology vision, guidelines and R&D facilitations. On the other hand, the Chinese government has taken a very proactive and long term technological view in terms of carefully nurturing their development firms like Huawei by supporting them on all fronts, which has certainly raised their technological competitiveness.

To have some significant technological competitiveness in the telecom sector, Indian telecom product development firms must leapfrog now and the role of the government is important. This could be the beginning of the long journey of building competitiveness for the country.

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References

- Bourgeois L.J., III and Eisenhardt Kathleen M., 1988, "Strategic Decision Process in High Velocity Environments: Four Cases in Microcomputer Industry", *Management Science*, Vol. 34, No.7. (Jul.), pp.816-835.
- Cassiolato Jose E., Szapiro Marina H.S., Lastres Helena M.M., 2002, "Local system of innovation under strain: the impacts of structural change in telecommunications cluster of Campinas, Brazil", *International Journal of Technology Management*, Vol.24, No.7/8, pp. 680-704.
- Curwen Peter and Whalley Jason, 2001, "Alliances and Joint ventures in the telecommunications industry: The case of the mobile and vendor sectors", http://userpage.fu-berlin.de/~jmueller/its/conf/berlin04/Papers/curwen%20whalley.pdf. (Accessed on 24th April, 2008).
- Davison Robert, Vogel Doug, Harris Robert and Jones Noel, 2000, "Technology Leapfrogging in Developing Countries – An Inevitable Luxury?", *The Electronic Journal on Information Systems in Developing Countries*, EJISDC, 1, 5, 1-10.
- Ettlie John E. and Pavlou Paul A., 2006, "Technology Based New Product Development Partnerships", *Decision Sciences*, Volume 37, Number 2, May.
- Gao Xundong, Zhang Ping and Liu Xielin, 2007, "Competing with MNEs: developing manufacturing capabilities or innovation capabilities", J Technol Transfer, 32:87-107, Digital Object Identifier: 10.1007/s10961-006-9002-2.
- Gavosto Andrea, Ponte Guido and Scaglioni Carla, 2007, "Investment in Next Generation Networks and the Role of Regulation: A Real Options Approach", Working Papers, WP 031/2007/DE, ISSN No. 0874-4548, School of Economics and Management, Technical University of Lisbon, Department of Economics, December.
- Grant Robert M. and Baden-Fuller Charles, 2004, "A Knowledge Accessing Theory of Strategic Alliances", Journal of Management Studies, 41:1, January.
- Guangping Zhuang, 2007, "How could Huawei realize its great leap forward?", *China Economic Net*, July 06 (http://en.ce.cn/Insight/200707/06/t20070706_12077662.shtml). (Accessed on 24th April, 2008)
- Hagedoorn John, 1993, "Understanding the Rationale of Strategic Technology Partnering: Interorganizational Modes of Cooperation and Sectoral Differences", *Strategic Management Journal*, Vol. 14, No. 5, July, pp. 371-385.
- Husain Zafar and Sushil, 1997, "Strategic management of technology – a glimpse of literature", *Int. J. of Technology Management*, Vol. 14, No. 5, Pages 539-578.
- Jacobs Bodo, 2006, "Economics of NGN deployment scenarios: discussion of migration strategies for voice carriers", *Telecommunications Network Strategy and Planning Symposium, NETWORKS*, 12th International, ISBN: 3-8007-2999-7, Digital Object Identifier: 10.1109/NETWKS.2006.300357.
- Lee Keun, 2005, "Making a Technological Catch-up: Barriers and Opportunities", *Asian Journal of Technology Innovation*, 13, 2.
- Lee Keun and Lim Chaisung, 2001, "Technological regimes, catching-up and leapfrogging: findings from the Korean industries", *Research Policy*, 30, 459-483.
- Li Mingfang, 2007, "Innovation management: Chinese experience and global implications", J Technol Transfer, 32:1-8, Digital Object Identifier: 10.1007/s10961-006-9004-0.

- Mcdermott Christopher and Handfield Robert, 2000, "Concurrent Development and Strategic Outsourcing: Do the rules change in breakthrough innovation?", *The Journal of High Technology Management Research*, Volume 11, Number 1, pages 35-57.
- Minin Alberto Di, Palmberg Christopher, 2006, "A Case for Non-Globalization? The Organization of R&D in the Wireless Telecommunications Industry", Discussion Paper No. 1047, The Research Institute of Finnish Economy, October.
- Mittal Sudhir Kumar, 2003, "Government's Role in Facilitating R&D in Indian Telecom Sector", International Conference on Management of R&D (ICMARD) 2003, Published in the proceedings, Banwet D.K., Yadav S.S. and Momaya K (Eds.), *Management of Research & Development in the New Millennium*, Macmillan India Ltd., Pages 901-914.
- Momaya K., 2008, "Evaluating Country Competitiveness in Emerging Industries: Learning from a Case of Nanotechnology", *Journal of International Business and Economy*, Spring, Pages 89-112.
- Momaya K. and Kuroda M., 2008, "Cooperative Strategies for Innovation: Exploring Untapped Opportunities in Context of India and Japan in ICT Industry", *JSSPRM Conference*, Tokyo, Japan, Paper 1C13, Pages 140-145.
- Olson Eric M., Walker Orville C. Jr., Ruekerf Robert W. and Bonnerd Joseph M., 2001, "Patterns of Cooperation during New Product Development among Marketing, Operations and R&D: Implications for Project Performance", *Journal of Product Innovation Management*, July, Volume 18, Issue 4, pp. 258-271.
- Patel Pari and Pavitt Keith, 1999, "National Systems of Innovation Under Strain: The Internationalisation of Corporate R & D", DRUID's Summer Conference on *National Innovation Systems, Industrial Dynamics and Innovation Policy*, Rebild, June 9-12.
- Peng M.W., 2006, "Global Strategy", Thomson South-Western 2006, First Indian Reprint 2007, Printed by Baba Barkhanath Printer, Delhi, pp 14-15.
- Rama Ruth, 2007, "Foreign investment innovation: a review of selected policies", *J Technol Transfer*, Digital Object Identifier: 10.2007/s10961-007-9050-2.
- Shosteck Group White Paper, 2004, "The Indian Telecommunications Experience: Its Relevance for the World", September. (http://www.itu.int/ITU-D/imt-2000/TechnicalArticles/India%20Paper%20-%20FINAL.pdf). (Accessed on 19th February, 2008)
- Simons Craig, 2006, "The Huawei Way", *Newsweek*, Jan16, Issue (http://www.newsweek.com/id/47446?tid=relatedcl). (Accessed on 24th April, 2008)
- Sushil, 2005, "A Flexible Strategy Framework for Managing Continuity and Change", *International Journal of Global Business and Competitiveness*, Vol. 1, No. 1, Pages 22-32.
- Sushil, 1994, "Flexible Systems Methodology", *Systems Practice*, Vol. 7, No. 6, Pages 633-652.
- Szapiro Marina Honorio de Souza, 2000, "Technological Capability in the Telecommunications Industry in Brazil: Development and Impacts of the Structural Reform in the 90s", *Druid's Winter Conference*, Aalborg, Danmark, January 6, 7 and 8.
- TRAI Study Paper, 2005, "Indicators for Telecom Growth", Telecom Regulatory Authority of India, Study Paper No.2/2005, (http://www.trai.gov.in/trai/upload/StudyPapers/2/ir30june.pdf). (Accessed on 24th April, 2008)

- Veryzer Robert W., Jr., 1998, "Discontinuous Innovation and the New Product Development Process", *Journal of Product Innovation Management*, July, Volume 15, Issue 4, pp. 304-321.
- Voelpel Sven C., Leibold Marius and Tekie Eden B., 2004, "The wheel of business model reinvention: how to reshape your business model to leapfrog competitors", *Journal of Change Management*, Vol. 4, No. 3, 259-276, September.
- Wirtz Bernd W., Mathieu Alexander and Schilke Oliver, 2007, "Strategy in High-Velocity Environments", *Long Range Planning* 40(3), pp. 295-313.
- Wu Donglin and Zhao Fang, 2007, "Entry Modes For International Markets: Case Study of Huawei, A Chinese Technology Enterprise", *International Review of Business Research Papers*, Vol. 3, No. 1, March, pp 183-196.