terms such as 'atlas of science' and 'scientography' (geography of science). In the 1990s, Olle Persson, Umea University, came up with the ready-to-use open source software, BibExcel, which enabled even novices to dabble with mapping science. And yet information display is still in the adolescent stage of evolution in the context of its application to scientific domain analysis.

Recently, Garfield has come up with HistCite, a powerful tool to identify key papers and major developments in the evolution of a field or the work of an individual or institution, and Chamomei Chen, Drexel University, has developed Citebase, which uses cocitation mapping for comparing science maps year by year. Loet Leydesdorff, Amsterdam University, has developed an advanced visualization technique (dynamic animation) that can trace the evolution of the changing structure (or map) of science as a time series.

This book is an effort by Félix de Moya-Anegón and Benjamin Vargas-Quesada of the Grupo SCImago, University of Granada, Spain, to describe in sufficient detail the work that the SCImago group has carried out since the mid 1990s. They examine the deep-rooted association between visualization and analysis of knowledge domains and describe how to analyse knowledge domains through representation via social networks.

They use the vast publication and citation data available from the *Web of Science* and construct citation networks borrowing ideas from social network theory and graph theory. They apply PathFinder Network (PFNET) to prune the resulting maze of connections to get graphs that are largely free of superfluous relationships.

After a brief introduction to the idea of visualization and its importance in science and domain analysis, the authors devote a chapter to explain the concept of social network, social network analysis and scientography, a term coined by the late George Vladutz, to describe the action and effect of drawing charts of scientific output. The next chapter is devoted to tools and methods used prior to the arrival of scientography such as cluster analysis, multidimensional scaling, factor analysis, neural networks, Path-Finder network, the Kamada–Kawai algorithm, the Fruchterman and Reingold algorithm, and scalable vector graphics.

Then comes the second part of the book, viz. analysis by the SCImago group of papers published in 2002 and indexed in *Web of Science*, downloaded on 2 August 2004. The chapter on materials used describes in detail the problems faced in using the *Web of Science* data, originally meant to help users identify literature relevant to their work, in scientometric applications. This and the following chapter on methodology are important not only to understand the work of the SCImago group, but also serve as a good introduction to anyone wanting to work in scientometrics in general and visualization in particular. Considerable space is devoted to explain the use of the PathFinder network. The authors demonstrate how the essential structure of science could be captured in a set of a few diagrams by means of the most significant citation links.

The authors present their results on the analysis of world science (in 2002) as a whole, and using factor analysis analyse the structure of different disciplines. Of the 218 categories into which knowledge is classified in *Journal Citation Reports* (*JCR*), biochemistry and molecular biology was the most central category in 2002; it was the category with the most shared sources and the top contributor to world scientific advancement. An observation that hardly anyone would doubt. The authors further demonstrate the power of their technique by comparing the scientographs of USA and the European Union and by mapping science in Spain. I enjoyed reading this chapter and in particular, the use of evocative terms such as 'vertebration of science'. Talking about the differences one might observe in the results obtained using the *JCR* categories and the Spanish ANEP taxonomy (of 25 classes), the authors make the insightful comment, 'We must recall that the relations revealed in the scientographs are no more than the reflection of the unconscious labour of hundreds of thousands of researchers coming to the surface through their citations. In contrast, the ANEP classification is a taxonomy elaborated by a handful of experts'.

The book ends with 68 pages of annexure and more than eight pages of references. The authors have profusely acknowledged the contributions made by others. On the downside, one would need a magnifying glass to view some of the scientographs, certainly a drawback for a book on visualization. The publishing fraternity often claims that it adds value to authors' manuscripts, but this book does not have an index!

On the whole, this is an excellent book that scientometricists around the world would find useful. The authors deserve our congratulations.

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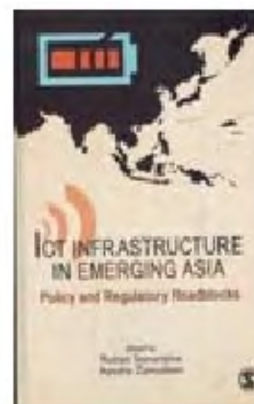


**ICT Infrastructure in Emerging Asia: Policy and Regulatory Roadblocks.** Rohan Samarajiva and Ayesha Zainuddin (eds). Sage Publications India Pvt Ltd, B1/I-1 Mohan Cooperative Industrial Area, Mathura Road, New Delhi 110 044. 2008. 333 pp. Price: Rs 595.

Need (or demand), affordability, technology, and regulation/policy have been the four primary drivers of telecom growth in any country. As all these drivers start falling in place, telecom grows rapidly. Telephony in India and most of the emerging Asia has been witnessing this exponential growth in recent years. There is hope that the Internet would get into a similar growth trajectory soon, though at least in India, the hope has been so far belied.

Telephone has always been known to connect people across cities and countries at a personal level. Somewhere in the seventies and eighties, as India became more and more integrated, people started migrating to different parts of the country in large numbers. This happened simultaneously with growth in road transport, larger focus on professional education (engineering, medical and

management) and growth of IT industry in India. Soon after (in the nineties), the global integration of Indian economy started. The demand for telephone was ever-increasing. The capital expenditure required (given the technology) to provide telephony, however, was just too expensive and largely unaffordable to even the middle classes (let alone the poorer sections), especially in low-income countries like India. It made no business sense. There was only one way to provide this highly needed service; that is by Government subsidy. The Government monopoly carried this task. A large country that India is, required a huge amount of money to build adequate telecom infrastructure and with its cash-starved Government providing meagre investments, the service was provided somewhat poorly. Telecom operators of some smaller countries did, however, build this infrastructure with foreign aid or investments and could provide better service.

Telecom technology started changing in the eighties. Optical fibre technology matured, and its huge bandwidth meant that 'distance' was no longer a factor in telephone quality or costs. The integrated circuit (IC) technology revolution, coupled with the advent of microprocessors and digital signal processors made telecom switches as highly inexpensive; the cost was now driven by the software effort involved in building them. The only bottleneck was the local loop (or the access network), the last few miles connecting the telephone switches to individual homes. Wireless technology came in to break this last technology and cost barrier in the mid-nineties. The need for telephony was already there and the technology had now made the service affordable.

The stage was set for the policy and regulation reforms to convert telephony into a viable business. While incumbents would provide the transition, private players would invest heavily and gradually take over the service. The Government would gradually privatize the incumbent operator. This indeed happened in most Asian countries in the nineties. Some moved fast, whereas others did it slowly. Some protected the incumbent a little too much (especially as the labour unions associated with these Government-owned incumbents queered the pitch), whereas others moved onto privatization faster.

The book under review is a study of this process in Asian countries. The appropriately titled Introduction: 'What is . . . and What could have been', points out how at times the governments and regulators did not quite get this change process right; and even though the number of telephones finally grew in all Asian countries exponentially, the growth could have been more stupendous, only if . . . .

The book starts with pointing out how telecom is (today) one of the largest contributors to growth of Gross Domestic Product in some countries. Further, the availability of modern telecom facilities of reasonable quality enables improved performance in all other sectors of the economy of a nation. That it makes a business sense is no longer in doubt. But while the middle classes in these countries have now been served adequately, serving the bottom of the pyramid (BoP) remains a challenge in business terms. The book focuses on this and points out how appropriate policies and regulations would go a long way in overcoming this logjam. The first section of the book, with three chapters, adequately places research results showing that the demand pervades amongst all sections of people today, including those at the BoP. The second section consisting of three chapters, discusses how even while there is a significant demand at the BoP segment, it remains under-served, constrained by poor policies and regulations and unimaginative business plans. It looks at how market participants, where policy and regulatory inadequacy compounded by hostilities from incumbent operators (slow them down), have found their own solutions. The workarounds may not be optimal, . . . but they are the best available alternatives. The technological solutions alone are often inadequate in finding a solution and innovative business models are required. The third section is perhaps the strongest of the book. Its four chapters give several examples of how the regulations and policies stifle the serving of the needs and a few examples of how they enable it. It deals with complexities involved in managing this change process from monopoly incumbent to competitive business. The chapter 'Access deficit tax' is a strong indictment of the Indian regulators.

The section entitled 'What could be?' has three chapters painting a vision of what could be achieved if the policy and regulation were right. The chapter 'High

AMPU from low ARPU' deals with creating sustainable business models for the under-served, focusing on margins rather than average revenue per user. Finally 'Regulating for the next billion' points out that the thinking in policy and regulation has to be out of the box, if the focus is to serve BoP customers. The book leaves us with no doubt that this is indeed doable.

The book is unique, as it focuses on an important problem, and presents enough research to back its policy arguments. Its theme, 'Policy and regulations have constrained the growth of telecom in Asia in recent years, especially in serving the disadvantaged', does appear to be true if one takes a static view. It is a bold statement, especially when the growth of telecom in Asia and its contribution to the rapid rise of China and India as world powers is being celebrated all over the world. Let me take a deeper look at the change process in India, to discuss the theme of the book further.

As discussed earlier, demand, technology, affordability and policy (and regulation) are the four drivers of telecom. In the absence of any one of these, the growth gets stifled. The demand for telephones was present in the eighties; but it was largely unmet, with customers having to wait eight years to get a telephone. The technology was such that the capital expenditure involved in installing a telephone was high. The low affordability, even for the middle classes in India, did not enable business-led growth. The telecom department depended on annual grants from the Government. Pushed by this large unmet demand, the telecom officials over-loaded the exchanges. The service was therefore poor. It was at such a time that Sam Pitroda came to India to build an Indian telephone exchange, using digital IC technology, to bring down the prices and overcome the service constraints. It was indeed a marvellous feat. As optical fibre started being used in the backbone network, an initiative was taken to bring down the off-peak hour long-distance charges. As the high cost of access network still constrained the growth, shared telephones (Public Call Offices) were introduced in a large way. One naturally found the customers flocking to such booths in large numbers. Telecom revenue grew significantly.

It was in such a backdrop that talks about telecom liberalization started taking place. Maybe there was a business case to bring in private players to fulfil

this huge unmet demand. The opening up process started in 1993 and bids from private parties to operate telephony were called in. There was huge response, with some players bidding astronomical amounts to get the telecom operation license. The licenses were indeed awarded, but there was hardly any growth. While the demand was there and policy steps were taken, the right technology to make telecom affordable to the Indian middle classes, was still missing. The cost associated with the access network and the time to build it up (digging of roads to lay copper wires) severely constrained any growth.

It was then that wireless as local loop was envisaged in India. Initially it appeared as an expensive option since copper was being replaced by high-cost electronics. But the scientists who pushed for it understood that Moore's Law would help bring down the cost of wireless telephony to that affordable to middle classes in India. It took six to seven years for this to take place; responding to the changes, the regulators had to modify some licensing conditions and only then did the growth really take place. Thus the technology did play a key role in the growth. The book points out that it was the scale of production and competition amongst manufacturers that brought the cost down. Without the right technology,

the scale or competition alone would have failed to make telecom affordable in countries like India. For example, the costs of wired local loop would not come down due to scale. It was the evolution of digtalization, IC technology, microprocessor and digital signal processor architecture, optical fibre and wireless access technology, that created the conditions to bring down the costs with the right scale of production and competition.

It is correct that when demand, technology and affordability exist, are there, it is indeed the policy and regulation that plays the key role. Transition from State run monopoly to private competition is indeed a difficult task, with various interest groups pushing the policies in different directions. This is specially so in strong democracies, where short-term interest may often prevail over the long run. Further, the BoP has inadequate lobbies compared to other interest groups. It takes a much longer time to align the interests in such nations. One therefore needs to be careful while comparing the experiences of different political systems, for it may be easier to handle such contradictions in countries with lesser democracy. Further, it may not be meaningful to compare the policies in small countries and large countries. Large, populous nations have large momentum; they do not easily move; however, once

they get moving, the same high momentum would make it difficult to stop them. A smaller country would naturally be more agile.

The success and failure of policies and regulations need to be studied under such a backdrop. Each nation would have its specificities, and comparisons between nations may often be difficult. It is this difficult task that the book takes up. It has done a great job in reminding us that the telecom demand is stronger than what most envisage. It points to the constraints posed by policies and regulations, especially in reaching the BoP. It gives enough examples of what would indeed be possible only if one gets the policies right. It is a great book for those who influence policy and regulation. It is an interesting reading for those who are looking for novel business models to expand the market. Finally, it is a worthwhile reading for scientists and technologists who do not often understand the constraints posed by policy framework in limiting utilization and proliferation of technology.

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