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ICT Human Resource Development
in
Asia and the Pacific
Current Status, Emerging Trends, Policies and Strategies

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Abbreviations and Definitions

ICT:	Information and Communication Technology
ICTs:	Information and Communication Technologies
IT:	Information Technology
ITes	Information Technology enabled services
OECD	Organization of Economic Co-operation and Development
UN	United Nations
UN ESCAP:	United Nations: Economic & Social Commission for Asia & the Pacific
ILO	International Labour Organization of the United Nations
UNESCO	United Nations Education, Science and Culture Organization
IS	Information Security
CISCO:	A US based ICT Company specializing in networking.
IDC:	International Data Corp. (A US market research company)
NIIT:	National Institute for Information Technology (an Indian IT training company)
Region:	Unless otherwise mentioned means Asia Pacific Developing Countries
Nasscom:	National Association of Software and Service Companies India
ERP:	Enterprise Resource Planning
OS:	Operating System Software.
BPO:	Business Process Outsourcing

1.0 Introduction

The last decade has seen the Asia Pacific region emerge as the world leader both as a consumer and as a supplier of ICT products and services. From a marginal exporter of electronics and information technology hardware products in late 1980s China has surpassed the USA as the world's leading exporter of IT products for the first time in 2004. ICT service exports from the region have shown exponential expansion similar to that of the ICT hardware exports, with India emerging as the globally preferred destination for IT and BPO off shore services. Other nations in the region, notably Malaysia. Thailand, Philippines and Vietnam are also accelerating their ICT based social and economic development. During the last five years the region's domestic markets for IT products and services have also consistently shown double digit annual expansion, riding on the massive penetration of information technology in the urban centres of the region.

ICT is a skill intensive industry. Human resources related to ICT need close monitoring and development if the region has to maintain and accelerate the current momentum of ICT led economic development and social transformation. The present paper is based on the research and analysis of the status of and trends in ICT sector in the region and in the region's present and potential international markets; and to analyze the implications of these trends on the ICT human resource development. For the purpose of this study and research the information obtained from available UN sources has been supplemented with basic information from a number of technical papers and documents, news reports and governmental policy papers from various national and international governmental and non-government sources (major ones are listed in Appendix 1). The available national information related to ICT skills, is in most cases, fragmented and piece meal. The most difficult task of this research and analysis has been to put these pieces together to develop a reliable and meaningful scenario of human resources for ICT in the Asia Pacific region, its present status, trends in demand and supply and most importantly the changing pattern of demand for ICT skills. In conclusion the paper

has provided some strategic options for the development of ICT HR policies and strategies, for the consideration of decision and policy makers in the region.

2.0 Global and Regional trends

Globalization and increasing diffusion and penetration of ICTs in the region are most significant trends that have profound effect not only on the ICT sector but on the region's economy as a whole, as much as on its social fabric. The forces of globalization are leveling the playing field for every country, community and individual. Internet and web technologies are making it possible for buyers of products to locate the most economical source any where in the world and likewise for a seller to locate the most lucrative markets for his or her products, without the distortions of a middle man. What applies to physical products applies to services as well, in the sense that the market for most services (if not all) is as much global as it is for physical tangible products. In the emerging globalize and networked world we may be in way approaching Adam Smith's vision of perfect competition.

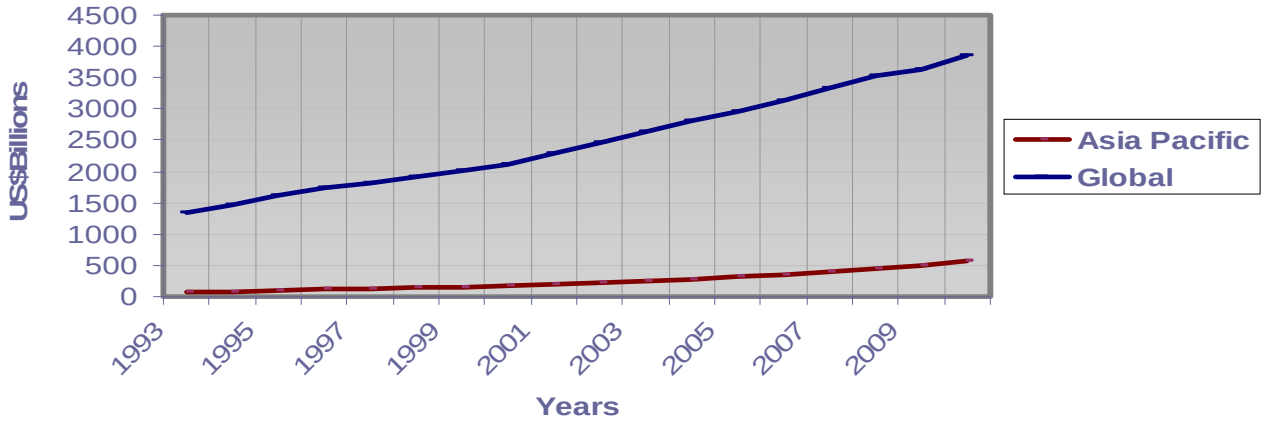
This process of globalization and market integration for both products and services sustained by the increased adoption of ICTs has brought the market to the door steps of the producers and service providers, no matter where in the world they are located. The region has been a major beneficiary of these global trends.

The needs for ICT human resources in a country are related to the level of ICT activities in that country. As the world ICT markets are getting more and more globalized and as the region takes an increasingly larger share of the global ICT products and services markets, the global ICT market trends would be as much important for determining the regional ICT manpower needs as would be the developments in the domestic markets of the region.

Global and regional trends in ICT consumption and trade determine the level of activity in the ICT sector and therefore the demand for ICT manpower. Fig 1 shows the actual and projected global and Asia Pacific IT market size over a

seventeen year period 1993-2010. It can be seen that the global IT market size has steadily risen from a level of about 1 trillion US dollars in 1993 to a value of nearly 3 trillion US dollars in 2005 and is projected to increase by about 6 percent a year to reach a size of 4 trillion US dollars in 2010. The growth of the domestic IT market in the Asia and Pacific region has been growing faster than the world average. As a consequence

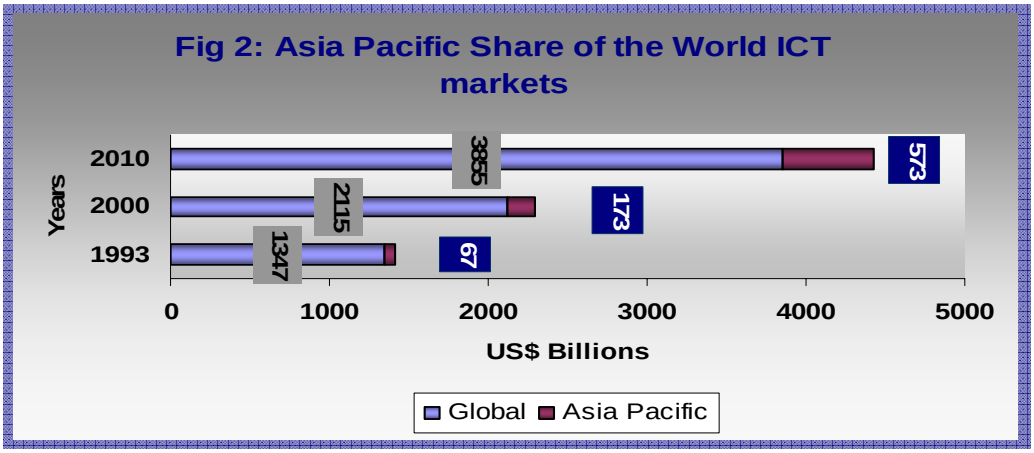
Fig 1: World and Asia Pacific ICT Market



Data Source: IDC; Projections by author

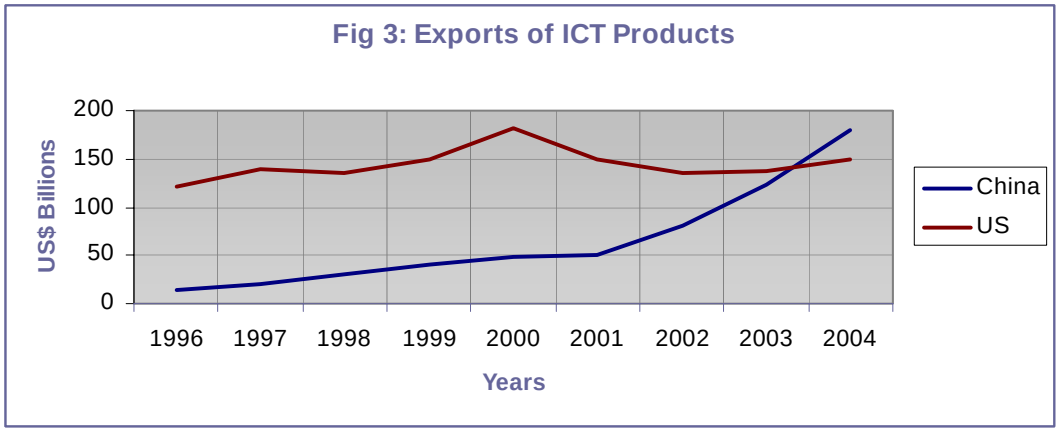
the share of the Asia Pacific region (excluding Japan, New Zealand and Australia) of the global IT market is estimated to have increased from a level of 5 percent in 1993 to about 9 percent in 2005 and is projected to increase to about 14 percent in 2010 (Fig 2).

Fig 2: Asia Pacific Share of the World ICT markets

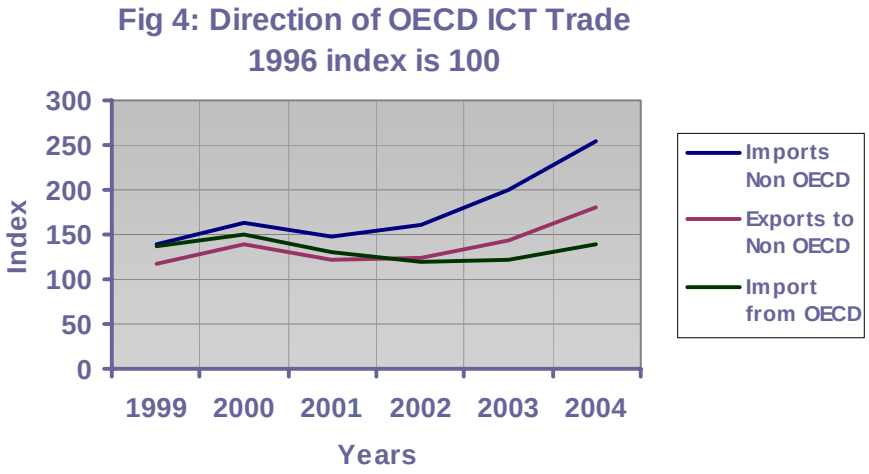


Data Source: IDC, Projections by author

The Asia Pacific region is also globally the preferred source for ICT products and services. Traditionally, US had been the largest exporter of ICT products. As can be seen in the Fig 3 the export volumes from US have remained more or less flat at about US$150 billion a year during the last ten years. On the other hand China, as the largest source of IT products in the world has sharply expanded its exports surpassing US as the largest exporter worldwide.



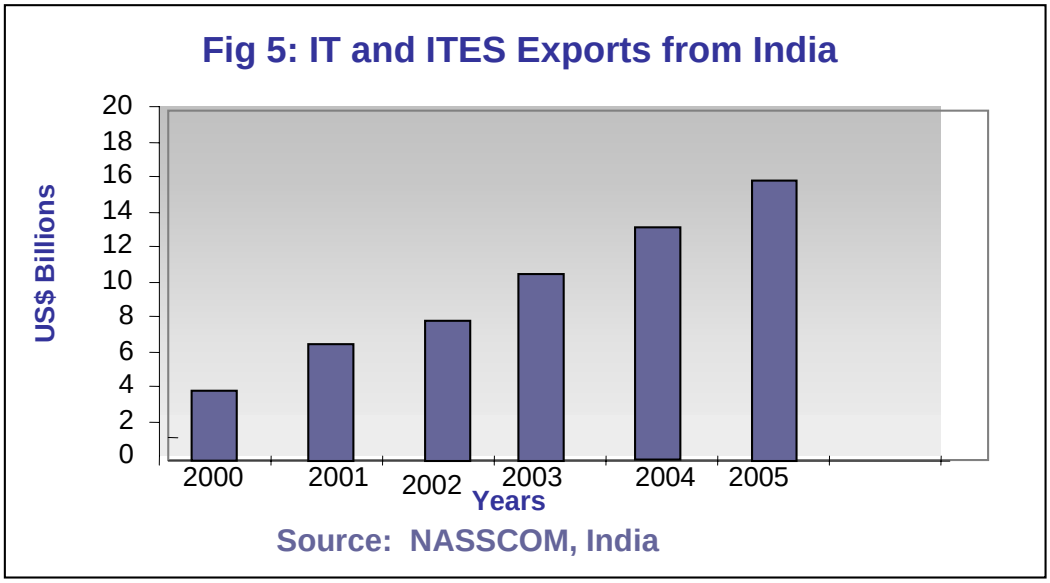
Data Source: OECD



Data Source: OECD

Organization of Economic Cooperation and development (OECD), a grouping of 30 industrialized and economically developed countries in the world, represent nearly 80 percent of the world market for ICT. The trends in the trade of ICT

products during the period 1999-2205, shown in the Fig 4, indicate the expansion of the share of the non-OECD countries in the total trade; the non OECD countries mainly consist of Asian countries. It can be seen that while imports into OECD from non OECD countries (which is mainly developing countries of Asia) have increased by nearly 70 percent during 1999 and 2004, the imports from OECD countries have marginally decreased during the same period.



The two major regional players in the world ICT markets are China and India. Other smaller countries in the region are also developing their capacities and increasing their export of ICT products and services. China has increased its ICT exports, consisting mainly of IT, telecommunication and IT electronic products, from a level of about US$ 50 billion in the year 2000 to a level of about US$ 120 billion in the year 2005. While the export revenues from ICT exports from India have been modest as compared to that of China the rate of increase on a year to year basis has been very sharp. The ICT exports from India, consisting mainly of IT and IT enabled services, have grown four fold from a level of US$4 billion in the year 2000 to a level of over US$ 18 billion in the year of 2005 (Fig 4) and is projected to reach a level US$30 billion by 2008.

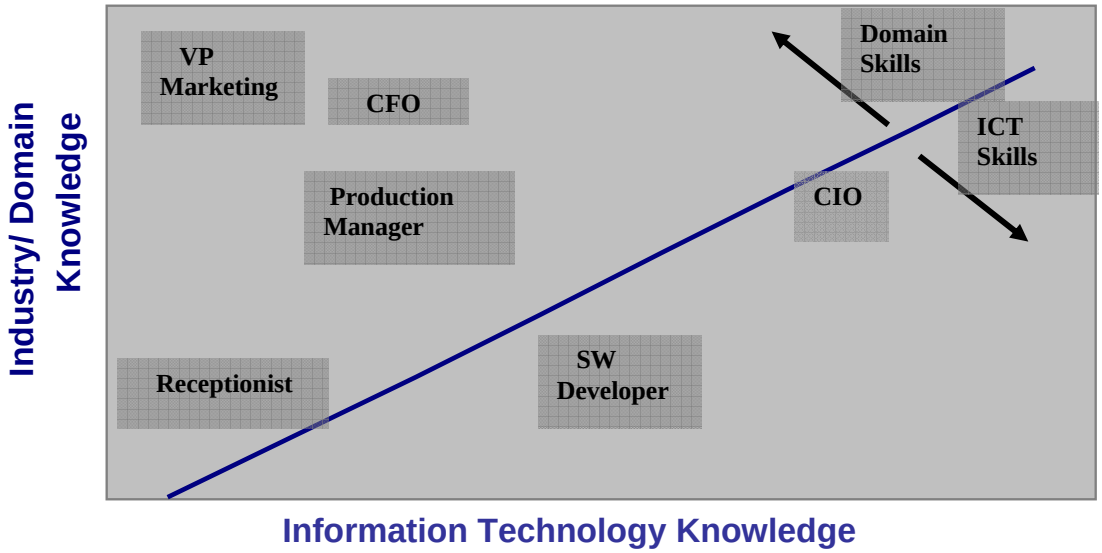
China, India as well as the other smaller countries of the Asia Pacific region are experiencing sharp expansion of their domestic IT market as well as their share of the international ICT market. As a result of the natural advantages that many regional countries have in terms of cheap knowledgeable and productive work force and favorable climate for ICT investment, there has been a sharply increasing trend towards off shoring of ICT work to the region and an equally sharp increase in Foreign Direct Investment (FDI) in the ICT sector of the region, from sources outside the region. The main beneficiaries of this trend have been the emerging countries: China, India, Malaysia, Russia, Philippines, Thailand and Vietnam.

3.0 Defining and Classifying ICT Skills

In assessing and evaluating the status of and trends in human resources and skills for information and communication technology it is important to clearly define the skills that may be termed as ICT skills. There is no standard international or regional definition and classification for ICT skills, which are universally accepted and used. Various organizations, institutions and individuals concerned with ICTs or with professional human resources management have variously defined ICT skills and occupations. For instance the *Bureau of Labour Statistics* and the *Department of Commerce* of the government of the United States use a classification scheme that includes two main classes of workers: core IT workers and IT related workers. The former consists of four occupations: Computer Scientist, Computer Engineers, Systems Analysts and Computer Programmer. The latter in contrast consists of some 23 occupations which use ICT intensively and are closely related to ICT industry. The ILO 1990 scheme for IT occupation classification ISCO88 has some 390 job categories and uses a different classification scheme for IT related workers. In both of these classification systems it can be observed that ICT skills have been narrowly focused on computer, communication and electronics hardware. This is understandable since these classification schemes were developed at a time when IT had very narrow applicability and software, services and web based technologies had yet to emerge. *National Workforce Centre for Emerging Technologies based in USA* has used a cluster based classification that comes close to present day realities but

leaves out a number of important ICT skill areas such as information security and protection; and the ICT skills at the user end that would inevitably consist of a combination of IT skills with the so called domain skills and industry vertical know how (Appendix 4). The work force skill projecting models proposed by Freeman and Aspray has, among others, included the following conceptual matrix of IT and domain skills: a space diagram where the various IT and IT related professional could be placed. Each point on the diagram determines a set mix of ICT and domain Knowledge corresponding to the job responsibilities of the various occupations in the ICT, ICT enabled and user sectors.

Fig 6 : IT Worker and IT enabled worker skills matrix



The ICT skill development policies and strategies at the national and regional level will have to be holistic in order to cover the ICT skill needs of all sections and segments of the nation or the region at their various levels. This would for instance involve looking at skill needs of the ICT industry; IT enabled sectors, IT user sectors and even that of the general public at its most basic level.

Conceptually, the need for ICT skills in a country arises from the need for ICT skills in the ICT sector, which comprise the ICT products and service producing industry; and ICT skills that are needed in the user segments, comprising the other segments of the economy and even ordinary citizens that must acquire minimum skills to effectively use ICTs in their day to day life. Within these two major categories of ICT skills we have categories and sub categories. Based on this conceptual thinking the ICT skill needs in a country can be evaluated.

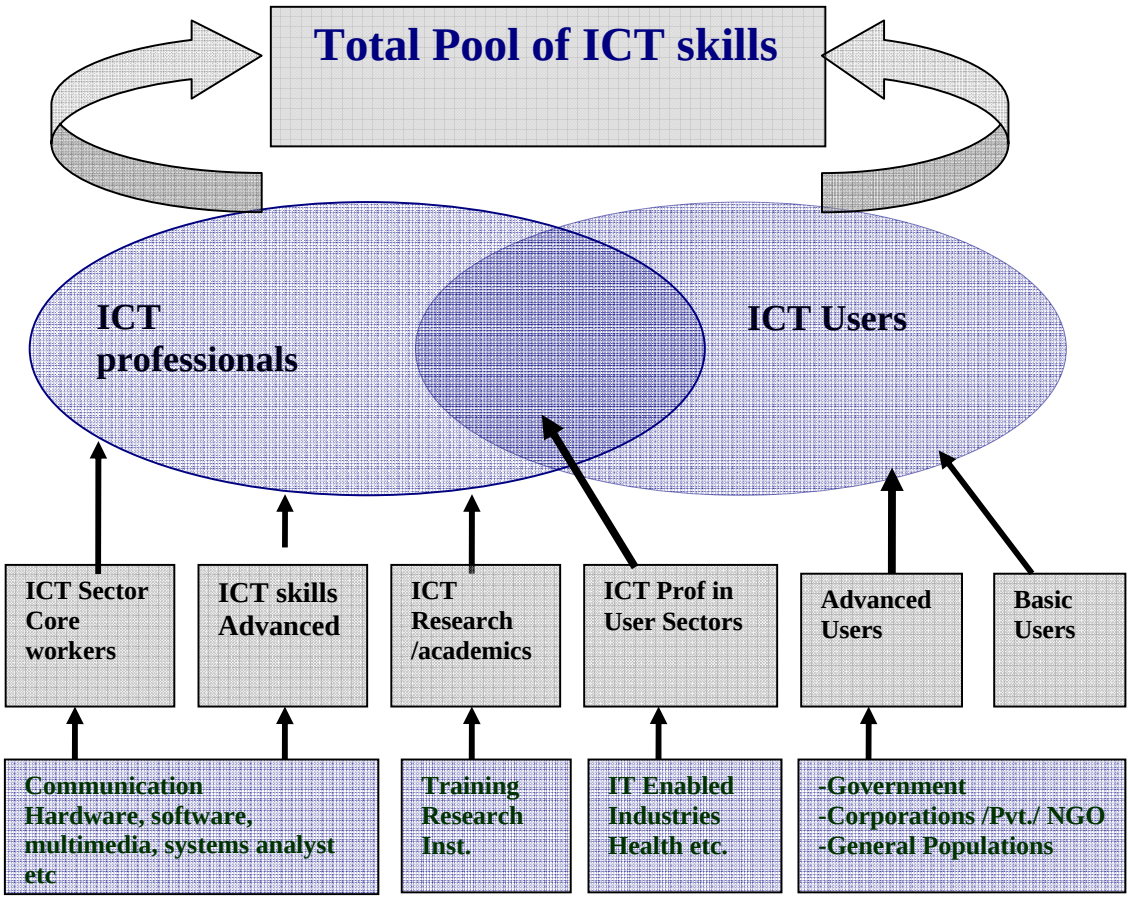


Fig 7: ICT Skills Categories

It can be observed that at the top level we have two sets of ICT skills.

1. *ICT Professional Skills*
2. *ICT user skills*

It can also be observed in Fig 7 that at the top level these two sets are intersecting. The intersecting part of the two sets represents the ICT professionals working out side ICT industry. As we go down to levels 3 and 4 the ICT professionals within the ICT sector can be sub divided into their specializations and super specializations. ICT workers in the user industries can also be classified and sub classified as shown. The general user ICT skills will consist of the basic ICT skills in the institutional segments such as the governments, non governmental organizations and private institutions and in the general population. When we talk of ICT users we are not talking of ICT professionals but general users from other professions such as engineers, medical graduates, government officers and other professionals that must use ICT tools to facilitate their work. The ICT skills can be subdivided into the following broad categories:

A ICT Professional skills in the ICT industry: These encompass the ICT skills needed in the ICT sector itself and could include all ICT industries, hardware manufacturers, ICT service providers, ICT consultants, ICT Researchers and ICT Trainers. These has been further subdivided into

1 Core ICT worker skills
2 Advanced ICT worker skills
3 ICT Researchers and Teachers

B ICT Professional skills in the User sectors

C ICT Users

1. Advanced user skills (Active Users)
2. Basic user skills

4.0 Demands for ICT Skills

The present and potential demand for ICT skills in the Asia Pacific region cannot be assessed in isolation of the demand for such skills in the world at large. In the present day globalized world shortages and surpluses in one part of the globe would influence the demand and supply elsewhere. This is particularly true of the Asia pacific region and more so in the case of ICT related products, services and

skills. The web and internet technologies have made most ICT and ICT based jobs *location independent*. For instance a software engineer in China, India or Malaysia could now be working for a US company without physical relocation to US. Thus for all practical purposes the ICT skills in India or china or elsewhere with good connectivity would be available to any one in the world. The international companies or other employers, wishing to take advantage of the lower skill costs in the developing world have the following options:

1. *Relocate a part of their operations to low cost locations though establishment of fully owned subsidiary companies, set up joint venture companies and acquire local companies in the low cost countries.*
2. *Offshore work to local companies and institutions in low cost countries.*
3. *Hire individual professionals located in low cost countries to work remotely.*
4. *Recruit professionals from the low cost countries and relocate them to home of the employing company.*

While the fourth option mentioned above has been the traditional method of utilizing qualified low cost manpower from developing countries, the other three options have become common in the recent past. The conclusion that we can draw is that the demand for ICT skills in the Asia Pacific region would be influence by the global demand for ICT skills as it would be by the demand pressures that would arise from within its own borders.

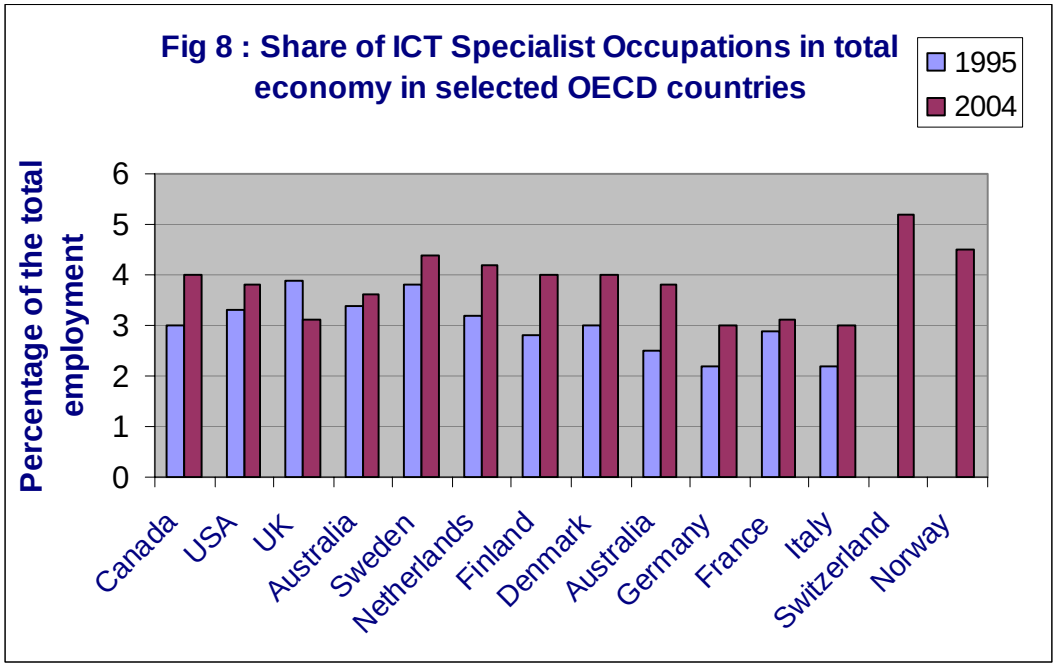
4.1 Global Demand for ICT Skills

The OECD region, comprising some thirty countries of the developed word constitutes nearly 90 percent of the world market for ICT products and services and is the main ICT trading partner of Asia Pacific. Therefore, for the purpose of assessing global trends in ICT skills outside the Asia pacific Region, it makes sense to closely look at the trends in the demand for ICT skills in the OECD region. *OECD Information Technology Outlook 2006*, is the latest publication from OECD that provides a comprehensive insight into the developments and trends in ICT in the OECD region. This publication also provides a detailed overview on the demand for ICT skills in OECD.

Three categories of ICT competencies have been distinguished in this OECD report:

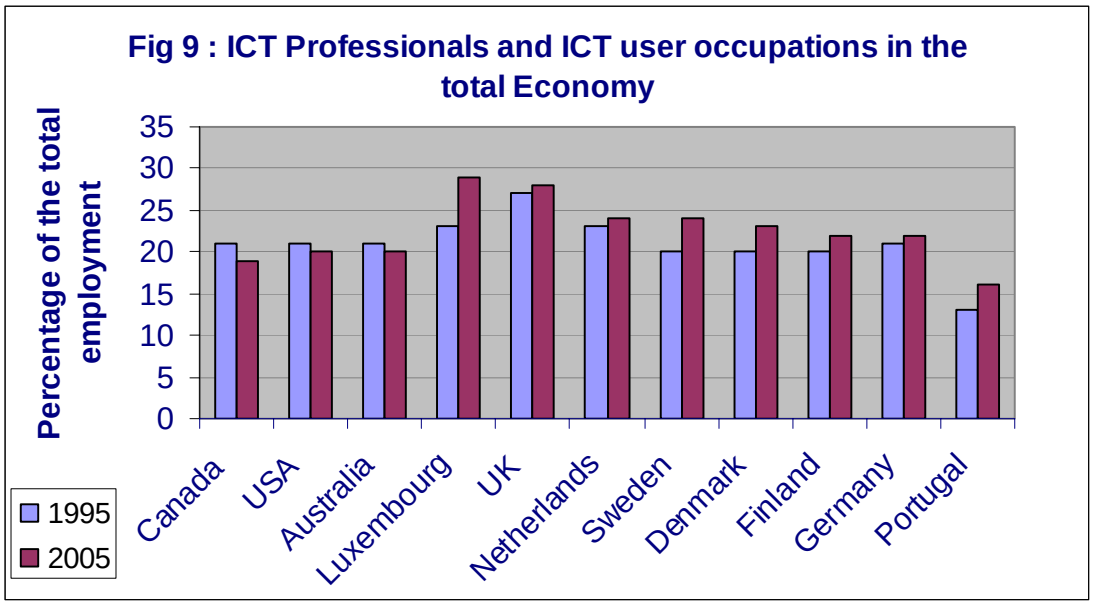
1. ICT Specialists: who have the ability to develop, operate and maintain ICT systems. ICTs constitute the main part of their job
2. Advanced ICT users: Competent users of advanced, often sector specific, software tools. Here ICTs are not the main job but a tool.
3. Basic Users: competent users of generic ICT tools (MS word, Excel etc.) needed for the information society, e-government or working life in information society.

The categorization of ICT skills given in this report is similar to the model proposed here, where the ICT Specialists (professionals) and ICT users are separately identified. ICT specialists or professionals constitute from 3 to 4 percent of total employment in most of the countries of the OECD. In all countries of the OECD except Portugal the share of the ICT professionals in the total employment of the country has increased during the period 1995 to 2004 (Fig 8)



Source: OECD

The share of the ICT professionals and the Users combined in the total employment is given in the Figure 9 below. In 2004 the combined ICT professionals and ICT users accounted for 20 to 30 percent of total employment in the OECD countries.



Source: OECD

The rapid diffusion of ICT in all the countries of OECD, including USA, Europe, Japan, Canada and Australia, has led to severe shortage of ICT skills. Thus each country has been following policies and strategies to expand the availability of local ICT skills on one hand and on the other hand tap into the ICT skills that are available outside the OECD, especially in the Asia Pacific region. USA and many West European countries have expanded and facilitated immigration of ICT professionals. A rough estimate would put the number of ICT specialists in the OECD at about 15 million expanding at about 5 percent a year. This excludes the much larger number of professionals working in the IT enabled and user industries. For every one ICT professional working in the ICT industry there are roughly 5 to 6

professionals in the IT enabled and user sectors. This would put the population of ICT workers in the OECD as a whole at about 100 million.

In a recent survey, the leading US-based market analyst IDC has projected the number of jobs in the ICT sector in 2005 to be about 12 million. This expanding trend estimates that USA would have 15 million ICT jobs in 2010. Another survey by business intelligence leader Gartner Inc has also indicated that end-user organizations across the globe are boosting ICT employment. This trend indicates a continuing demand for ICT specialists in USA and in much of the OECD.

The Information and Communications Technology (ICT) industry in Europe is reportedly experiencing a severe shortage of skilled personnel. With the support of the European Commission, a consortium of eleven major ICT companies, (BT, Cisco Systems, IBM Europe, Intel, Microsoft Europe, Nokia, Nortel Networks, Philips Semiconductors, Siemens AG, Telefonica S.A., Thales), and the European Information and Communications Technology Industry Association have been exploring new ways of addressing this skills shortage. A study was undertaken to put in place a clear framework for students, education institutions and governments that describes the skills and competencies that are presently and potentially required by the ICT industry in Europe. The study has indicated that the number of jobs in ICT in Europe in 2004 is estimated at about 7.8 million likely to grow at about 5 percent a year. 44 percent of these jobs are in the ICT supplier industries and 56 percent in user industries. The largest concentration of ICT jobs is in the software and services industry and the fastest growing ICT occupations are software engineers, analysts and programmers.

There is consensus among the ICT industry and the recruitment agencies in most OECD countries that shortage of ICT skills would loom large if the current trends in expanding demand and drop in the ICT enrollment in universities continues. For instance it is reported that Australia is facing a severe shortage of ICT skills, right at the time that the industry is entering another boom. Enrolment

numbers in ICT courses at universities and colleges have plummeted, and there is talk of increasing the number of skilled migrants in the area.

In its latest report dated July 2006, the CNC Global, a leading IT recruiting firm in Canada has reported a 17 percent surge in demand for ICT professionals across Canada during the last 12 months. IT infrastructure skills remains an important area of demand but has declined proportionately. Web developers and e-commerce specialists are high in demand and now constitute about 25 percent of the total number. This appears to reflect a shift from infrastructure to more front end application jobs. In line with this shift, the demand for technical skills is also shifting to Java, SQL and UNIX.

In a recent study, commissioned by CISCO, IDC has estimated serious gaps between the demand and supply of networking skills in Europe. In this study the IDC estimates the gap of actual number of skilled people needed with advanced networking skills at 160,000 growing to about 500,000 by 2008. Overall, IDC estimated that the networking skill gap to be about 235,000 in 2005 rising to about 635, 000 in 2008.

4.2 Demand for ICT Skills in Asia and Pacific

The information and data related to ICT, ICT skills and employment in the Asia Pacific region is fragmented and piece meal. Thus attempts to build a demand assessment and projection model for the region as a whole has proved to be a difficult undertaking. The data and skills definitions are not comparable from one country to another. The author has tried to estimate the present demand for ICT skills by building an ICT scenario for each country including what ever information that could be gathered about the demand and supply of ICT skills in each country of the region. The demand for ICT skills has been estimated for each country based on the analysis of the ICT industry trends, domestic market trends as well as the trends in the exports (if the country is an exporter or is likely to become an exporter). In some country such as Pacific Island nations and countries emerging from war, where limited or no historical information is available, estimates have been made of the size

of the ICT work force as a proportion of the total work force that would be necessary, as these countries move from their very initial stage of ICT diffusion to increased usage of ICTs, taking cues from a cross country assessment of countries at similar stage of ICT adoption.

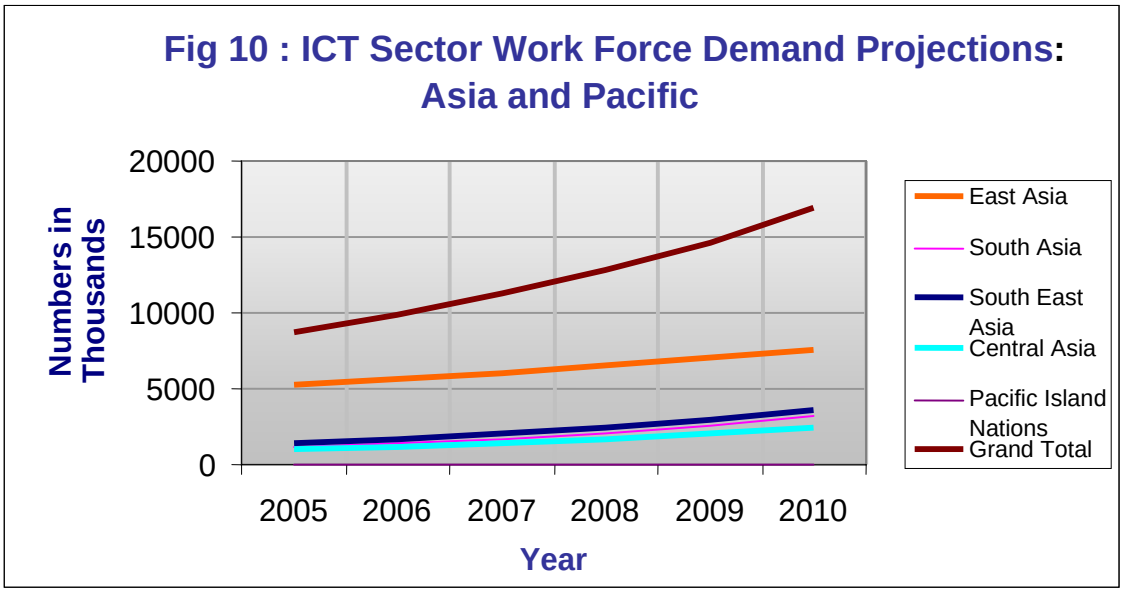
The assessment and projection of demand of ICT skills have to be made in three segments as follows:

1. Demand for ICT skills in the ICT supply industry
2. Demand for ICT skills in the ICT enabled and use sector.
3. Active users in the economy

Conceptually, the demand for ICT professionals in the ICT supply industry of Asia and the Pacific would arise from the activities of the ICT industry itself, which in turn would be determined by the level of demand for ICT products and services in the domestic and export markets. The demand for ICT skills in the ICT enabled and ICT users sectors would be however more complicated and difficult to determine and forecast. The most significant factor in the estimation of the ICT skill demand in the ICT user sectors would be the level of ICT penetration or diffusion in the economy. Higher the diffusion of ICT in an economy higher would be need for ICT professionals in the ICT users sectors. Based on a cross country study of the ratio of the ICT professionals in ICT supplying industry to the ICT professionals in the ICT user sectors a pattern can be identified. This ratio is seen to vary from a low of 1 to as much as 6 in a country with a high degree of ICT penetration. Another important factor to influence the ratio of ICT professionals in ICT industry to ICT professionals in the user sectors would be degree to which the country is an exporter of ICT products versus being a supplier to local market. ICT exporting nations in the Asia Pacific region such as China and India may find that this ratio would be lower in their case rather than a country whose ICT industry is primarily focused on the domestic market.

The coverage of the demand projections done here has been limited to only the developing countries of Asia and the Pacific.

The estimates and projections of demand for ICT manpower in the ICT industry are given in Appendix 5 attached here. The demand projections for ICT professionals in the ICT user sectors are given in Appendix 6 attached. The consolidated results of this demand projection exercise are given below:



As can be seen in the figures 10 and 11, the total demand for ICT professionals in the ICT supplying industry in the developing Asia Pacific region would reach about 17 million by the year 2010. The largest increase is expected in the East Asian region, which includes China. The lowest growth in the ICT industry and therefore in the demand for ICT professionals would be in the Pacific Island nations where the development of a local ICT industry of any sizeable size is unlikely in the next five years.

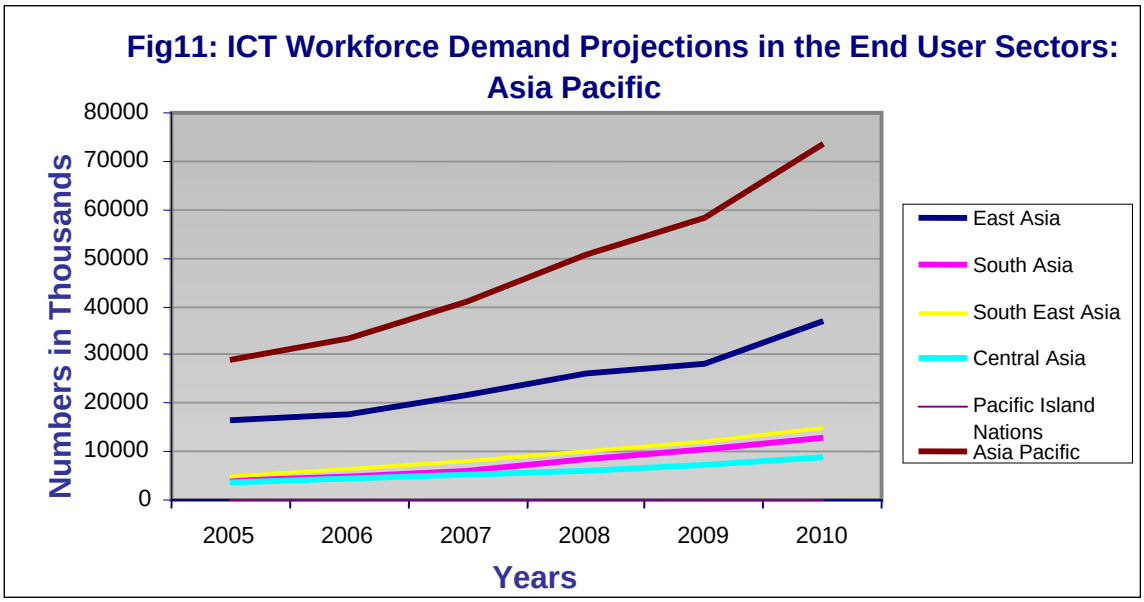
The six top countries in terms of demand for ICT manpower in ICT supplying Industry are as follows:

Table 1 : The top six countries with the largest estimated ICT work force

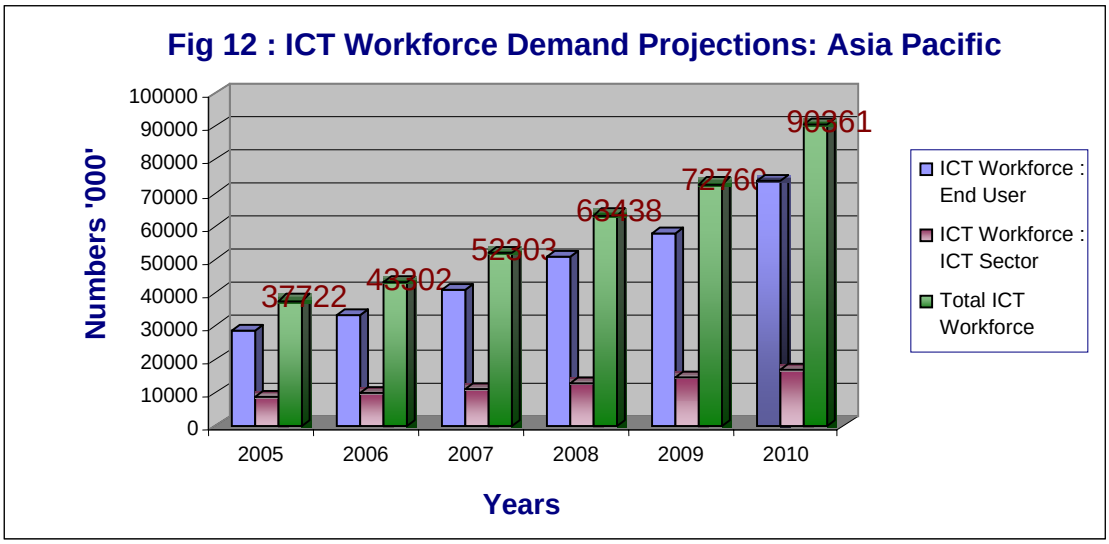
S. No	Country	Estimated Demand in thousands		Estimated % Growth/ year
		2005	2010	
1	China	4360	6400	9
2	India	1000	2820	18
3	Russian Federation	800	1991	20
4	Indonesia	400	1500	30
5	Philippines	211	527	20
6	Malaysia	220	443	15

The Asia Pacific economies with large ICT sector are the six top contenders for ICT manpower as shown above. These six countries together should account for more than 80 percent of the estimated demand for ICT manpower in the region by the year 2010.

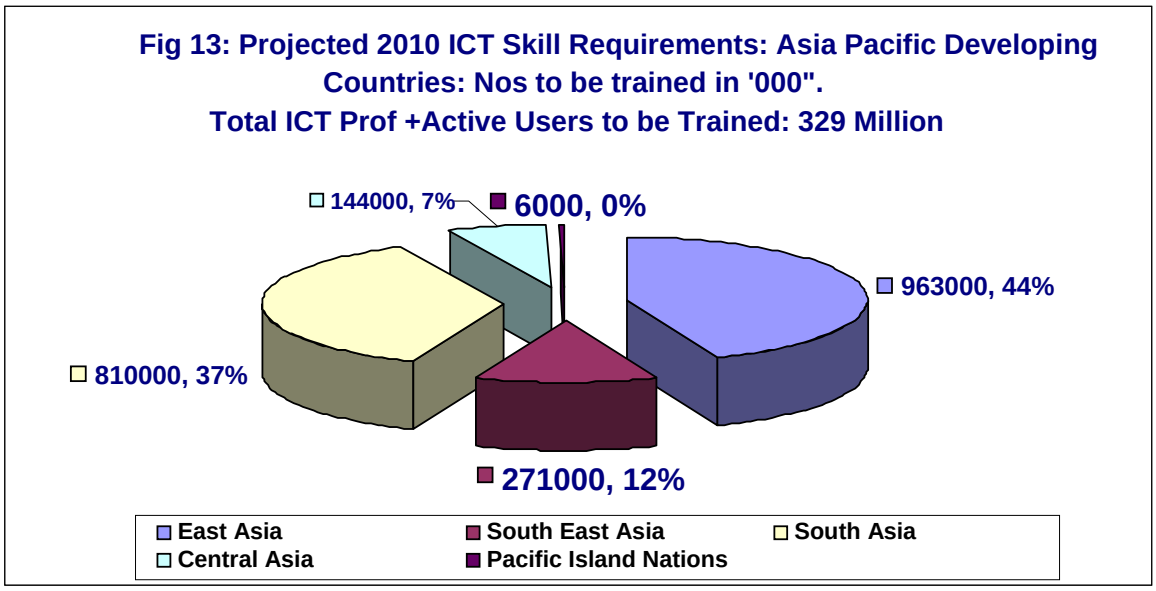
The second and the much larger segment of the ICT manpower is the ICT specialists in the ICT enabled and user sectors. These would consist of ICT professionals working for governments, businesses and other institutions and organizations which are users of ICT. Appendix 6 attached here gives a country wise estimate of the ICT professionals in the ICT user sectors in the region.



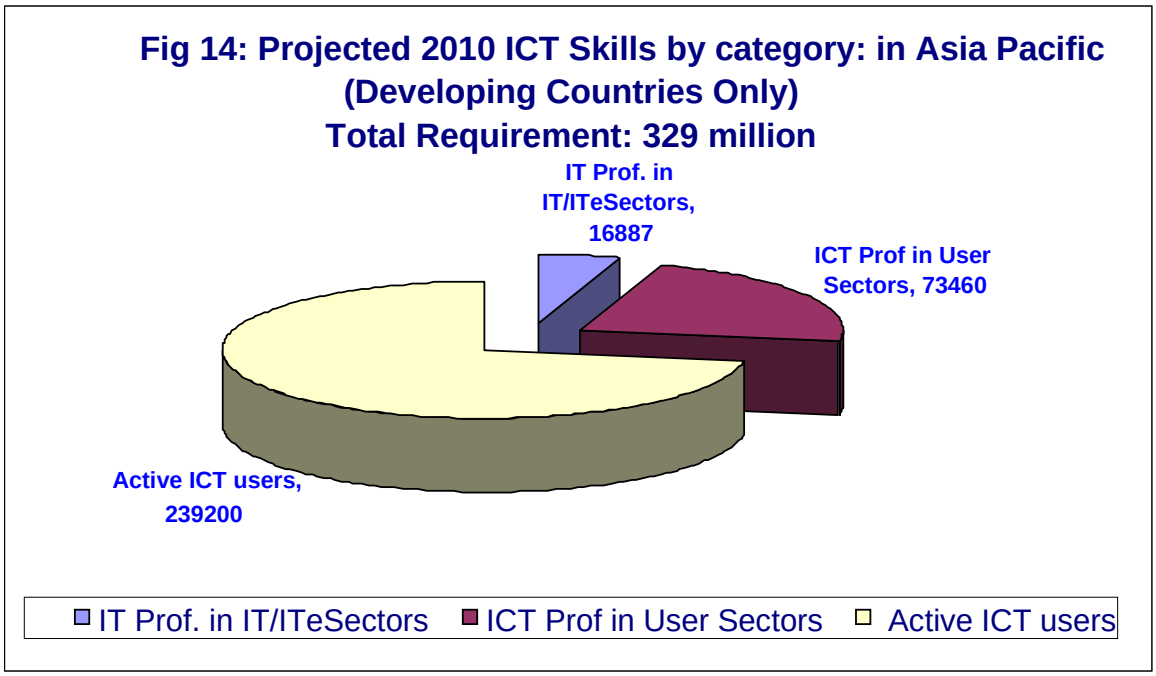
The total demand for ICT professionals in the user sectors in the region is estimated at 73 million with East Asia leading at 34 million, nearly half of the total users. As shown in the figure 12 below the growth of the ICT Professional in the users sectors would be faster than the expansion of the ICT professionals in the ICT supplying industry. The demand for ICT professionals in the ICT supplying industry is estimated to increase by nearly 90 percent during the period 2005 to 2010 and the demand for ICT professionals in the ICT users sectors is expected to increase by 150 percent during the same period. The combined demand for ICT professionals is expected to increase to about 90 million by 2010.



The third category of ICT skills that would be demanded would be basic and sometimes advanced ICT skills required in the various sections of the society. This will include government officials at various levels that would need to use ICT, industry and business employees that must use ICT for conducting their business, students that must learn to use ICT for their education and even ordinary citizen for day to day life. The estimation of this demand has to be based on the population size of each country and the degree of ICT diffusion in that country. Even though the country may be a large exporter of ICT products or services its active ICT user population as active ICT users may be low as a percentage of the total population because of the poor ICT penetration in the country; such as could be the case in India. It is estimated that by 2010 at least 239 million active ICT users in the region will need to be trained if the existing ICT diffusion and expansion trends in the region are to be sustained in the region. The consolidated demand for ICT skills by 2010 is given in figures 13 and 14



East Asia and South Asia would be the sub regions where the main demand would arise on account of their large population and the fast expanding ICT sector in these parts of the region.

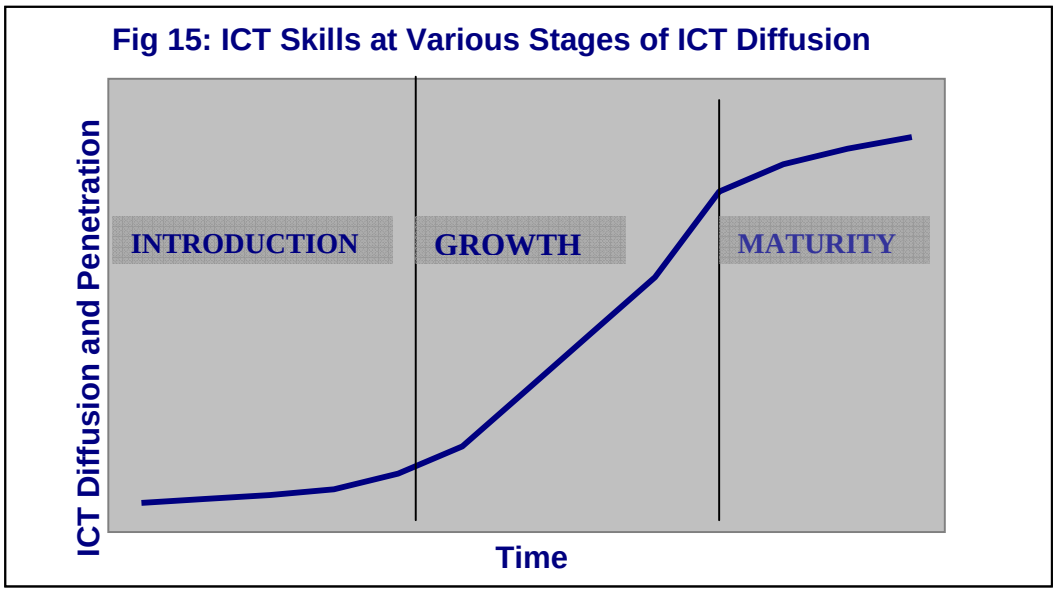


4.3 Nature of ICT Skills Required

The type of ICT skills required would vary from country to country on one hand and on the other would vary across the three segments of the ICT professionals and users that have been mentioned. The needs of the general users (termed as Active users here) would be basic to enable them to use ICTs in their day to day working life. However, within the active users there would be a section of advance users who would require ICT skills of some intensity. For example doctors working in an e-health environment or teachers working with ICT in education would need training where some specific ICT tools and concepts would need to be taught that relate to the use of ICT in their domain specialization besides the general basic training in ICT. An extreme example might be that of geologist, mining engineers, foresters and land use specialists requiring training in advanced tools of Geographical Information Systems or doctors and medical researchers training in bioinformatics.

The volume and pattern of demand for ICT skills in a country would be determined by the level and type of ICT production and manufacturing infrastructure in that country and the extent and pattern of ICT usage determined to a large extent by the ICT diffusion and penetration.

The penetration and diffusion of ICTs, like other innovative technologies, proceeds along identifiable stages of *introduction, rapid diffusion and growth and maturity*. The volume and nature of ICT skills vary as the country moves along this ICT diffusion continuum, from introduction to maturity. The demand of ICT skills at these three stages of ICT diffusion varies, both in terms of the volume and nature.



As shown in the figure 15 above the *Introduction stage* is characterized by slow rate of diffusion as the country develops a critical mass of ICT users and practitioners and has the necessary infrastructure and means for wide and rapid diffusion. During the growth phase the rate of diffusion is rapid. This is followed by a phase of subdued expansion as the maturity has been achieved.

The developing countries in Asia and the Pacific region are either at the introductory stage or in early growth stage. The developed countries of the region such as Australia and Japan can be considered to be in the early maturity level. It would be logical to expect that a country during its introductory stage is new to ICT technologies and infrastructure is largely absent. Thus during this stage the focus is on developing capacity, creating basic skills and establishing infrastructure During the growth phase, while the expansion of infrastructure continues the ICTs are adopted in various sectors and industries need for ICT skills in application development becomes prominent. At the highest level of penetration when the stage of maturity is reached the application development skills and IT maintenance skills become prominent.

This conceptual model for ICT skill demand over the life cycle of ICT diffusion is an important tool for the decision makers to strategize their ICT human resource development policies and dynamically adjust the strategies and policies as the country moves from one phase to another. The analysis of the demand for ICT skills in the developed economies of the west and in the developed countries within Asia Pacific region over the last two decades provides ample proof of validity of this conceptual model. As mentioned earlier, there is a marked shift in the pattern of demand in the Europe, Australia, Canada other members of the OECD toward ICT skills in applications such as e-Business, IT security and IT maintenance from the 1990s to the present day.

Based on the degree of ICT diffusion in the various countries that make up the Asia Pacific region one could get an indication on the type of ICT skills that may be required, as is depicted in the table 2 below. However, one must warn, that this would pertain to the ICT skills that would be required to sustain the ICT usage in the domestic markets. This may not account for the ICT skills that would be required to sustain the ICT export industry that the country may have, which would be determined by the type of ICT export industry that the country in question may have.

Table 2 : ICT skills for Domestic Market at various phases of ICT diffusion

Phase of ICT Diffusion	Examples of the Countries/ sub regions in Asia Pacific in the Phase	Type of ICT skills predominantly required for the domestic Market
Introduction	Pacific Island, Afghanistan, Lao-PDR	IT infrastructural, Basic ICT usage, IT training
Growth	Russia, India, China, Vietnam, Malaysia, Indonesia, Philippines,	IT applications, IT infrastructural, IT security, IT usage
Maturity	Japan, Singapore	IT applications and maintenance

The skills required in a country would also vary from one segment of the ICT population to another. Where as the basic Active ICT users in a country would by and large require basic ICT usage training and the advance Active users would require domain specific ICT usage training; the ICT professionals in the using sectors would require ICT technical training combined with their domain based skills. For instance ICT professionals in the health sector would need skills that focus on the application of ICT in health, combing the ICT knowledge with that of health. The ICT Professionals in the ICT supplying industry would require more technology based training depending on the type of ICT products and services that they may be dealing with. The ICT professionals in a country with large ICT hardware manufacturing would require skills more centred on electronics manufacturing and assembly in contrast to countries that are in the software and services business. This categorization of ICT skills based on the ICT Professionals and User categorization is shown in the table 3 below:

Table 3 ICT Skills categorization within a country

Main Segments	Sub-Segments	Location	Type of Skills	Size of Trainee population
ICT Professionals	ICT Supplying industry	ICT Product	ICT Oriented	Small
		ICT Services	ICT Oriented	Small
		ICT Research, Development and Training	Technical and Research Oriented	Very small
	ICT Using industry	Government, and public sector, NGOs	Combined ICT and some domain	Small
		Various Economic Social Sectors	Combined ICT and some domain	Large
ICT users	Advanced	Various economic and social sectors	Domain with some ICT	Large
	Basic	General Population	Basic ICT	Very large

5.0 ICT Skills: Demand Supply Balance in the Asia Pacific Region

Information and data on the status and trends in the supply of ICT skills in the developing countries of Asia and the Pacific is more fragmented and incomplete that that related to the demand for ICT skills. From the limited and often fragmented information that has been collected and analyzed some broad conclusions can be, however, drawn and their implications assessed. For some countries such as India, China and Malaysia detailed information could be obtained about the trends in the technical and general Human Resources supply potential but this would be at best tangentially relevant, to the ICT sector.

5.1 Overall Demand Supply Imbalance

For the region as a whole the supply of ICT skills are likely to fall considerable short of the needs. A rough estimate has indicated that the college and university enrollment in the developing countries of the region is about 15 million, out of which it may be assumed that not more than 20 percent would take up ICT as a professional career. Thus each year there would addition of 3 millions from the university college systems into the ICT work force of the region. The need for the region is for about 10 million ICT professionals each year to enter the work force if the needs of the region for ICT professionals are to be fully met. It is quite likely that a part of the supply would be forthcoming from the private companies and training institutes that are mushrooming in the region. This would mitigate the shortage to some extend. In India alone these private institutes are training about 0.5 million ICT workers each year and almost an equal number in China. In the region the present supply potential of the ICT institutes would be less than 2 million. There would be therefore yearly short fall of about five million ICT workers unless the ICT training capacity in the colleges, universities and private institutions is increased by at least 100 percent.

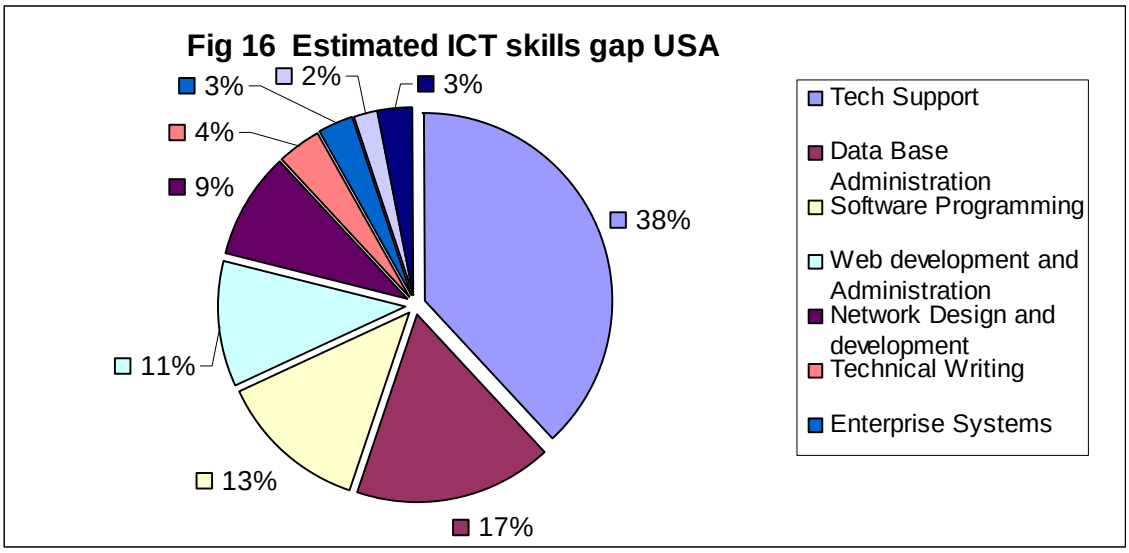
5.2 Quality of Supply

The demand supply situation reflected by mere numbers doesn't give the complete picture. The quality of ICT workforce trained by colleges, universities and other training institutions are often seen as lacking the skills and knowledge that the job demands. In a recent statement by the chief of Infosys Technologies (the second largest IT services company in India) mentioned that Indian universities produce about 3m graduates a year. But only about a quarter of engineering graduates and 10 to 15 per cent of general college graduates are considered suitable for direct employment in the IT and business process (back office) outsourcing industries. In another statement in a recent conference the Intel Chief in India expressed the same sentiments that it was becoming more and more difficult to find the required skills among school leavers and graduates in India. He said that firms hiring people with basic level skills from universities found that it took a very long training programme to integrate them into the companies' work culture. These remarks are not isolated and applicable only to India but could well apply to graduates from educational institutions in most other countries in the region.

5.3 Lower Level Demand Supply Balance

Demand and supply balance at the aggregate level has to be accompanied by the demand supply balance at the levels of individual skills, occupations and sectors. There may be situations when balance is achieved at the aggregate level but imbalances, either surpluses or shortages, remain at the individual skills and occupational levels. Thus planning and tracking of supply and demand must be undertaken at all levels.

As noted earlier, the emerging ICT skills shortages in the OECD region will have significant effect on the demand for ICT skills in the region. A few years back an ICT demand skills gaps assessment study was commissioned by OECD. Figure 16 shows the demand skills gaps identified by this study:



Since the Asia Pacific region consists of countries at various levels of ICT developments their national ICT skills demand will considerably vary from each other. However, there are some skills categories that have a marked and predominant demand and unfortunately serious shortages are expected to develop in these skill categories. Some of these skill categories are discussed in the sections below.

5.3.1 Demand Supply gap in Computer Networking Skills

Computer Networking skills are in serious short supply in the Asia Pacific region. The situation is likely to get worse in the next five years. A recent IDC study commissioned by CISCO has revealed that by 2009, "the Asia Pacific region, excluding Japan, will have 221,000 fewer people than it needs with advanced network skills in wireless technologies, security and IP telephony, up from 113,000 in 2006. This represents 55 percent of the total network professional shortfall, which IDC forecasts will be 396,000 in 2009, up from 210,000 in 2006. As the network becomes more important to individuals and organizations, this skills shortage may eventually

Impede the region's economic development.” The "gap" refers to a shortage of people with the required network skills to support business functions. The study further states that “the People's Republic of China and India represent the large high-growth markets, where demand for information technology (IT) network skills will be the greatest. For example, local-area network (LAN) penetration in China is currently at 28 per cent, and a mere 2 per cent of the companies there constitute an additional 30,000 businesses that need network skills. In India, the demand for network skills is growing at the fastest rate in Asia Pacific, driven primarily by the expanding market for IT-enabled services and business-process outsourcing. Indonesia, Malaysia, the Philippines, Thailand and Vietnam make up the "developing economies" grouping that represents relatively immature markets with limited complexity and a growing demand for network infrastructure. The third group comprises mature economies (Australia, Hong Kong, Taiwan, Singapore, South Korea), where growth in IT spending and network equipment is relatively low. These markets have established complex infrastructures and educational systems that produce a steady supply of graduates with network technology skills. However, the mature economies still have skills gaps, in particular for advanced technology skills. Korea has the largest gap in this group, as sophisticated network infrastructures - which require professionals with both network and application skills - are being developed in response to the growth in commercial and consumer markets.”

IDC, on commission from CISCO, undertook similar studies in Europe and USA and elsewhere. These studies have indicated increasing networking skills gap worldwide. For instance in Europe the advanced networking skills gap in Europe will rise to as much as 500000 by 2008 and the total networking skills gap has been estimated at 615,000 by 2008. The expanding shortage of skills in this area, outside the Asia Pacific region, would mean a pull for the networking skilled workers to work outside the region on account of better earning potential in the developed countries. The policy makers of the region have to provide for a certain percentage of drain on account of the emerging world wide shortages.

5.3.2 Information Security (IS) Skills

With the explosive growth of the internet worldwide, especially in the Asia Pacific region, and the threats to information infrastructure and resources arising from terrorists, hackers and cyber criminals extreme shortage of specialist skills in information security should be a matter of grave concern to the decision makers in the region. The needs for specialist skills are expanding exponentially where as the supply of such skills in the region are miniscule. A recent Nasscom-JobsAhead.com study reports: "the demand for IS professionals is 18,000 and 60,000, in India and worldwide respectively. This is estimated to grow to over 77,000 in India and 188,000 worldwide by 2008. Thus the requirement for IS professionals, which presently accounts for about 3 percent of overall IT workforce demand, will rise to around 5-6 percent in 2008. The need for IS professionals will exponentially increase in the coming years as more overseas companies look to India to cater to their information processing needs. Unfortunately, this is not matched by a corresponding supply of skilled IS professionals. The Nasscom report says that less than 10,000 professionals have a working knowledge of IS and not more than 2500 fully qualified IS professionals in the country. At this rate there will be an expected shortfall of over 100,000 IS professionals globally, by the year 2008''. The situation in India reflects the situation in other Asia Pacific countries.

5.3.3 Application Oriented ICT Skills

There is large and expanding demand for skills in the ICT applications areas. The professionals that work in these areas invariably require deep knowledge of the domain area in which they work in combination with their ICT know how and skills. This is a development that is evident all over the world, as much in the OECD countries as in the relatively advanced countries of the region. These skills may not be prominent and urgent in the countries that are at the ICT introductory stage. But sooner or later as they progress into the growth stage ICT application skills will become important. The most important among these application areas are listed in the table below. This list is however indicative and does not include all the possible ICT application areas. Moreover, the application areas are dynamic and ever expanding as new ICT application segments emerge.

Table 4 : Indicative ICT Application Skill Areas

S. No	ICT Application Segment	Domain Area	Skills Required	Remarks
1	E-Business	Business and commercial enterprises of all kind	Domain Knowledge, management skills and ICT skills	Demand large and expanding.
2	E-Government	Governments and Government institutions and departments	Government and public sector knowledge with ICT and management skills	Demand is untapped will expand sharply in the world especially in the Asia and Pacific region
3	E-manufacturing and engineering	Manufacturing and engineering enterprises	Brings together skills of engineering and ICT	Market is not very large but is expanding very fast as the adoption of ICT by the manufacturing and engineering is still at a very initial stage in this region
4	E- health	Governments, Medical Research, Pharmaceuticals companies	Medical domain expertise with ICT skills. Bioinformatics	Highly specialized and important field
5	E-Education and Training	Governments, Training and educational institutions	Educational domain knowledge with ICT skills	Large market and expanding

5.3.4 Graphics and Animation skills

Computer graphics and animation is a growing and expanding application area, in which the supply of expertise falls far short of what is required. There is an increasing trend towards off shoring of the Graphics and computer animation work from the multimedia companies, film and television and other media and entertainment companies in the OECD to the region. For the export of ICT services from the region this is considered to be a hot segment of the off shoring market. Computer animation industry is one of the fastest growing industries. The demand for animated entertainment is expanding with the increase in broadcasting, cable and satellite TV and the increasing popularity of the Internet. A key trend that we notice is the increasing outsourcing of animation content to Asia. Animation being a labour intensive activity the major factor behind this shift of computer animation

production to the Asia/Pacific region is the availability of low cost labour in the Asian and Pacific compared to OECD. Most of the animation work outsourced to the region is for 2D content. With the expansion of the Animation skills in the region it is possible for the regional players to take increasing share of 3D animation market as well.

The region has both the tradition of art as reflected in its temple architectures and the computer technology to play a significant part in the estimated US$100 billion global animation market. The region holds less than 1 percent of this huge market. One of the main stumbling blocks is the lack of skills in this area. Most of the region including, India, China, South East Asia and Indo china have rich tradition in art and animation, both historical and contemporary. Even before the advent of computers art, film and media had relied on the local artists to create animated contents for various purposes. Asian films have used animated contents in the historical past; even there have been attempts to make full length documentaries and animated films. Now is the time when the modern computer skills could be combined with the artistic traditions of the region.

In a recent Indian Animation and Gaming conference organized by Nasscom in the southern city of Hyderabad in January 2007 it was mentioned that the world gaming and animation market exceeds $100 billion and is expected to grow by 15 to 20 percent each year. India has a very small share of this market at $325 million. It has 300 companies in this industry and employs some 120000 people. India wants to triple its animation exports to about US$1 billion by 2010. The main constraint to achieving this goal would be the lack of manpower. It must increase its computer animation skill base from the current 15000 to about 30, 000.

Computer animation industry is also very important in other parts of the region. For instance in the Philippines, which has a thriving computer animation industry, which consists of 40 animation studios, employs some 4500 animation artists and earns more than $54million in revenue. The industry grew by about 38 percent in the year 2006. Currently the United States, Canada and Japan are leading countries in the global Computer animation and gaming markets. China, India, Philippines and Malaysia are making serious efforts to make inroads into these markets. The demand for computer animation professionals in the region falls

woefully short of what the region would need if a large share of the world market is to be taken and the expanding local demand is to be met. Export Development Authority of Canada, itself a leading source of animation skills and technology in the world, estimates that China needs 250000 computer animation specialists and have capacity to train only 350 per year. India needs at least 30000 and has only 5000. In Malaysia and Philippines as well, large gap exits between demand and supply of animation skills.

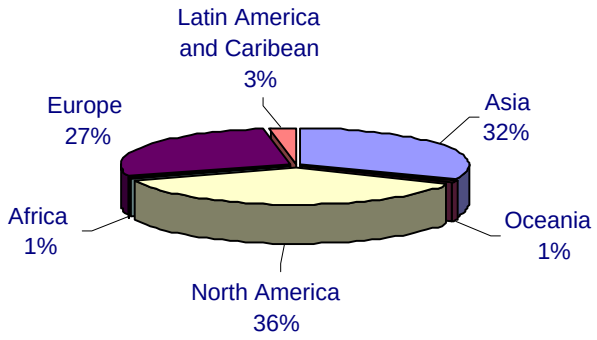
5.3.5 ICT research and Development

ICT research and development in the developing countries of the region is limited. As the region is assuming a leading role in global ICT sector it must seriously consider as to where it stands with regard to ICT research and innovation. All the developing countries of the region including the bigger countries in this region depend on western and imported technology and intellectual products. Though major ICT Corporation have emerged in the region such as the telecom and hardware companies Huawei, ZTE and PC manufacturer Lenova of China, TCS and Infosys Technologies of India, most if not all their commercial activities are based on imported technologies. Indian software firms, either the local grown ones or the Indian subsidiaries or MNCs, by and large work as off shore contractors for western clients or they service domestic and international customers using imported intellectual products. Except perhaps for *i-Flex and Finacle* India has yet to produce any internationally recognized software brand of its own. The region is the base for most of the PC assembly, PC parts manufacturing as well as electronic and telecommunication equipment manufacturing in the world. Almost all the major computer, electronics and related MNC, including IBM, Dell, HP, Intel, and Acer have manufacturing, assembly or research and development centres in China, Taiwan, India, Malaysia, Philippines, or Indonesia or other countries of the region. The primary motivation of the MNC to shift operations to the region is the lower labour costs in the region. An ICT industry assembler or technician in China costs only 10 percent of cost in USA.

In spite of the impressive growth in the ICT industry in the region- a trend which is likely to accelerate in the years to come- the regional ICT industry is primarily depend on imported technology . Innovation in the regional ICT industry

is limited. Statistical data on ICT Research and Development is not readily available. However the broad R&D statistics indicate that the R&D in most countries of Asia is growing but it is far below the levels existing in USA and Europe as shown in the fig and table below:

Fig 17 World Shares of Gross Expenditure on R&D 2002



Source: UNESCO

The Asian share shown at 32 percent in the year 2002 should be seen in the light of the fact that in last ten years the major corporations and private institutes have moved R&D centres to Asia or have established new R&D Centres in Asia to take advantage of the low labour costs existing in Asia.

Table 5: Comparative R&D Expenditure as a % GDP

Country	Research Expenditures % GDP	
	1997	2002
Japan	2.83	3.06
USA	-	2.6
South Korea	2.69	2.92
Russia	1.04	1.24
China	0.68	1.29
India	0.55	0.78

As the figures in the above tables indicate the R&D Activities in some of the countries are increasing sharply such as in China, India and Malaysia, though comparatively it remains considerably lower than in the west. It is difficult to say if the over all trends in R&D could be applicable to R&D in ICT in absence of data pertaining to ICT Research and Development. Based on the country reports and publicly available data it can be concluded that there is an upward trend in the ICT R&D in the region. However the increase is mainly accounted for by expanding R&D investment by the MNCs. Intel, Microsoft, Philips, GE and many other MNCs have established R&D activities in the region. Whether the results of the research to be undertaken in these MNC owned centres can be considered as regional achievements is debatable. Even though the main manufacturing and development centres for ICT will increasingly shift to Asia on account of the economic advantages that the developed world would gain as a result of lower cost of research in this region, it is unlikely that there would be any major innovation in the ICT area to emerge in Asia in the near future. China has the largest number of semiconductor based industry but limited fundamental semiconductor research. The current research advances in ICT such as on Quantum and grid computing are all centered in the research labs of the developed world. Thus the next wave of innovations in computer and communication technology is likely to come from the west.

5.3.6 Localization and globalization skills

To effectively globalize its ICT products and services and extend their global market reach the region will need specialized know how and skills that the region apparently has in short supply. Some Asian ICT product brands such as Finacle and i-flex banking software packages, Lenova and Hwei hardware products, have no doubt gained some degree of global acceptance. These are however only isolated examples. The full potential of the locally developed ICT products and services of the region can be realized if they could be remodeled and adjusted to appeal to the global markets and marketed aggressively as Asian brands.

This will require the regional decision makers to re-visit their strategies, make necessary commitment of resources and more importantly develop the management skills that it requires.

On the reverse side is the need for the region to localize the new technologies as many of the computer and internet technologies are not available in local languages. At the very basic levels scripts and fonts in many regional languages are not available to enable digital communication and information management in the local languages. The situation is improved as many of the regional languages groups such as Chinese, Japanese, Hindi and Korean are now usable in the computer and internet and for accessing online applications on the internet in these languages. Many regional and national efforts are now underway to localize new technologies and develop content in local languages. The Pan Localization Research project supported by IDRC is a regional initiative to develop local language computing capacity in Asia. The need for skills and manpower for localization of technologies in numerous local languages of the region and for development and management of content in local languages is going to increase very sharply as the ICTs diffuse in the region.

5.3.7 Open Source Skills

Open source movement both globally and regionally is taking roots. Most developing countries of this region and else where in the world are leaning towards Free and Open Source Software. To save millions of dollars on proprietary software and to gain independence with regard to future application development the decision makers both in the public and private sectors in the region are increasingly favoring open source to proprietary technology. Many Federal and provincial governments and their agencies have openly declared their preference for Linux and other open source software. Although Microsoft still holds the major share of the desktop market server market is increasingly shifting to Linux. Linux is however making inroads into the PC market. Many PC makers in China, India and other places in the region are now offering Linux loaded PCs which are 20 to 30 percent cheaper than the windows OS PCs. Open source operating systems are also making in roads into

the mobile computing and cell phone market. Korean giant Samsung Electronics Co. and Shanghai startup E28 have recently unveiled cell phones that use Open source operating system. Governments in the region especially in China, India, Thailand, Philippines see FOSS as a tool for cutting costs as well as a means to crack down on software piracy and make technology accessible to masses. IDC has recently estimated that Linux servers in Asia will grow about 30 percent annually to the year 2008 to account for near 10 percent of the total.

A trend towards increasing use of FOSS in the region is clear. However it is also increasingly difficult for skills in FOSS within the region. For every hundred ICT technologists on windows operating systems there will be not more than 5 competent in Linux. Those of us who are familiar with the regional ICT skills market would know how difficult would it be to find FOSS based application technologists. For instance for every 1000 dot net specialists there would not be more than 20 who are fully conversant with web applications in open source.

There is a movement sweeping across the region to develop open source communities. The initiatives have come from governments, civic society and technical community groups. Since the demand for open source software will be increasingly used as the operating system and application platform the need for FOSS experts would sharply increase in the years to come. In fact it can be said the need already exists but is suppressed for want of supply.

6.0 ICT Development: Policies and Programmes

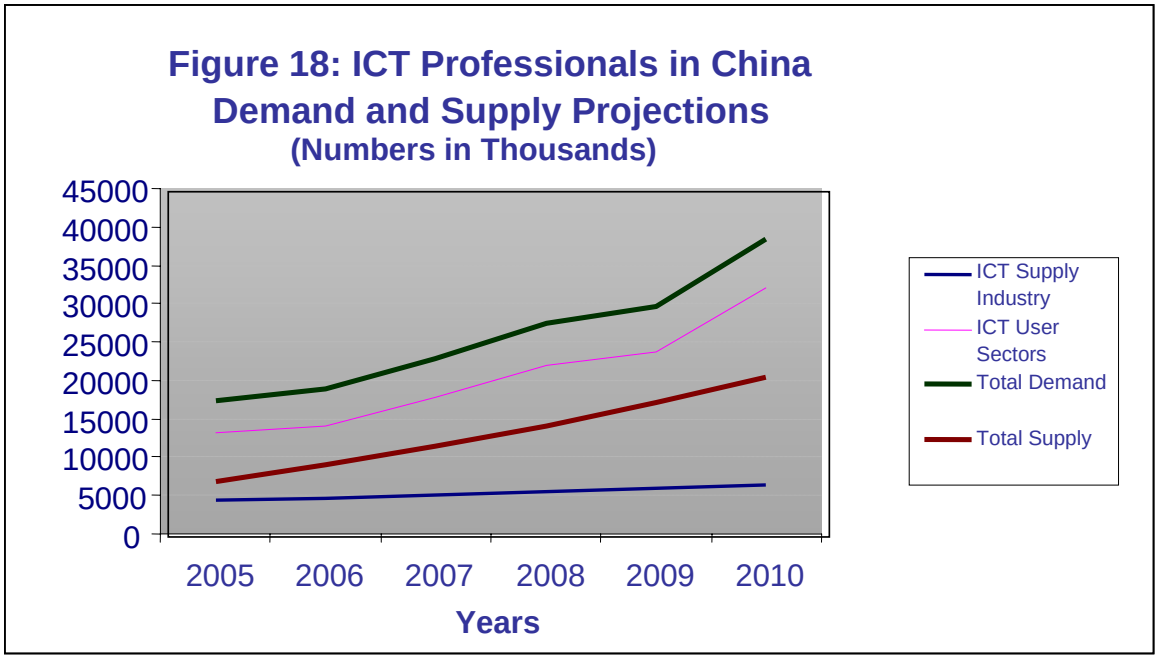
Almost all the developing countries of the Asia Pacific region recognize the importance of ICT skills for the overall national social and economic development. Therefore, invariably some policies have been formulated and some actions have been initiated at the government level to monitor and expand ICT skills. However, in most cases the focus of the decision makers has been on the ICT skills for the ICT sector rather than for the economy as a whole. This limited focus has often led to underestimating demand and therefore has resulted in shortfalls in the ICT skills in the ICT using and IT enabled sectors.

The six major countries that are projected to account for more than 80 percent of the demand for ICT skills in the region by 2010 are China, India, Russia, Indonesia, Philippines and Malaysia. It would be useful to assess the status of ICT skills and take a bird's eye view of the ICT human resources development policies and strategies in these countries.

6.1 China

As already noted ICT industry for China is an important industry in terms of contribution to the national economic and is one of the fastest sectors of the Chinese economy. The China ICT industry driven by large exports of ICT hardware and electronics products and increasing domestic demand is poised to be a dominant force in the world ICT industry. China along with India and Russia are among the fastest growing ICT domestic markets. The current trend of the country is to diversify its ICT exports to include a larger share of ICT services in its export portfolio.

From the reported national employment figures and the growth rates in employment the author estimates the ICT employment of some 4.3 Million in 2005 likely to grow from 8 to 10 percent each year to reach an demand of some 6.5 million by the year 2010. Since its domestic market for ICT products and services is expanding sharply (at about 23 percent /year) as ICT penetrates in the country the need for ICT skills in the user markets would expand faster than the ICT skills in the ICT sector itself as shown in the fig .



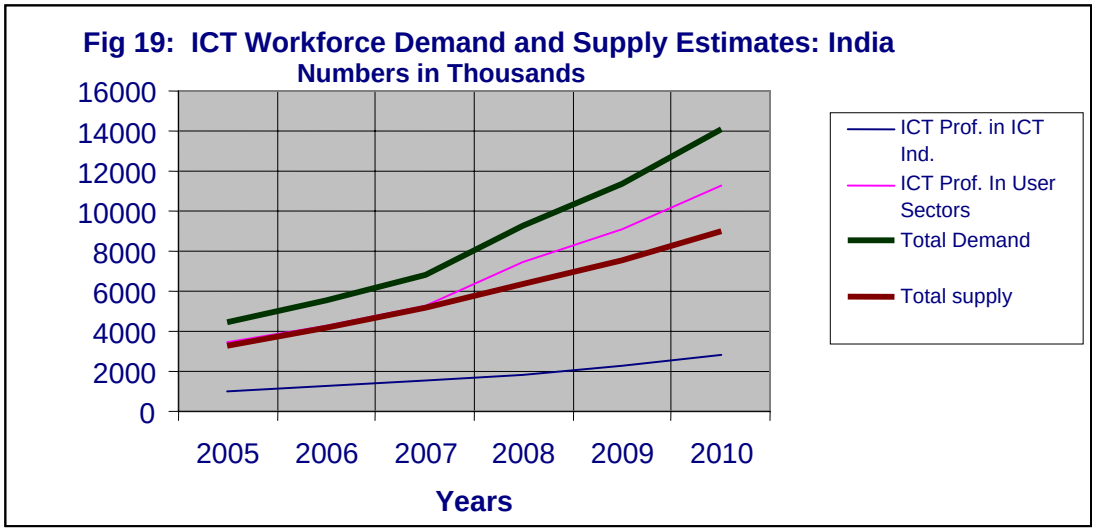
The supply of ICT skills are the graduates in ICT and related subjects from Universities and Colleges of China and the private sector training institutes that have been recently established. The private sector ICT training includes training activities of Intel, Microsoft, and CISCO as well as the training facilities that have been established in the country in collaboration with NIIT and Aptech International, two major ICT training companies from India. The total college and University enrollment is estimated to be about 6 million rising each year from 6 to 7 percent in line with the additional education facilities that are being established in the country each year. It has been assumed that about 20 percent of the college graduates would join the ICT sector. An overall gap of nearly 20 million is expected by 2010 if the current trends continue.

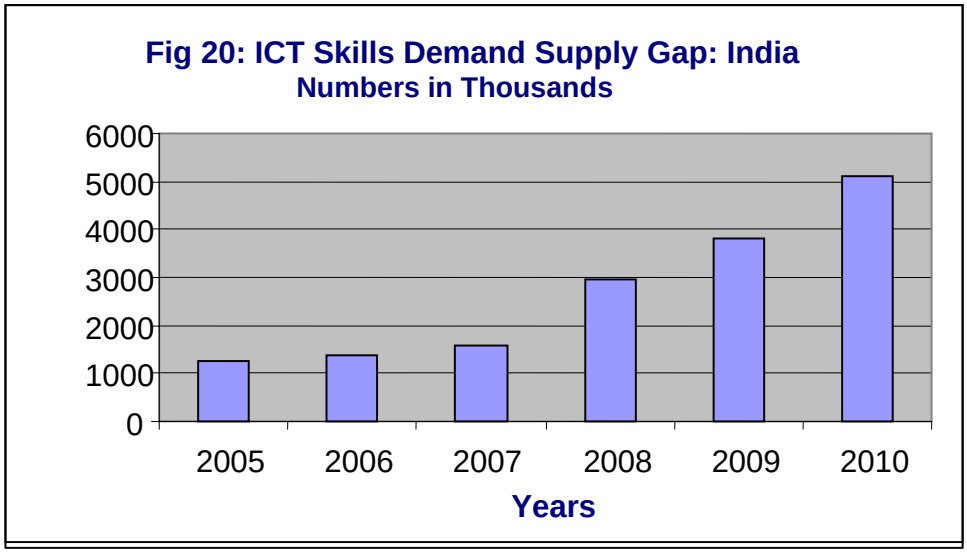
In addition there would be serious imbalances at the occupational and skill levels. As a result of the expansion of the ICT usage within the country the domain specific application skills, e-business skills, networking and internet skills as well as programming skills will be seriously in short supply. Lack of data prevents a skill based analysis of demand and supply.

6.2 India

As in China, the ICT industry in India is the fastest growing sector of the economy and the major contributor to its foreign exchange earnings. There are two segments to the Indian ICT industry. One segment of the ICT and also the more visible part of the industry, caters for the export markets. The second and perhaps potentially important part of the ICT industry supports and supplies the needs of the domestic market. The ICT workforce skills arise for both these segments as well as from the other sectors of the economy.

The estimates of demand for the ICT work force in India are shown in the figure 19 below





The total demand for ICT work force, both in the ICT industry and in the ICT user sectors is estimated to be about 14 million by the year 2010. Having considered the supplies from the existing public institutions and private sector companies such Microsoft, Intel, CISCO, NIIT, Aptech, New Horizon and other smaller companies there would still be a gap of some 5 million ICT workers in the economy by the year 2010. The ICT task force set up by the government of India some years ago had recommended increasing the enrollment capacity of its universities and colleges by some 150 percent. This recommendation is understood to be still being considered. As in China, in India as well the lower level demand supply imbalances will develop especially in the area of IT application, IT infrastructure, Networking, Graphics and animation, local content developers and multimedia. Quality of education provided by the Indian educational institutions will remain a matter of concern for the ICT industry.

6.3 Russian Federation

Russian ICT industry is the fastest growing industry in the country. The size of the country's ICT is estimated at US$ 31 billion in the year 2006. Russia is currently in its fourth consecutive year of high double digit growth. During the last five years the industry has grown at an average annual rate of 22 per cent. This boom is expected to continue during the period 2007-2010. The country is well in the process of upgrading requisite infrastructure, and making legal and policy provisions for its ICT industry. The industry is well supported by the government with legislation having been passed to provide for special tax beaks and incentives for promotion of ICT service exports and establishment of special export processing zones and software parks.

The exports of ICT products and services are estimated at close US$0.5 billion in 2006. This is expected to increase very sharply as the country tackles the problems of software piracy, establishes infrastructure and further increases the flow of Foreign Direct Investment into the ICT industry. It is the aim of the government to be among the top three best software outsourcing locations in the world by 2015.

The Government of the Russian Federation has developed a number of programs aiming at wide dissemination of the modern computer technologies in the country. The e-Russia 2002-2010 Program was started in 2002 to increase the efficiency of the economy both in the public and private sectors by increased use of information technologies in government departments, and transfer much of the state's work online. The e-Russia entails investment of $2.6 billion over the period 2002-2010.

Expansion of the domestic ICT market as well as exports will give a boost to the local ICT industry and the sharply increase usage of the ICT in other sectors of the economy. Therefore the demand for ICT Professionals in the country is expected to increase very sharply. It has been estimated, based on these emerging trends that the demand for IT workforce in the IT industry and in the other sectors of the economy would be 2 million and 7 million respectively. In other words nearly 6 percent of the population should be in the ICT and ICT related occupations if the current vision of the government and its goals are to be realized.

It is difficult to assess whether or not the existing ICT workforce supply in the economy will keep pace with the increasing demand on account of lack of up to date information and reliable data. A review of the existing trends in the development of ICT skills in the country would provide some insight.

The country has a high literacy rate and 20 percent of the population are college graduates and has among the highest number of PhDs in science and technology on a per capita basis in the world. About 1.3 million Russians have degrees in Computer, engineering and related fields. On account of Russia's traditional skills in engineering and technology the Russian software developers have outstanding skills for solving complex projects based on core engineering and natural talent for solving mathematical algorithms. Russia has some 14 centres of excellence in science and technology including the Kaliningrad State University, Moscow State Technical University, Moscow Institute of Physics and Technology, Moscow State Institute of Electronic Engineering and St Petersburg State Poly technical University. The expansion of ICT education in these institutes is being supplemented by training by companies and by other innovative programmes such as the e-education initiative of the government (a part of the e-Russia programme).

6.4 Indonesia

Indonesia is the fourth most populous nation with a population of some 210 million. Even though the ICT penetration in the country is still low the rate ICT expansion in the country in recent years has been high and is likely to continue with the encouragement that the government is giving to the adoption of ICT as a vehicle for economic development and the rapid growth of the ICT industry to feed the needs of the domestic market as well as exports. The IT industry in the country is estimated at about US$ 1.2 billion and is expected to reach US$ 1.9 billion by 2010 expanding at a compound average rate (CAGR) of 10 percent a year (IDC). The telecom market is about twice as big as the IT market. The domestic IT market distribution is as shown in the following figure

Fig 21:Indonesian IT market segments
IDC 2003

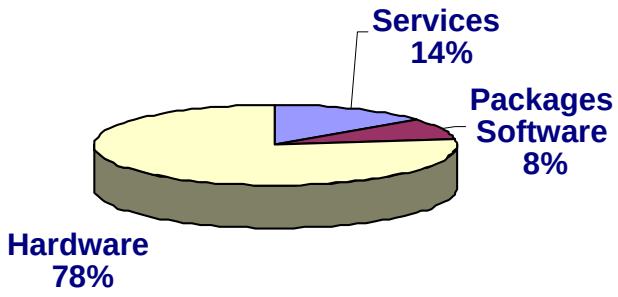


Figure 21 indicates the dominance of the hardware segment, understandably on account of the initial stage of growth of the ICT in the country, where the main focus is on IT infrastructure establishment. The export of ICT and related products are estimated at about US$ 6 billion mainly consisting of micro- electronics, monitors, input out devices and the like.

The demand for ICT work force in the country both in the ICT supplying and using sectors is estimated at about 7.5 million, of which about 1.5 million are estimated to be required to support the emerging trends in the ICT industry growth and ICT penetration in the country. The pattern of skill demand can also be expected to change as the IT services assume a proportionately higher share of the total market than it is at present. There are more than 90 million people in the work force and 17 percent of population is reported to have attained at the least a high school diploma. In terms of numbers the country may not face problem in finding the potential work force of the large magnitude that is estimated. Will the country's 1400 odd higher centres of learning (including universities and colleges) rise to the occasion to provide the needed ICT manpower that the country needs is an important question that needs to closely examined.

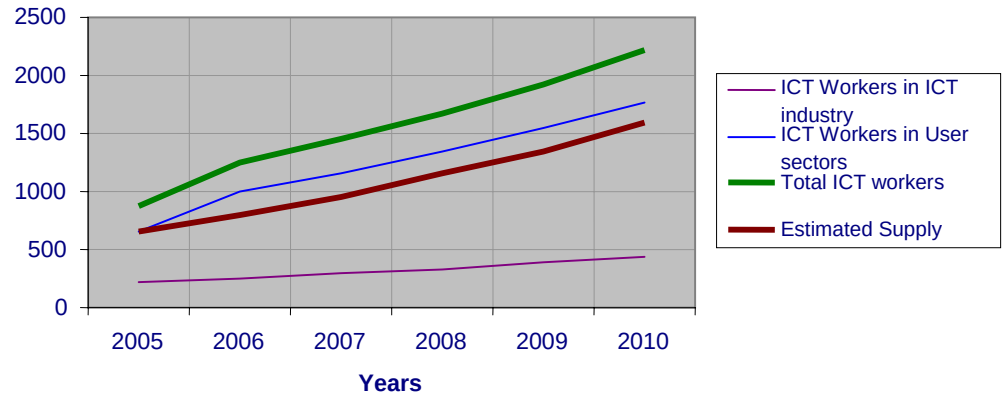
6.5 Malaysia

Malaysia is among the most dynamic countries in the region. It envisions joining the ranks of the developed nations by the year 2020. The so called Vision 2020, has been the motivator for the government to enunciate policies and implement programmes that would permit quick and fast penetration of ICTs in every day life and create a really knowledge based economy by 2020. As a part of the programme to realize its long term vision Malaysia launched the Malaysian Super Corridor (MSC) project that has created high Tech environment and top class infrastructure for the high tech industries of the world. The operations of the MSC would have a multiplier effect on the Malaysian Economy as a whole.

Malaysian ICT market is estimated at about US$ 7.5 billion growing at an average rate of 9 percent year. The exports of ICT hardware and software have shown growth in the last five years from a level of US$29 billion in 2002 to US$33 billion at an average rate of 5- 6 percent a year, helped in part by the operations of some of the leading ICT and related companies in the MSC.

Considering the demands of the local ICT manufacturing and Service industry and the ICT workers demand in the user industries it is projected that the country would need an additional 1 million ICT workers between 2006 to 2010. as shown in the Fig below.

Figure 22: ICT workforce estimated demand and supply: Malaysia
Numbers in Thousands



Malaysia has in all some 600 universities and colleges including 18 public institutions of higher learning including International Islamic University, University of Malaya, University of Technology as well as and 70 technical institutes to meet the needs for ICT manpower. Malaysia has also in the recent times pursued some innovative programmes of skill development including its Smart-School programs for the primary and secondary schools and Multimedia Internship programme to satisfy the increasing demand for knowledge workers. A Labor Force Survey showed that the proportion of the labor force with tertiary education increased from 13.9 percent in 2000 to 17.1 percent in 2003. It is projected that if the current trends continue Malaysia can supply over 100,000 to 150,000 such workers each year with a high percentage in research, engineering and IT, increasing the ratio of researchers and engineers five-fold by 2010 - from 15 for every 10,000 workers now, to 75 for every 10,000 workers in 2010. There may be still be some unfulfilled demands by the 2010 on an overall basis. However the main concern of the country should not be with the numbers but with the quality of skills and with balancing the demand at individual skill levels.

7.0 Challenges and Opportunities

The fast expanding ICT markets in the developing countries of Asia Pacific region and its expanding role as a global supplier of ICT products and services poses unprecedented challenges and opportunities to the ICT industry managers, government policy makers; as much as to the educational and research institutions in the region that must supply the human resources with the right skills to keep the ICT sector in the region on its growth path.

In the preceding sections of this paper the author has tried to project the ICT human resource demand supply scenario based on the emerging ICT supply and consumption trends in the region and in the world at large and the increased penetration of ICTs in the region. These projections point to the major challenges that the government and industry leaders in the region face and the opportunities that are unfolding as the region continues its march towards a knowledge society.

7.1 Large and Expanding Demand Supply Gap

In the demand and supply of ICT and related skills in the region, both in the supplying industry and the using sectors, in all countries of the region the supply of the right skills falls considerably short of the emerging demand. The countries which are more ICT export oriented the demand supply gap is projected to be larger than in the countries that are net ICT users. Again, the demand supply gap is larger in countries where the ICT penetration rate is higher. In all the countries of the region the effects of the emerging shortages of ICT skills are felt, as is evidenced by the numerous national studies and reports. In the views of the author however, these studies and reports have often underestimated the demand as the focus of most of the studies have been on ICT skill needs in the ICT industry itself or in many cases on ICT as an occupation. ICT penetration in a country triggers demand for ICT skills across all economic and social sectors and therefore the demand for ICT skills is broad based and much larger than narrow ICT industry focused studies would estimate. National and regional strategies, policies and programmes are called for to bridge the emerging gaps.

7.2 Demand and supply pattern and dynamics

Bridging the overall gap between demand and supply is not enough. Even if macro level demand supply balance is achieved there could be serious imbalances at the lower levels of specific skills. Moreover the demand pattern for ICT skills at the national levels is likely to change rapidly over time as the domestic markets for ICT products and services change and as the new export markets are explored and as existing export markets expand.

Thus a multilevel tracking of demand for and supply of ICT skills is called far. A tracking model is required, which is skill based, multilevel and dynamic. Perpetual review and monitoring is essential as the demand pattern could change drastically and rapidly over time.

The author has proposed three major categories at the highest level:

ICT skills in the ICT supplying Industries

ICT skills in the ICT using industry

Active ICT users

Each of the above categories of course would cover a mix of skills. Therefore, lower level tracking of skills is essential in order to achieve demand and supply balance at all levels.

7.3 ICT Diffusion and its implication on Human Resource Skills

ICT diffusion is rapidly taking place in most countries of the region. This implies the need for ICT skills that could keep the ICT industry efficiently running to feed the domestic market. In addition the ICT adoption in the country would alter the pattern of demand for human resource skills in the economy in its entirety. Some skills will become redundant as the ICT is adopted in a particular industry and some others would emerge. As the ICTs penetrate deeper in a country the Human Resource skills in all economic and social sectors would change. This does not refer to ICT skills only but to the skills associated with most occupations. This is an important challenge the leaders and policy makers face in this region and indeed in every country of the world

An interesting research study was recently undertaken at the Indian Institute of Information Technology at Bangalore in India, to assess the labor market implications of ICT diffusion in India. The study found that ICT diffusion leads to *Deskilling and Skill Polarization*. For instance in traditional manufacturing sector, as ICTs diffuse, craft based skills such as welding and machining becomes redundant where as need for cognitive skills increase. Even within the realm of cognitive skills ICTs render routine tasks less relevant over time, where as the need for non routine decision making is enhanced. The workers in an ICT intensive manufacturing environment would get, so to say, dematerialized. That is, workers now need skills for interpreting symbols and data to manipulate the production process rather than handle the materials that are being worked on. The effects of ICT diffusion is felt at all levels in an organization. For instance in a company or an organization adopting an ERP solution the senior management gains better control over operations at the lower levels therefore their dependence on the middle management decreases. The study referred to above confined itself to IT and IT enabled sector and the Automobile industry. However, the results of the study could well apply to all other

industrial and non industrial sectors. Similar results have been obtained by various surveys and research undertaken on this subject in USA and Europe.

7.4 Quality of the ICT skills

As mentioned before, the ICT education and training institutions and organizations in the region have failed to supply the skill quality that the ICT industry and the ICT users demand. They may have produced the numbers but have obviously not come up to the standards that would be required to meet the needs in terms of quality of skills. The President of the NASSCOM (the association of software and service companies of India) in a recent conference mentioned that India produces a large number of graduates from its universities but only a small percentage of these graduates have the skills and education to make them suitable for employment in ICT and ICT related industry. He went on to say "*While some young men, on the brink of starvation, desperately look for work, employers elsewhere look – with almost similar desperation – for appropriate persons to fill tens of thousands of vacancies. That this should happen in the same country is odd enough; however, what is more striking is not the known urban-rural difference, the clichéd India-Bharat divide, but the vast differential within educated urban India. Even as unemployed graduates abound, others with the very same qualifications are chased by recruitment agencies and offered huge raises over already-high salaries.*" His views reflect the views of most industry operators in the region. Although region's universities and colleges have an estimated capacity to produce in excess of 15 million graduates a year the graduates in most cases do not have the skills and knowledge that are needed.

7.5 Standard ICT skill Classifications

There are present no regional or international standards that are appropriate to the emerging situation in the region. The existing ICT occupational classifications now existing internationally is not suitable for the new skills matrix that is now emerging in the region and indeed in the world. ISCO 88 or some versions of it have been used by some countries in the region where as some others have their own

classification system. There is an urgent need to harmonize the ICT skill classification standards. This would facilitate the mobility of ICT professionals, research in ICT skill development, education and training of ICT professionals and enhance regional cooperation in ICT skill development.

7.6 Research and Development Skills

As compared to the USA and Europe, the research and development in ICT in the region appears to be low. However, there is an upward trend in the number of people employed in ICT research and development as well as in the investment that is flowing into it. There are clear indications that this increase to a large measure is accounted for the research and development undertaken by the US and European based multinational companies in the region, in order to take advantage of the cheaper research workers in the region. There are limited numbers of national or regional institutions in the region that are undertaking any fundamental research connected to ICT. The leaders in this region must recognize that this indicates a perpetual dependence of the regional ICT industry on the foreign technology.

8.0 Strategic Options

The emerging challenges and opportunities facing the leaders in the region demands that strategic options be explored for actions at the national and regional levels to meet the challenges and take advantage of the opportunities that are emerging in the region. As mentioned earlier, the need for ICT skills vary quite significantly from country to country depending on the character and nature of its ICT industry as well as on the degree of ICT penetration in the country. ICT skill needs are also determined by the long term national strategies and policies of the country in question. Thus strategic actions have to be by and large national. However, there would be strategic options which could better be undertaken at the regional level. Some of the strategic options are discussed in the section below:

8.1 Bridging the Demand Supply Gap

The sheer numbers that need to be trained and retrained are mind boggling. The demand estimated earlier is:

ICT Professional in ICT:	*17 million*
ICT professionals in ICT user sectors:	*73 million*
Active ICT users:	*239 million*

The estimates made here may be questioned on account of the methodology used or some basic assumptions used. It can be said however, with a high degree of confidence that the order of magnitude indicated by these estimates will hold. The question that needs to be asked is if the existing and planned ICT training institutes and organizations in the region would be able to meet these needs. It has been mentioned earlier that the national estimates of supply could not be made for all countries on account of lack of information and data. For some of the countries this could be done. It is unlikely that the existing universities and colleges using traditional methods would be able to handle skill development to meet the massive demand for skills as estimated. The strategic actions that could be considered at the national level could be one or more of the following:

Strategic Action 1: Expand Enrollment of Existing Universities and colleges

This is happening in almost all countries. All state universities have expanded enrollment. The Chinese and Indian universities and colleges have almost doubled their enrollment either by setting up branches or campuses in the last ten years. The sharpest relative growth in this regard has occurred in Malaysia. The expansion has to continue and indeed to accelerate. The extent of expansion needed and the direction of expansion would vary from country to country.

Strategic Action 2: Expand private educational institutes and facilitate ICT training by private companies

This is an increasing trend in the region. The training courses provided by these companies are skills focused rather than degree focused, therefore has considerable appeal to the employers. This strategy would also be very useful for retraining of existing staff to enable them to obtain new skills. Training provided by companies like Microsoft, Intel, Oracle and CISCO has been greatly expanded the

ICT skills in the region. CISCO has been very active in the region in imparting networking training and skill certification. The role of these companies is important. However it has to be recognized that the training provided by these companies is narrow and relates mainly to the product or service technologies with which the companies deals.

The private training companies that are broad based such as the NIIT and APTECH of India respond to skill development in an objective way. Since these companies are not affiliated to any particular product or specific technology their education is obviously more independent and broad based. These training companies offer educational programmes that are skill specific and are often related to the needs of the ICT industry. These training companies are in many countries outside the normal educational system of the countries. Monitoring the quality of their education can often be challenging.

Strategic Action 3: Integrating ICT education at the basic and secondary school level

Changing the education curriculum to include a high content of ICT education at the very basic level in schools and colleges is a long term solution to create ICT literate population in the region and to make ICT skill development much easier. All countries in the region have recognized the importance of integrating ICT in the core curriculum in their schools and colleges.

To expand ICT skills in the schools Malaysia launched the smart school programme. Initially the project has been rolled out to 90 schools on a pilot basis and is expected to cover 8000 schools in the country. At the Multimedia University, for example, new skills such as information and knowledge management, as well as programming applications, will be incorporated into the education and training curriculum. Malaysia's strategic path to development of a knowledge based society by 2020 is among *others to "upgrade the quality of education at the primary, secondary and tertiary levels, and to foster a cultural and intellectual infrastructure to support the lifelong learning. This is a long-term sustaining strategy"*.

The ICT human resource development strategies and policies followed by most countries in the region, including in China and India has centred on creating

ICT skills at the basic educational levels and integrating ICT as a part of the general education in the colleges and schools. The Chinese IT policy includes for instance mandatory ICT courses to be included in the school and colleges curriculum. By 2001 it was mandated that all senior middle level schools all over the country and junior middle schools in big and medium size cities would have ICT course integrated in their curriculum.

Indonesian ICT policies include targets for introducing ICT in general school and college education. According to these policies the ICT curricula for schools should have been developed fully implemented by 2004 and to use ICT as a learning tool in school and college education by 2005.

UNESCO in the Asia Pacific region has been very active in the design and implementation of numerous projects and programmes aimed at promoting ICT in education, ICT education policy development and in the training of teachers in ICTs.

Strategic Action 4: Self, Distance and Life long learning

With the massive numbers of the existing ICT users and professionals that must be either trained or retrained self education by the professionals should be an attractive option. In this paper an estimate has been made of the ICT professionals and users that must be trained at over 300 million. This estimate only includes what we have preferred to call *Active Users*, (that is ICT users who must use ICT on job in order to earn a living). It does not include the vast majority of ICT users who must learn ICT in order to carry on their routine day to day activities in a changing society which will be increasingly centered on ICTs. If only one member of each family was to be trained in the region it would mean exposing some one billion people to ICT. Formal training of such a massive number is not possible and feasible. The only feasible option would be creation of mass ICT awareness supported by opportunities for self learning.

Remote and self learning based on web delivery of content, development of Electronic Learning Management systems, encouragement of learning and knowledge sharing communities and creation of self learning attitude, is very attractive strategic option for ICT training for various reasons. A large mass of potential trainees can be reached at reasonable costs, reaching trainees at remote

locations and continual learning at the self pace of the trainees would be possible. The later is extremely essential in the dynamic ICT environment where perpetual learning is a must for the ICT professionals as much as for ICT users. Remote and distance learning in innovative ways is an strategic option that would need to be made a part of the over all national and regional ICT training strategy

Strategic Action 5: From Brain Drain to Brain Gain

During the last thirty years the subject of brain drain has been an important subject for the developing countries of this region. Trained and skilled manpower from the region as also from other parts of the developing world have been migrating abroad to study and work abroad, where the working and living conditions were far better than at home. This trend termed as the brain drain since the developing countries were losing their trained and skilled human resource. The developed countries on the other hand were benefiting from it as they would be getting trained manpower with little or no contribution in developing this human resource in the first place. India and China had the largest number of their experts working in the USA and Europe. An estimate indicates that nearly 5 percent of the graduates from China, India, Malaysia and Indonesia live abroad.

In technological field particularly in the areas of ICT there is now a reverse trend of the ICT professionals returning home either permanently or to set up their businesses in their countries of origin. As the opportunities in the region increase this trend is likely to gain pace. The countries of the region have benefited enormously by the trend both in terms of the knowledge and skills these experts bring home with them after many years of experience in the west and in many cases also increased investment at home. The brain drain phenomena of the yester years is in a way transforming in to what has been variously described as *brain gain or brain circulation.*

Most countries of the region have policies that aim at accelerating this trend. Malaysia has some one million professionals abroad that could be encouraged to return home. Indian and Chinese ICT professionals are already marching back home or in the least are now trying to find foot hold in their countries of origin. Indian

government recognizes the important contribution that its Diaspora is making to the development of the country so much so that it has decided to offer them the option of a special citizenship called the OIC (overseas Indian citizen).

8.2 Bridging the skill quality gap

Improving and maintaining the quality of the ICT education and providing the level of expertise to ICT professionals is a challenge that we are facing in the region. Even if graduates are produced in the required numbers by the training institutes and universities but do these graduates have the skills needed. This is a serious problem that all the countries in the region face. Having mere degrees and diplomas is not enough in a skills intensive knowledge society. What strategic options do we have improve and maintain quality in the ICT training? Some of the strategic options that can be considered are:

1. Strict control on the quality of education given, by perpetual monitoring of the ICT education curricula as well as pedagogy.
2. Establishment of national and regional skill certification centres patterned on the Chartered Accountant examinations (which must be passed in order to get certification to practice).
3. Continual interaction between the ICT industry and government and the educational institutions in order to develop appropriate ICT knowledge and skills including cognitive skills are imparted and changes made as required.

8.3 Strategies for Regional Co-operation

Where as most of the actions and policies aimed at ICT human resource development would be nationally focused there are many areas where strategic actions at the regional level would be useful.

8.3.1 Regional ICT Skills Demand and Supply Monitoring

A regionally based demand and supply ICT skill monitoring model could be developed that could perpetually assess and project the demand for and supply of

ICT skills in the region. Each country is following its own mechanism for human resource assessment and projections. In the ICT human resource area there appears to be considerable diversity in this and in some cases total absence at the national level. The proposed regional initiative would bring some degree of harmonization and provide vital guidance for national policy making. This regional action could be taken by such international bodies like the APCICT and the ILO of the UN.

8.3.2 Development of Regional Standard Classification of ICT skills

As noted before, there is no uniform ICT skill classification system in the region. There is a need for developing and adopting regional standard ICT skill classification system which may be adopted region wide and which responds to the current needs of the ICT supplying and ICT using industries. The regional standard could and must be harmonized with the international standards as and when they universally adopted.

8.3.3 Regional ICT skill Certification Centre

Maintenance of a high standard in ICT skills and reaching a certain standard in the quality of ICT education is an important challenge that each country in the region faces. Certifying skills of ICT professionals as they graduate from their universities and colleges and over their working life as new technologies appear is apparently an urgent need if the goal of quality ICT education and life long learning is to be attained. The proposed Regional Centre for ICT skill certification could provide this service to the regional professionals. This would ensure that a certain level of skill will be maintained irrespective of where and from which college or institution the professional got his basic degree or diploma.

8.3.4 Regional Co-operation in ICT R&D and ICT Education

Even though there is an increase in the ICT product related research and development in the region, there is limited research in the regional centres of excellence in ICT, which is fundamental, basic and innovative. If the region has to, in the long run, decrease its dependence on foreign basic technology it must develop

its own capabilities in this direction. Co-operation between the ICT research centres in the region is an effective strategy to achieve this goal.

In a recent address to the students at the University of Mauritius, the President of India H.E Dr APJ Abdul Kalam, himself an eminent technologist and an educator, proposed an interesting technological model for virtual education and collaborative research. I am tempted to reproduce this model here as Appendix 7 .

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Appendix 2

IT related occupations in the Standard Occupational Classifications

1. Engineers, science and computer systems managers
2. Database Administrators
3. Systems Analysts
4. Computer programmers
5. Broadcast Technicians
6. Computer equipment Operators
7. Data Processing equipment Repairers
8. Communication Equipment Operators
9. Electric Power line installers and repairers
10. Telephone and cable TV installers and repairers
11. Central office and PDX installers and repairers
12. Electromechanical Equipment Assemblers
13. Electrical and Electronic engineers
14. Computer Engineers
15. Computer Support specialists
16. All other Computer Scientists
17. Electrical and Electronic Technicians
18. Duplicating, mail and other office machine operators
19. Billing Posting and calculating machine operators
20. Data Entry keyers
21. Electronic Repairers, commercial industrial equipment operators
22. Electrical and Electronic equipment assemblers precision
23. Electronic semiconductor processors

Source: United States Department of Commerce

Appendix 3

IT related Occupations in ISCO 88 Classifications

2131 Computer systems designers, analysts and programmers
2139 Computing professionals not elsewhere classified

3121 Computer assistants
3122 Computer equipment operators
3123 Industrial robot controllers

4111 Stenographers and typists
4112 Word-processor and related operators
4113 Data entry operators
4114 Calculating-machine operators
4115 Secretaries
2144 Electronics and telecommunications engineers
3132 Broadcasting and telecommunications equipment operators
Electrical and electronic equipment mechanics and fitters
7241 Electrical mechanics fitters and services

7242 Electronics mechanics, fitters and servicers[1]
7244 Telegraph and telephone installers and servicers
7245 Electrical line installers, repairers and cable jointers
1226 Production and operations managers in transport, storage and communications
1227 Production and operations managers in business services enterprises
1236 Computing services managers
1316 Managers of small enterprises in transport, storage and communications
1317 Managers of small enterprises in business services enterprises
2432 Librarians and related information professionals

Appendix 4

IT Career Clusters based on Standard Skills

Database Administrator and Developer

Data Analyst
Database Administrator
Database Developer
Data Architect
Data modeler
Knowledge Architect

Digital Media

Animator
2D/3D Artist
Virtual Reality Specialist
Multimedia author
Media Specialist
Media/ instructional design

Enterprise Systems Analysis & Integration

Systems Analysis
Systems Integrator
E-Commerce Specialist
Data Systems Manager
Infrastructure Analyst
Chief Information Officer

Network Design and Administration

Network Technician
Network Engineer
Network Operations Analyst
Data Communication Analyst
Network Architect

Programming/ Software Engineering

Software Engineer
Software Tester
Software development Engineer
Programmer/ Analyst

Technical Support

Technical Support Representative
Customer Service Representative
Help Desk Technician
PC support specialist
Sales support technician
Maintenance Technician

Technical Writing

Technical Writer
Document Specialist
E- Publication Specialist
Technical Publication Manager

Web Development & Administration

Web Page Developer
Web site developer
Web master
Web Administrator
Web Designer

Source: National Workforce Center for Emerging Technologies

Appendix 5

Estimated ICT Work Force Demand in ICT industry: Asia Pacific

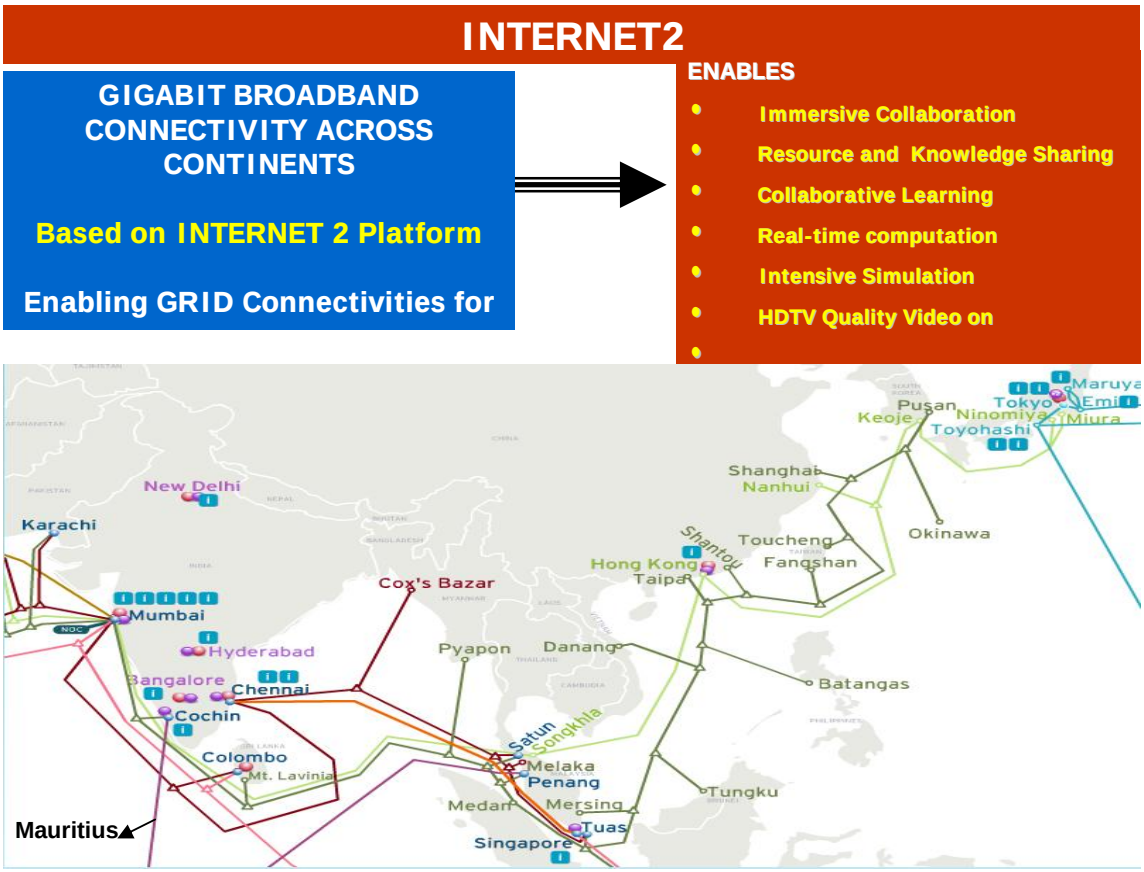
S.No	Country	2005	2006	2007	2008	2009	2010
1	China	4360	*4710*	*5080*	*5490*	*5930*	*6400*
2	Tapei, China	190	201	211	221	232	244
3	Korea Republic of	616	650	685	723	763	820
4	Mongolia	66	76	87	100	115	135
	Total East Asia	**5232**	**5637**	**6063**	**6534**	**7040**	**7599**
1	India	1000	1230	1512	1860	2280	2820
2	Pakistan	120	134	162	193	231	278
3	Bangladesh	15	18	22	25	30	40
4	Srilanka	10	13	16	21	27	35
5	Bhutan	0.5	1	1	1.5	2	3
6	Nepal	5	9	10	11	12	14
7	Maldives	0.3	0.5	1	2	2.5	4
	Total South Asia	**1150.8**	**1405.5**	**1724**	**2113.5**	**2584.5**	**3194**
1	Malaysia	220	253	290	334	385	443
2	Philippines	211	254	304	365	439	527
3	Vietnam	60	78	120	156	210	270
4	Thailand	176	202	232	267	307	354
5	Singapore	300	315	330	346	364	382
6	Cambodia	35	51	62	72	86	100
7	Indonesia	400	520	676	878	1142	1500
10	Lao-PDR	0.5	2	3	5	7	10
11	Myanmar	3	4	6	8	11	15
12	Brunei	1	2	3	5	7	9
	Total South East Asia	**1406.5**	**1681**	**2026**	**2436**	**2958**	**3610**
1	Iran	150	180	216	260	311	375
2	Afghanisthan	0.2	0.5	1	2	3	5
3	Kazakhstan	5	9	11	13	16	20
4	Kyrgyzstan	3	4	5	6	7	8
5	Russian Federation	800	960	1152	1382	1658	1991
6	Tajikstan	3	4	5	7	9	11
7	Turkmenistan	2	3	4	5	7	9
8	Azerbaijan	12	15	20	26	32	42
9	Uzbekistan	11	12	14	17	22	28
	Total Central Asia	**986.2**	**1187.5**	**1428**	**1718**	**2065**	**2489**
		0.8	1	1.5	2	3	4
	Total Asia Pacific in 1000s	**8775.5**	**9911**	**11241**	**12801.5**	**14647.5**	**16892**

Appendix 6

Estimated ICT Workforce Demand in the User sectors: Asia Pacific Region

S.No	Country	2005	2006	2007	2008	2009	2010
1	China	13080	*14130*	*17780*	*21960*	*23720*	*32000*
2	Tapei, China	760	804	844	884	929	976
3	Korea Republic of	2464	2600	2740	2892	3052	3280
4	Mongolia	198	228	304	350	402	540
	Total East Asia	**16502**	**17762**	**21668**	**26086**	**28103**	**36796**
1	India	3500	4305	5292	7440	9120	11280
2	Pakistan	420	536	648	772	924	1112
3	Bangladesh	60	72	88	100	120	160
4	Srilanka	40	52	64	84	108	140
5	Bhutan	3	5	5	8	10	15
6	Nepal	25	45	50	55	60	72
7	Maldives	2	3	5	10	13	20
	Total South Asia	**4050**	**5018**	**6152**	**8469**	**10355**	**12799**
1	Malaysia	660	1000	1160	1336	1540	1772
2	Philippines	633	762	1212	1460	1756	2108
3	Vietnam	180	234	260	676	840	1080
4	Thailand	528	707	812	934	1228	1416
5	Singapore	1500	1575	1650	1730	1820	1910
6	Cambodia	123	200	248	288	344	400
7	Indonesia	1200	1820	2704	3512	4568	6000
10	Lao-PDR	2	8	12	20	28	40
11	Myanmar	12	16	24	32	44	60
12	Brunei	5	10	15	20	35	45
	Total South East Asia	**4843**	**6332**	**8097**	**10008**	**12203**	**14831**
1	Iran	600	720	860	920	1244	1500
2	Afghanisthan	1	3	5	10	15	75
3	Kazakhstan	20	36	44	52	64	80
4	Kyrgyzstan	12	16	20	24	28	32
5	Russian Federation	2800	3360	4032	4837	5803	6968
6	Tajikstan	12	16	23	28	36	44
7	Turkmenistan	8	12	16	22	28	36
8	Azerbaijan	48	60	80	104	128	168
9	Uzbekistan	44	48	56	65	88	112
	Total Central Asia	**3545**	**4271**	**5136**	**6062**	**7434**	**9015**
	Pacific Island Nations	4	5	6	8	15	20
	Total for Asia Pacific	**28940**	**33383**	**41053**	**50625**	**58095**	**73441**

Appendix 7



Source: HE. Dr APJ Abdul Kalam: Address /Presentation at University of Mauritius