CHAPTER-5

COMPARATIVE CASE STUDY OF LOCATION ATTRACTIVENESS OF BRIC NATIONS FOR O&G ESO

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Brazil, Russia, India and China are capturing global attention for the BPO, IT, ITeS outsourcing industry due to their mix of low costs and other favourable factors. These countries have well recognised the potential of the outsourcing industry and are trying to vie investors by introducing favourable policies for introducing foreign capital and technology with the aim of diversifying their outsourcing industry. The governments of these countries are serious about creating a first-class high-technical labour force. Both multinational and domestic firms are also providing training in partnership with the government. At undergraduate, post-graduate and adult education levels, universities and training institutes are increasingly emphasizing in imparting training in software development and applications and other technical and engineering skills. Even as companies in these countries continue to move from strength to strength as providers of BPO, IT/ITeS services to companies around the world, the possibility now exists for these countries to add a major services growth stream - O&G Engineering Services Outsourcing - to their rapidly evolving economies. Achieving more than a moderate degree of success in O&G ESO will require a serious commitment from the business and political leadership in each country to make their nation a more attractive business destination. To capture its full potential share of this new business, each of these countries need to take steps to address the elements of location attractiveness for O&G ESO that are identified in this chapter.

In this chapter, the results of the Phase-I survey to define the elements of location attractiveness are presented followed by a comparative study and analysis of the factors determining location attractiveness in BRIC nations. The Case studies and comparative analysis are combined in this chapter. The variables for comparing Location Attractiveness of BRIC nations for O&G ESO identified as Objective No.1 listed in Section 1.3 of Chapter-1 are arrived at in Section 5.1 of this chapter.

5.1 VARIABLES OF LOCATION ATTRACTIVENESS FOR O&G ESO INDUSTRY

For analysis, the identified aspects of Location attractiveness (LA) have been treated as *variables* (also referred to '*Elements*') on which the O&G ESO investment decisions in these economies are dependent. These variables have been identified from the Phase-1 survey results as presented in Figure 5.1 from an interview of 18 Subject Matter Experts in the O&G industry. The identification of these variables to compare location attractiveness completes the Objective No. 1 of this thesis listed in Section 1.3 of Chapter-1.

Two elements (Geo-political risks and Cultural/language compatibility with Outsourcer nations) were excluded from the study since less than 11 respondents voted for these factors as explained in Chapter-2: Research Methodology. The balance ten variables that have been used for the Comparative Case study analysis are mentioned below:

- Cost competitiveness of services (C)
- Talent pool availability (T)
- Operations technology & Infrastructure (O)
- Innovation Capability (I)
- R&D and testing facilities for O&G engineering (R)
- IP/Data security (D)
- Advanced educational institutes for O&G engineering (A)
- Presence of established O&G ES companies (P)
- Process efficiency & quality of services (Q)
- Policy incentives for service industry (S)

Or,

LA = f (C, T, O, I, R, D, A, P, Q, S)

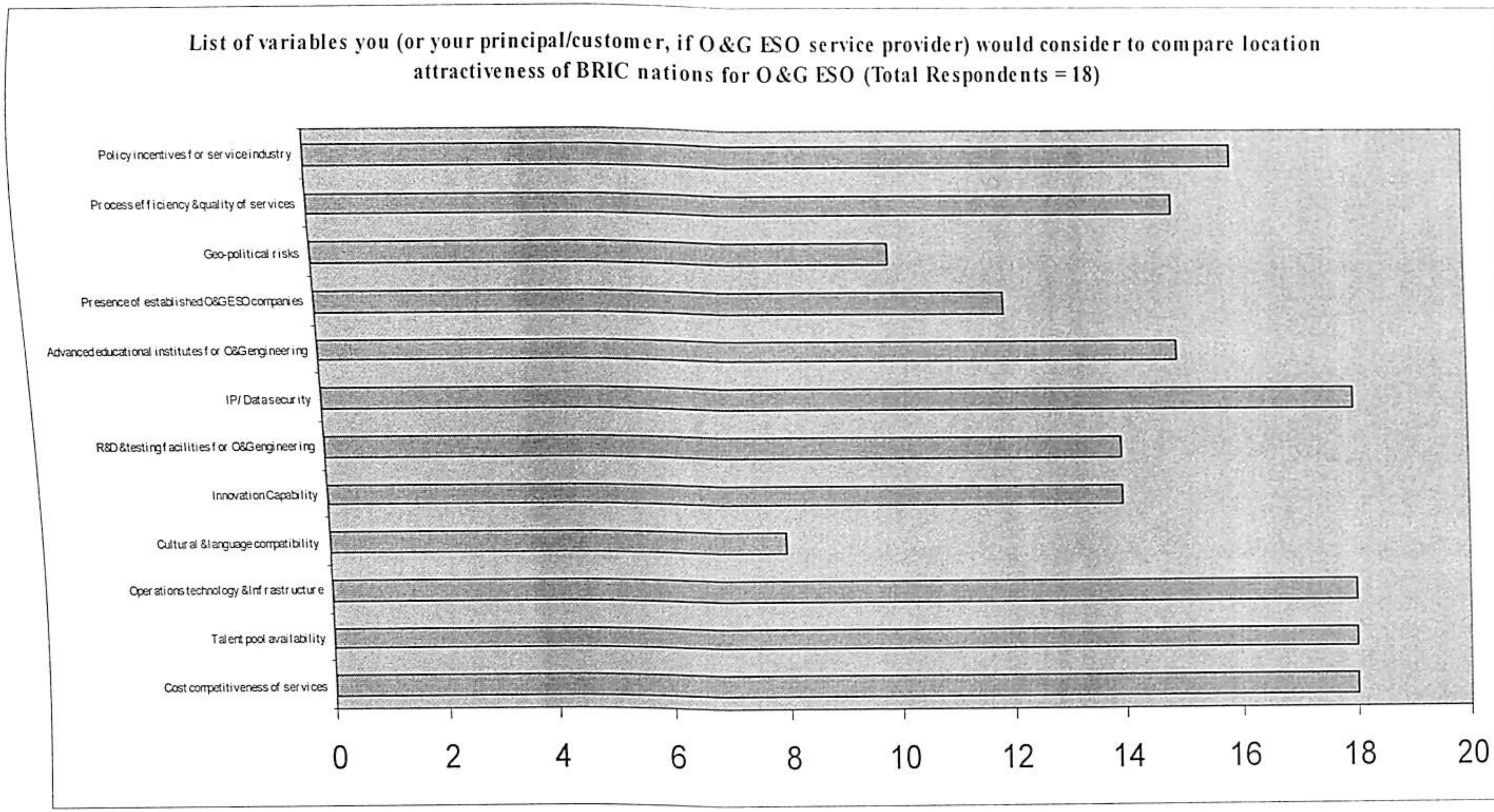
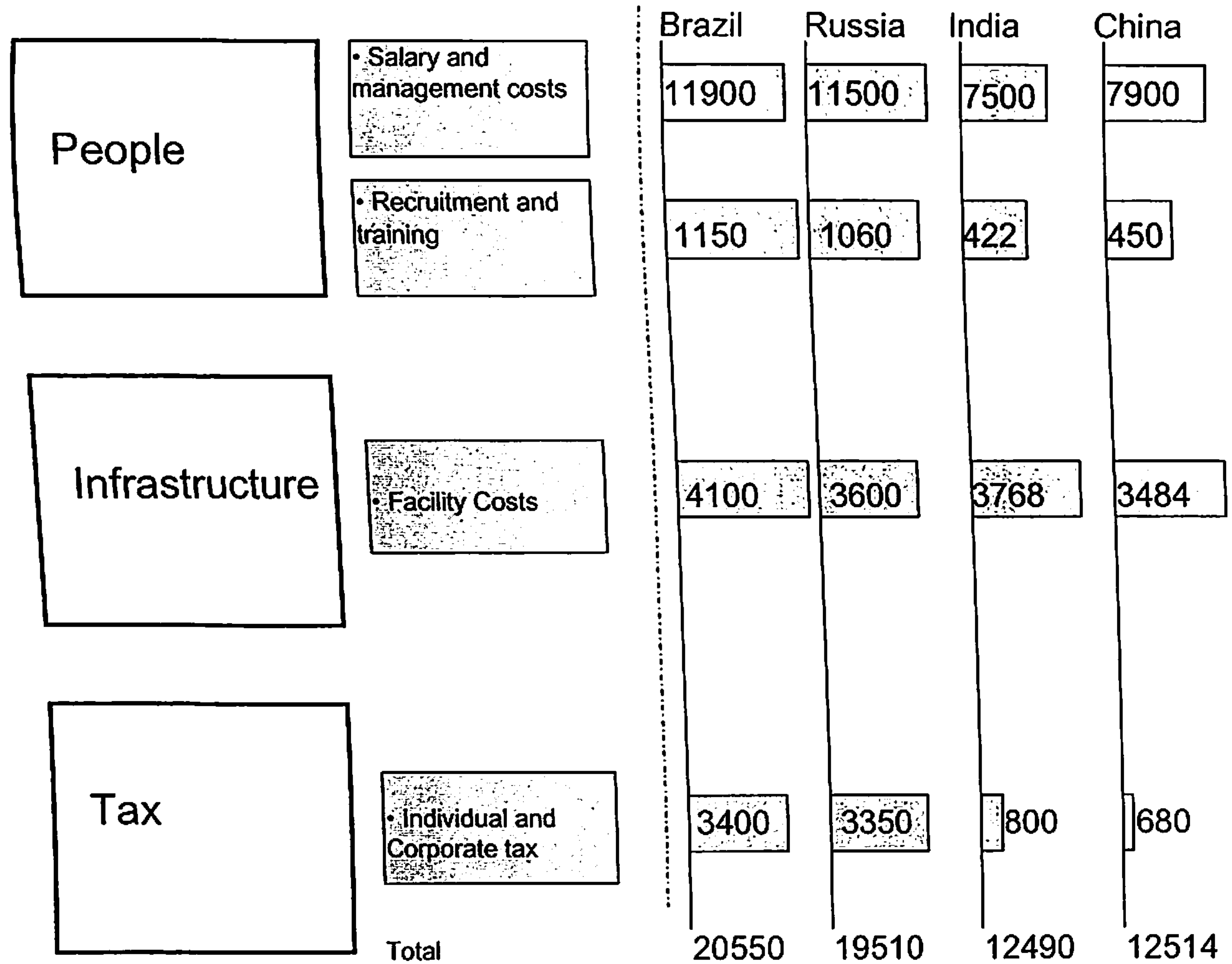


Figure 5.1: Phase-1 survey results to determine 'Elements of Location Attractiveness for O&G ESO industry'

A comparative analysis of the four BRIC economies has been carried out for the above mentioned ten variables. The result of the primary/secondary data presented and analysis have been plotted on a four point scale for each variable to get the forced ranking of BRIC economies on these variables. This analysis will lead to an overall assessment of BRIC O&G ESO industry and finally determine the favourable destination(s) for doing business on the basis of identified variables. The analysis presented here in conjunction with the Phase-2 survey results (presented in Chapters 6 and 7) will also help in identifying the strategic issues that will impact the future development of the O&G ESO industry in BRIC nations. Finally, it will also substantially contribute in making appropriate recommendation for the Indian O&G ESO industry and policy makers to ensure sustained growth for long term.

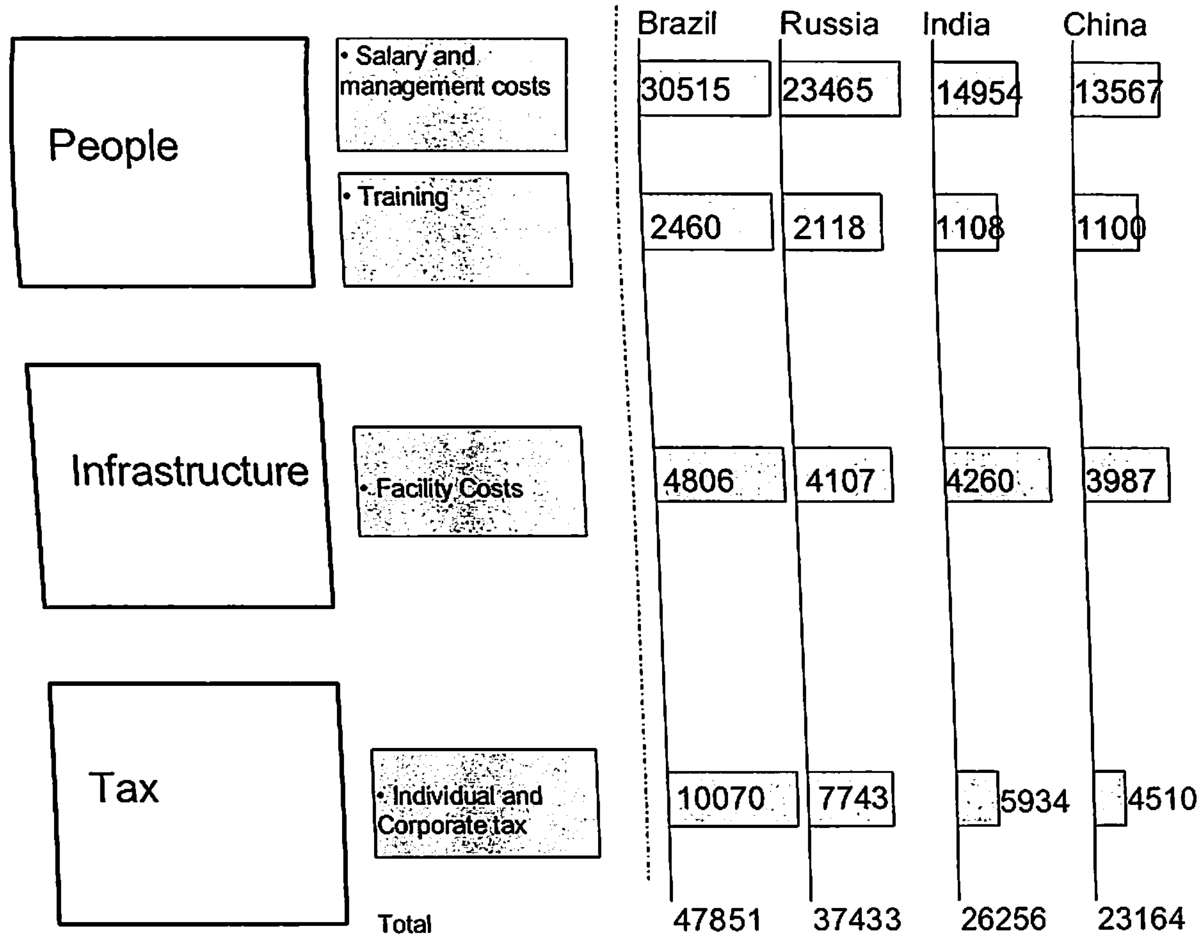
5.2 COMPARISON OF COST COMPETITIVENESS OF SERVICES

Lower costs have always remained a primary driver to outsource work to 'best cost centres'. However if the different outsourcing locations are to be compared on this parameter, a clear understanding of what constitutes 'cost' need to be defined. Wages or salary alone is only a part of the 'cost' element and expenditure on taxes, education, training and infrastructure use need to be considered. For the purpose of this study the Cost variable is defined as the sum total of People cost, Infrastructure and applicable taxes. Statutory rates of corporate tax prevailing in the BRIC countries have been used and benefits on account of tax incentives in individual nations have been excluded from this comparison. Cost comparison data for BRIC nations was been excluded from this comparison. Cost comparison data for BRIC nations was collected through expert interview sources through survey questionnaire (Appendix-A) as also from 2007 Global Tax Comparison Survey by Mercer. Two separate cases for all the four countries were considered for the purpose of analysis - Fresher graduate engineer in an O&G ESO company (Case 1) and that of a ten year experienced graduate engineer in an O&G ESO firm (Case 2). The data is depicted in Figure 5.2 and Figure 5.3.



(Note: All Figures in USD. Representation above not to scale and is only indicative of the mean values obtained from the survey)

Figure 5.2: Case 1: Annual cost of offshoring (USD per annum cost per fresher engineer – ongoing)
Source: Author research and Global Tax Comparison Survey (Mercer, 2007)



(Note: All Figures in USD. Representation above not to scale and is only indicative of the mean values obtained from the survey)

Figure 5.3: Case 2 : Annual cost of offshoring (USD per annum cost per 10 year experienced engineer – ongoing)
Source: Author research and Global Tax Comparison Survey (Mercer, 2007)

Based on the analysis of the self-explanatory data presented in the two cases, the four BRIC nations have been plotted on a four point scale for variable '*Cost Competitiveness of Services*' and the results are placed in Table 5.1.

Table 5.1: Comparison of '*Cost Competitiveness of Services*' variable for O&G ESO industry in BRIC nations

	HF	F	MF	UF
Brazil				X
Russia			X	
India	X			
China	X			

(Legend: HF = Highly Favourable, F = Favourable, MF = Moderately Favourable and UF = Unfavourable)

5.3 TALENT POOL AVAILABILITY

The shortage of trained personnel suitable for the O&G industry in design, engineering and production sides has reached new proportions and serious concerns are being raised about this. The variable '*Talent Pool Availability*' figured prominently in the survey as an important parameter that will determine country location attractiveness for the O&G ESO industry.

The average age of a technical professional in the O&G industry is about 50 years as per statistics released by the Society of Petroleum Engineers (SPE) in the year 2003. Only 27% of the technical professionals were below 40 years of age and 15% from the below-thirty mark. This implies that within the next 10 years, about half of the current skilled professionals in the O&G industry will retire. It is estimated that an additional 30% professionals from current levels are immediately required to cater to the growing needs of industry which in turn implies that by the year 2020, about 80% of the professionals who will be in the O&G industry will be new and are currently not working in it. Annual requirement of skilled professionals for the O&G sector in a developing economy like India alone is 2500+ Petro-Engineers. The most sought after knowledge professionals are E&P positions like Reservoir Engineer, Geologist, Geophysicist, Petroleum Engineer, Drilling Engineer and Production Engineer (Category-1). The next discipline is in the engineering & construction field like

Process engineer, Project Engineer, Structural Engineer, Civil Engineer, Electrical/Instrumentation, Mechanical Engineer and Subsea Engineer (Category-2). The third discipline is in the management level like Operations Manager, Project Manager, Construction Manager, Exploration Manager and Country Manager (Category-3). There are no alternative educational backgrounds to hire from for the Category-1 professionals .On the supply side, the number of students graduating with engineering degrees related to O&G from Western universities has been declining during the last 10 years. The conclusion in the SPE research study is that the USA and also Western Europe are not educating and training enough professionals to take care of their own needs and will have to resort to outsourcing. The Outsourcing location will be based on the availability of skilled technical manpower, with financials being the second consideration. This severe shortage of engineering manpower globally has opened up opportunities for Brazil, Russia, India and China as O&G ESO destinations. Structured outsourcing has become an unavoidable part of staying in business for engineering companies and end-users in Western Europe and USA. At a more technical level, consultants, mostly US-based, are employed worldwide to complement local expertise. Consulting work became more prevalent after the widespread industry layoffs of the mid-1980s as many companies chose to maintain access to their former employees on an as-needed basis. Some international O&G companies augment local technical knowledge and experience with staff members from centralized locations, mostly the USA and Western Europe, but these usually fill a specialty technical gap.

The current estimate as per SPE is that there are about 400,000 knowledge workers worldwide in middle to high level positions employed in O&G upstream companies. The size was about double fifteen years ago. For instance the total employee count of the 25 largest O&G companies has been reduced from 1,200,000 in 1986 to 600,000 in 1996. Efficiency gains have allowed the reductions at end-user companies; however another halving of the workforce, especially the knowledge workers, is unaffordable. Outsourcing of areas considered as 'non-core' has also contributed to the halving of the workforce. Design and Engineering alongside Information Technology services are being prominently looked at by these Oil majors as areas where tasks could be outsourced. Figure 5.4 shows the required Knowledge workers and potential shortage for the O&G upstream industry. These statistics do not include positions in allied industries like engineering consultancies, OEMs, midstream and also downstream refining and petrochemical industries. Put together, the global O&G industry employs over two million Knowledge professionals. The country-wise distribution of professionals in the O&G upstream industry are detailed in Figure 5.5.

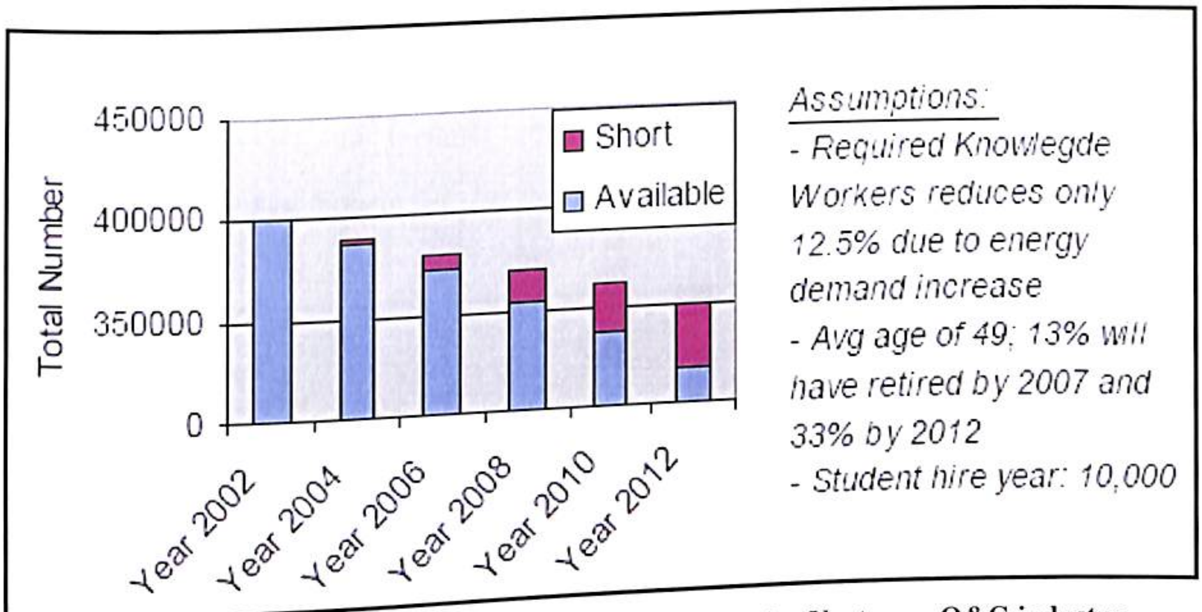


Figure 5.4: Requirement of Knowledge professionals for Upstream O&G industry
Source: Study by Society of Petroleum Engineers Inc. (2003)

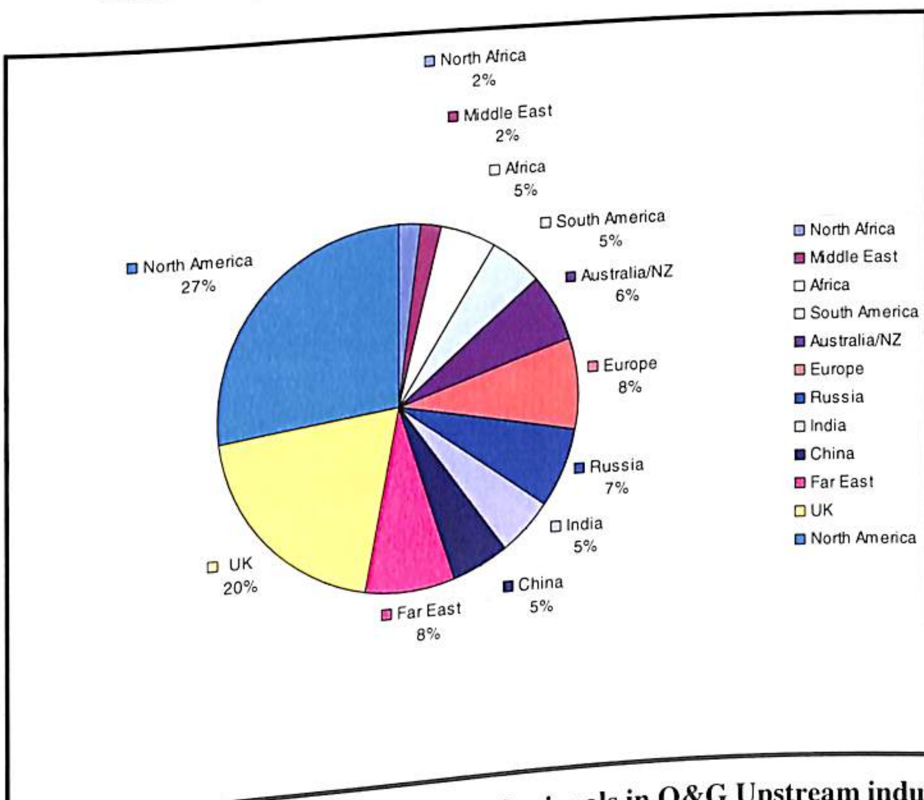


Figure 5.5: Distribution of Knowledge professionals in O&G Upstream industry
Source: Study by Worldwideprofessional b.v (2002), Schlumberger Consulting (2005)

An independent study conducted by the Boston Consulting Group (BCG) in 2004 based on then available US Census bureau data indicates that India will have 47 million more people in the working age group/total population by 2020 compared to today, as compared to Brazil which is expected to have a surplus of 3 million more people while Russia and China will have a deficit of 6 million and 10 million people respectively in the working age group compared to that in 2004 when the study was conducted. The potential workforce surplus is calculated keeping the ratio of working population (age group 15 – 59) to total population constant and under the assumption that this ratio needs to be broadly constant to support economic growth. The study results are depicted in Figure 5.6.

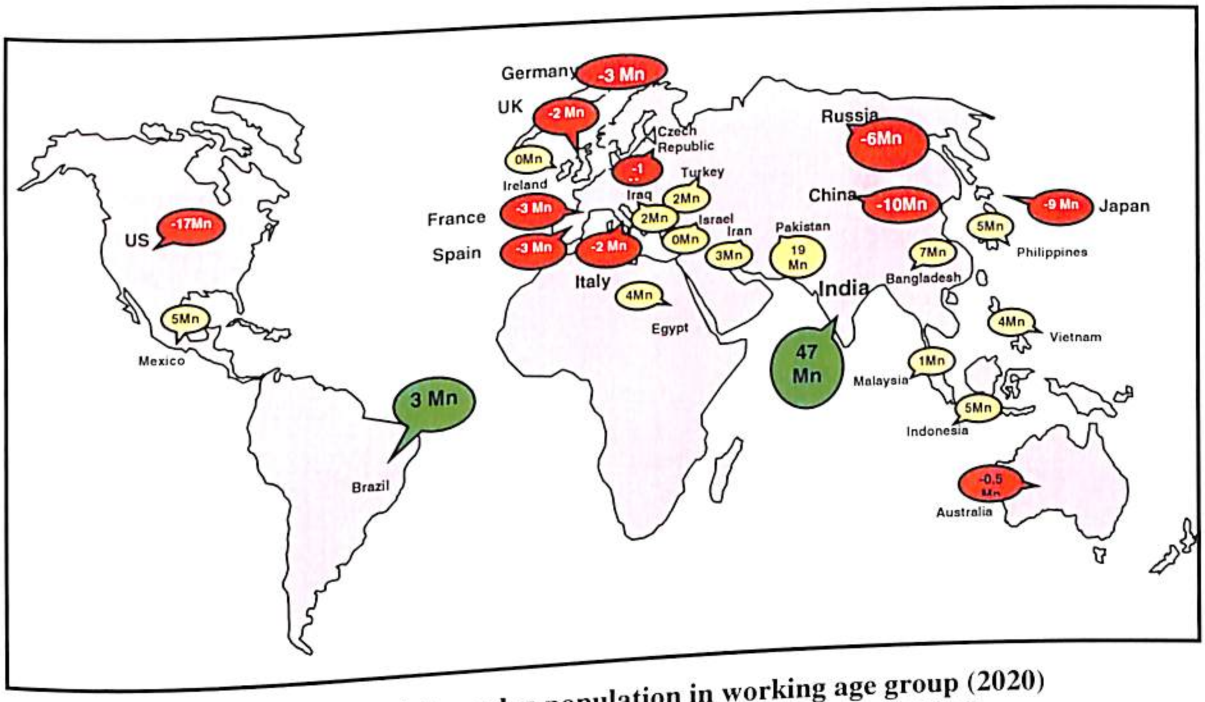


Figure 5.6: Potential surplus population in working age group (2020)
Source: U.S. Census Bureau; Boston Consulting Group (2004)

A global study conducted by Schlumburger Consulting in 2005 quantifying the supply and demand of petrochemical expertise indicated that Asian countries like India and China generate more talent than Brazil and Russia. However, the study concluded that increasing focus on project execution in several parts of the world will cause a major shortage of talented and experienced resources in the next one decade. Figure 5.7 represents the study findings in a pictorial form.

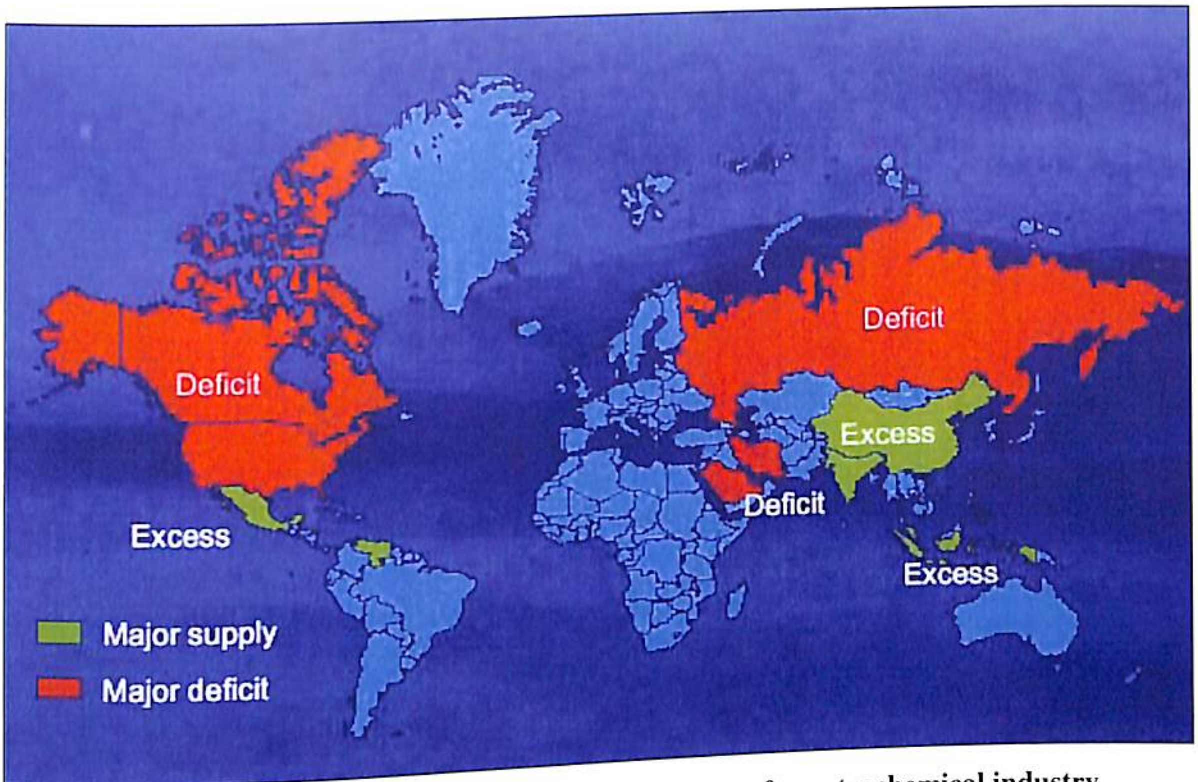


Figure 5.7: The regional imbalance of young talent for petrochemical industry
Source: Schlumberger Consulting (2005)

Based on the analysis of the data presented in this section, the four BRIC nations have been plotted on a four point scale for variable *'Talent Pool Availability'* and the results are placed in Table 5.2.

Table 5.2: Comparison of '*Talent Pool Availability*' variable for O&G ESO industry in BRIC nations

	HF	F	MF	UF
Brazil			X	
Russia			X	
India	X			
China			X	

(Legend: HF = Highly Favourable, F = Favourable, MF = Moderately Favourable and UF = Unfavourable)

5.4 OPERATIONS TECHNOLOGY AND INFRASTRUCTURE

The general infrastructure of a country has been identified in the Phase-1 survey as a major factor in enabling a country to become an O&G ESO outsourcing leader. The quality of the telecommunication infrastructure, the availability of high-speed Internet and the bandwidth available are very crucial for any country to attract investments in the O&G ESO business. In order to attract investors, the banking system, the transportation capabilities and the number of Western-style hotel rooms are also extremely important factors. Data points from the US Central Intelligence Agency (CIA), World Fact Book (2006) and the Database of infrastructure economic performance published by the World Bank Infrastructure Network (2005) are used for this comparative study to determine the ranking of BRIC nations for the variable '*Operations Technology & Infrastructure*'.

Brazil

Roads are the primary method of transportation in Brazil of both passengers and freight. With an estimated 21.31 million passenger cars and 5.5 million commercial vehicles at the beginning of the millennium, the highway system is inadequate and poorly maintained. There are approximately 1.98 million kilometres (1.23 million miles) of highways in Brazil, but only 184,140 kilometres (114,425 miles) of these roads were paved in 1996. A study conducted by the World Bank in 2005 shows that 28 percent of the country's highways were in poor condition. Furthermore, the lack of proper maintenance increased transportation costs in Brazil by nearly 15 percent over the same period. The government implemented road construction plans in order to integrate the industrialized south with the less developed north eastern and northern areas. This integration enabled producers to move goods to ports located in the coastal areas for exportation. The railway system in Brazil is very limited. There are only 27,882 kilometres (17,326 miles) of tracks in Brazil (excluding urban commuter lines) and this number is in decline as track falls out of service.

In contrast, Brazil's air transportation is well developed with 48 main airports, 21 of which are international. In 2005 about 41 million passengers used Brazilian airlines, travelling a total of 27.39 million kilometres (17.02 million miles). The total weight of airline freight was equal to 602.74 million metric tons and Brazilian airlines carried freight over 2.2 billion kilometres (1.36 billion miles). Guarulhos International Airport at São Paulo and Galeão International Airport at Rio de Janeiro are the most important and active international airports of Brazil.

Hydroelectric plants generate most of Brazil's electrical power, responsible for 91 percent of the total production. Secondary sources include fossil fuels and nuclear energy. Only state companies are allowed to supply electrical power to the population, producing a total of 316.927 billion kilowatt hour (kWh) of electricity in 2000. Domestic production falls 20 billion kWh short of domestic need, causing Brazil to import electricity from neighbouring countries such as Paraguay. Power supply is reliable most of the time, and shortages and blackouts are infrequent in urban areas.

Telecommunications services are well developed. Privatized in 1999, telephone service is provided by a number of privately held foreign capital companies. The country has approximately 19 million main lines in use and 8 million mobile cellular phones in use (2005 est.). There are 138 television broadcast stations that are sent to 316 television sets per 1,000 people. Computer access is still limited, evidenced by the number of personal computers (30.1) and Internet hosts (1.84) per 1,000 people.

Russia

The transportation infrastructure in Russia is underdeveloped. The transport system is heavily Moscow centred, with virtually all transportation channels of economic significance emanating from Moscow. Commercial transportation relies heavily on rail. The Russian railway system includes a total of 150,000 kilometres (93,210 miles) of broad gauge rail, making it one of the most extensive railway systems in the world. However, of these total only 87,000 kilometres (54,061 miles) is in "common carrier" service. The remaining 63,000 kilometres (39,148 miles) serve specific industries or are dedicated railways lines and are not available for common carrier use. The Russian highway system includes a total of 948,000 kilometres (589,087 miles) of road including 416,000 kilometres (258,502 miles) that serve specific industries or farms and are not maintained by governmental highway maintenance departments. Of the total road system, only 336,000 kilometres (208,790 miles) are paved. Russia's great territorial expanses and rugged terrain have hindered the development of a nation-wide highway Russia has some 630 improved airport facilities, 50 of which are capable of accommodating international flights. Russia's overall electricity production in 2005 was 771.94 billion kWh. Of this amount, some 69 percent was produced through burning fossil fuel, 20 percent resulted from hydroelectric generation, and roughly 13 percent was produced at commercial atomic generating stations. Electricity consumption amounted to 702.71 billion kWh, while 21 billion kWh was exported and 5.8 billion kWh was imported. Russia's telecommunications system is in the midst of the global telecommunications revolution. The country's phone system has undergone significant changes since the breakup of the state phone monopoly in 1990. By 2005, there were over 1,000 companies licensed to offer communication services. During this period access to digital lines has improved, particularly in urban centres. Internet and e-mail services are now widespread and rapidly improving. In a few short years, Russia made significant progress toward building the telecommunications infrastructure necessary for a market economy. Cross-country digital trunk lines run from Saint Petersburg in the northwest to Khabarovsk in the Russian Far East and from Moscow in the country's European centre to Novorossiysk in the south. The telephone systems in over 60 regional capitals had installed modern digital infrastructures by 2000. Cellular services, both analog and digital, expanded rapidly in 2000 and 2001. Three undersea fibre-optic cables connect Russia to the international phone system. Digital switches in several cities provide more than 50,000 lines for international calls. Satellite earth stations provide access to Intelsat, Inter-sputnik, Eutelsat, Inmarsat, and Orbita.

India

Very less percentage of Indian population have access to electricity network (40%) in addition to the low quality service provided by electricity service providers that uses poor technology to contain transmission and distribution losses that result in technical inefficiency. In India the loss is 26.21%, implying that more than one-fourth of output goes in waste. Access to improved water source is satisfactory in India due the abundant natural resources, but sanitation facilities are far from desirable levels in addition to the quality of water service is not satisfactory in India. Access to telephone network in India is comparable to other BRIC nations, however the cost of calls in India is one of the lowest in the world. Availability of telephone and cellular services are relatively better in India as compared to other BRIC nations. Both road and rail density in terms of population are extremely low; however, in terms of land is comparatively better in

India. Quality of road services is poor but port, railroad and air transportation services are relatively better. In comparison, China is far ahead of India but the infrastructure is equivalent to that in Brazil but superior to that in Russia. These shortfalls in facilities are likely to have an adverse impact not only on the wellbeing of people but also on their long-term development prospects. It is only the Information and Communication Technology (ICT) sector that seems to have better prospects, because of low cost to access. In comparison to emerging economies, India has better access to Internet than Indonesia, China and Russia. Despite the high economic growth rate in the last decade, the improvement in infrastructure facilities is not satisfactory. There are several reasons for this: Firstly, misallocation of funds is the primary reason. Premature investments in capacity – especially in water supply, railways, power, ports and irrigation often absorbed resources that could have been devoted to maintenance, modernization, or improvement in service quality. In many cases, the big projects are overambitious, placing great burden on the poor people. Secondly, lack of adequate maintenance is the other reason for high cost and low quality of infrastructure facilities. For example, a well-maintained paved road should last for 10 to 15 years, but due to lack of maintenance, degrades in half of the time. Finally, waste and inefficiency claim a large share of resources that could be used for delivering infrastructure services. For example, in India most of the telephone lines are very old; and outdated technologies continue to be used, resulting in very high phone fault rate, therefore high maintenance and repairing costs. However, some recent developments are opening the window of opportunity for fundamental changes. First, important innovations have occurred in technology and management of markets. Second, greater concern now exists for poverty reduction by way of developing infrastructure facilities. Third, slowly but steadily consensus is building for privatization which is expected to take India's infrastructure network to the next higher level.

China

China suffered economically in the 19th and most of the 20th century, yielding until recently to a lagging modern infrastructure (rail, road, airports). However, the country is now catching up extremely rapidly at all levels, and has already outpaced its rivals in most areas. The telecommunication industry provides perhaps the most successful example of how China's interventionist economic strategy has enabled the country to outpace its rivals. China has more cell phones or landlines than Russia, India and Brazil combined. The number of Digital Subscriber Line (DSL - broadband Internet) connections in the BRIC countries clearly shows the advantage China has over the other BRIC countries. The latest statistics released by the DSL Forum show that by the end of June 2006 China was ranked First in the world by the number of DSL connections with 33,305,000 subscriptions. Brazil was ranked 11th with 3,796,600 subscriptions, India was behind at 15th place with 1,537,000 subscriptions while Russia did not rank in the Top 20. China has 5 times more high-speed connections than the other BRIC countries together. Moreover the bandwidth generally available to Chinese consumers is usually between 264 Kbps and 1 Mbps, which is more than India where the average bandwidth is of 64Kbps. In addition to the consumer market, Chinese businesses have access to very high-bandwidth leased lines. In addition, the Golden Projects or the more recent Government Online Project are evidence of the government's support for the Internet development in China.

China is focusing on creating a premier infrastructure at all levels, not only in ICT (Information & Communication Technologies). The many examples of recent achievements include the opening of the world's highest railway between Golmud and Lhasa, a route reputed as impossible to open because of the permafrost; visitors arriving at the Shanghai airport can take the train that connects to the city, whose speed culminates at almost 300 miles an hour. Moreover, and just to mention a few, China is building new engineering wonders that include the Central Chinese Television building in Beijing, the new Shanghai and Beijing airports, the Olympic stadium in Beijing, the 20-mile long, 6-lane wide Donghai Bridge, the National Grand Theatre in Beijing etc.

Based on the analysis, the four BRIC nations have been plotted on a four point scale for variable '*Operations Technology & Infrastructure*' and the results are placed in Table 5.3.

Table 5.3: Comparison of '*Operations Technology & Infrastructure*' variable for O&G ESO industry in BRIC nations

	HF	F	MF	UF
Brazil		X		
Russia			X	
India		X		
China	X			

(Legend: HF = Highly Favourable, F = Favourable, MF = Moderately Favourable and UF = Unfavourable)

5.5 INNOVATION CAPABILITY

Knowledge is far more important than land, physical capital, or labour in the knowledge - based economy (Drucker, 1993), and is the dominating resource accounting for a major portion of the variation in economic growth and development between nations and continents. Technological innovation can circumvent entry barriers and help firms to innovate to keep pace with the latest ideas. Similarly, if country does not innovate, it may be left behind as competitors devise more advanced and marketable products. Effective management of knowledge and innovation thus has become a key to corporate success, technology progress and economic development (Quinn, Anderson & Finkelstein, 1996).

'Innovation Capability' was identified as a key variable to compare location attractiveness of nations for O&G ESO industry. This section evaluates different indicators of technological innovation, as well as comparison of technological innovation of the BRIC nations. Secondly, the relative innovation strengths in different technological fields for the four countries are evaluated. Finally, this section looks into the sources of knowledge for technological innovation in BRICs to arrive at the location attractiveness of BRIC nations for variable *'Innovation Capability'*.

This section conducts a comprehensive comparative study to investigate technological innovation in each of the BRIC nations. Several indicators for measuring technological innovation have been proposed and used. Patents granted to inventors in BRIC nations are considered a major measure for innovation capability (Ernst, 1998; Ernst, 2001; Tseng & Wu, 2007) and are hence used in this comparative study to arrive at country location attractiveness based on the independent variable '*Innovation Capability*'. The information contained in patents has a particular advantage because patent data are easily accessible via the database, are not subject to problems of imprecise definition and lack of comparability between firms that beset R&D data, and can be allocated directly to more detailed fields of analysis, such as, fields of technology, products or inventors. Patents are hence an objective measure of technological innovation, since patents will be examined and eventually granted by the patent office. Finally, in comparison to other sources, patents are often the only source for the timely recognition of technological changes, which gains importance in the light of increasing global competition.

Patent and citation data set used in this section consists of all patents granted by the U.S. Patents and Trademark Office (USPTO) to assignee residing in BRICs countries from 1976 to 2006 (ended December 15, 2006). To get accurate patent data of Russia, this study merges USSR into Russia. Three indicators – Patent Count, Citation Ration and Science Linkage - are used in this section to measure *Innovation Capability* in BRICs.

Patent Count: Patent Count is the summed value of those patents that are granted when they contain technological innovations which exceed a certain level of newness. Patent Count defines the number of patents granted to a country at a particular year. Figure 5.8 displays the comparison of patent count during BRICs countries from 1976 to 2006. Brazil, China and India had a low level of patent count before the1990 year, and only Russia had more granted patents. Comparison of the numbers of patent granted among four countries is not significantly different during years 1991 to 1998. Both China and India had increased markedly over time after 1999, peaking in 2006. Simultaneously, Brazil had slightly growth tendency in number of patents. Average patent of Russia after 1999 is not different from that of Russia before 1999. Patent count assigned to China indices over 1976 to 2006 totalled 2750. India, Russia and Brazil have only 1,673, 1,545 and 1,138 patents respectively. However, the gap during the four countries in terms of patent count has become broader. Patent count assigned to China was similar to Brazil during 1999, but patent count assigned to China was seven times those assigned to Brazil during 2006.

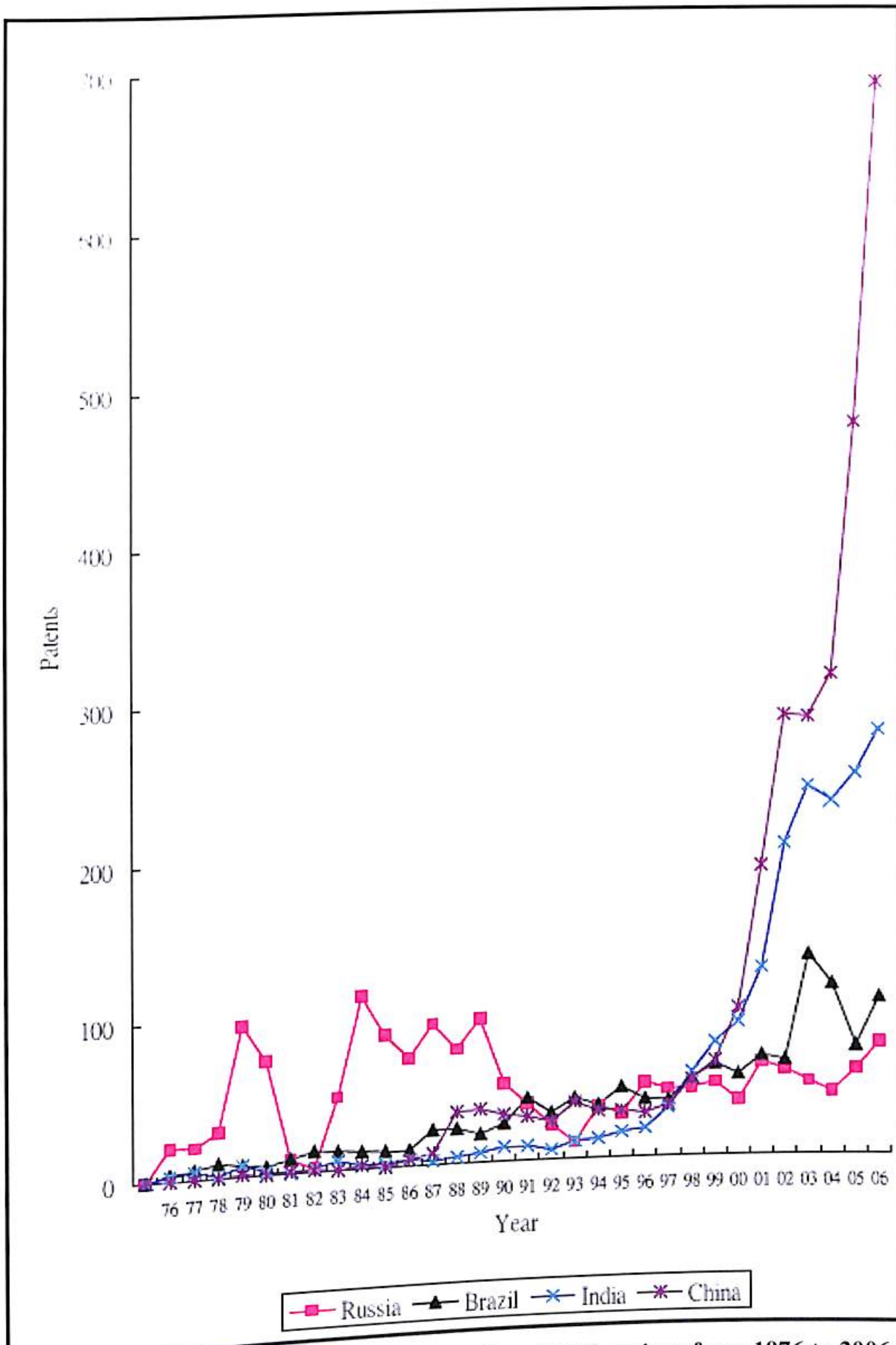


Figure 5.8: Patent Count (Patents granted) to BRIC nations from 1976 to 2006

Source: U.S. Patents and Trademark Office (USPTO), 2007

Citation Ratio: Patent quality is extremely heterogeneous with a few patents being high quality and most being low quality (Schankerman & Pakes, 1986). Patent citation is a measure patent quality since patents that are highly cited, referred to in many subsequent patents contains important technological advances (Thomas & McMillan, 2001). Citation ration proposed by Bloom and Reenen (2002) offers a valuable proxy for assessing patent quality. Citation ratio is defined as average numbers of a country's patent are cited by later patents. Table 5.4 demonstrates that citation ratio of Russia, Brazil, China and India are 4.183, 3.028, 1.870 and 0.981 respectively. Technological innovation of Russia is stronger than of other countries based on the analysis of citation ratio. India and China have relatively poorer patent quality.

Table 5.4: Forward Citation and Citation Ratio of BRIC patents

Country	Patent Count	Cited by forward patents	
		Citations	Citation Ratio
Brazil	1138	3448	3.028
Russia	1545	6478	4.183
India	1673	1665	0.981
China	2750	5159	1.870

Source: Mizuho Research Institute, Comparative Analysis of the BRICs (2006)

Science Linkage: Science Linkage is a measure of the extent to which a company innovation builds upon cutting-edge scientific research. A patent's citation may come from three sources: (1) other firms' patents; (2) its own past patents; (3) academic literature (scientific journal papers and conferences). Science Linkage is calculated based on the average number of references made by firm patents to scientific journal papers and conferences, as distinct from references to previous patents (Deng, Lev & Narin, 1999; Thomas, 2001). The underlying concept behind Science Linkage is that the number of citations an organization lists on its patents will increase with the number of inventions incorporating recent scientific discoveries from outside the organization and linked to basic science or fundamental research (Bierly and Chakrabarti, 1996). Organizations whose patents cite many scientific papers are assumed to be partial to the fundamental research. Comparatively, organizations which has lower scientific linkage ratio are assumed to focus more on the applied research. Deng et al. (1999) indicated that Science Linkage is positively and significantly associated with the market performance. Table 5.5 provides summary of backward citations and science linkage for two countries. The indicators of science linkage show that India (3.741) has been using scientific research more extensive than other countries do. Technological innovation of India is anticipated to be working closely with the latest scientific developments. In other words, India is partial to fundamental research. Comparatively, Brazil, China and Russia which have lower scientific linkage ratio are focused more on the applied research.

Table 5.5: Backward Citation and Science Linkage of BRIC patents

Country	Patent Count	Citing backward patents		Citing scientific journal papers and conferences	
		Citations	Average citations	Citations	Average citations
Brazil	1138	11463	10.073	1041	0.914
Russia	1545	11849	7.669	1825	1.181
India	1673	12637	7.553	6258	3.741
China	2750	25761	9.368	3014	1.096

Source: Department of Business Administration, Tunghai University (2007) and U.S. Patents and Trademark Office (2007)

Table 5.6 indicates the percentage of patents granted to BRIC nations in 32 technological fields (% measure of Innovation strength in various technological fields). The data indicates that India has more relative innovation strength in Organic chemistry (28.97%), Polymers (2.93%), Biotechnology (7.23%) and Basic materials Chemistry (6.1%), whereas Russia possesses relative innovation strengths in Machine tools (8.93%), control technology (8.48%) and chemical engineering (8.09%). Design field (18.10%), mechanical elements (7.03%) and engines (6.94%) are the fields of relative innovation strength of Brazil. On comparison, China presents a very equal development in 32 technological fields except design patent (36.76%).

Table 5.6: Relative innovation strengths in different technological fields for BRICs during 1976-2006

32 technological fields	Brazil		India		Russia		China	
	Patents	%	Patents	%	Patents	%	Patents	%
Electrical engineering	3	0.26	19	1.14	68	4.40	160	5.82
Audiovisual technology	8	0.70	2	0.12	8	0.52	55	2.00
Telecommunications	11	0.97	40	2.39	23	1.49	87	3.16
Information Technology	13	1.14	11	0.66	2	0.13	19	0.69
Semiconductor	0	0.00	0	0.00	16	1.04	0	0.00
Optics	23	2.02	7	0.42	31	2.01	65	2.36
Control Technology	33	2.90	50	2.99	131	8.48	85	3.09
Medical Technology	36	3.16	17	1.02	101	6.54	42	1.53
Organic Chemistry	16	1.41	483	28.87	57	3.69	99	3.60
Polymers	14	1.23	49	2.93	34	2.20	43	1.56
Drugs	32	2.81	298	17.81	58	3.75	94	3.42
Biotechnology	16	1.41	121	7.23	23	1.49	42	1.53
Materials	31	2.72	74	4.42	108	6.99	35	1.27
Food Chemistry	6	0.53	57	3.41	16	1.04	9	0.33
Basic Materials Chemistry	27	2.37	102	6.10	33	2.14	58	2.11
Chemical Engineering	58	5.10	69	4.12	125	8.09	120	4.36
Surface Technology	23	2.02	13	0.78	62	4.01	29	1.05
Materials Processing	28	2.46	39	2.33	41	2.65	22	0.80
Thermal Processes	29	2.55	7	0.42	32	2.07	28	1.02
Environmental Technology	6	0.53	15	0.90	13	0.84	7	0.25
Machine Tools	40	3.51	7	0.42	138	8.93	62	2.25
Engines	79	6.94	10	0.60	58	3.75	24	0.87
Mechanical Elements	80	7.03	9	0.54	41	2.65	42	1.53
Handling	59	5.18	5	0.30	32	2.07	38	1.38
Food Processing	16	1.41	8	0.48	13	0.84	15	0.55
Transport	46	4.04	9	0.54	29	1.88	38	1.38
Nuclear Engineering	0	0.00	1	0.06	9	0.58	2	0.07
Space Technology	20	1.76	5	0.30	15	0.97	5	0.18
Consumer Goods	47	4.13	8	0.48	40	2.59	140	5.09
Civil Engineering	64	5.62	9	0.54	80	5.18	47	1.71
Design patent	206	18.10	72	4.30	23	1.49	1011	36.76
Others	68	5.98	57	3.41	85	5.50	227	8.25
Total	1088	100	1663	100	1530	100	2732	100

Source: Department of Business Administration, Tunghai University (2007) and U.S. Patents and Trademark Office (2007)

From the analysis of the above data and graphs it is evident that Brazil has a slightly grow tendency in patenting year by year, but patent count assigned to Brazil was least among BRIC nations. Brazil has owned second good patent quality in BRIC nations. Brazil is found to focus more on the applied innovation. Mechanical elements and engines are major technological fields of relative innovation strength in Brazil. Russia had more granted patents than other BRIC nations before 1990, but has less granted patents than other BRIC nations after 1990. Russia owns the best patent quality in BRIC. Russia has major technological fields of relative innovation strength in Machine tools, control technology and Chemical engineering (Organic and Inorganic Chemistry). Patent count assigned to India was 1,673 and was second best in BRIC nations. India's patent quality is the most poorest in BRIC nations as a result of less citation ratio. India has focused on O&G related subjects such as Organic chemistry, Basic materials Chemistry and Polymers in addition to drugs and Biotechnology. China has an enormously growing tendency in patenting after 1999. China had owned 2,750 patents, highest among BRIC nations. Patent quality of China is not considered good due to low Citation ratio. China presents a very equal development in 32 technological fields except design patent. Electrical engineering is second best in China. Brazil, Russia and China are found to focus more on the applied innovation whereas technological innovation of India is anticipated to be working closely with the latest scientific developments, and tends to fundamental innovation.

Based on the analysis of the data presented in this section, the four BRIC nations have been plotted on a four point scale for variable '*Innovation Capability*' and the results are placed in Table 5.7.

Table 5.7: Comparison of '*Innovation Capability*' variable for O&G ESO industry in BRIC nations

	HF	F	MF	UF
Brazil			X	
Russia		X		
India		X		
China		X		

(Legend: HF = Highly Favourable, F = Favourable, MF = Moderately Favourable and UF = Unfavourable)

5.6 RESEARCH AND DEVELOPMENT (R&D) AND TESTING FACILITIES FOR O&G ENGINEERING

In today's dynamic business environment, innovation through a sustained process of Research & Development (R&D) is the only cutting edge tool for organizations to thrive. With emphasis on development and speedy commercialization of globally competitive products, processes and technologies, the focus has now shifted from R&D to RD&D (Research, Development & Deployment). The variable 'R&D and testing facilities for O&G engineering' figured in the list of variables for comparing location attractiveness of BRIC nations for O&G ESO. Brief details of the O&G research activities in each of the BRIC countries are explained below:

R&D and Testing Facilities in Brazil

Petrobas and ***Braskem*** lead the R&D activities related to O&G within Brazil.

Petrobras is a publicly listed company based at Rio de Janeiro. Founded in 1953, Petrobras is now the world's 9th largest oil company, by market value. Leader in the Brazilian oil sector, Petrobras is also present in 27 countries, and its reserves amount to 15.1 Billion barrel of oil equivalent (boe), according to criteria set by SPE.

Petrobras spending on R&D amounted to 1.7 BUSD in 2008. The technological gains from R&D spending have been decisive in Petrobras' progress towards developing deep water oil E&P projects, particularly discoveries in the pre-salt layer as well as developing new technologies to upgrade the Company's capacity to refine heavy oil. Petrobras generates the most patents, both and home and abroad, and it owns the exclusive rights to numerous technological innovations. In 2008, the company applied for 72 patents in Brazil, 17% more than in previous year. Its portfolio of patents covers all the areas in which the company is involved.

The Leopoldo Americo Miguez de Mellp centre for R&D (Cenpes) is responsible for developing technology that can be applied in the company's production processes, in response to Petrobras present and future requirements. To this end, Cenpes has qualified technical staff of more than 2,000 professionals, 60% of whom are university graduates. Of those, 58% have master's degree or doctorates. The partnership embraces multi-client projects, co-operative research, strategic alliances and technology exchanges. Within an investment budget of around 400 Million BRL a year, the partnership with national Science & Technology institutions has been fundamental to the positioning of the Brazilian technological infrastructure, which provides support to the company's activities on a level that is compatible with that of world's most developed countries.

Braskem is the leader in the Latin American market for thermoplastic resins since it was founded in August 2002, when Odebrecht and Mariani integrated their petrochemical assets with Copene Petroquímica do Nordeste S.A., the former centre for petrochemical raw materials in Camaçari, Bahia, which they had controlled since 2001. Braskem invests approximately 50 Million BRL per year in R&D. In recognition of its organized and consistent efforts in technological innovation, Braskem in early 2009 received the National Association of R&D of Innovative Companies (ANPEI) Innovative Company Seal. The award was created by the National Association for Research, Development and Engineering of Innovative Companies in 2008. In 2008, Braskem launched 31 development projects for new plastic resins, process modifications, partnerships with suppliers and Clients, and new applications. A good example of the return on this investment in innovation, research and technology for Braskem and its clients is the development of polyethylene cisterns in partnership with FortLev to replace concrete structures.

R&D and Testing Facilities in Russia

Russia is a major player in world energy markets. It has more proven natural gas reserves than any other country, is among the top ten in proven oil reserves and is the largest exporter of natural gas, the second largest oil exporter, and the third largest energy consumer. Energy exports have been a major driver of Russia's economic growth over the last five years, as Russian oil production has risen strongly and world oil prices have been very high. This type of growth has made the Russian economy dependent on oil and natural gas exports and vulnerable to fluctuations in oil prices. Russia's ability to maintain and expand its capacity to produce and to export energy faces difficulties. Russia's O&G fields are aging. Modern western energy technology has not been fully implemented. Considering all the above aspects Russian O&G

Companies are involved in R&D to increase their production. Also, Universities like the Gubkin University and Tyumen State O&G University are also involved in the R&D activity in O&G.

Rosneft is the leader of Russia's petroleum industry, and ranks among the world's top publicly traded O&G companies. The Company is primarily engaged in E&P of hydrocarbons, production of petroleum products and petrochemicals, and marketing of outputs. Rosneft has been included in the Russian Government's List of Strategic Enterprises and Organizations. Rosneft's Corporate Scientific Research Complex consists of a Corporate R&D Centre and 10 regional R&D institutes, of which seven specialize in E&P, and three in refining and marketing. The Corporate Scientific Research Complex provides R&D support and organizes use of technology throughout the Company's production chain.

R&D in exploration is focused on technologies that reduce geological risks and enable greater accuracy in detection of promising structures. For this purpose, in 2008, the Company made extensive use of sedimentological and regional modelling: specialized IT programs were acquired, 17 specialists from the Corporate R&D Centre underwent appropriate training, and five projects were carried out. Seismic centres with a total of more than 50 specialists were set up within the R&D institutes, and a seismic information bank was created at the R&D subsidiary, LLC KrasnoyarskNIPIneft. As a result, the Company was able to carry out in-house interpretation of 70% of its 2D and 3D seismic data, which matches rates at other leading international oil companies. Use of sedimentation models and standardized storage of seismic data and geophysical core information should increase success rates in exploration by 20%.

The Corporate R&D Centre carried out 14 projects in 2008 for the application of new technologies at the field development stage (compared with nine such projects in 2007). Rosneft mobilizes specialists from the parent company, subsidiaries and corporate institutes, and also calls in international experts to facilitate work on these projects. The Company continued to use an integrated approach to implementation of field development projects during 2008, constructing unified models that take account of all aspects of development (formation, wells, surface infrastructure, and economic calculations). A total of 10 such integrated projects were carried out in 2008 at the Company's most important fields (compared with five projects in 2007). The positive effect from creation of unified projects is confirmed by significant improvement in key economic indicators for field development. Use of algorithms and software, designed in-house, enabled selection of optimal development systems for major fields such as Priobskoye, Malobalykskoye, Prirazlomnoye, and others. This integrated approach to field development, with the application of new technologies, gave an increase of 3.5 percentage points in the average-weighted oil recovery ratio relative to original oil-in-place in the period from 2005 to 2008, representing an extra 1.5 Billion boe of recoverable reserves. A further 366 thousand barrel of daily crude oil output was added following the implementation of a comprehensive management system for base production.

Overall, the Company tested and implemented 44 innovative techniques at 696 wells during 2008. For instance, spatial geo-navigation (a periscope probe) was used for the first time in Russia at the Odoptu offshore field (Sakhalin Region) to achieve particularly large horizontal displacement in a horizontal well section. Increase in effective horizontal length gave an extra 585 bbl of daily crude production. Company R&D provided support for the drilling of 128 sidetracks during 2008. Company subsidiaries also successfully tested new machinery and equipment in 2008. In particular, new units for electric-centrifugal pumps (low-load submersible motors) increased the average life of the pumps by 70% and a slow-start device for high-voltage electric motors gave a 50% increase in motor reliability and service life.

Lukoil is one of the world's biggest vertically integrated companies for production of crude oil & gas, and their refining into petroleum products and petrochemicals. Lukoil made much progress in development of new drilling methods during 2008 and applied them in practice. At the Condor Block in Colombia, the company completed drilling of the Lengupa-1 exploration well. This was the first ever use by Lukoil of casing pipes at well, which was subject to extremely rapid absorption of drilling fluids. At the Karakuduk field, for the first time in Kazakasthan, the company used multiple drilling of slant wells : 53 wells were completed with an average daily flow rate of 21 tons. One of the most important outcomes of the Company's technology development efforts is increasingly widespread application of methods for intensifying oil production and Enhanced Oil Recovery (EOR) techniques. The methods offer significant increase of recoverable reserves and oil production, enabling commercial development. In recent years the share of oil produced at Lukoil fields using various EOR techniques has been over 20% of total oil production. The Group carried out 5,376 EOR operations in 2008, which is almost 100 more than in 2007. The company applies physical, chemical, hydrodynamic and heat methods to stimulate extraction. Additional production in the accounting year thanks to application of EOR methods was 23 million tons, or almost 26% of the total oil production by the Company in Russia.

Lukoil Group spent more than 95 MUSD on R&D in 2008. (40% more than in 2007) of which almost 70 MUSD represented R&D work in E&P.

Lukoil obtained 63 intellectual property patents in the accounting year (for inventions, models, industrial patterns and computer software). The Russian Patent Authority is currently considering more than 100 applications from Lukoil for patenting of unique technical solutions and other copyright items. The company has a total of 599 intellectual property items on its balance sheet at the end of 2008. Lukoil is among leading companies, both in Russia and abroad measured by commercialization rate of its intellectual property (about 40%). In 2008 the company designed its first Medium-term target program for scientific and technical development of the Group. In 2010-2011, setting main priorities and directions for scientific and technical development, and also devised a plan for medium-term investment in R&D.

Established in 1993, Open Joint Stock Company '***Surgutneftegas***' is one of the major Russian vertically integrated oil companies with over 100,000 employees. The Company's activities include prospecting and exploration of hydrocarbons, Oil and O&G fields development and construction; oil products and petrochemicals manufacturing and marketing; power generation; gas processing and gas products marketing. Within sufficiently short time period Surgutneftegas has significantly expanded geography of its operations way beyond its traditional region of Western Siberia and now is present at 3 oil production centres, two of which, in Eastern Siberia and Timano- Pechora, are to be built up within the next 3 years. Today the Company operates in 16 constituent territories of the Russian Federation – from Republic of Sakha (Yakutia) to Kaliningradskaya Oblast. The Company places high emphasis on its R&D activities as promoting innovative technologies help remain highly competitive. The Company's R&D portfolio is represented by two largest institutes - SurgutNIPIneft R&D Institute in Surgut and its branch in Tyumen, and engiproneftekhim Institute for Engineering of Petrochemical and Oil Refining Facilities (Saint-Petersburg), which are both engaged in developing current and future projects on reservoir engineering, O&G production and refining. The number of projects completed by the institutes grows each year. In 2008, SurgutNIPIneft Institute implemented 80 research projects with total benefit of 12 Billion RUB, which offer solutions for enhanced oil recovery, well construction and servicing. Lengiproneftekhim Institute together with leading Russian institutes develop R&D projects for the Company's oil refining segment, including solutions for catalyst performance forecast, enhancement of quality and range of products, protection against equipment corrosion, and optimization of equipment performance.

Employees involved in R&D activities significantly contribute to the Company's innovative potential, and help find effective business solutions. Thus, in the reporting year 2008, over 3,000 employees offered their projects, 2,435 innovative solutions were implemented providing economic benefit of 795 Million RUB.

Surgutneftegas obtains patents and Rospatent certificates (the Russian Federal Service for Intellectual Property, Patents and Trademarks) to protect innovative solutions developed by its employees. In 2008, the Company asserted 27 intellectual property patents and received 20 documents of title. The Company's upstream intangible assets increased by 50.7 Million RUB, and economic effect produced by use of intellectual property totalled 132.6 Million RUB.

TATNEFT is an internationally recognized Company that ranks No. 6 in Russia by the volume of oil production after Rosneft, Lukoil, Surgutneftegaz, TNKBPand Gazprom Neft. In the national fuel and energy industry structure, TATNEFT is surrounded by Transneft, NOVATEK and other energy companies. In the competitive refining segment the Company develops its own facilities, at the same time expanding the markets of oil, gas and petrochemical products. Application of modem research complexes using IT technologies provides for qualitative interpretation of geological and geophysical archive for its subsequent use in the Company's production activity

TatNIPIneft R&D Institute developed a concept of the Computer-Aided Design (CAD) and works performance for the purpose of supporting the Company's construction complex business-process. This concept unites over 250 working places of TATNEFT construction specialists, and allows performance of end-to-end design and joint work of different groups of designers.

Optimization of movement parameters and effective use of technological transport, as well as organizational and technical activities are provided for by application of modern IT solutions. The developed system of motor transport monitoring covers over 5,000 corporate transport pieces, and enables the real time control of location, speed and the travelling route, reduces idle run, appreciably saves fuel and does not allow violating the speed mode.

Joint Stock Company ***Gazprom Neft*** is the No. 5 O&G producing companies in Russia. The main areas of Gazprom Neft's business activity include oil and natural gas production, O&G field facility services, oil refining and marketing of petroleum products. The proven reserves of the company exceed 6,9 billion barrels, which ranks the company amongst the world's twenty largest oil companies. Gazprom Neft' carries out its activities in Russia's largest oil - and gas-bearing regions such as Khanty-Mansiysk Autonomous District, Yamalo-Nenets Autonomous District, Tomsk and Omsk Regions, and Chukotka Autonomous District. The Company's major oil refineries are located in the Omsk, Moscow and Yaroslavl Regions. The Gazprom Neft' distribution network operates countrywide. Gazprom Neft' is currently one of the fastest growing oil companies in the country.

In year 2008, Gazprom Neft spent a total of 34 Million RUB in R&D for oil refining. The main areas of R&D in 2008 were related to safety and environmental protection; as well as to product quality maintenance and production technologies, efficient inventory consumption technologies, including those used to inspect installations and issue operation optimization recommendations. The Company pays increased attention to modernization and new construction for the purpose of meeting the technical regulations on requirements for Motor and Aviation Gasoline, Diesel, Marine Fuel, Jet Fuel and Residual Fuel Oil. To meet the legislative requirements a motor fuel quality upgrade program was developed for JSC Gazpromneft-Omsk Refinery. Under this program in 2008 the Company continued to implement isomerisation, diesel fuel hydrotreatment, L-24/9 hydrotreater reconstruction, and catalytic cracking gasoline hydro-treatment projects.

R&D and Testing Facilities in India

The growth in R&D, in India, has been led by the increasing demand for low-cost products supported by rising income levels. This has been limited to a small segment of the economy, though there have been innovations in both the formal and informal sectors. In the 11th Five Year Plan, the Indian Government have envisaged to increase the country's R&D spends from less than 1 percent to 2 percent by 2012. This move will put India in league with the developed countries that spend 2.5 percent of their GDP on R&D on an average.

A favourable innovation environment includes policies, institutions and capabilities that impact the creation and absorption of knowledge with the enterprises at the centre. Most of these entities exist in India; however, putting them all together in a coherent whole will further boost innovation in the country. The private-sector R&D intensity has marginally increased from 0.07 percent in 1991 to 0.53 percent in 2004, and the public R&D infrastructure has also been focused only towards developing technologies supporting small industries and large enterprises in key sectors and defence. This trend points to a need for improving the effectiveness of the innovation system.

Established as an oil marketing entity on 30th June 1959, Indian Oil Company Ltd. was renamed ***Indian Oil Corporation Ltd.*** on 1st September 1964 following the merger of Indian Refineries Ltd. (established in August 1958) with it. The integrated refining & marketing entity has since grown into the country's largest commercial enterprise and India's No.1 Company in the prestigious Fortune 'Global 500' listing of the world's largest corporates since 2002, currently at the 105th position (2009). It is also the 18th largest petroleum company in the world.

In the global recognition of IndianOil's commitment and success of green technology initiatives, IndianOil was conferred with the prestigious World Petroleum Congress Award-2008 for its path-breaking R&D work in hydro-processing technologies. IndianOil INDMAX Technology chosen for setting up INDMAX RFCC unit of the proposed 15 MMTPA grassroot refinery at Paradip was reconfigured to make it more flexible. This novel technology has also evinced interest from oil companies abroad. Continuing with pursuit of developing Green technologies, the Company rolled out two new technologies, this year, INDAdeptG & INDAdeptD – Adsorbent based Processes, for deep desulphurization of gasoline and diesel streams, respectively, meeting EURO-IV norms. Another breakthrough achievement of the year was successful development of 'IndVi'- a revolutionary high metal tolerant catalyst additive formulation, for FCC and RFCC.

IndianOil developed and released 186 product formulations for commercialization, and received OEM/Customer approvals for 47 formulations. The significant ones among them were Mahindra & Mahindra, Suzuki, Tata Motors, Volvo, Eicher, Honda Motors, Cummins, Steel Authority of India Limited, Indian Railways and Defence. As a step forward, field trial clearance from leading marine engine OEMs such as MAN B&W (Germany) and SEMT Pielstick (France) were obtained for improved grades of SERVO marine oils for Diesel Generator set applications

IndianOil has intensified research to reduce the carbon footprint of its products and operations. The first ever life cycle analysis of bio-diesel from Jatropha was conducted in collaboration with National Renewable Energy Laboratory, USA, with encouraging results. IndianOil also developed eco-friendly low Polycyclic Aromatic Hydrocarbons (PAH) jute-batching oil. Recognitions for green efforts followed as IndianOil won the Golden Peacock Innovation Award for its eco-friendly agro spray oils, as well as the Petrofed Group Innovation Award for its novel low emission fuel additive.

IndianOil launched several research programs in frontier technology areas of second-generation bio-fuels, renewable and alternative sources of clean fuels from bio and fossil sources. A Memorandum of Understanding (MoU) was signed with The Energy Research Institute (TERI) for advancing research in bio-fuels. Continuing with research in commercializing Hydrogen as fuel, IndianOil commissioned the first commercial H-CNG dispensing station at Delhi. Research was initiated on E-10 (10% blend of ethanol with gasoline) in association with the Society of Indian Automobile Manufacturers.

Seventeen (17) US/Indian patents were filed and ten (10) patents were granted during the year, taking IndianOil's active portfolio of IP to 214 patents. During 2008-09, there was 100% increase over the previous year on the number of patents applied for.

IndianOil has entered into research agreements with Criterion for novel catalyst development and evaluation; with Bhabha Atomic Research Centre (BARC) for tomography studies for Trickle Bed Reactor and acoustic emission testing; with Indian Institute of Science, Bangalore (Nano Tribology), for study of boundary lubrication in engine and metal working tribology; with Sud-Chemie for commercial production of metal passivation additive; with Delhi College of Engineering for development of parallel hybrid electric vehicle; and with Engineers India Limited (EIL) for licensing DHDS/DHDT technology, with TERI, and Indian Institute of Technology (IIT), Madras for talent development.

Oil & Natural Gas Corporation (ONGC) has institutionalized R&D in the O&G, and related sectors and established separate institutions to undertake specific activities in key areas of exploration, drilling, reservoir management, production technology, ocean engineering, safety and environment protection in the form of 9 independently-managed R&D centres. These institutes are also supported by regional laboratories. These R & D institutes with experienced and highly qualified manpower support E&P activities of ONGC.

List of R&D institutes under ONGC and their activities are listed below:

a. GEOPIC: Geodata Processing and Interpretation Centre
b. KDMIPE: Keshav Deva Malaviya Institute of Petroleum Exploration
c. IDT: Institute of Drilling Technology
d. IEOT: Institute of Engineering and Ocean Technology
e. IMD: Institute of Management Development
f. INBIGS: Institute of Biotechnology & Geotectonics Studies
g. IOGPT: Institute of O&G Production Technology
h. IPSHEM: Institute of Petroleum Safety, Health & Environment Management
i. IRS: Institute of Reservoir Studies

The ***Geodata Processing and Interpretation Centre (GEOPIC)*** located at Dehradun was established in 1987. It is ONGC's largest computing facility and one of the few centres around the world where integrated processing and interpretation of different geo-scientific data from seismic to petro-physical, geological and reservoir engineering are carried out. Over 60 per cent of the seismic data acquired by ONGC is processed at GEOPIC, which includes all the 3-D seismic data acquired so far over 69 prospects/fields. About 68 billion bits of data are processed here every day.

Keshava Deva Malaviya Institute of Petroleum Exploration (KDMIPE) is located in Dehradun in the state of Uttaranchal. It was founded in 1962 with an objective to provide geo-scientific back up to the exploratory efforts of ONGC. The product developed at KDMIPE relates to various processes and technologies connected to exploration technology. Various innovations, problem solving measures, indigenous resourcing and applied R&D are carried out that totally caters to the requirements of the different assets/ basins of ONGC.

The core strengths of the institute are:

a. Basin evaluation and opening of new areas of exploration.
b. Geoscientific laboratory analysis (Sedimentology, Biostratigraphy, Geochemistry, Reservoir, Petrophysics, and Gravity-Magnetic).
c. Developing exploration concepts and models.

d. Play models and petroleum systems.

e. Attain breakthrough in exploration in frontier basins.

f. Hydrocarbon Resource Appraisal of Indian and foreign basins.

g. E&P data network.

h. Induction of appropriate technologies and related skills.

The ***Institute of Drilling Technology (IDT)*** was set up in 1978 at Dehradun and has rendered excellent services in the area of O&G well drilling technology. Over the years, the Institute has emerged as a premier R&D centre in South East Asia, capable of providing advance technical knowledge through training and offering plausible solution to field problems. The institute with highly qualified and experienced scientists and engineers, carries out applied research in all facets of drilling related activities to achieve technical excellence in R&D efforts and assimilation of emerging technologies.

The ***Institute of Engineering and Ocean Technology (IEOT)*** was founded in 1983 to achieve self reliance in technology by innovation, development and acceleration of the future plans of ONGC. The institution has developed expertise in the fields of Concept Evaluation & Risk Analysis, Geo-technical Engineering, Structural Engineering and Materials& Corrosion Engineering. IEOT has collaborations with premier research and academic institutions like Indian Institute of Technology, Mumbai; Bhabha Atomic Research Centre, Mumbai; Structural Engineering Research Centre, Chennai; Central Electrochemical Research Institute, Karaikudi and various other universities for carrying out studies on different problems related to engineering in O&G industry.

Institute of Management Development (IMD), now renamed as ***ONGC Academy*** is located in Dehradun in the hill state of Uttaranchal. It is ONGC's premier nodal agency for training and developing human resources. The Institute emerged out of SWOT (Strength, Weaknesses, Opportunities, Threats) analysis carried out by the organization in 1982 to look at the company's resource requirement for the growth in the next century. Designing parameters for measuring performance of human resources, succession planning, mapping of individual relations scenario, work climate and work culture analysis and managing change are some of the areas of research related to management development. To serve this purpose, the Academy is committed to excellence in the cause of HRD and of the availability of appropriate systems and procedures with a view to ensure managerial effectiveness, quality and productivity in E&P Sector. ONGC Academy is also responsible for coordinating training/seminars for ONGC executives abroad. The academy has acquired ISO-9001 certificate through implementation of quality assurance system. Formal alliances with reputed organizations and Institutions like Administrative Staff College of India (ASCI), Hyderabad, Management Development Institute (MDI), Gurgaon, International Management Institute (IMI), New Delhi, Institute of Cost and Work Accountants of India (ICWAI), New Delhi, Andhra University, Roorkee University, and the Indian School of Mines (ISM), Dhanbad have helped the Institute to provide quality dissemination of knowledge. The R&D wing of ONGC Academy is continuously engaged in updating strategic HRD plans to improve productivity, efficiency and effectiveness of ONGC executives.

The ***Institute of Biotechnology & Geotectonics Studies (INBIGS)*** was founded in 1989 at Jorhat in the North East state of Assam. Assam was the pioneer in crude oil production and has a number of oil fields. The North-East region was selected to locate INBIGS in view of its rich flora & fauna and marked tectonic movements. Biotechnology being an emerging branch of science is the buzz word of the 21st century. In Petroleum sector, it plays a vital role in geo-microbial prospecting, enhancing oil recovery from reservoir and environment protection by bioremediation of oily waste. INBIGS is engaged in the innovative research of petroleum biotechnology through a talented and dedicated team of bio-scientists.

To meet the technological requirements of O&G production, the ***Institute of O&G Production Technology (IOGPT)*** was established in 1984 at Panvel about 50 km from Mumbai airport in the state of Maharashtra. The objective was to improve the economics of operations and boost indigenous hydrocarbon production. This is the first institute in India to provide integrated R&D support to the entire spectrum of O&G production, beginning with well/field production analysis to transmission to consumer point. The institute has the distinction of providing specialized training including simulator based training to production engineers.

In 1989, the ***Institute of Petroleum Safety, Health and Environment Management (IPSHEM)*** was established with the objective of promoting standards of safety, health and environment in petroleum sector in India. The institute is committed to upgrade and develop human resources with a view to minimize the overall risk to human life, damage to property, process and the environment. The main functions of the institute are Training, R&D, Consultancy Services, Data bank and Information services and by serving in an advisory capacity in evolving standards and procedures. The Institute offers training courses in Basic & Advanced Safety and Environment Management, Fire Safety, Offshore Survival & Safety and Coxswain Boat Handling etc. The offshore survival and safety and Coxswain program are practical training programs for offshore going personnel.

The ***Institute of Reservoir Studies (IRS)*** was founded in 1978 as a single-source and multi-service reservoir engineering agency with the objectives to:

a. Maximize hydrocarbon recovery at minimum cost
b. Provide holistic reservoir description through integration of all data
c. Maximize the value of proven reserves with conventional and improved recovery techniques
d. Enhance the skills and knowledge for better reservoir management

Reliance Industries Limited (RIL) is India's largest private sector company. It emerged as the second-largest company from India to feature in the 2007 Fortune Global 500 listing of the world's largest corporations. The company is involved in R&D in the O&G, petrochemicals and polymer divisions. The company has a Polymer Research and Technology Centre (PRTC), which is involved in R&D in the field of polymers.

Apart from the companies mentioned above, other companies involved in similar R&D are Bharat Petroleum Corporation Ltd (BPCL), Hindustan Petroleum Corporation Ltd (HPCL), Gas Authority of India. Also institutions like the IITs, UPES, Maharashtra Institute of Technology etc are also involved in the O&G R&D.

R&D and Testing Facilities in China

China National Petroleum Corporation (CNPC) has 76 scientific research institutions with 28,486 scientific research personnel. CNPC's annual R&D investment has exceeded 4 Billion RMB in recent years. The Company has established various long-term partnerships with Chinese Academy of Sciences (CAS), universities and research organizations. The Company also continuously enhances technical communication with its international counterparts, jointly facing challenges in the development and utilization of O&G as well as environmental protection.

CNPC's major R&D progresses, evaluated and chosen by its research institutions and experts every year, represent its annual remarkable achievements in major scientific and technological projects and progresses in technology integration and application, in terms of O&G exploration, development and production, refining and chemical, engineering and construction, and equipment manufacturing. All these reflect the improvement of CNPC's core competitiveness and independent innovation, and provide enhanced technical support to sustained and coordinated growth of the company. In 2008, CNPC were granted 1,287 patents out of 1,446 applications. By the end of 2008, CNPC had acquired a total of 8,247 patents out of its 11,139 applications.

China National Offshore Oil Corporation (CNOOC) is the largest offshore O&G producer in China. Established in 1982, the Company has its headquarters in Beijing. It has 57,000 employees and registered capital of 94.9 Billion RMB as on 1st Dec 2009. In 2008, CNOOC continued to carry out the Eleventh Five-year Plan with a focus on the technology research for the core business. The company undertook 747 research programs, including 50 at national level, 10 at provincial and ministerial level and 220 at Group level. CNOOC continued to work on 30 major research programs among which the national program on the development of large O&G field and coal-bed methane was launched in 2008. During the year, the Company also began to participate in projects of the National Basic Research Program, or 973 Program. In 2008, the group put in 3.281 Billion RMB on scientific and technological programs with an increase of 18% over last year, with the fund on R&D increasing by 5.5% to 1.134 Billion RMB. The Group has strengthened the construction of its technology innovation system. The Deepwater Engineering Research Centre and New Energy Engineering Centre jointly constructed by CNOOC and Shanghai Jiao Tong University were put into operation. The National Laboratory of Petrochemical Industrial Water Treatment received approval for construction. With 32 subsidiary research institutes under its command, the Group's technology innovation system has begun to take shape aiming to improve production efficiency through technological progress. The selection of 32 Group-level technical experts has further stimulated the drive for innovation among the research staff. The research and application of exploration technologies has made new progress and helped the Company achieve its record-high O&G reserves and production in 2008. The 3,000-meter deepwater semi-submersible drilling platform has begun construction, with the Company owning independent intellectual property rights. The marine high-precision single-detector multi-streamer seismic data collection system and the Formation Characteristic Tool (FCT) prototype have passed preliminary sea testing. In 2008, the Company issued 183 standards, including 85 national standards and 26 industrial standards. 3 standards received the Chinese Standards Innovation Contribution Award.

Sinopec Corp. the first company in China listed on the stock exchanges in Hong Kong, New York, London and Shanghai, is an integrated energy and chemical company with upstream, midstream and downstream operations. R&D expense in Sinopec Corp. amounted to 1.176 Billion RMB for the six-month period ended 30 June 2008 as against RMB 1.212 Billion RMB for the whole of the year 2007. In 2008, Sinopec applied for 918 domestic patents, of which 572 were granted, and applied for 225 patents overseas, of which 173 were granted. In 2008, adhering to the principle of meeting the need of core business development, the company concentrated on independent innovation, accelerated the research on core & special technology, and expedited the promotion and application of technological achievements. Science & Technology plays a more vital role in supporting the business operation and development. In 2008, Sinopec was named Innovative Enterprise jointly by the Ministry of Science and Technology, State Asset Supervision and Administration Commission of the State Council and All China Federation of Trade Unions. The second award of National Award for Technological Invention went to high-efficiency shape selective catalysis technology development and its role in producing Paraxylene. Other 8 projects were named the 2nd National Prize for Progress in Science and Technology. They are stable productions technology at block oilfield in Shengli Oilfield; scientific and technological integration and innovation at scientifically deep drilling in mainland China; research and application of packaged technology on 100 kt/a aniline; application of packaged technology on recovering ethylene resources from refineries; FCC dry gas to ethyl-benzene gas phase alkylation and liquid phase paraffin transfer technology and commercialization; migrating double pipe gas returning units; new technology and project application of bio-de-NOx waste water technology research and application of packages technology and key equipments on 0.3-million-ton synthetic nitrogen. Sinopec has a complete system for technology development, and intellectual property management, and has strong capabilities in technological R&D. The R&D department is in charge of technology development, promotion and application, intellectual property rights, technology licensing, international technological exchange and cooperation, development of new products, development of catalysts, additives and auxiliary agents, quality supervision, standards and measurement management. Among the Company staff, 19 members are academicians of China Academy of Sciences and China Academy of Engineering.

Other than the above China University of Petroleum, Chengdu University of Technology (CDUT), etc are also involved in O&G research in China.

The list of major R&D institutions conducting research in O&G and allied areas in BRIC nations are listed in Table 5.8.

Table 5.8: List of major R&D facilities in BRIC nations specializing in O&G research

Country	Name of R&D institution
Brazil	• Petrobas R&D Centre • Braskem R&D Centre
Russia	• Rosneft Corporate Scientific R&D Centre • Lukoil R&D Centre • Surgutneftgas - Surgutnipineft R&D Institute, Surgut • Surgutneftgas - Lengiproneftekhim Institute for Engineering of Petrochemical and Oil Refining facilities, Saint Petersburg • Tatneft – Tatnipineft R&D Institute • Tatneft – NIS Engineering Centre • JSC Gazprom Neft R&D Centre
India	• IndianOil Corporation R&D Centre, Faridabad • Oil and Natural Gas Corporation (ONGC) – Geodata Processing & Interpretation Centre (GEOPIC) • ONGC – Keshav Deva Malaviya Institute for Petroleum Exploration (KDMIPE) • ONGC – Institute of Drilling Technology (IDT) • ONGC – Institute of Engineering and Ocean Technology (IEOT) • ONGC – Institute of Management Development (IMD) • ONGC – Institute of Biotechnology and Geotectonics Studies (INBIGS) • ONGC – Institute of O&G Production Technology (IOGPT) • ONGC – Institute of Petroleum Safety, Health and Environment Management (IPSHEM) • ONGC – Institute of Reservoir Studies (IRS) • Bhabha Atomic Research Centre O&G Lab, Mumbai • Structural Engineering Research Centre (O&G Lab), Chennai • Central Electrochemical Research Institute (O&G Lab), Karaikudi • R&D Labs of National Oil/Gas Companies – BPCL, HPCL, CPCL, GAIL
China	• China National Petroleum Corporation (CNPC) R&D Centre • China National Offshore Oil Corporation (CNOOC) R&D Centre • Sinopec R&D Centre • China University of Petroleum • Chengdu University of Technology (CDUT)

Based on the analysis of the data presented in this section, the four BRIC nations have been plotted on a four point scale for variable '*R&D and testing facilities for O&G engineering*' and the results are displayed in the Table 5.9.

Table 5.9: Comparison of '*Research & Development (R&D) and testing facilities for O&G engineering*' variable for O&G ESO industry in BRIC nations

	HF	F	MF	UF
Brazil				X
Russia	X			
India	X			
China		X		

(Legend: HF = Highly Favourable, F = Favourable, MF = Moderately Favourable and UF = Unfavourable)

5.7 INTELLECTUAL PROPERTY RIGHTS (IPR) / DATA SECURITY

The protection of Intellectual Property Rights (IPR) together with secure data exchange has become one of the most contentious issues in global commerce. Maintaining high levels of IP security was identified as a critical component when high-value and complex engineering design and conceptual work are outsourced in the O&G industry.

Disputes related to IPR dominate not only trade among nations, but businesses within nations. The emerging trends of technology globalization together with the phenomenon of rapid development of emerging economies have jointly elevated the importance of IPR protection, both politically and commercially. End users and principals in the O&G ESO industry consider effective enforcement of IPR protection as an important factor to be evaluated to determine the attractiveness of a country location. IPR infringement causes significant financial losses for rightsholders and legitimate businesses around the world. In its most pernicious forms, it can also endanger the public. This section summarizes the most salient IPR issues related to the BRIC nations and proposed reforms taken by individual countries to evaluate the attractiveness of BRIC nations as service providers for the O&G ESO industry on the variable '*Intellectual Property Rights/Data Security*'. A comparison is made on the status-quo of IPR enforcement in the BRIC nations as also on the individual country administration's resolve to encourage and maintain effective IPR protection. Data points from the 'Special 301 report' (2009 edition) are extensively used for this comparative study. The Special 301 report is an annual review of the global state of IPR protection and enforcement, conducted by the Office of the United States Trade Representative (USTR) pursuant to Section 182 of the Trade Act of 1974, as amended by the Omnibus Trade and Competitiveness Act of 1988 and the Uruguay Round Agreements Act (enacted in 1994).

IPR/Data Security in Brazil

Among the BRIC countries Brazil is rated as a relatively 'low risk' area with the Brazilian government committed to anti-piracy and anti-counterfeiting policies by conducting public awareness and education campaigns. Enforcement actions, including investigations into IPR violations, raids, and seizures of pirated and counterfeit products are stringer when compared to other BRIC partners. Successive governments have continued to strengthen Brazil's IPR enforcement legislation and have taken more vigorous action to address book and Internet piracy and accede to and implement the WIPO (World Intellectual Property Organization) Internet Treaties. Concerns do remain regarding patent protection, however mechanisms (e.g. U.S - Brazil Bilateral Consultative Mechanism) are being evolved to mitigate the IP risk of doing business in Brazil.

IPR/Data Security in Russia

Russia remains on the Priority Watch List of the Special 301 report of 2009. While Russia is making some progress in improving IPR protection and enacting necessary legislation, concerns remain, particularly with respect to Russia's slow implementation of some of its commitments in the November 2006 bilateral agreement with the US on IPR (IPR Bilateral Agreement). The U.S. copyright industries estimate a loss in excess of $2.7 billion in 2008 due to copyright infringement, especially through online piracy, which has become an acute problem. The Russian Government has setup a Computer Crimes Unit of the Ministry of the Interior Department to combat copyright infringement that occurs on the Internet by providing investigation and prosecution guidelines for these crimes. In the IPR

Bilateral Agreement, Russia committed to fight optical disc and Internet piracy and protect against unfair commercial use of undisclosed test or other data generated to obtain marketing approval for pharmaceutical products, deter piracy and counterfeiting through criminal penalties, strengthen border enforcement, and bring its laws into compliance with WTO and international IPR norms. Russia's implementation of these IPR commitments will be essential to completing the final WTO accession process. While Russia has made some progress in implementation, additional work remains for Russia to fully implement its commitments under the IPR Bilateral Agreement. On the positive side, Russia recently acceded to the WIPO Internet Treaties, and has made progress combating software piracy. Amendments to the Civil Code and Customs Code are being introduced and under active consideration. Certain Business to Business (B2B) and Business to Consumer (B2C) internet sites and physical markets in Russia are named in the 'Notorious' section of the Special 301 report of 2009.

IPR/Data Security in India

India remains on the Priority Watch List of the Special 301 report of 2009. India has made progress on improving its IPR infrastructure, including through the modernization of its IP offices and the introduction of an e-filing system for trademark and patent applications. Further, the IP offices have started the process of digitization of intellectual property files. In addition, the Indian ministerial committee on IPR enforcement has supported the creation of specialized IPR police units. Customs enforcement has also improved through the implementation of the 2007 IPR (Imported Goods) Enforcement Rules as well as by seizures of unlicensed copyrighted goods intended for export. Developed nations including the United States are continuously engaged with India to improve its IPR regime by providing stronger protection for copyrights and patents. India is yet to enact legislation to strengthen its copyright laws and implement the provisions of the WIPO Internet Treaties. Piracy and counterfeiting continue to remain a serious problem in India. India's criminal IPR enforcement regime remains weak. Police action against those engaged in manufacturing, distributing, or selling pirated and counterfeit goods, and expeditious judicial dispositions for IPR infringement and imposition of deterrent-level sentences, is needed.

IPR/Data Security in China

China remains on the Priority Watch List of the Special 301 report (2009) and will remain subject to Section 306 monitoring. China's enforcement of IPR and compliance with its TRIPS (Trade Related Aspects of Intellectual Property Rights) Agreement obligations remain top priorities for developed nations. Developed nations are also looking forward to see China implement the WTO Dispute Settlement Body's recommendation of measures related to the Protection and Enforcement of IPR dispute. While the Chinese Government continues to provide increased attention to the IPR environment, the general perception of developed nations is that the shared goal of significantly reducing IPR infringement throughout China has not yet been achieved. China's IPR enforcement regime remains largely ineffective and non-deterrent. In recent times Chinese officials, apparently hard pressed by the financial crisis and the need to maintain jobs, are urging more lenient enforcement of IPR laws. Most developed nations believe that, consistent with the rule of law, IPR enforcement actions should be initiated, cases should be decided, and remedies should be granted based on the merits of the case and in accordance with the law. Moreover, a strengthened approach to IPR protection and enforcement in China would contribute to a more robust and innovative economy in the longer term. Of particular concern is the rise of Internet piracy in China, especially given its emergence as a leading nation in terms of the number of Internet, broadband and mobile device users. Strong action to curb trademark counterfeiting and copyright piracy on the Internet is critical to the future of IPR protection in China. China should significantly increase criminal prosecutions and other enforcement actions against Internet-based piracy and counterfeiting operations through a coordinated, national effort backed by appropriate resources. Retail and wholesale trademark counterfeiting in China continues to be a major source of frustration for international brand owners. In spite of significant attention and resources from brand owners, administrative supervision, civil lawsuits, agreements with landlords, and attention from China's central Government and foreign governments, counterfeiting remains pervasive in many retail and wholesale markets. It appears that additional measures, including criminal sanctions, will be necessary to bring this problem under control. Overall piracy and counterfeiting levels in China remained unacceptably high in 2008. While Internet piracy continues to grow, trade in illegal optical discs also continues to thrive, supplied by both licensed and unlicensed factories and by smugglers. Piracy of books and journals and end-user piracy of business software also remain key concerns. Inadequate IPR enforcement is a key factor contributing to these shortcomings, and there are a number of legal obstacles to effective enforcement that result in limited deterrence provided by Chinese law. These impediments include high value and volume thresholds that must be met before criminal prosecution of IPR infringement is possible as well as difficulties in initiating or transferring cases to the criminal authorities that do meet China's thresholds for criminal prosecution. Rules designed to promote the transfer of cases to criminal authorities do not appear to have solved the problem. Moreover, the vast majority of enforcement is channelled to administrative authorities. Most rightsholders continue to point out that administrative fines are too low and irregularly awarded to provide an effective deterrent, and as a result infringers continue to consider administrative seizures and fines as a cost of doing business. Civil damages for infringement are also low. IPR enforcement at the local level is hampered by poor coordination among Chinese Government ministries and agencies, local protectionism and corruption, high thresholds for initiating investigations and prosecuting criminal cases, lack of training, and inadequate and non-transparent processes. Most developed nations are continuing to review the policies and enforcement situation in China at the sub-national levels of Government. The Chinese Government is currently considering legal. The Standards Administration of China is expected to issue revised draft regulations regarding the treatment of patents and other IPR in national standards. Earlier draft regulations, issued in 2005, prohibited the incorporation of patents in mandatory national standards. U.S. stakeholders continue to have concerns about these issues, due in part to recent Chinese Government officials' public comments suggesting that patent holders might be required to share their patented technologies on a royalty-free basis or meet other mandatory requirements such as participation in patent pools, in order to participate in the standards development process. China enacted the Third Amendment to its Patent Law in 2008. These changes will go into effect on October 1, 2009. While many areas of the Patent Law were clarified and improved, rightsholders have raised a number of concerns about the new law. Also, there are concerns regarding the inadequacy of a two year statute of limitation for filing a patent infringement case and about the scope and role of compulsory licensing under the new law. Certain B2B and B2C internet sites and physical markets in China are named in the 'Notorious' section of the Special 301 report of 2009. Developed nations like the United States are continuing to put serious efforts into its joint work with China on IPR enforcement and protection strategies, innovation policies, and the range of other important IPR related matters in their bilateral economic relationship, including through the Joint Commission on Commerce and Trade (JCCT) and other forum.

Based on the analysis, the four BRIC nations have been plotted on a four point scale for variable '*Intellectual Property Rights (IPR)/Data Security*' and the results are placed in Table 5.10.

Table 5.10: Comparison of '*IPR/Data Security*' variable for O&G ESO industry in BRIC nations

	HF	F	MF	UF
Brazil		X		
Russia				X
India			X	
China				X

(Legend: HF = Highly Favourable, F = Favourable, MF = Moderately Favourable and UF = Unfavourable)

5.8 ADVANCED EDUCATIONAL INSTITUTES FOR O&G ENGINEERING

Advanced education refers to a level of education that is provided at universities, vocational universities, community colleges, institutes of technology and certain other collegiate-level institutions, such as vocational schools, trade schools, and career colleges, that award academic degrees or professional certifications. As knowledge becomes more important, so does advanced or higher education. Countries need to educate more of their young people to a higher standard - a degree is now a basic qualification for many skilled jobs. The quality of knowledge generated within advanced education institutions, and its accessibility to the wider economy, is becoming increasingly critical to national competitiveness and was identified as an important element to compare location attractiveness of BRIC nations for O&G ESO. This poses a serious challenge to the developing world. In this section a general overview of higher education scenario in each member country is presented followed by a listing of the institutes/universities that offer specialized courses related to O&G engineering.

Advanced Educational Facilities for O&G Engineering in Brazil

Brazil has invested significant resources into developing its higher education system over the past three decades. As a result, a system has evolved in which some institutions have achieved recognizable excellence in teaching and research, while, more generally, the majority of institutions have struggled to provide relevant, quality education at reasonable cost. Looked at in isolation, certain parts of the system are sound and productive. Taken as a whole, the system still has a number of large challenges to overcome. About 15 per cent of the age cohort in Brazil is enrolled in higher education. Merely doubling the number of spaces offered however, will not double the rate of coverage, because a demographic bulge of young Brazilians is reaching university age. Over the past 15 years, growth in private provision of higher education was roughly equal to the moderate growth of the university-age cohort, but now large absolute increases in enrolments would be needed to maintain the current rate of coverage. In addition, graduation rates from secondary schools are rising sharply and more older, working Brazilians are seeking tertiary degrees. In short, a larger percentage of a growing number of Brazilians are demanding higher education, and the system cannot keep pace with this demand under existing conditions. The Government of Brazil has adopted a three-pronged strategy for improving higher education: (i) to change the legal framework for the sector; (ii) to change to a performance-based funding system that supports stated policy goals of improved access, quality, and efficiency; and (iii) to improve capacity for evaluating quality of instruction and performance of institutions. To date, substantial progress has been made in points (i) and (iii), and planning for (ii) is underway.

Table 5.11 is the list of institutes/universities in Brazil offering specialized courses related to O&G domain.

Table 5.11: List of major Universities/Institutes in Brazil offering specialized courses in O&G Engineering

University	Year of establishment of University/Institute	Courses offered
Centre for Petroleum Studies (CEPETRO)	1987	• Bachelor/Master degree in Petroleum Engineering • Ph.D. in Petroleum Engineering
Centro Universitário Monte Serrat - Unimonte in Santos (SP)	1973	• Master's degree in O&G engineering • Specialized courses in exploration and evaluation of O&G (upstream) • Specialized training modules in Safety, Environment and Health in the Oil Industry
The Catholic University of Petrópolis (UCP)	1953	• Specialized courses leading to Technical/ Management degrees related to O&G
The University of Sao Paulo, Sao Paulo, Brazil	1934	• Graduation in Geology • Post-Graduation in Geo-Science (Mineral Resources and Hydrogeology) • Undergraduate Course in Petro-Chemistry. • Co-operative Course in Petro-Chemistry • Graduate Degree in Chemical Engineering
Universidade Gama Filho, Brazil	1939	• Undergraduate Course in Petroleum Engineering. • Undergraduate Technology course in O&G Engineering. • Graduate Course in Petroleum Engineering and Offshore Systems

Source: Websites of Ministry of Education, Brazil and secondary data sources

Advanced Educational Facilities for O&G Engineering in Russia

Russian education is generally considered to be one of the most fundamental and profound in the world. It is associated with quality-prestige-recognition-affordability. The graduates of Russian universities obtain degrees recognized by the employers of all countries. Through August 1996, there were two federal bodies that exercised management and administration over the educational system in the country: the Ministry of Education of the Russian Federation and the State Committee of the Russian Federation for Higher Education. The Ministry of Education was in charge of the elaboration and implementation of state policy in the field of pre-school, general, and vocational education as well as of complementary education at the corresponding levels. The State Committee for Higher Education was responsible for the elaboration and implementation of state policy in the field of post-secondary education: non-university and university level higher education, doctoral studies, as well as of complementary education at the corresponding levels.

State higher education in the Russian Federation comprises 552 higher education institutions, not including military institutions. Some 2.6 million students had enrolled in higher education institutions in 1996 (coming from the Russian Federation and 150 countries world-wide) with a teaching staff of over 220,000 full-time professors, associate professors and lecturers at university-level institutions. The government of the Russian Federation has stipulated three levels of study:

- Level I generally lasts 2 years to study for a Bachelor's or specialist's intermediate diploma. This level concentrates on compulsory fundamental courses in the given disciplines. Students holding a Level I qualification may either continue their studies or, if they choose not to, leave the institution with an intermediate diploma.
- Level II marks the continuation of studies for additional two years leading to a Bachelor's degree. Consequently, this first academic degree entails four years of study.
- Level III represents an educational level common to both the Master Diploma and the Specialist Diploma

Table 5.12 is the list of institutes/universities in Russia offering specialized courses related to O&G domain.

Table 5.12: List of major Universities/Institutes in Russia offering specialized courses in O&G engineering

University	Year of establishment of University/Institute	Courses offered
Gubkin Russian State University of O&G, Moscow, Russia	1930	• Bachelor/Master of Science (O&G specialisation) • Diploma Specialist • Master's courses in Geology of O&G, Prospecting and Exploration • Specialised courses - Borehole Drilling for O&G, Development of O&G Fields, Transportation of O&G, Refining or Marketing in O&G Industry, Economics of O&G Industry. Automation in O&G Industry, Manufacture of Machinery for O&G Industry, Ecology in O&G Industry • Legal Services in O&G business
Tyumen State O&G University, St., Tyumen, Russia	1956	Master's programme in the following areas: • Reservoirs Opening-Up Technology, Horizontal Wells Drilling, Shelf Drilling, Drilling Fluids Technology, Modelling of Oilfields Development, Oilfields Development, Wells Operation under complicated Conditions, Development of the Shelf Gas and Gas-Condensate Fields, Physics of the Reservoir Fluids, Hydromechanics of Oil-Gas-Condensate Fields, Operation of Gas and Gas-condensate Wells, Fields Development with the Horizontal wells, Geological-Physical Problems of O&G Fields Development, Pipeline Transport of Hydrocarbons, Resource and Power Saving Technologies of Hydrocarbons Transport and Storage, Reliability of O&G Pipelines and Storages, Technologies Modelling of the O&G Pipelines and Storages Construction and Repair, Technical Diagnosis of Petroleum Transport System Doctoral programmes in the following areas: • Doctorate in Geology and Combustibles Exploration, Construction and Operation of Oil- and Gas Pipelines, Bases and Storages, Geo-Ecology, Liquid, Gas and Plasma mechanics, Petro-Chemistry, Chemical Technology of Fuels and High-Energy Substances, Development and Operation of O&G Fields
Institute of O&G, Russia, Primorsky Krai	2002	Bachelor's Degree programmes in the following areas: • Design, Construction and Operation of Oil Pipelines, Chemical Technology of Natural Energy and Carbon Materials Bachelor/Master/Doctoral Degree programmes in the following areas: • Geology and Geo-Chemistry of O&G

University	Year of establishment of University/Institute	Courses offered
Tomsk Polytechnic University, Tomsk, Russia	1896	Bachelor's degree programmes in the following areas: • Science in Gas-and-Oil Technology Master's degree programmes in the following areas: • Preservation and Conservation of Geological Environment, Exploration Geophysics Techniques, Ground Water Resources Accumulation, Geology and Engineering Surveying, Geology and Prospecting of Mineral Deposits, Geo-Ecology of Columbines, Hydraulics and Engineering Hydrology, Reservoir Engineering Simulation, Technology of Drilling-in O&G Layers, Safety of O&G Pipelines and Storages Specialist programmes in the following areas: • Underground Water Exploration and Geology Surveying, Geophysical Techniques of Wells Investigation, Geophysical Methods of Mineral Deposit Prospecting, Exploration Techniques of Mineral Deposits, O&G Geology • Specialist programs in Geo-Ecology, Water Resources Multiple Use and Protection, Development and Exploitation of O&G Deposits, O&G Drilling, Design, Building and Exploitation of Gas and Oil Pipelines and Oil Storages, Exploration and Prospecting of Underground Water and Geological Engineering Survey, Geological Surveying, Exploration of Mineral Deposits Doctoral programmes in the following area: • Fire and Industrial Safety (in fields)
Komsomolsk-on-Amur State Technical University, Russia	1956	• Bachelor of Engineering and Technology
Kuban State Technological University, Russia	1918	Specialities Graduate programmes in the following areas : • Petro-Chemistry, Chemistry and Technology of Fuels and Specialty Products Specialities Doctorate programmes in the following areas : • Petro-Chemistry, Technology of Drilling and Well Development, Development and Exploitation of O&G Fields
Omsk State Technical University, Russia	1942	Specialisation courses in the following areas : • Vacuum and Compressor Engineering and Machines, Chemical Technology of Organic Substances, Machines and Equipment for Chemical Manufacturing, Environment Protection and Natural Resources Conservation, Chemical Technology and Biotechnology, Design, Building and Operation of Gas Oil pipe line and Gas Oil Storage, Hydraulic Machines, Hydraulic Circuit and Hydraulic Pneumatic Automation, Standardization and Certification for O&G, O&G Technological Processes and Manufacturing Security, Emergency Cases Security, Fire & Safety, Environment Engineering Security in O&G

University	Year of establishment of University/Institute	Courses offered
Perm State Technical University, Russia	1953	Undergraduate/Post-graduate courses in the following areas: • O&G business, Metallurgy Specialisation degree programmes in the following areas : • Geology of O&G, Physical Processes of Mining or O&G Production, Design, Construction and Operation of Oil Pipelines, Development and Exploitation of O&G Fields, Drilling O&G Wells, Machines and Equipment of O&G Fields, Metallurgy and Heat Treatment of Metals
Saratov State University, Russia	2009	Undergraduate programmes in the following areas : • Geology of O&G Doctoral programmes in the following areas : • Geo-Physics, Geo-physical Methods of Minerals Exploration, Geology, Search and Exploration of Combustible Minerals, Geo-Ecology
North Caucasus State Technical University, Russia	1971	Bachelor's degree programmes in the following areas : • Chemistry of O&G, Physical-Chemistry of Oil Disperse Systems, Bases Heterogeneous Catalysis and Manufacture of catalysts, Bases of Scientific Researches and Designing, Chemical Technology of Fuel and Carbon Materials, Technology of Petrochemical Synthesis, Technology of Processing of Natural Gas, Lubricating Oils and Paraffin Production, Technology of Thermo-catalytic Processes of Oil Refining, Storage and Transportation of Gas, Oil and Mineral Oil, Alternative Motor Fuel, Development of the Basic Systems and General Plans of Oil Refineries, Petroleum Products Evaluation and Marketing Master's degree programmes in the following areas : • Ecology, Chemistry and chemical Technology of Petroleum Fuels and Special Products
Ufa State Petroleum Technological University, Russia	1940	Bachelor/Master of Engineering and Technology in the following areas : • O&G Engineering, Design, Construction and Operation of Gas and Oil Pipelines and Storage Facilities, Operation of O&G Pipelines and Storages, Operation of O&G Pumping Units of Pipelines and Storages, Construction and Maintenance of O&G Pipelines and Storages, Geology and Mineral Deposits Exploration, Geophysical Methods for Well Logging, Technology of Geological Survey, Applied Geology, Geology of O&G, Development and Exploitation of O&G Fields, Development and Exploitation of Gas and Gas Condensate Fields, Methods for Enhanced Reservoir Recovery and Well Work over, Development and Exploitation of Offshore and Shelf Deposits, Drilling of O&G Wells

University	Year of establishment of University/Institute	Courses offered
Yakutsk State University, Belinsky, Russia	1956	Speciality programmes in the following areas : • Ore Geophysics, Geophysical Methods of Prospecting and Exploration, O&G Exploration Geophysics, Technology of Drilling Exploratory Wells, Technology and Exploration Techniques, Drilling for O&G, Geological Survey, Prospecting and Exploration, Hydrogeology and Engineering Geology, Prospecting and Exploration of Groundwater and Geological Engineering
Yugorsk State University,Lyantor, Khanty-Mansiysk Autonomous, Russia	2002	Speciality/Bachelor/Master/Doctoral programmes in the following areas : • Natural Resource Management, O&G Geology, Geophysical Prospecting Methods, Geology & Mineral Exploration, Natural Resource Management, Ecology & Natural Resource Management

Source: Websites of Ministry of Education, Russia and secondary data sources

Advanced Educational Facilities for O&G Engineering in India

Higher Education in India is one of the most developed amongst the BRIC counterparts. There has in fact been considerable improvement in the higher education scenario of India in both quantitative and qualitative terms. In technical education, the IITs, and in management, the IIMs have already marked their names among the top higher educational institutes of the world. India is today one of the fastest developing countries of the world with the annual growth rate going above 7-8% for the last 5 years. In order to sustain that rate of growth, there is a need to increase the number of institutes and also the quality of higher education in India. Therefore, the Central Government has announced the establishment of 8 IITs, seven IIMs and five Indian Institutes of Science, Education and Research (IISERs) and thirty Central Universities. The outlay for education during the 11th Five Year Plan, which runs from the 2007-08 to 2012-13, represents a four-fold increase over the previous plan and stands at 2500 Billion INR.

As on 31.03.2009, there were 471 universities, 268 State universities, 40 Central Universities, 125 Deemed Universities, five institutions established under various State Legislations and 33 Institutes of National importance established by Central

Legislation. In addition, there are 22,0644 colleges including around 2,260 colleges for women. At the beginning of year 2008-2009, the total number of students enrolled in the forma system in universities and colleges are 12.3 Million. The technical education system in the country can be broadly classified into three categories viz. Central Government funded Institutions, state Government / state funded institutions & self financed institutions. In 2008-2009 there were 63 centrally funded institutes of technical and science education in the country. The details of the 63 institutes are in Table 5.13.

Table 5.13: List of Centrally funded institutes in India for Science & Technology

Centrally Funded Institutions	Number of Institutions
Indian Institutes of Technology (IITs)	13
Indian Institutes of Management (IIMs)	7
Indian Institute of Science (IISc.)	1
Indian Institutes of Science Education & Research (IISERs)	5
National Institutes of Technology (NITs)	20
Indian Institutes of Information Technology (IIITs)	4
National Institutes of Technical Teachers Training & Research (NITTTRs)	4
Others Schools of Planning & Architecture (SPAs)-3, Indian School of Mines University (ISMU), North-East Regional Institute of Science & Technology (NERIST), National Institute of Industrial Engineering (NITIE), National Institute of Foundry & Forge Technology (NIFFT), Sant Longowal Institute of Engineering & Technology (SLIET), Central Institute of Technology (CIT).	9
Total	63

Source: Ministry of Education - India Annual Report 2008-2009

The All India Council of Technical Education (AICTE) grants approval for starting new technical institutions and for introduction of new courses. Table 5.14 lists the number of AICTE approved technical educational institutions and their annual intake (as of 31st August 2008):

Table 5.14: Number of AICTE approved technical education institutions and their annual intake (as on 31st August 2008)

S.No.	Programme	Degree		Diploma	
		NOI*	Intake	NOI*	Intake
1.	Engineering & Technology	2388	841018	1659	471006
2.	Architecture	106	4133	--	--
3.	MCA	1137	81761	--	--
4.	Pharmacy	1001	62307	575	32181
5.	Applied Arts & Crafts	10	840	4	480
6.	MBA	1231	114641	--	--
7.	PGDM	285	36418	--	--
8.	Hotel Management	86	5847	86	4490
	Total	6244	1146965	2324	508157
	Grand Total	Institutions			8568
		Intake			1655122

*NOI - Number of Institutions

Source: Ministry of Education - India Annual Report 2008-2009

Table 5.15 is the list of institutes/universities in India offering specialized courses related to O&G domain.

Table 5.15: List of major Universities/Institutes in India offering specialized courses in O&G engineering

University	Year of establishment of University/Institute	Courses offered
Anna University, Chennai, India	1978	• B.Tech. Petroleum Refining and Petrochemicals Engineering • B.E. Mining Engineering • M.Tech (Petroleum Refining and Petrochemicals) • M.E. Energy Engineering
Nowrosjee Wadia College, Pune, India	1932	• M.Sc. (Applied) Petroleum Technology
University of Petroleum & Energy Studies (UPES), Dehradun, Uttarkhand, India	2003	• B.Tech. Applied Petroleum Engineering with specialization in Upstream, Applied Petroleum Engineering with Specialization in Gas, Chemical Engineering with Specialization in Refining & Petrochemicals, Geo-Informatics Engineering, Geo Sciences Engineering. • BBA (O&G Marketing) • M.Tech. (Petroleum Exploration), M.Tech. (Health, Safety & Environmental Engineering), M.Tech. (Pipeline Engineering), M.Tech. (Process Design Engineering) • MBA (O&G Management), MBA (Energy Trading). • Executive MBA (O&G) - Part time • Doctoral programmes in O&G Engineering/ Management

University	Year of establishment of University/Institute	Courses offered
Pandit Deendayal Petroleum University, Gandhinagar, Gujarat, India	2007	• B.Tech program with special focus on O&G Sector. • Executive MBA program with a focus on O&G Sector. • PhD Program with a focus on O&G Sector. • B.Tech Program in Petroleum Technology. • M.Tech Program in Petroleum Technology. • PhD Program with special focus on O&G Sector
Rajiv Gandhi Institute of Petroleum Technology, Rai Bareli, Uttar Pradesh	2008	• B.Tech program in Petroleum Refining engineering • B.Tech program in Petroleum Reservoir and Production Engineering • MBA (Petroleum & Energy Management)
Maharashtra Institute of Technology (MIT), Pune, India	1983	• BE (Petroleum Engineering. • M.E. (Petroleum Engineering) • PhD in Geology, Petroleum Engineering
Indian School of Mines, Dhanbad, Jharkhand, India	1957	• B.Tech in Petroleum Engineering • M.Tech in Petroleum Engineering • 5 years Dual Degrees (B.Tech + M.Tech. Petroleum Management) • PhD in Petroleum Engineering
Visvesvaraya National Institute of Technology, Nagpur, India	1960	• B Tech program in Metallurgical & Materials Engineering, Mining Engineering. • M Tech program in Process Metallurgy, Material Engineering. • PhD in Metallurgical and Material. Engineering. Mining
Dibrugarh University, Assam, India	1969	• Master of Technology Degree in Petroleum E&P
National Institute of Technology, Durgapur, India	1960	• Bachelor of Engineering (BE) in Metallurgical Engineering • M. Tech. in Mechanical Shaping of Metals.
Indian Institutes of Technology (IIT) at Kharagpur, Chennai, Mumbai India	1952	• M.Sc. - Exploration Geophysics, Applied Geology, Geophysics, Geological Sciences • M.Sc.- Ph.D. Dual Degree. in Geophysics, Geological Sciences, • M.Tech. - Earth & Environmental Sciences, Computational Seismology, Mining Engg, Metallurgical & Materials Engg. • B.Tech.- Mining Engg., Metallurgical and Materials Engg. • Dual Degree - Mining Engg. / Safety Engineering and Disaster Management • Dual Degree - Mining Engg. / MBA • Dual Degree - Metallurgical & Materials Engg. / MBA

Source: Websites of Ministry of Education, AICT, UGC (India) and secondary data sources

Advanced Educational Facilities for O&G Engineering in China

Higher education in China has maintained a steady growth. In 2008, institutions of higher education nationwide numbered 2,663, including 2,263 regular higher education institutions, 355 more than the previous year, and 400 institutions of higher adult education, 13 fewer than the previous year. Among regular institutions of higher education, 1,079 were four-year undergraduate institutions, and 1,184 were polytechnic colleges. There were altogether 796 master's-degree-granting institutions in China, including 479 colleges and universities and 317 research institutes. The enrolments for institutions of higher education and the number of students attending school continued to increase. The total number of students in all kinds of higher education institutions reached 29,070,000 in 2008 and the gross enrolment rate for higher education reached 23.3%. The enrolments for postgraduates nationwide reached 446,400, a 6.64% increase of 27,800 compared to the previous year, among which 59,800 were doctoral candidates and 386,700 were candidates for master's degrees. The number of postgraduates attending school was 1,283,000, a 7.36% increase of 88,000. Among these, 236,600 were doctoral candidates and 1,046,400 master's candidates. The total number of graduates reached 344,800, an increase of 33,000, 10.58% compared with last year. Among them were 43,700 doctors and 301,100 masters. The total number of students enrolled for regular institutions of higher education reached 6,076,600, an increase of 417,400 over that of last year. The number of students at school reached 20,210,200, an increase of 1,361,200, 7.22% higher than last year. The number of graduates reached 5,119,500, increasing by 641,600, 14.33% more compared to last year. The number of students enrolled in institutions of adult higher education was 2,025,600, and the number of students attending school and graduates reached 5,482,900 and 1,690,900 respectively. 9,888,200 people applied to sit for the self-taught higher education examinations, and 551,900 graduated with diplomas. The average number of full-time undergraduates at regular institutions of higher education and students at secondary vocational schools or polytechnic colleges was 8,679 in 2008. There were 2,051,000 faculty and staff members at regular institutions of higher education, an increase of 76,500 compared with previous year; among them, the number of full-time teachers reached 1,237,500, an increase of 69,200 over the previous year. The student-teacher ratio was 17.23:1. There were 89,900 faculty and staff members at institutions of higher education for adults, which was a decrease of 46,400 compared with last year; among them, the number of full-time teachers decreased by 27,000 to 53,200.

Table 5.16 is the list of institutes/universities in China offering specialized courses related to O&G domain.

Table 5.16: List of major Universities/Institutes in China offering specialized courses in O&G engineering

University	Year of establishment of University/Institute	Courses offered
China University of Petroleum, Beijing, China	1953	• Bachelor's Degree in Petroleum Engineering, O&G Storage and Transportation Engineering • Master's Programs in Fluid Mechanics, Geotechnical Engineering, O&G Drilling Engineering, O&G Development Engineering, O&G Storage and Transportation Engineering, Design and Manufacture of Ships and Marine Structures • PhD Programs in O&G Drilling Engineering, O&G Development Engineering, O&G Storage and Transportation Engineering, Petroleum Engineering Management • M.Sc. in Mineralogy, Petrology and Mineral Deposit Geology
Guangzhou Institute of Geochemistry under Chinese Academy of Sciences, Guangzhou City, China	1993	• PhD in Geochemistry, Mineralogy, Petrology, Structural Geology • M.Sc. in Geochemistry, Mineralogy, Petrology
The University of Science and Technology, Beijing, P. R.China	1952	• Undergraduate in Metallurgical Engineering, Ecology, Mining Engineering • Graduate in Mineral Processing Engineering, Mineralogy, Petrology, Mineral Deposit Geology • Graduate in Mining Geological Engineering, Geotechnical Engineering
Chengdu University of Technology, Sichuan Chengdu, PRC	1956	• PhD in Geochemistry, Geotechnical Engineering, Mineralogy, Petrology, Mineral Deposits, Oil-Gas Field Development Engineering • Master Degree Programs in Geochemistry, Mineral Resources Prospecting and Exploration, Mineralogy, Petrology, Mineral Deposits, Oil-Gas Field Development Engineering • Bachelor Degree Programs in Geochemistry, Natural Resources Prospecting Engineering, Petroleum Engineering
Liaoning Shihua University, China	1950	• Bachelor Degree Programs in Petrochemical Technology
Ocean University of China	1924	• Doctoral Program in Marine Geochemistry • Masters Program in Marine Geology, Geo-chemistry, Mineralogy-Petrography-Ore Deposits, Geo-Exploration & Information Technology, Mining Exploration & Engineering

Source: Websites of Ministry of Education, China and secondary data sources

Based on the analysis of the data presented in this section, the four BRIC nations have been plotted on a four point scale for variable '*Advanced Educational Institutes for O&G Engineering*' and the results are displayed in the Table 5.17.

Table 5.17: Comparison of '*Advanced Educational Institutes for O&G engineering*' variable for O&G ESO industry in BRIC nations

	HF	F	MF	UF
Brazil			X	
Russia	X			
India		X		
China		X		

(Legend: HF = Highly Favourable, F = Favourable, MF = Moderately Favourable and UF = Unfavourable)

5.9 PRESENCE OF ESTABLISHED O&G ES COMPANIES

An already mature O&G ES industry and the established presence of small, medium and large sized O&G ESO players (both for domestic market as also the International market for 'offshoring' services) figured as a key factor to determine location attractiveness. Success stories and breadth of services rendered by existing O&G ESO players in BRIC nations provides insights into their approach and strategy to market, and becomes an incentive for new players to invest in new units or expand existing units. The perspectives from the experience of existing players will enable new players to develop an entry strategy for BRIC Nations. Data from McGraw-Hill Construction ENR reports (2008) supplemented by primary/secondary data collection have been used to compare the BRIC nations for comparing location attractiveness for the variable '*Presence of established O&G ESO Companies*'.

Listed in Table 5.18 is a list of 'Top 10' International Design firms (listed in McGraw-Hill Construction Engineering News Record 2008 report) and details of the services they render from their Captive or Joint Venture O&G ESO centres in BRIC nations. These 10 Companies had combined revenue of 16.54 BUSD in 2007 only from O&G engineering services. This represents 16% of the total design spend of 100 BUSD in the same year. 8 out of the 'Top 10' companies had offices in Russia and India and 5 of these had offices in China and 3 had offices in Brazil.

Table 5.18: Details of O&G ESO Centres of 'Top 10' International Design Firms

Company Name	Details of Services rendered from O&G ESO Centre in each country			
	Brazil	Russia	India	China
Fluor Corporation Inc. (USA; 41,000 employees; 3.36254 BUSD; 94%)	No O&G ESO centre in Brazil	• Engineering (Basic and Detailed) • O&M services • Project Management	• Engineering (Basic and Detailed) • Procurement/Construction Management • O&M services • Project Management	• Engineering (Basic and Detailed) • Procurement/Construction Management • O&M services • Project Management
Worley Parsons Ltd. (Australia NA; 2.936986 BUSD; 88%)	• Basic design and FEED • Project Integration • Commissioning and Start-up.	• Feasibility studies • Site selection, technology selection • Environmental impact assessments, cost estimation, scheduling, and financial structuring. • Contracting strategy development • Project risk assessment	• Feasibility studies • Bid specification preparation and assessment of EPC offers • Engineering (Basic and Detailed) • Site selection, technology analyses and selection • Consulting engineering services for FPSO • Deep water production and drilling platforms	• Design and Consultancy • Engineering (Basic and Detailed) • Consulting engineering services for FPSO
Jacobs Engineering Group Inc. (USA; 55,000 employees; 4.361364 BUSD; 53%)	No O&G ESO centre in Brazil	No O&G ESO centre in Russia	• Engineering (Basic & Detailed) • Construction • Maintenance, and construction management services for the upstream O&G sector • Consulting services, process assessments, feasibility studies, technology evaluations.	• Engineering (Basic & Detailed) • Construction • Maintenance, and construction management services for the upstream O&G sector • Consulting services, process assessments, feasibility studies, technology evaluations.
Bechtel Corporation (USA; 44,000 employees; 2.22 BUSD; 93%)	• Project Management • Procurement • Engineering (Basic & Detailed) • Construction	• Project Management • Procurement • Engineering (Basic & Detailed) • Construction	• Project Management • Procurement • Engineering (Basic & Detailed) • Construction	• Project Management • Procurement • Engineering (Basic & Detailed) • Construction

Company Name	Details of Services rendered from O&G ESO Centre in each country			
	Brazil	Russia	India	China
Fugro NV (Netherlands; 13,750 employees; 2.473118 BUSD; 72%)	• Basic and Advanced Soil Laboratory Testing • Foundation Analyses of Offshore Structures • Pipeline Engineering • Model Testing	• Desk Top Studies • Basic and Advanced Soil Laboratory Testing • Foundation Analyses of Offshore Structures • Pipeline Engineering • Model Testing • Specialized Computer Programs	• Desk Top Studies • Basic and Advanced soil Laboratory Testing • Positioning Services • Marine Survey Services • Construction Support • Offshore Survey Data Centre • Oceanography & Meteorology	• Basic and Advanced Soil Laboratory Testing • Foundation Analyses of Offshore Structures • Pipeline Engineering • Model Testing
Kellogg Brown & Root Pvt. Ltd. (USA; 50,000 employees; 1.51087 BUSD; 92%)	No O&G ESO centre in Brazil	• Drilling • Fluid Services • Pipeline & Process Services • Project Management Services • Reservoir Testing/Analysis • Software and Simulation Services • Well Completion services	• Digital Asset services • Program and Project management • Hazard and risk assessment	No O&G ESO centre in China
Foster Wheeler AG (Switzerland; NA; 1.42 BUSD; 82%)	No O&G ESO centre in Brazil	• Field development concepts • Feasibility studies • Pre-FEED • FEED • Project Management • Engineering (Detailed & Basic) • Procurement • Installation management • Construction management • Commissioning	• Market research and strategic studies • Economic evaluations • Feasibility studies • Process design packages • Basic & Detailed engineering • Procurement • Construction management • Project management • Commissioning and start-up • Training	• Field development concepts • Feasibility studies • Pre-FEED • FEED • Project Management • Engineering (Detailed & Basic) • Procurement • Installation management • Construction management • Commissioning

Company Name	Details of Services rendered from O&G ESO Centre in each country			
	Brazil	**Russia**	**India**	**China**
Tecnicas Reunidas (Spain; 7,000 employees; 1.057143 BUSD; 98%)	No O&G ESO centre in Brazil	• Project Management • Health, Safety and Environmental Management • Detailed Engineering and Hazop Studies • Procurement, Inspection and Expediting of Materials and Equipment • Project Control & Planning • Construction Supervision • Commissioning • Start-Up assistance	No O&G ESO centre in India	• Basic/Detailed engineering and construction services • Feasibility and Market Studies • R&D • Management, planning and project control • Procurement, inspection • Construction, erection, Start-up and personnel training
URS Corporation (USA; 50,000 employees; 4.795714 BUSD 18%)	• Planning, Engineering (Basic & detailed) • Environmental, construction, program and construction management • Systems integration • O&M services	• Engineering and environmental management services from project inception and facility operation, through to site closure, redevelopment and divestment	No O&G ESO centre in India	• Engineering and environmental management services from project inception and facility operation, through to site closure, redevelopment and divestment
The Shaw Group Inc. (USA; 28,000 employees; 2.468919 BUSD; 95%)	No O&G ESO centre in Brazil	No O&G ESO centre in Russia	• Basic Engineering and Detail Engineering Services • Project Consulting • Procurement & Construction Management • Plant Data Management	• Basic Engineering and Detail Engineering Services • Project Consulting • Procurement & Construction Management • Plant Data Management

Note: Figures in Brackets below each company name indicate Location of Global Headquarters of the Company; Employee size; Global Revenue in BUSD; % of Global revenue from O&G ES)

Source: McGraw-Hill Construction ENR (2008), Company Annual reports and Expert Interviews

Table 5.19 lists the number of captive centres (or subsidiaries or Joint Ventures) the 'Top 225' International Contractors, the 'Top 200' International Design Firms and 'Top 500' American Design Firms specialising in O&G ES had in the BRIC nations in the year 2007.

Table 5.19: Number of Captive Centres/Subsidiary/JV offices of 'Top 225' O&G International Contractors, 'Top 200' O&G International Design Firms and 'Top 500' American O&G Design Firms

	Brazil	Russia	India	China
'Top 225' O&G International Contractors	36	47	56	57
'Top 200' O&G International Design Firms	38	43	54	64
'Top 500' American O&G Design Firms	53	48	75	105

Source: McGraw-Hill Construction ENR (2008) and Author Analysis

Even though, Russia figures prominently with 8 companies in the 'Top 10' list in Table 5.18, companies listed in Table 5.19 have very low presence in the country as compared to India and China. Likewise, China has a significant presence of O&G ES companies in the categories listed in Table 5.19 even though it has only 5 companies listed in the 'Top 10' category. India has a good mix of 'Top 10' companies and also from the categories listed in Table 5.18. Brazil had the lowest number of companies in all categories listed in this section.

Based on the analysis of data presented in this section, the four BRIC nations have been plotted on a four point scale for variable '*Presence of established O&G ESO Companies*' and the results are placed in Table 5.20.

Table 5.20: Comparison of '*Presence of established O&G ES Companies*' variable for O&G ESO industry in BRIC nations

	HF	F	MF	UF
Brazil			X	
Russia		X		
India	X			
China	X			

(Legend: HF = Highly Favourable, F = Favourable, MF = Moderately Favourable and UF = Unfavourable)

5.10 PROCESS EFFICIENCY AND QUALITY OF SERVICES PROVIDED

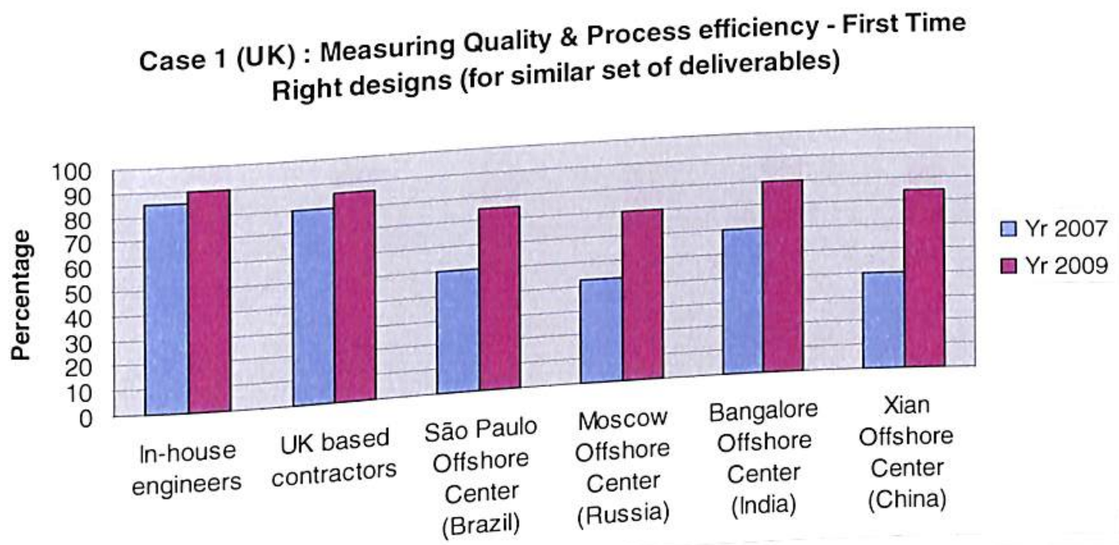
In order to measure the quality of talent and process efficiency two separate Case Studies were instituted at one of the Global O&G engineering majors that outsources work from its centres in BRIC nations. The company runs 100% owned captive engineering centres at both Bangalore and Chennai in India, São Paulo in Brazil, Moscow in Russia and both at Beijing and Xian in China. The engineering centres serve offices of the parent company in over 15 countries. The end user clients are primarily O&G upstream and downstream companies. The parent company offices in the United Kingdom and Norway outsource around 6 to 8 percent of their annual engineering manhours to these captive outsourcing locations. Both these offices adopt a strong Quality Management System in the name of TOPS (Total Optimisation of Process Systems) and continually track the 'correctness' of the work delivered by its engineering centres. Five different situations were studied by both of these offices over a period of two years so that the work carried out of the different captive centres could be compared with that done by their in-house engineering teams. The five different situations in each case were:

- Case 1A : Work done by own in-house resources in the UK
- Case 1B : Work done by local UK 'high-cost' contractors. Typical salaries for these contractor staff are in the range of GBP 40 per hour.
- Case 1C : Work done at the Captive engineering centre in São Paulo (Brazil)
- Case 1D : Work done at the Captive engineering centre in Moscow (Russia)
- Case 1E : Work done at the Captive engineering centre in Bangalore (India)
- Case 1F : Work done at the Captive engineering centre in Xian (China)

- Case 2A : Work done by own in-house resources in Oslo
- Case 2B : Work done by local Norway 'high-cost' contractors. Typical salaries for these contractor staff are in the range of NOK 650 per hour.
- Case 2C : Work done at the Captive engineering centre in São Paulo (Brazil)
- Case 2D : Work done at the Captive engineering centre in Moscow (Russia)
- Case 2E : Work done by Captive engineering centres in Bangalore (India)
- Case 2F : Work done at the Captive engineering centre in Xian (China)

Similar set of work was offshored to the captive locations for the comparative study and the key metric that was used to measure performance was the percentage of deliverables that were 'First time right'. The outcomes in 2 different years were studied - that of 2007 when the captive centres in the BRIC nations were just being setup and that in 2009 after the centres in these countries have 'matured' in processes and delivery mechanism.

Figure 5.9 shows the results in a graphical form for either of the cases. Case 1 relates to the parent company in the UK and Case 2 relates to the parent company in Norway. The arithmetical mean of the percentage band has been used to depict the data in graphical form e.g. 50-55% has been represented as 52.5% in the graphical representation.



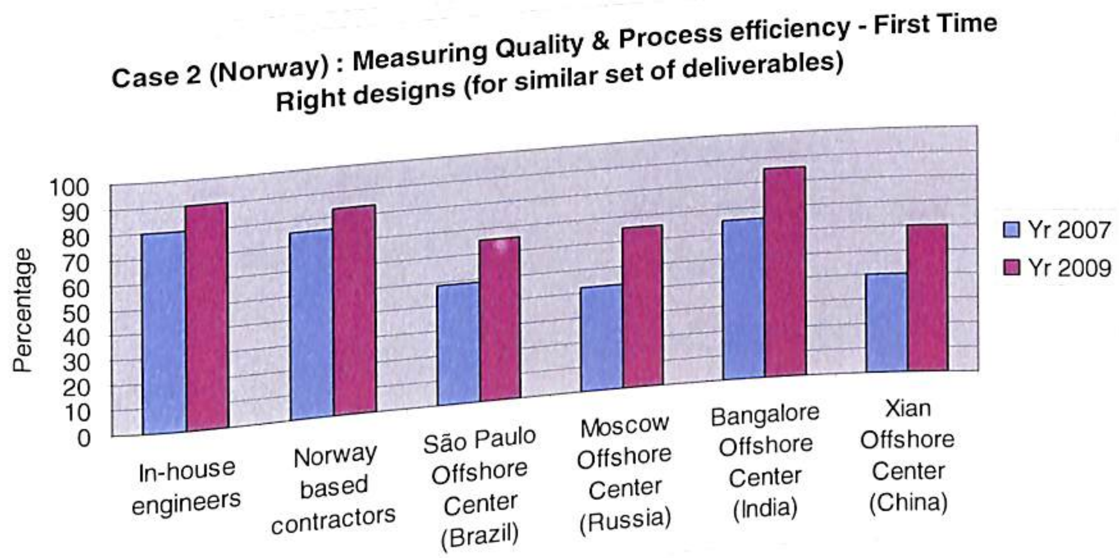


Figure 5.9: Comparative Study of Quality and Process efficiency between BRIC nations for O&G ESO

Results/findings from the Case Study on Quality and Process efficiency : While at the start, resources from all BRIC nations underperformed as against output from the parent company's in-house resources and contract resources based in UK/Norway, the resources showed better performance in the year 2009 after the outsourcing process matured. The underperformance in the beginning is being back-traced to lack of adequate processes and the absence of a strong delivery mechanism. However, the processes matured over the years and visible improvement has been seen in the survey in year 2009. Indian engineers showed more flexibility to accept errors and change the way of working and this resulted in rapid ramp-up of performance in the Year 2009. Results delivered by the India captive centre in Year 2009 were comparable with that of high-cost contractors and in case of Norway they even bettered in performance (85% versus 83% in year 2009).

Based on the analysis, the four BRIC nations have been plotted on a four point scale for variable '*Process Efficiency and Quality*' and the results are placed in Table 5.21.

Table 5.21: Comparison of '*Process Efficiency & Quality*' variable for O&G ESO industry in BRIC nations

	HF	F	MF	UF
Brazil		X		
Russia			X	
India	X			
China			X	

(Legend: HF = Highly Favourable, F = Favourable, MF = Moderately Favourable and UF = Unfavourable)

5.11 POLICY INCENTIVES FOR SERVICE INDUSTRY

Over the past two decades, governments in BRIC have been actively promoting their countries as investment locations to attract MNC companies as also domestic investors to setup units for exports of engineering/software services to help achieve the country's development goals and provide employment for their educated population. They have increasingly adopted measures to facilitate the entry of FDI. Examples of such measures include liberalizing the laws and regulations for the admission and establishment of foreign investment projects; providing guarantees for repatriation of investment and profits; and establishing mechanisms for the settlement of investment disputes. Tax incentives are also part of these promotional efforts and are defined as incentives that reduce the tax burden of enterprises in order to induce them to invest in particular projects or sectors. They are exceptions to the general tax regime and would include, for example, reduced tax rates on profits, tax holidays, accounting rules that allow accelerated depreciation and loss carry forwards for tax purposes, and reduced tariffs on imported equipment, components, and raw materials. Investment experts, particularly from investment promotion agencies, view incentives as an important policy variable in their strategies to attract FDI for economic development. This was also the agreed conclusions of the United Nations Conference on Trade and Development (UNCTAD) Expert Meeting on 'Investment Promotion and Suggested Measures to Further Development Objectives' held in 2000.

BRIC countries have put in place an array of tax incentives to promote the export of engineering/software services. They offer incentives such as income tax exemption or reduced rate of taxes, investment allowance and remission from customs duty for equipment and goods destined for use in designated and demarcated areas. Wherever special economic zones or free trade areas are present, they offer liberal exemption from profit tax, customs duty and Value Added Tax (VAT). Corporate taxes generally range between 30 and 40 per cent of taxable income in most countries. Most countries have withholding taxes for dividend, interest and royalty payment and these policies are liberalized for the engineering/software exports sector.

A comparative study of each country on the Statutory tax rate, Regional incentives, Sectoral incentives, Export incentives, Incentives in free trade zones and other incentives has been presented below to arrive at the country ratings for the variable '*Policy Incentives*'.

Policy Incentives for Service Industry in Brazil

Statutory Tax Rate

Brazil imposes a 12 per cent social contribution tax in addition to the statutory corporate income tax rate of 15 per cent,. Dividends paid are not subject to withholding tax. Withholding tax on interest and royalties is 15 per cent although interest paid to the Government or its agency is exempt from tax.

Regional Incentives

Regional incentives seek to encourage the economic and social development of certain areas of the country. Two autonomous federal agencies administer the regional incentives traditionally offered : the Superintendence for the Development of the Northeast (Superintendência do Desenvolvimento do Nordeste - SUDENE) and the Superintendence for the Development of the Amazon Region (Superintendência do Desenvolvimento da Amazônia - SUDAM). The north-eastern region, covering about 19 per cent of Brazil's territory, includes the states of Alagoas, Bahia, Ceará, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, and Sergipe, and parts of the states of Maranhão and Minas Gerais. The Amazon region, which occupies almost 60 per cent of the country, includes the northern states of Acre, Amapá, Amazonas, Pará, Rondônia, Roraima, and Tocantins; the northern portion of the state of Mato Grosso; and the western part of Maranhão. Enterprises operating in the northeastern region for which the SUDENE is responsible are eligible for the following incentives:

- A 37.5 per cent reduction in the income tax for enterprises established in the region that will be progressively reduced starting from year 2008
- A 75 per cent reduction of the income taxes effective up to December 31, 2013. This percentage was scheduled to be reduced to 50 per cent from December 2008 but is still continuing for a further 2 year period.
- Partial exemption from state and municipal taxes; and
- Exemption from duties on imported equipment.

Eligibility for these benefits depends on SUDENE's prior approval of a new project or the expansion of an already existing project. Any income derived from the project cannot be remitted abroad. Approved enterprises operating in the Amazon region, for which the SUDAM is responsible, are offered similar incentives. Numerous tax incentives and financing programmes are also available at the state level. Governors in all regions of the country, but most notably in the states of Paraná and Rio Grande do Sul (southern states), Bahia, Ceará, and Minas Gerais, are competing fiercely to attract business investment and generate employment in their states.

Sectoral Incentives

A number of tax incentives are extended to the services export industry, which seek to increase industrial technology development. The incentives apply to projects previously approved by the Ministry of Science and Technology (Ministerio da Ciencia e Tecnologis - MCT), and some of them are scheduled to be progressively reduced up to the tax year 2013. In general, they grant or allow:

- Accelerated amortization of identified intangibles;
- Double deduction of technology development expenses, limited to 8 per cent of the basic income tax liability;
- Reduction of up to 50 per cent of withholding taxes due on remittances of royalties and technical services fees; and
- Increase in the deduction of royalty and transfer of technology expenses to 10 per cent of related gross sales.

Export Incentives and Free Trade Zones

In 1988, the Brazilian Government authorized the creation of export processing zones (EPZs) (or Zonas de Processamento de Exportação). These EPZs are free export trade zones that may be created by states and municipalities in the areas covered by SUDENE and SUDAM to reduce regional differences and further Brazil's development. Companies established in these zones must be manufacturers/service providers exclusively for export and they are committed to predefined minimum levels of local expenditure. By November 1996, 18 EPZ authorizations had been granted. Imports and exports of companies operating in the EPZs are exempt from import duties, the federal excise tax (IPI), social contribution on turnover, and the financial transactions tax; and warehouse space is available at concessionary rates. There are no restrictions placed on either Brazilians or foreigners for acquiring control of an existing company located in an EPZ and thus obtaining benefits they provide.

Other Incentives

Imports of equipment related to approved projects involving the introduction of new technologies are granted a reduction in import taxes.

Policy Incentives for Service Industry in Russia

Statutory Tax Rate

The statutory tax rate is 30 per cent with tax revenues divided into federal (11 per cent) and local parts (19 per cent). Interest and dividend are taxed at 15 per cent. Royalty, licensing and management fees are subject to a 20 per cent withholding tax. In addition, regions and cities impose a wide variety of taxes.

Regional Incentives

Some regional governments extend tax holidays or reduced tax rates on their share of the profits tax.

Sectoral Incentives

Contracts for export of software/engineering services are exempted from VAT. Also, profits reinvested in the same sector are exempted from tax.

Export Incentives and Free Trade Zones

VAT exemptions are available for goods and services for export. Russia Federation has set up over 20 Free Customs Zones to increase exports. In these zones, investors in theory can receive tax incentives. In practice, however, these regulations have not been implemented well and the zones have attracted little foreign investment. A new law on economic zones has been under consideration for several years but it has not been implemented.

Other Incentives

There is a two-year tax holiday for small businesses, defined as those with less than 250 employees. There is no VAT on imported fixed assets. Reduced duty rates are available on the importation of fixed assets. Companies that employ 50 per cent or more disabled persons full-time enjoy a 50 per cent reduction in profit tax but these are not beneficial to the O&G engineering services industry.

Policy Incentives for Service Industry in India

Statutory Tax Rate

The national corporate tax rate is 35 per cent and the tax rate for foreign companies is 48 per cent. The 1999/2000 budget announced a surcharge of 10 per cent, making the effective rate 38.5 per cent. Dividends declared, distributed or paid after 1 June 1997 are not subject to withholding tax. However, companies making distributions are subject to a 10 per cent additional tax on the dividend amount. Dividends paid to a foreign company are subject to a withholding tax of 20 per cent. Under domestic law, the withholding rates on interest paid to companies vary with the type of loan or security. The rate most likely to apply to foreign investors, in the absence of a free rupee market, is that applied to foreign currency loans. The details are listed in Table 5.22.

Table 5.22: Rate of Withholding tax in India based on type of loan or security

Type of loan or security	Rate of withholding tax
On foreign currency loans, foreign currency Non-resident accounts, and foreign currency deposits with public limited companies	20 per cent
Bonds of an Indian company purchased with foreign currency	10 per cent
General rate	48 per cent

Source: Tax incentives and FDI - A Global Survey, UNCTAD (2008)

The rate of withholding tax on royalties is 20 per cent. This rate applies to agreements entered into after 31 May 1997 regarding royalties, as defined under domestic law and approved by the central Government, or where it is in accordance with the industrial policy in force. A 30 per cent rate applies to agreements concluded on or after 1 April 1976 as approved by the Central Government or where it is in accordance with the industrial policy in force. For approved agreements concluded before 1 April 1976, the rate is 50 per cent of the net amount after deduction for expenses. If an agreement has not been approved by the Indian Government, the rate is 55 per cent with effect from 1 April 1994, and 48 per cent from 1 April 1997.

Regional Incentives

An industrial undertaking set up in a specified underdeveloped state or union territory or in a specified industrially underdeveloped district, and which commenced manufacturing or production before 31 March 1995, is eligible for a 30 per cent tax exemption on its profits for the 10 years beginning with the year in which manufacturing or production takes place. An industrial undertaking set up before March 2000 in a particular class of backward state specified in the Eighth Schedule of the Constitution backward areas stipulated by the central Government as Category A is eligible for 100 per cent tax exemption on its profits for the first five years and 30 per cent for the next five years. Similar benefits are available for an industrial undertaking set up in an industrially backward district stipulated by the central Government as Category B. The exemption for such undertakings is 100 per cent on profits for the first five years and 30 per cent for the next three years.

Sectoral Incentives

An approved company set up before 1 April 1999, and engaged in scientific and industrial R&D, is eligible for 100 per cent tax exemption on its profits for five years.

Export Incentives and Free Trade Zones

A complete tax holiday is provided to companies that are set up in Free Trade Zones (FTZs) for the first 10 years of operation. These FTZs are Kandla Free Trade Zone (KAFTZ), Gujarat; Santacruz Electronics Export Processing Zone (SEEPZ), Mumbai; Madras Export Processing Zone (MEPZ), Tamil Nadu; Cochin Export Processing Zone (CEPZ), Kerala; Noida Export Processing Zone (NEPZ), Uttar Pradesh; and Falta Export Processing Zone (FEPZ), West Bengal. Approved, newly established 100 per cent export-oriented industrial undertakings and units in electronic hardware and software technology parks are entitled to a similar tax holiday. A resident tax payer engaged in the export of manufactured goods or computer/engineering software is allowed a deduction from profits on the basis of the ratio of export turnover to total turnover. The proceeds must be received in convertible foreign exchange.

India also has approved Software Technology Parks of India (STPI) with over 6327 units registered in March 2007 as compared to 2895 units in March 2001. This has immensely contributed to India's success in attracting investors to setup software and engineering outsourcing centres.

In addition to this, India passed the Special Economic Zone (SEZ) act in 2005 replicating the success of the China model to help augment exports (both goods and services) and develop the less developed regions of the country. However, the policies of the scheme are not well suited to the Software/engineering services sector which despite being export oriented works on different parameters as compared to the manufacturing industry.

The details of the various schemes that the Indian government conceived and implemented to boost exports are depicted in Figure 5.10.

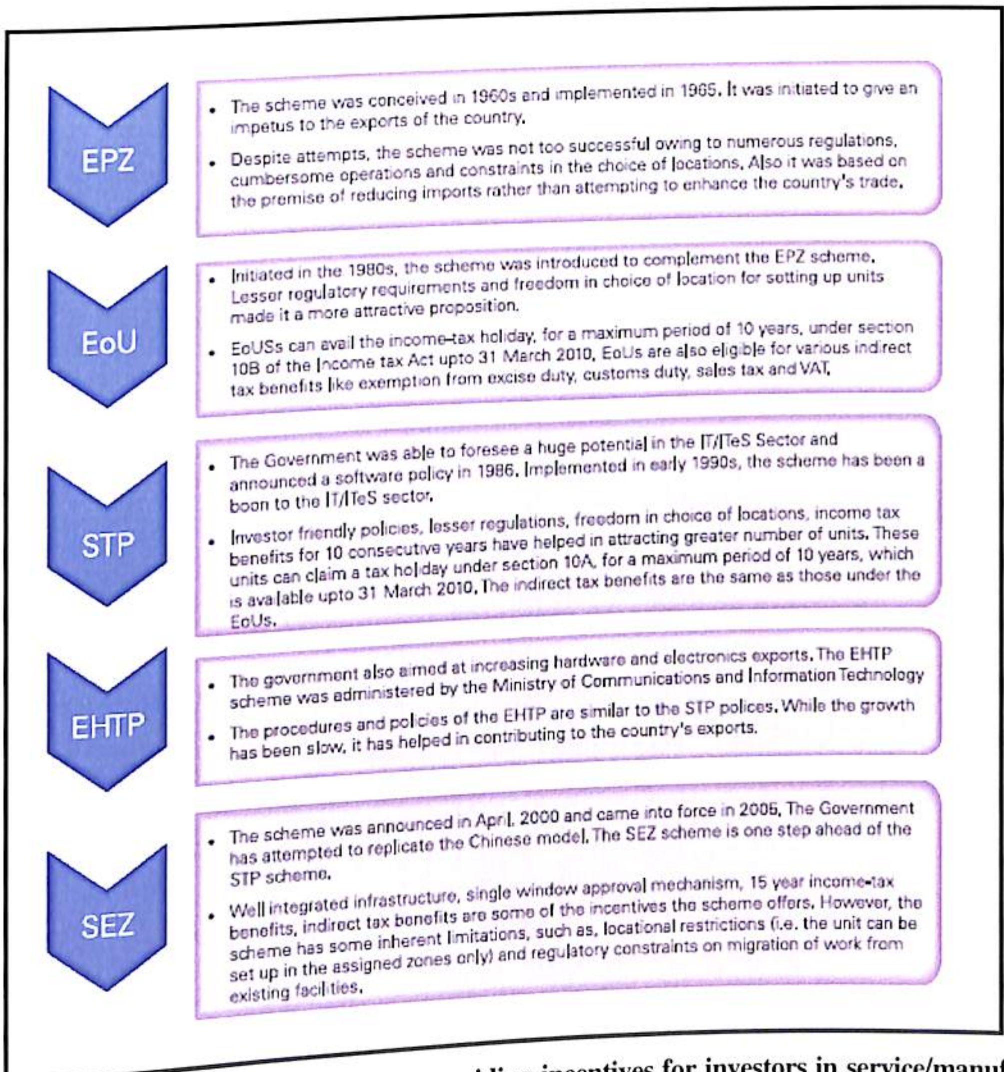


Figure 5.10: Major milestones in India for providing incentives for investors in service/manufacturing exports

Source: Indian IT/ITeS Industry Expiry of income-tax holiday: Needs a re-examination, Study by KPMG-CII (2008)

Other Incentives

A foreign institutional investor investing in shares and securities of an Indian company India would be liable to tax at 10 per cent on its long-term capital gains and 30 per cent on short-term capital gains. The minimum period of holding in the case of equity shares would be more than one year to be considered long term, and three years in the case of other securities.

Policy Incentives for Service Industry in China

Statutory Tax Rate

The standard income tax rate applicable to enterprises with foreign investment in China is 30 per cent. The local governments and municipalities levy a 3 per cent tax on net taxable income in all areas other than the SEZs. This may be waived or reduced at the discretion of the local governments. The effective corporate tax rate is therefore 33 per cent (30 per cent income tax plus 3 per cent municipal tax). In principle, withholding tax at the rate of 20 per cent is levied on dividend income received by foreign companies, enterprises and other economic organizations that do not have permanent establishments or sites in China. However, dividends received from Foreign Investment Enterprises (FIE) are exempt from tax on that income which is not effectively connected with a permanent establishment. Withholding tax on interest is 20 per cent. The rate of withholding tax on royalties is 20 per cent. Royalties paid for the use of technology that is held to be advanced, or provided on preferential terms, may be exempt from tax. The rate is reduced to 10 per cent on royalties paid for the use of certain proprietary technology for specific important development areas and paid by foreign investment enterprises located in specified investment zones.

Regional Incentives

Special incentives are granted for investment in Shantou, Shenzhen, and Zhuhai in Guangdong province; in Xiamen in Fujian province; and on the island of Hainan which are demarcated as SEZs. The rate of income tax levied on production-oriented FIEs in SEZs is 15 per cent. An FIE is defined as a Chinese-foreign equity joint venture, a Chinese foreign cooperative joint venture, or a wholly foreign-owned enterprise established in China. Similar reduced rates are granted for foreign investments in Economic and Technological Development Zones (ETDZs), which include the following coastal cities: Beihai, Beijing, Dalian, Fuzhou, Guangzhou, Lianyungang, Nantong, Ningbo, Qingdao, Qinhuangdao, Shanghai, Tianjin, Wenzhou, Yantai, and Zhanjiang. Other regions are following the successful models of the SEZs and ETDZs. For example, the Pudong new development area, adjacent to the city of Shanghai, was approved in 1990 to offer incentives to foreign investors, and six free trade zones have been established, one each in Dalian, Guangzhou, Shanghai, Tianjin and two in Shenzhen. Areas throughout China are being designated as high- or new-technology development zones. Zones similar to the ETDZs are to be created in the mid-western regions.

Sectoral Incentives

Foreign investment enterprises scheduled to operate for at least 10 years, and engaged in production/service oriented activities, are entitled to an exemption from income tax for two years, starting with the first profit-making year. This is followed by a 50 per cent reduction of the usual income tax rate (30 per cent, 15 per cent, or 24 per cent) over the subsequent three years. However, the State Council is authorized to issue separate exemption and reduction regulations for FIEs engaged in the exploitation of resources such as petroleum, natural gas and rare or precious metals or providing service for these. Those FIEs that the Ministry of Foreign Trade and Economic Cooperation has certified to be technologically advanced enterprises may be granted a 50 per cent reduction of the usual income tax rate in the three years following the expiration of the initial tax exemption and reduction period, provided they remain technologically advanced. A technologically advanced enterprise must possess technologically advanced production techniques and equipment, and these techniques and equipment must either be in short supply in China or the enterprise must develop new products, products that replace existing domestic products, or products that will expand exports or serve as import substitutes. If foreign investment exceeds 5 MUSD, an FIE that is established in an SEZ, that is engaged in a service industry, and that has a scheduled term of operation of at least 10 years may, on approval by the tax authorities of the SEZ, be granted an exemption from income tax in its first profit making year, followed by a 50 per cent reduction of the usual income tax rate in the next two years. A Chinese-foreign equity joint venture with a scheduled term of operation of at least 10 years, which is confirmed as a high- or new-technology enterprise and established in a high- and new-technology development zone may, on approval by the local tax authorities, be granted an exemption from income tax for two years, starting with the first profit-making year.

Export Incentives and Free Trade Zones

Export-oriented enterprises (FIEs that produce goods mainly for export and balance their foreign exchange revenue and expenditure or that earn a foreign exchange surplus) may also be entitled to further tax reductions after the expiration of the initial tax exemption and reduction period. In any year in which the FIE exports at least 70 per cent of its total output, it may be granted a 50 per cent reduction of the usual income tax rate. If, however, the FIE is established in a SEZ or ETDZ in which the rate is already 15 per cent, it will pay tax at 10 per cent instead of at 7.5 per cent. Free trade zones are entitled to the following advantages:

- Goods imported into the zone from abroad are exempt from customs duty. However, if the goods are subsequently transferred to another part of China that is not a free trade zone, customs duty will be levied; and
- Products manufactured in a free trade zone are exempt from customs duty when sold inside the free trade zone or shipped outside China.

Other Incentives

A foreign investor that directly reinvests its share of profits derived from a FIE may obtain a refund of 40 per cent of the tax already paid by the FIE on the reinvested amount, subject to the approval of the tax authorities. To obtain the refund, the foreign investor must either use its share of the profits (before the profits have been distributed) to increase the capital of the FIE or use the profits (after distribution) as capital to establish another FIE. The profits must be reinvested for at least five years. If the reinvested amounts are withdrawn within five years, the foreign investor must repay the tax refunded. A 100 per cent tax refund is granted to foreign investors if profits are reinvested in an export-oriented enterprise or a technologically advanced enterprise.

A synopsis of the type of policy incentives in the BRIC nations are summarized in Table 5.23.

Table 5.23: Synopsis of Tax incentives in BRIC nations

Country	Tax holiday/Tax exemption	Reduced tax rate	Investment allowance/ Tax credit	Duty/VAT Exemption/ reduction	R & D Allowance	Deduction for qualified expenses
Brazil	X	X	X	X		X
Russia	X	X		X		
India	X	X	X		X	X
China	X	X	X	X	X	X

Source: Author analysis of data in Tax incentives and FDI – A Global Survey, UNCTAD (2008)

Based on the analysis, the four BRIC nations have been plotted on a four point scale for variable '*Policy Incentives for Service Industry*' and the results are placed in Table 5.24.

Table 5.24: Comparison of '*Policy incentives for Service Industry*' variable for O&G ESO industry in BRIC nations

	HF	F	MF	UF
Brazil		X		
Russia			X	
India		X		
China	X			

(Legend: HF = Highly Favourable, F = Favourable, MF = Moderately Favourable and UF = Unfavourable)

From the overall analysis, it is clearly observed that the impact of identified set of elements of Location Attractiveness of BRIC nations for O&G ESO varies from country to country. For final analysis, the ranking of the results of all ten variables of Location Attractiveness (LA) have been presented together in Table 5.25 to get the consolidated comparative table for BRIC nations.

Table 5.25: Ranking of BRIC Nations on Elements of Location Attractiveness for O&G ESO industry

Elements of Location Attractiveness	Countries			
	Brazil	**Russia**	**India**	**China**
Cost competitiveness of services	UF	MF	HF	HF
Talent pool availability	MF	MF	HF	UF
Operations technology & Infrastructure	F	MF	F	HF
Innovation Capability	MF	F	F	F
R&D & testing facilities for O&G engineering	UF	HF	HF	F
IP/Data security	F	UF	MF	UF
Advanced educational institutes for O&G engineering	MF	HF	F	F
Presence of established O&G ESO companies	MF	F	HF	HF
Process efficiency & quality of services provided	F	MF	HF	MF
Policy incentives for service industry	F	MF	F	HF
Overall	**UF**	**MF**	**HF**	**F**

(Legend: HF = Highly Favourable, F = Favourable, MF = Moderately Favourable and UF = Unfavourable)

Based on my comparative study, India emerged as **Highly Favourable** in Location attractiveness for O&G ESO industry relatively among the BRIC nations as all ten elements of location attractiveness are working effectively and supports growth for the O&G ESO service provider industry. China emerged as a close competitor with **Favourable** ranking primarily due to low rating on IPR/Data security and an ageing workforce. The talent pool availability in China is also dwindling in the ten year horizon for which this study was conducted. Russia emerged as **Moderately Favourable** destination followed by Brazil which is an **Unfavourable** destination for O&G ESO service provider business. These rankings are further validated statistically as will be explained in the next chapter (Chapter-6).