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Developing and Harnessing Software Technology in the South

The Roles of China, India, Brazil, and South Africa

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Abstract

Software technology is gaining prominence in national information technology (IT) strategies due to its huge potential for socioeconomic development, particularly through the support it provides in the productive sectors of the economy, delivery of public services and engagement of citizens. In growing numbers of developing countries, software technology is also being leveraged for income generation from digital services and products. For instance, in recent years, India, Chile, the Philippines, Brazil, China, and Indonesia have emerged as important global players in the offshore software services industry, with India and China standing out as leaders. Cooperation between developing countries (south-south) in the area of software technology has also been growing; particularly in the application of software technology to agriculture, public

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Keywords: software technology, software industry, south-south cooperation, China, Brazil, India, South Africa

JEL classification: L86, O3

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administration and governance (e-governance), transportation and the society (knowledge society).

The paper presents the current state of software technology in the south and specifically, the maturity of the software industries in China, India, Brazil, and South Africa (CIBS). It establishes profiles of different regions based on the level of education, quality of research and availability of e-infrastructure and e-applications for determining the potential of these regions in terms of growth and competitiveness in the global software industry. Further complementary analysis of country profiles produced country clusters, helping to identify potential collaboration scenarios for advancing software capacity in the south. Finally, the paper discusses how CIBS can pivot regional or inter-regional cooperation in software technology in the south.

Acronyms

CIBS	China, India, Brazil, and South Africa
FDI	foreign direct investment
IT	information technology
MDGs	Millennium Development Goals
PPP	purchasing power parity
SSC	south–south cooperation
SSC-ST	south–south cooperation in software technology
SMEs	small- and medium-size enterprises

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1 Introduction

South–south cooperation (SSC) continues to be very relevant for socio-political and economic development despite its modest achievements and many challenges. With more cooperation initiatives linked to the Millennium Development Goals (MDGs), SSC is assuming strategic importance in the south.

Several efforts are transforming the SSC landscape, from better policy and institutional environment for cooperation, through need-based approach to planning, increased focus on human resource development and increased national allocations, to integration of efforts for mutual benefits and building partnership around common development issues (United Nations 2001). Another characteristic defining the present SSC landscape is the growth of cooperation initiatives in service-related industries. This is not surprising as service provision presently accounts for more than 60 per cent of the world GDP (OECD 2006). In fact, the size of the service industry and the availability of requisite ICT infrastructure are critical for competitiveness in the new economic order.

ICT infrastructure, and particularly software technology, underpins the delivery of innovative applications for socioeconomic benefits, e.g., delivery of public services, engagement of citizens in policy development, and creation of platforms for small- and medium-size enterprises (SMEs) to make their services and products available globally. Software technology is also central to the creation and efficient utilization of modern manufacturing processes (UNCTAD 2002).

Global software and ICT services market is the fastest-growing segment of the service industry. It was expected to grow up to US$1.27 trillion by the end of 2006, an estimated annual growth of 30 per cent from US$95 billion in 1996 (UNCTD 2002). Few countries in the south, largely in Asia, are known for the production and delivery of software and IT services (Joseph 2005a). India, for instance, is well known for its successful foray into international offshore software services and software export market (UNCTAD 2002; Meyer 2006). India's earnings from software export were projected to exceed US$31 billion in 2006-07 (at an annual growth rate of 32.6 per cent) and 5.4 per cent of its GDP (Nasscom 2007). The Chinese software and service export industry earnings have been growing at an average rate of 40 per cent from 1992, to reach about US$3.6 billion in 2005 (GoI 2006). In addition to India and China, countries like Brazil, Philippines, Mexico, Costa Rica, Indonesia, Vietnam, South Africa, and Singapore are also exporters of software products and services in the south (UNCTD 2002; Carmel 2003). However, internationally competitive IT service and software industry is limited in the south to India and China (Joseph 2005a, 2005b). Effectively, the contributions of the south to the global IT and software services export market constitute no more than 3 per cent, with India largely responsible for most of this contribution. Given the cost advantage and available software industry capacity in the south with China, South Korea and India providing 3.74 per cent, 2.65 per cent and 2.56 per cent, respectively, of the global industry capacity in 2004 (SCD 2006), there appears to be good opportunities for the south in the global software and services sector.

This paper investigates the existing and potential software technology capacity in the south, proposes cooperation scenarios, and examines the current level of cooperation between countries of the south in this area, particularly cooperation involving the CIBS (China, India, Brazil, and South Africa). Issues facing the software industry in the south such as structural imbalance, intellectual property rights protection, role of research,

government policy, existing trade agreements, and prevalent foreign direct investment (FDI) conditions are discussed. Finally, concrete roles and conditions for effective CIBS intervention are presented.

The rest of the paper is organized as follows. Section 2 describes the conceptual and theoretical framework for the study. The current state of software technology in the south and the maturity of the software industry in CIBS are presented in section 3. Possible SSC scenarios in software technology are discussed in section 4 while section 5 outlines important issues which could influence the growth of the software industry and capacity in the south. Section 6 presents recommendations on how CIBS can pivot the development and use of software technology in the south, while conclusions are given in section 7.

2 Conceptual framework

This study considers 'software technology' as any output, whether software products or services obtained through the application of scientific knowledge in computer science, information systems, systems engineering or related disciplines. Our notion of software products includes application packages, operating systems, system software and custom applications. By software services, we imply all services related to software development processes, ranging from specification and analysis, through design and implementation, to testing and maintenance. Software services also include data entry and other IT-enabled services.

We consider the software (technology) capacity of a state as a measure of its software industry; software product and services export; available ICT infrastructure and literacy; strategic and innovative applications in different industries; and quality of education and research in science and technology (software technology in particular). This view transcends the traditional narrower view of software capacity that is based on the software export profile of states.

Therefore, for a sustainable development of the software capacity of a state, growth is essential in all major perspectives—software industry, exploitation of software technology for socioeconomic and political benefits in the society, and investment in education and research in software-technology related areas.

In terms of the development trajectory of the software industry, states are naturally likely to move from low-barrier segments to high-barrier areas. By low barrier segments, we imply the provision of software services and custom applications for the local market. While the success stories for the countries in the south have been in software services exports, this segment may currently present significant barriers for new entrants (Aspray, Mayadas and Vardi 2006; Heeks 1999). Even more challenges are faced when the aim is to produce application packages for both local and international markets.

In the area of software technology exploitation for public value generation, support is essential for service delivery (public and business), public consultation, citizen engagement, and empowerment. Exploitation of software technology in core vertical areas such as education, health, security, and public safety is particularly crucial.

With several countries (including the CIBS) already participating in the global software industry and with the existence of several regional cooperation frameworks, software capacity of the south in general can be effectively developed through technology and knowledge transfer with experience sharing. In the context of the growing debate on the effectiveness of regionalism, our position is that regionalism (contiguity) provides an important cooperation context that cannot be ignored, while the more global south-wide cooperation provides ample opportunities in general. Therefore, we assume that effective capacity-building and dynamic cooperation environment can be obtained through cooperation from nations within the same region/subregion and countries with similar profiles, irrespective of their regions in the global south.

In general, we refer to any cooperation arrangement between countries of the south in the area of software technology as south–south cooperation in software technology (SSC-ST). Specifically, SSC-ST covers all kinds of cooperation activities between countries of the south (bilateral, subregional, regional or inter-regional, triangular, etc.), leading to increased capacity in (i) developing software products and artifacts; (ii) implementing application software in support of education, health, governance, transportation, security and other sectors; (iii) producing and delivering indigenous software services; (iv) outsourcing and in-sourcing software services; and (v) selling software products and services in the global markets.

We also assume that SSC-ST can promote the creation of innovation system in the south (similar to the notion of national innovation system outlined in Koenig 2006), through which the south in general can foster the production of software technology-related knowledge and the ability by countries to creatively apply this knowledge to address their concrete developmental problems, say those linked to MDGs. Forms of SSC-ST may include application and technology transfer, capacity development, experience sharing, common policy adoption, trade agreement, and the sharing of open-source software.

To determine possible scenarios and opportunities for SSC-ST actions, profiles of countries in the south would need to be analysed. Cooperation could in general exploit similarities between countries, e.g., for economies of scales and for experience sharing, while differences could provide the basis for complementary alliances. In establishing viable and more concrete roles for the CIBS within the SSC-ST framework, the software-capacity (industry and structure) and cooperation profiles of each of its four member countries should be explored in more depth.

3 The state of software technology in the south

This section presents an analysis of the current software capacity in the south and its potential for growth. The state of the software industry in China, India, Brazil, and South Africa is reviewed before presenting the analyses of the country profiles. The analysis establishes subregional profiles as well as country clusters based on the similarity of countries using the data obtained from UNCTAD (2003); EIU (2006); UNCTAD (2006) and UN-DESA (2005).

3.1 Software industry

The global software industry is largely dominated by the United States and the EU member states. The estimated global software revenue was US$783 billion as of 2004, with US and EU countries accounting for 40 per cent and 30 per cent of this figure, respectively (SCD 2006). Table 1, providing a snapshot of the global software industry output in 2004, shows the key software houses, industry output and the contribution to global revenue of each country. The total industry output consists of revenue from packaged and customized products, system integration services, local services and export services.

The main focus of the software industry is cantered on software service and product export, in which India is a classic example of success. The software export figures on the overall size of the industry inaccurately reflect the capabilities and outputs of other countries that have policies focusing on the development of their domestic software markets, such as Brazil and China. For instance, the information provided in Table 1 challenges the popular perception of the relative industry sizes of China and India. As discussed below, countries with large manufacturing bases such as telecommunication, hardware, aerospace, automobile, and aeronautics tend to provide a significant and sophisticated patronage to their local software industries. Brazil and China are excellent examples of the countries with a good manufacturing base. A review of the CIBS software industry (covering domestic software market and the software export profiles) is provided below.

Table 1
Gross software industrial output, 2004

Rank	Region	Key companies	Output (U$ billions)	Global %
1	US	IBM, Microsoft, EDS Computer Sciences Corporation, Accenture, Lockheed Martin, HP and Oracle	311.5	39.8
2	EU	SAP, IONA, Business Objects and Capgemini	238.2	30.44
3	Japan	Hitatchi, NEC and Fujitsu	83.2	10.63
4	China	China Standard, Neusoft, Kingdee, ZTE, Langchao, Baosight and CVIC Software Engineering	29.3	3.74
5	South Korea	Haansoft and Tmaxsoft	20.7	2.65
6	India	TCS, INFOSYS, Wipro	20	2.56

Source: SCD (2006).

China

In comparison to China's IT and hardware industries, its software industry is relatively unknown, perhaps because of the local orientation of the Chinese software industry, compared to India, which has an international focus (discussed later). Another possible reason is the lack of data on the true capabilities of the industry, due to its highly fragmented nature where a relatively large number of small software houses and a few large ones exist (Tschang 2003).

The Chinese software industry is active in both service and product sectors although to varying degrees (SCD 2006; Tschang 2003). The services sector covers a wide range of outputs from outsourcing to systems integration, while the product sector extends to system software, packaged application software and custom application software. The software industry is estimated to have been about US$50.1 billion as of 2005. The industry is rapidly growing, employing about 186 professionals in 2000 (Tschang 2003) and over 720,000 workers in 2005 (SCD 2006; Chonia 2003). With an estimated 20 million SMEs, China has a substantial business base (Tschang 2003), and the domestic packaged software market is expected to grow to about US$100 billion by 2008.

As at 2000, only 5.6 per cent of the software industry output was export-based, while products accounted for about 33 per cent, indicating a strong focus on products. Japan is the foremost client of outsourced services; for instance, China earned about US$10 billion delivering software services to Japan in 2004 (SCD 2006).

A particular strength of the Chinese industry is its technology capability, delivered through its world-class research institutions and strong linkages between universities and software companies. On the other hand, the organizational, process and managerial capability of the country's software companies are underdeveloped, constituting a challenge to the global competitiveness and growth of the industry.

Brazil

The Brazilian software industry is similar in structure to that in China. In 2001, the software industry output had grown to US$7.7 billion, with domestic markets accounting for 98 per cent of this value (Botelho, Stefanuto, and Veloso 2003). The industry employed over 165,000 people across about 10,000 firms, contributing in 2001 about 1.5 per cent of GDP.

Like the Chinese, the industry in Brazil developed on the basis of the hardware industry. The Softex Programme (UNDP 2006a)—aimed at establishing Brazil as a centre of excellence in the production and export of software, with collaboration from other government agencies, non-profit organizations, local governments and private institutions—is a joint venture between the National Technology Research and Development Council of the Brazilian Ministry of Science and Technology and UNDP, and contributed to the development of the software industry in the 1990s.

In 2001, software products and services earned US$7.7 billion or 42.6 per cent of the total IT industry output. The industry provides software support, application development, systems integration, training, and outsourcing services. In 2002, system integration was the leading activity of the software industry with a share of 17 per cent. Application development accounted for 8 per cent and application outsourcing only 1 per cent. These figures do not take into account the sales of software products. In 2002, the packaged software market in Brazil was worth about US$2.0 billion (Behrens 2003).

The telecommunication and financial sectors are particularly strong, attracting significant foreign direct investment. Growth of knowledge-intensive industries directly increases the local user-base, and facilitates the provision of specialized high-end products and services for the software industry. Most Brazilian firms have unique competence in such vertical markets. This potentially provides an alternative to the increasingly commoditized international service market.

Brazil—like China—also offers high-quality education with top-level research institutes in computer science and software engineering.

India

The origin of the Indian software industry can be traced to its defence industry, with strong government support, similar to the IT industry in China. Presently, the Indian computer industry is the most recognized in the developing world due to its contribution to the global software services market, with an export revenue of US$17.1 billion in 2005 (Dossani 2005). According to another report, India's earnings from software exports were expected to exceed US$31 billion during 2006-07, contributing about 5.4 per cent of its GDP (Nasscom 2007).

The Indian software and services industry provides turnkey project services, professional services, training services, products and packages, support and maintenance, and IT enabler services. Products and packages constitute 52 per cent of the domestic software market, while turnkey projects and professional services account for 28.6 per cent and 4.1 per cent, respectively. However, professional services and turnkey projects account for 48.4 per cent and 31.5 per cent of export software respectively (Arora et al. n.d.).

In contrast to the Chinese software industry which is dominated by a large number of smaller firms, the industry in India is concentrated in a few local conglomerates with very strong capabilities, especially in the aspects of processes. By 2005, over 400 Indian software firms had acquired certifications with the Software Engineering Institute Capability Maturity Model (CMM), with 82 companies certified at level 5, higher than any other country in the world (UNU-INTECH 2003). Over 60 per cent of the revenue earned by the software industry is from the United States, with the domestic market only accounting for less than 20 per cent.

A major disadvantage of the software industry in India is its weak domestic market, which is largely due to the lack of strategic coupling of its software industry with other productive sectors and the absence of a strong hardware (and ICT in general) base (Kumar and Joseph 2005; D'Costa and Sridharan 2003). Another weakness of the Indian software industry is in the area of research and linkages between universities and companies (SCD 2006). If unaddressed, these two factors could be major threats to the competitiveness of India in the global software industry in the near future.

South Africa

Unlike the three other CIBS countries, South Africa is yet to emerge as a major player in the global software industry. However, in view of South Africa's growing investment in ICT (over 7.2 per cent of GDP as at 1999 [Cogburn and Adeya 2001]) and the maturity of its manufacturing and financial industries, significant growth in its software industry is to be expected. Unfortunately, little information is available in the public domain on the present size of the industry. As of 1999, total sales of computer software in South Africa were estimated at US$502 million and sales of locally-developed software at only US$40 million (James et al. 1999). Even at a compounded annual growth rate of 30 per cent, the size of the software industry at present is less than US$5 billion. With its relatively well developed industries, most of software products and services are expected to be consumed locally.

A prominent feature of the software industry developing in the country is the adoption of the Open Source Software and the Open Standard policy (NACI 2002). This policy has the potential to support speedy development of the local industry by mainstreaming software development through the open source phenomenon.

Another peculiar strength of the country is its economic and political dominance and leadership in the southern African subregion and in Africa as a whole. This provides a potential huge market and opportunities for South Africa for its developing software industry.

3.2 Enabling factors

This section examines the major factors promoting the development of the software industry in the south. These include quality of education, research capacity, and the availability of requisite e-infrastructure and applications.

Education and research

The level of education in the south is measures with education indices of its various subregions. The education index is computed based on such data as the adult literacy rate, and the combined gross enrolment for primary, secondary, and tertiary institutions. According to the 2006 *Human Development Report* (UNDP 2006b), South America is the south's the most educationally advanced subregion with education index of 0.89 (ibid). East Asia and the Caribbean follow with 0.88 and 0.84, respectively, followed by Southeast Asia, South and East Africa, and North Africa, with indices of 0.83, 0.77, and 0.68 respectively. Table 2 displays the computed education and research indices of the subregions, based on the UNDP data.

According to *THE* (2006), 24 of the top 200 universities (over 10 per cent) in 2006 were located in the south (see Table 3).

Table 2
Education and research indices

Region	Education index	R&D index
Africa, eastern regions	0.62	0.4
middle	0.59	NA
northern	0.68	0.4
southern	0.77	0.8
western	0.43	NA
Asia, eastern regions	0.88	0.8
south central	0.65	0.6
south eastern	0.83	0.5
western	0.78	0.2
Latin America, Caribbean	0.84	0.3
central	0.78	0.4
south	0.89	0.3
Oceania, Micronesia	NA	NA
Melanesia	0.69	NA
Polynesia	0.92	NA

Source: Authors' computations, based on UNDP (2006b).

Table 3
Top universities of the south

Country	Top universities
China	Beijing University Tsing Hua University Fudan University China University of Science and Technology Shanghai Jiao Tong University Nanjing University
India	Indian Institute of Technology Indian Institute of Management Jawaharial Nehru University
Hong Kong	University of Hong Kong Chinese University of Hong Kong Hong Kong University of Science and Technology City University of Hong Kong
Singapore	National University of Singapore Nanyang Technological University
Mexico	National Autonomous University of Mexico
Malaysia	University of Kebangsaan Malaya University

Source: *THE* (2006).

Table 4
Research and development capacities in the subregions

Region	R&D expenditure/GDP (%)	Researchers/per million
Africa, eastern regions	0.4	62
middle	NA	30
northern	0.4	605
southern	0.8	175
western	NA	132
Asia, eastern regions	0.8	672
south central	0.6	183
south eastern	0.5	286
western	0.2	675
Latin America, Caribbean	0.3	400
central	0.4	127
south	0.3	269
Oceania, Micronesia	NA	NA
Melanesia	NA	NA
Polynesia	NA	NA

Source: Computed by the authors based on UNDP (2006b).

Research capacity of the subregions is measured through two indicators: research and development (R&D) expenditures expressed as a percentage of the GDP, and the number of researchers per million people. The subregions of South Africa and East Asia lead in terms of R&D spending, with each subregion committing about 0.8 per cent of their GDP to this expenditure; south-central Asia follows with 0.6 per cent, with north and east Africa subregions and central Latin America expending equally 0.4 per cent of

their GDP on research. Table 4 shows a profile of the different subregions in terms of research and development.

In terms of the number of researchers per capita, western Asia leads with 675 researchers per million people, followed by East Asia and north Africa with 672 and 605 researchers per million people, respectively. The Caribbean, Southeast Asia and South America subregions follow with 400, 286 and 269 researchers per million, respectively.

In terms of research output in software engineering, according to Glass and Chen (2004), the top universities in the south are the National Chiao Tung University in China, City University of Hong Kong, and National University of Singapore.

E-applications and infrastructure

The south, in terms of availability of e-applications and the requisite infrastructure, is measured by the web presence and infrastructure indices in the 2005 *E-government Readiness Report* (UN-DESA 2005). Web presence is measured in terms of maturity of services provided on government portals, while the infrastructure index is a composite measure expressing the availability of computers, fixed telephones lines, mobile phones, TV and internet access. According to these criteria, Southeast Asia leads with an index of 0.46, closely followed by South America with 0.45. East Asia, Central America, and southern Africa follow with 0.40, 0.33, and 0.33, respectively. Table 5 provides a complete picture of the web presence in different subregions of the south.

The level of infrastructure in the south is generally poor. West Asia, the Caribbean, and Southeast Asia have infrastructure indices of 0.19, 0.18, and 0.17, respectively. South America follows with 0.14. Infrastructure in the African region is very poor, as the highest subregional index of 0.06 for north and southern Africa indicates (Table 5).

Table 5
Regional e-application and infrastructure index

Region	Web presence index	Infrastructure index
Africa, eastern regions	0.1664	0.0358
middle	0.0564	0.0488
northern	0.2492	0.0601
southern	0.3269	0.0629
western	0.1105	0.0196
Asia, eastern regions	0.4000	0.0960
south central	0.2971	0.0339
south eastern	0.4590	0.1665
western	0.3085	0.1884
Latin America, Caribbean	0.2145	0.1803
central	0.3330	0.1019
south	0.4548	0.1355
Oceania, Micronesia	0.0904	0.0416
Melanesia	0.1400	0.0431
Polynesia	0.1962	0.0425

Source: Computed by the authors based on UN-DESA (2005).

3.3 Country profile analysis

In this section, we briefly discuss the overall profile of the countries in the south, regardless of regional attributes, to provide a complementary view in which countries of similar profiles are grouped together. Table 6 provides the cluster analysis results based on eight indicators: web presence index, infrastructure index, digital opportunity index, education index, purchasing power parity (PPP), and—expressed as percentage of GDP—the size of exports (goods and services), size of the industry, and the size of the services industry. A few indicators are dropped due to insufficient data.

Three major clusters of countries emerged from the analysis, with 18, 32, and 79 countries occupying clusters 1, 2, and 3, respectively. Table 6 shows that cluster 1 is the most advanced group of countries overall in terms of education, e-applications, infrastructure, PPP, and the size of the service economy. In contrast, cluster 3 is the least advanced group of countries. Table 7 shows the membership of each cluster.

Table 6
Profiles for country clusters

Indicator	Overall	Cluster 1	Cluster 2	Cluster 3
Web measure index	0.3	0.5	0.3	0.2
Infrastructure Index	0.1	0.3	0.1	0.0
Digital opportunity index	0.3	0.5	0.4	0.2
Educational index	0.7	0.9	0.8	0.6
PPP in US$	5899.0	15901.5	7580.0	3010.2
Export of goods & services in % of GDP	39.2	57.7	44.2	32.1
% of GDP (industry)	28.9	32.1	28.6	28.0
% of GDP (services)	50.4	51.3	59.9	46.4

Source: Computed by the authors.

Table 7
Cluster membership

Cluster 1	Cluster 2	Cluster 3	
Malaysia	Belize	Afghanistan	Madagascar
Antigua and Barbuda	Botswana	Algeria	Malawi
Argentina	Brazil	Angola	Mali
Bahamas	China	Bangladesh	Marshall Islands
Bahrain	Colombia	Benin	Mauritania
Barbados	Costa Rica	Bhutan	Micronesia
Brunei Darussalam	Dominica	Bolivia	Morocco
Chile	Dominican Republic	Burkina Faso	Mozambique
Kuwait	El Salvador	Burundi	Myanmar
Maldives	Equatorial Guinea	Cambodia	Nepal
Mauritius	Fiji	Cameroon	Nicaragua
Qatar	Grenada	Cape Verde	Niger
Saudi Arabia	Guyana	Central African Rep.	Nigeria
Seychelles	Iran	Chad	North Korea
Singapore	Jamaica	Comoros	Pakistan
Thailand	Jordan	Côte d'Ivoire	Palestine
Trinidad and Tobago	Lebanon	Cuba	Papua New Guinea

Table 7 continues

Table 7 (con't)
Cluster membership

Cluster 1	Cluster 2	Cluster 3	
United Arab Emirates	Mongolia	DR Congo	Paraguay
	Namibia	Djibouti	Rep. Congo
	Oman	East Timor	Rwanda
	Panama	Ecuador	Samoa
	Peru	Egypt	Sao Tomé and Principe
	Philippines	Eritrea	Senegal
	St Kitts and Nevis	Ethiopia	Sierra Leone
	St Lucia	Gabon	Solomon Islands
	St Vincent and	Gambia	Somalia
	the Grenadines	Ghana	Sri Lanka
	South Africa	Guatemala	Sudan
	Swaziland	Guinea	Suriname
	Tonga	Guinea-Bissau	Syria
	Tunisia	Haiti	Tanzania
	Uruguay	Honduras	Togo
	Venezuela	India	Turkmenistan
		Indonesia	Uganda
		Iraq	Vanuatu
		Kenya	Vietnam
		Laos	Yemen
		Lesotho	Zambia
		Liberia	Zimbabwe
		Libya	

Source: Computed by the authors.

Figure 1 shows the geospatial distribution of the cluster members. A few Middle East and Latin American countries with Singapore and Malaysia occupy cluster 1. South Africa, Brazil, and China with a few other countries occupy cluster 2, while India and countries in Africa dominate cluster 3.

The values in Table 6 also show that countries in cluster 2 are generally more prepared than those in cluster 3. When we consider the emerging players in the global software industry, we observe the following (UNCTD 2002; Carmel 2003; Heeks 1999):

- Malaysia and Singapore are recognized as emerging players in cluster 1;
- Brazil, China, El Salvador, Iran, Jordan and Philippines as emerging players in cluster 2; and
- Bangladesh, Cuba, Egypt, India, Indonesia, Sri-Lanka, and Vietnam as emerging players in cluster 3.

As shown in Figure 2, emerging players in the global software industry come from all three major regions of the south, for instance exemplified by Brazil in South America, Egypt in Africa, and India and China from Asia.

Figure 1
Geospatial distribution of clusters

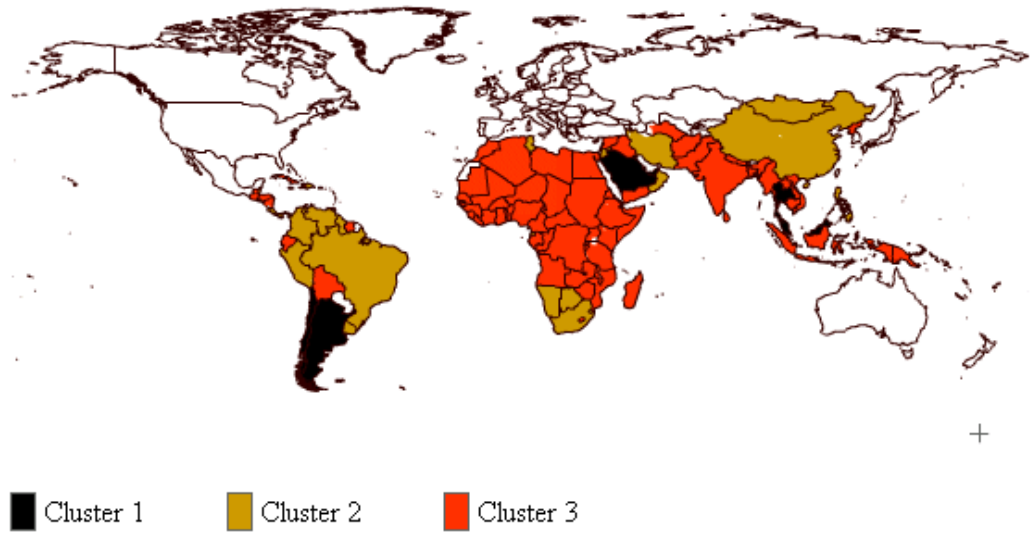
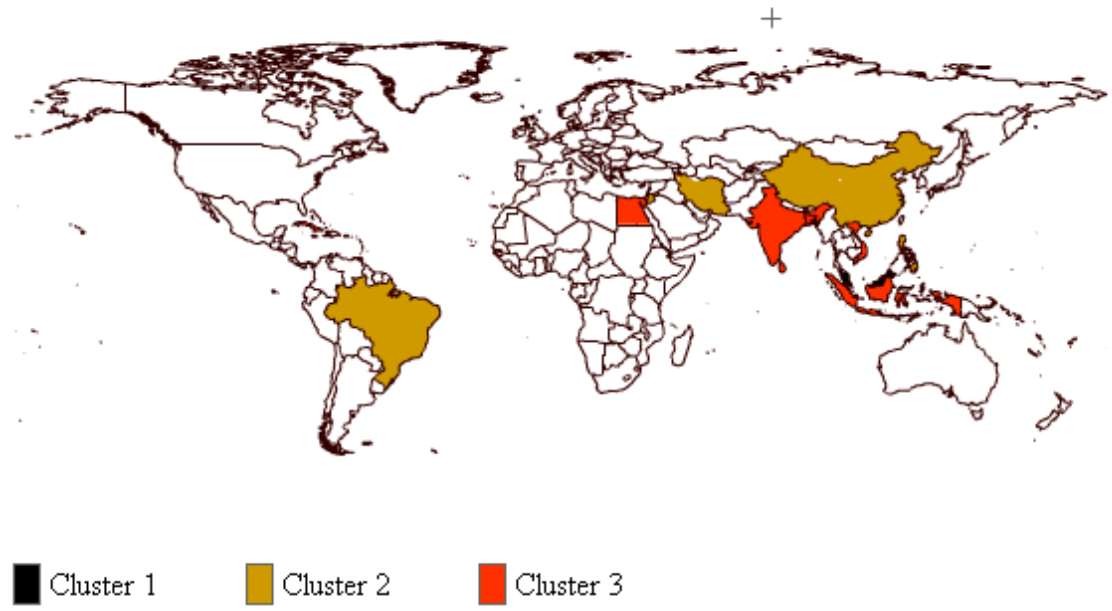


Figure 2
Geospatial distribution of emerging players



Sources for Figures 1 and 2: Compiled by authors, based on cluster analysis given in Table 7.

Against this background, we explore plausible cooperation opportunities in the south vis-à-vis existing cooperation among countries.

4 Potential and existing cooperation (SSC-ST)

4.1 Potential opportunities

From Table 7 and the figures in section 3, only countries in cluster 2 appear to be leveraging their available infrastructure, human capacity and economic environment in the development of their software industries, about 20 per cent participation in the global software industry. However, cluster 1 countries do not appear to exploit their developed infrastructure with respect to their software industry. Interestingly, although cluster 3 countries suffer from poor infrastructure base along with a challenging economic environment and a relatively poor human capacity, these countries are making significant efforts to participate in the global software industry.

Since data on other segments of the software industry (such as domestic market size) are not considered in section 3.3, the observations about cluster 1 would need to be examined more closely. For instance, there may be little motivation for an oil rich state like Saudi Arabia to invest in the software services exports, unlike other countries in cluster 3 that are in greater need of additional income from low-barrier segments of the global market. Since cluster 1 countries are better off than the other clusters in terms of e-applications and infrastructure, significant software exploitation capacity does exist in these countries.

These facts confirm that significant complementary software technology capacity is available in the south. Broadly, an optimal cooperation space will consist of inter-cluster and interregional experience sharing and knowledge transfer arrangements, complemented by intra-regional synergies (regionalism) and intra-cluster alliances. Specific cooperation scenarios or opportunities include:

i) Subregions with highly developed educational and research capacity like East-Asia and South America could provide capacity development assistance to other subregions.

ii) Cluster 1 countries with a relatively more advanced infrastructure and e-applications could share their best practices and experiences with members of other clusters.

iii) Cluster 3 countries with experience in global software industry could provide offshore services to Clusters 2 and Cluster 1 countries to reap possible cost advantages, possibly within a flexible framework of trade in services agreements.

iv) Countries with experience in the global software market, such as India, Philippines, El-Salvador, could offer expertise and guidance to peer countries in the same cluster (with similar environmental context) on acquiring requisite capabilities.

v) Cluster 1 countries, able to offer relatively good e-infrastructure, could attract an inflow of investments from CIBS (particularly China) and possibly from multinational software corporations from OECD countries.

Other cooperation and software capacity development opportunities include:

i) Open source based cooperation: Free and Open Source Software (FOSS) allows for free dissemination and transfer of information systems between countries. Developed systems based on open source software could be shared without royalty and rights constraints. The use of open source software also enables better diffusion of software among citizens and small businesses in countries. Brazil and South Africa have strong policies to support the development and use of open source software capabilities. These capabilities can be leveraged by other countries particularly in the south.

ii) A region such as South America with high-quality education can benefit from the global shortfall in software industry manpower by supplying the requisite professionals (software engineers) (UNCTD 2002). But language skills (for instance, fluency in English) may constitute a barrier in this effort.

4.2 Existing cooperation (SSC-ST)

In general, cooperation among countries of the south in the area of software technology has been on the increase since 2003. Existing SSC-ST arrangements range from bilateral to multilateral and regional agreements. United Nations organizations such as UNCTAD (UN Conference Trade and Development), UNU-IIST (UN University-International Institute for Software Technology), UNESCAP (UN Economic Commission for Asia and the Pacific) and UN-DESA (UN Department of Economic and Social Affairs, have facilitated several triangular cooperation agreements with donor countries in OECD and directly provided capacity development programmes. Details are provided in Ojo et al. (2007).

Some existing cooperation agreements involving CIBS include:

- India has bilateral agreements with over 30 countries in the area of e-government, computerization of government offices, and FDI in software industries of countries such as Sri Lanka, Mauritius, Vietnam, and Senegal. India has also been involved in trilateral relationships with Mexico and Venezuela.
- South Africa plays a prominent role in a few major regional economic frameworks such as the Southern African Development Community (SADC), Common Market for Eastern and Southern Africa (COMESA) and the African Information Society Initiative (AISI). These regional initiatives involve cooperation in the area of e-applications (such as e-learning and e-government).
- China has supported several developing countries through its technology cooperation programme, largely in the form of training. China also has some 130 technical cooperation agreements including SSC in science and technology with major players in the north, particularly the EU and the US.
- Brazil, as a member of Economic Commission of Latin America and the Caribbean, is involved in the development of regional information systems with other members.
- The India-Brazil-South Africa (IBSA) Economic Cooperation agreement includes: (i) facilitation of trade among the three countries, (ii) sharing of experience in the field of e-governance and (iii) mutually strengthening capabilities in free and open source software.

Generally, India stands out in terms of SSC-ST involvement. China and South Africa also have good SSCT-ST records, while South Africa has huge potential for championing the development of the industry within its region and in Africa in general.

5 The software industry and capacity in the south

We maintain that the popular view of software capacity as a measure of software export profile of states may be misleading. Popularity of the export-centric view of the software industry arose with the growing influence of globalization. In general, participation in the global software industry has opened up opportunities for the developing countries mainly in the low-end of the value chain for software services and products. Due to low cost of labour in the south, these activities are outsourced by OECD members to selected countries in the south (such as India and Philippines). Offshore services account for well over 60 per cent of the earnings of emerging players in cluster 3 (including India) from the software industry. In the case of India, about 80 per cent of its software earnings are from the export segment of the industry.

Structurally, the software industry of emerging players in Cluster 3 is very weak. For instance, India could loose its competitiveness if efforts to develop the domestic market are not made (D'Costa and Sridharan 2003). Cluster 1 and Cluster 2 countries are positioned particularly to offer policy advice, mentoring, and experience to emerging players in cluster 3 for sustainable presence.

The fragility of the labour-cost strategy needs to be addressed by emerging players by acquiring requisite capabilities to move up the value chain. India, given its globally-respected CMM reputation, offers excellent experience in this regard. This again underscores the centrality of balanced growth in major segments of the software industry for sustainability. Structural balance could be achieved through the use of policy instruments.

We also note that India is weakest among the CIBS nations in terms of domestic utilization of software capabilities, particularly in the areas of business and governance. For instance, India ranks 53rd out of 69 countries in the Economist Intelligence Unit e-readiness (for e-business) report for 2007 (EIU 2007) and 113th out of 182 countries in the overall UN e-government ranking (UN-DESA 2008), despite reported innovative applications in India. South Africa, although the weakest of the CIBS in terms of software capabilities, leads its CIBS peers in software e-applications. Brazil offers the most balanced software technology profile in terms of production and utilization capacity.

Although we have reported on the existence of several SSC-ST initiatives, there is no information (in the public domain) on the statuses of these cooperation efforts. Therefore, it is difficult to distinguish successful cooperation initiatives from non-successful ones. Learning from the challenges to regionalism, there is a need for an incentive system for cooperating parties, particularly the benefactors, when direct mutual benefits are not assured. For instance, cluster 3 countries with highly limited resources may not be able to share their expertise without funding or support from third-party organizations such as UN system and donor OECD countries.

A major threat to the development of domestic market in India and South Africa and further development of the Chinese and Brazilian domestic markets is the huge loss of revenue due to piracy and intellectual property right violations in all four countries. Specifically, trade losses in China in 2006 in business software are estimated at about US$1.95 billion (82 per cent). India, Brazil, and South Africa lost an estimated US$0.32 billion (70 per cent), US$0.5 billion (62 per cent), US$0.12 billion (35 per cent), respectively. The Chinese market is particularly affected by the piracy dilemma, and despite the small size of the Indian domestic software market, over 70 per cent of its revenue on packaged software is lost to piracy. Although Brazil is faced with an equally serious privacy problem, its open source policy could help to alleviate the problem.

6 The role of CIBS and success factors

Given the CIBS software profile and its current involvement in the SSC-ST regional arrangement, we propose the following additional roles for these nations in the general development of software capacity in the south:

i) China and Brazil could share their experiences on how domestic software industry can be developed to strategically align with the needs of other productive sectors;

ii) India could transfer concrete knowledge on mature software processes and development of export-quality software services;

iii) CIBS members could pivot inter-regional cooperation to broker the various cooperation opportunities discussed in section 4.

iv) CIBS members could provide and deliver capacity-development programmes to other countries in the south, particularly within their respective regions and clusters.

v) China and Brazil could provide institutional development programmes for software research institutions in the south;

vi) CIBS members could invest in software industries of countries in the south as a way to transfer technology.

The following are crucial to successful CIBS intervention:

i) CIBS need to address the inherent structural weakness in their respective software industries through learning from peers within the CIBS, region and cluster.

ii) There is a need to facilitate CIBS intervention through triangular cooperation efforts involving UN organizations and others international organizations.

iii) There is a general need to provide an incentive system for CIBS to encourage more interventions (point (ii) is a concrete instance of possible incentive).

7 Conclusions

The paper provides a clearer picture of the available software capacity in the south. It establishes both regional profiles of countries to support regionalism and cluster profiles to identify countries in the south with similar development environment to enable more dynamic global cooperation efforts. Based on these profiles, cooperation scenarios were generated. To determine the specific roles of CIBS in supporting other countries in the south in advancing their software capabilities, an analysis of their software profile was carried out. Structural issues that could threaten the CIBS' competitiveness even within the south if not addressed were identified. Possible roles for the CIBS have been provided, and some conditions for successful intervention outlined. Given the current state of software technology in south and its development context, software utilization and production capacity must be aligned through government policy instruments. Countries would also have to determine which industry development trajectory is best suited for their needs.

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