

# **Course: Economics of Innovation**

Topic: Systems of innovation

*PhD Bobur Tursunov*

# Conceptual Issues

- How much does ICT form an integral part of the national system of innovation of the selected economies?
- How does country-specific particular innovation systems work to facilitate or hinder ICT development?
- And conversely, how does ICT also influence and shape the country's innovation system?
- Examine this relationship by taking empirical account of a group of economies and try to draw principally comparative insight by focusing on each country's approach separately.

# Conceptual Issues

- What constitute National Innovation System and how to apply and integrate it to study technology accumulation and socio-economic development.
- Configuring NIS to give it a global or broader *framework by identifying meta elements*
- Linking NIS to ICT elements
- Technology specific system, i.e. ICT – identifying major elements and broader socio-economic goals

# Country Studies: Brazil, China, India, South Africa, Thailand and Southern African Countries

## Main Objectives:

- Whether the perception of ICT as a tool for all round socio-economic development is being reflected by the ground level developments/ realities.
- Or it is just a misplaced and over hyped 'faith' in a technology that is never going to deliver what it promises.
- While recognising the potential of ICT to contribute towards socio-economic development, we would like to challenge the view that ICT is the cure for all kinds of ills in the world thorough empirical investigation.

# ICT and National Innovation System

- A specific technology, left to itself or on its own is neither good nor bad. What is important is how a technology is designed, developed, employed, and whether it can lead to wider social benefits.
- ICT is believed to have the potential to transform socio-economic conditions of the people.
- But on its own ICT is not going to bring about socio-economic transformation. It requires appropriate institutional, social, political, and cultural environment to accomplish this.
- This environment is created by the national innovation system.

# National Innovation System

- National innovation system, we would argue, is not just a tool to achieve the narrow goal of industrial/economic competitiveness,
- But it is about achieving a broader development and wider social benefits.

# **National Innovation System**

1. Conceptual framing within politics and economics system
2. Co-evolution of Institutions/ Technological Cap./ Knowledge
3. Incentives
4. Implementation/ Learning/ Outcomes
5. Feedback / Socio-economic Changes

# Major Elements of National Innovation System (NIS)

- ***Conceptual Framing:***

Ideas, policies need to be linked to a conceptual framing of how economics and politics are co-governed and/or co-evolved.

Responding to opportunities, dealing with challenges require policies to be rooted in a conceptual framework that governs the dynamic interaction between a nation's political and economic change.

- ***Co-evolution of Institutions, Technologies, and Knowledge:***

Need strong interaction, linkages, synergies, and co-ordination to achieve coherent co-evolution leading to an efficient innovation system and higher level of technology accumulation.

- ***Incentives:***

Appropriate incentives to achieve co-evolutionary dynamics between institutions, technologies, and knowledge production by linking economic and non-economic agents to meet stated goals and objectives.

# Major Elements of National Innovation System (NIS)

- ***Implementation and Learning:***

Implementation of strategies, policies, projects, and programmes should include feedback mechanisms (review, monitoring, and feedback) leading to learning outcomes.

Ability to learn - self learning and ability to take corrective measures are imperative for building technological capabilities and embed innovation dynamics in both narrow industrial and broader socio-economic development.

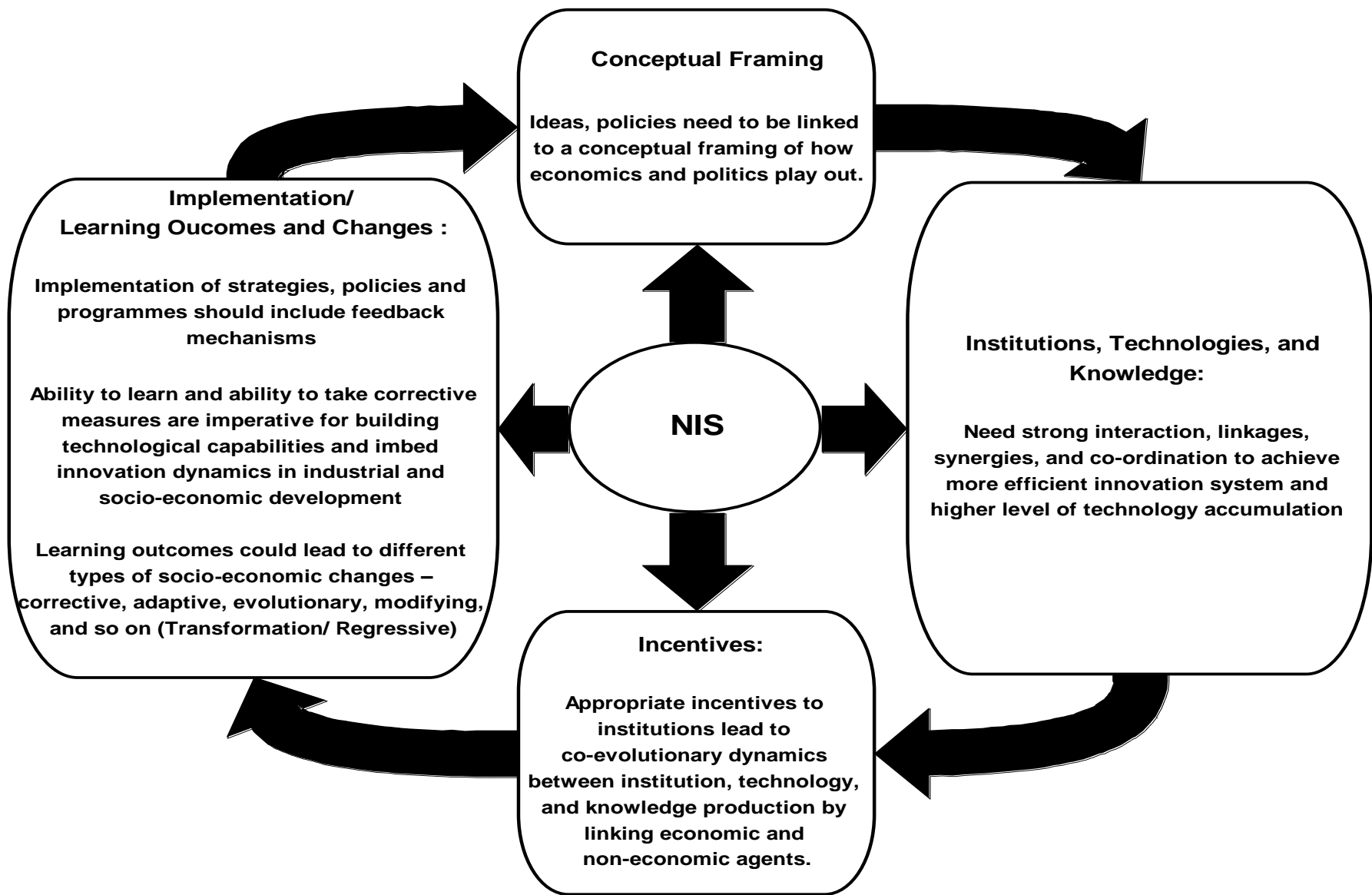
- ***Socio-economic Changes:***

Learning outcomes could lead to different types of socio-economic changes – corrective, adaptive, evolutionary, structural, contingent, and so on.

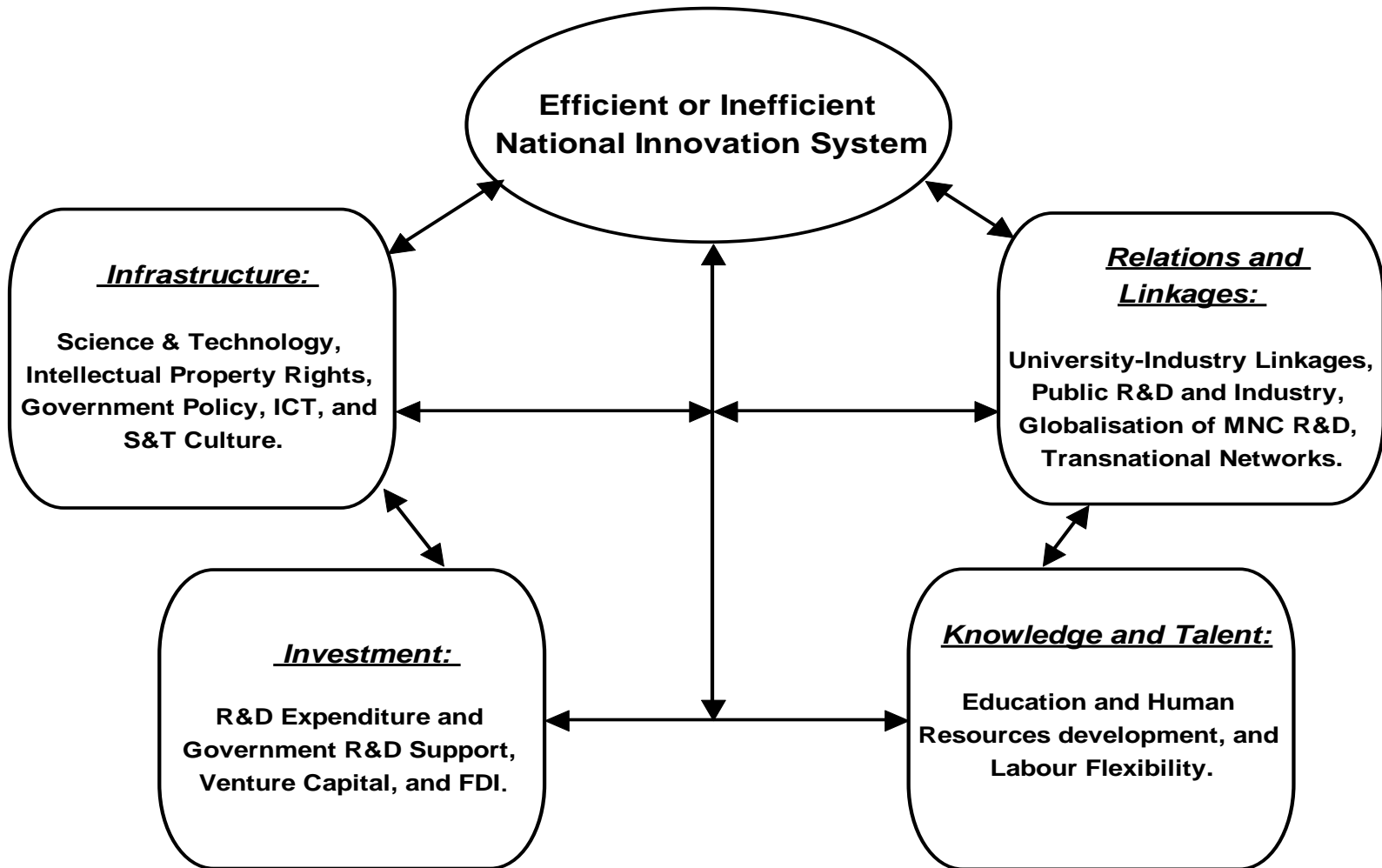
Transformation: When results in the most dramatic positive change of political/socio-economic system (but it is unlikely to happen often).

Regressive: When results in negative rather than positive impact on political/ socio-economic system.

**Figure 1: Major Elements of National Innovation System (NIS)**



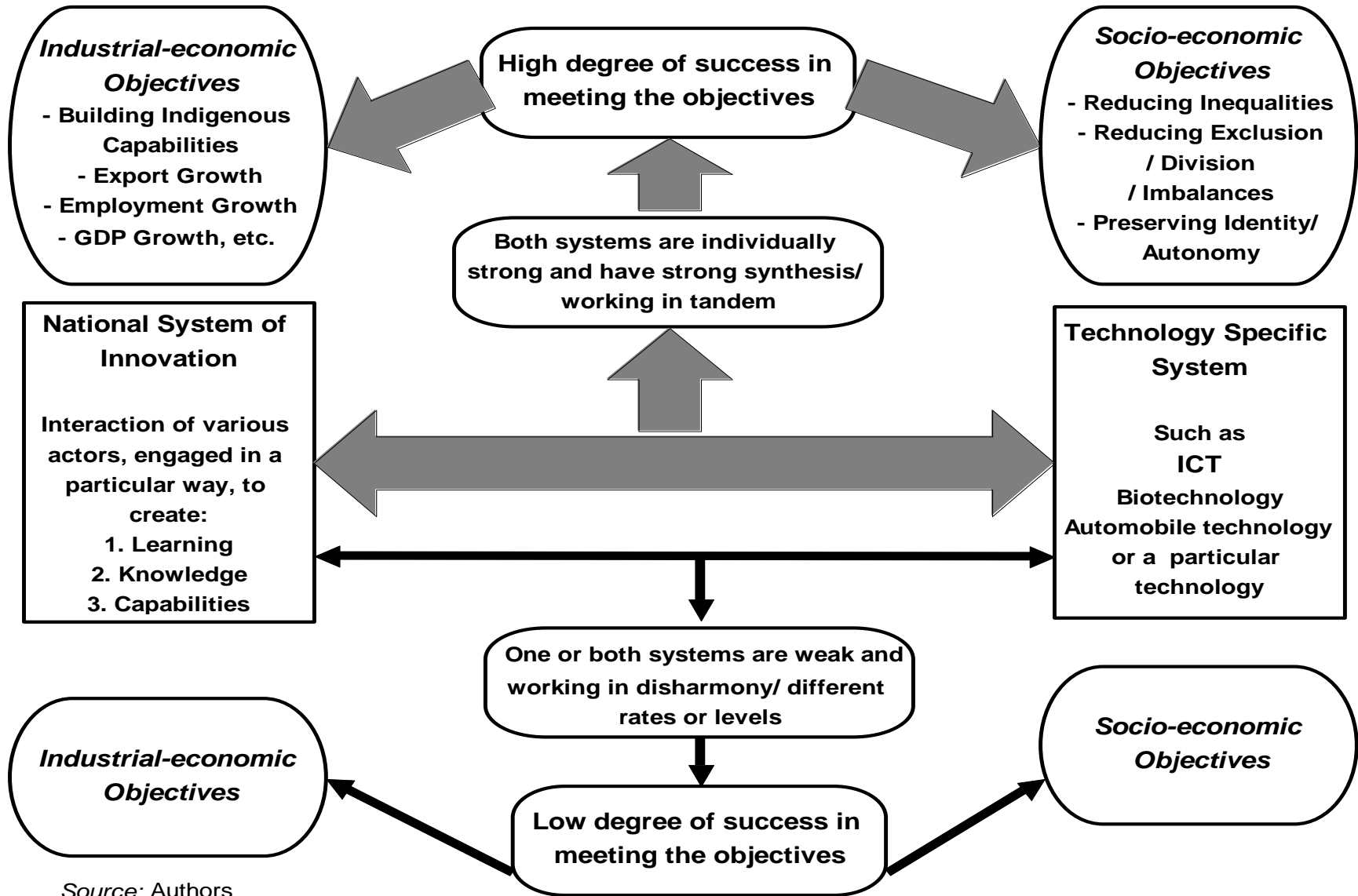
**Figure 2: Linkages between Institutions, Technologies, Knowledge and Incentives in NIS**



# **Institutions, Technology, Incentives and Linkages in National Innovation System (NIS)**

- ***Infrastructure:***  
Science & Technology, Intellectual Property Rights, Government Policy, ICT, and Culture.
- ***Investment:***  
R&D Expenditure and Government R&D Support, Venture Capital, and FDI.
- ***Knowledge and Talent:***  
Education and Human Resources development, and Labour Flexibility.
- ***Relations and Linkages:***  
University-Industry Linkages, Public R&D and Industry, Globalisation of MNC R&D, Transnational Networks.

**Figure 3: Linkages Between Systems of Innovation and Industrial-economic/ Socio-economic Objectives**



Source: Authors

# Linkage between National Innovation System and Technology Specific System (ICT)

## Positive Side:

- On the extreme positive side, national system of innovation and the ICT specific system are strong and show a high degree system synergy.
- This results in greater success in meeting both industrial related economic growth and broader social-economic objectives. In such environment, ICT can play a very positive role.

# **Linkage between National Innovation System and Technology Specific System (ICT)**

## **Negative Side:**

- On the extreme negative side, synthesis between broader NIS and ICT specific system is weak and they work in disharmony.
- In this case, both NIS and ICT will not lead to fulfilment of either narrow or wider social-economic objectives. Instead of positive contribution, ICT can play a negative role.

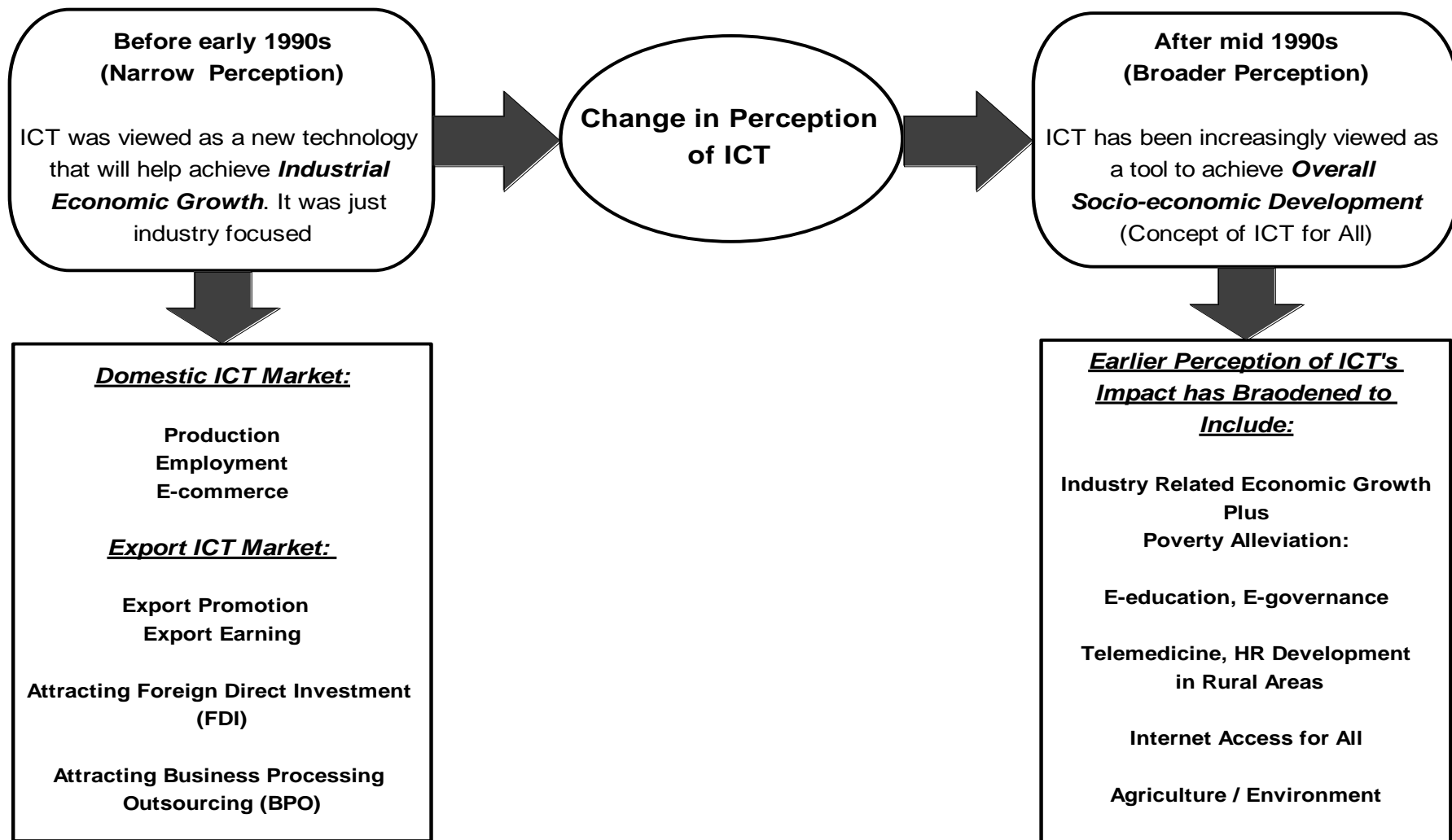
## **Between these two extremes:**

- it is possible there are varying degrees of system synergy and synthesis between NIS and ICT specific system.
- If this is relatively high, then some industrial and social objectives may be fulfilled but not all. If this is low, only few objectives can be realised.

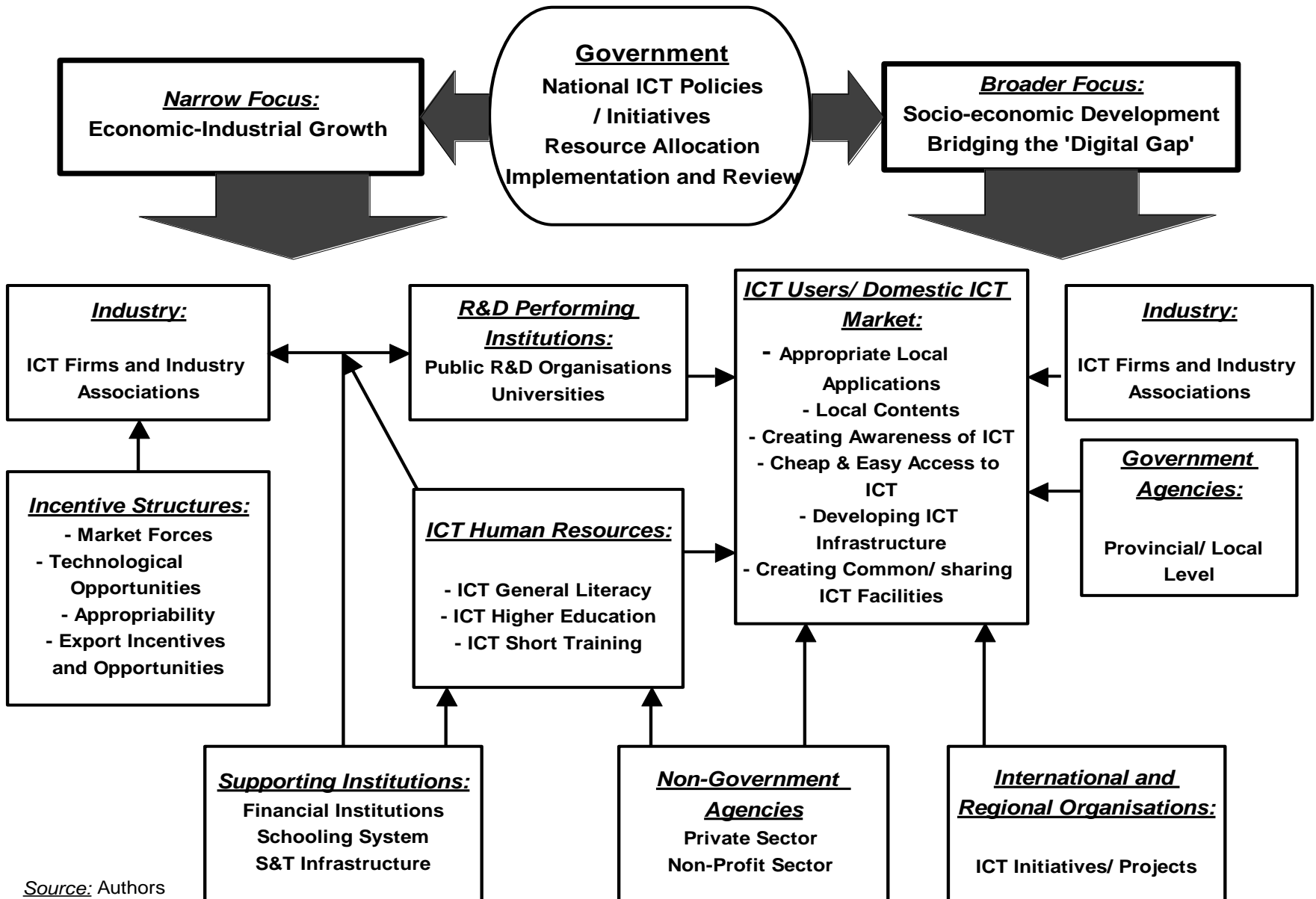
# Change in Perception of ICT: From Economic Growth to Broader Social-economic Development

- Until the early 1990s computer and telecommunications (mobile) technologies were viewed narrowly as new opportunities for industrial and export growth.
- Since the mid 1990s, increasingly ICT is being perceived by the national governments and international organisations as a vehicle for not only industrial economic growth (in terms of exports and employment), but also for achieving wider socio-economic development.
- G7/G8 Summit held in Okinawa in 2000
- The Millennium Declaration (Target18)
- United Nations Development Programme (UNDP)
- World Bank
- International Telecommunications Union (ITU)
- Various UN agencies have been promoting the application of ICT

**Figure 4: Change in the Perception of ICT:  
From a Technology for Industrial Growth to Tool for Achieving Overall  
Socio-economic Development**



**Figure 5: Technology Specific System (ICT ) -- Agents Involved**



Source: Authors

# Major Elements in ICT System

- Industrial growth through ICT (narrow objective): ICT industry, R&D performing institutions, incentive structures, ICT human resources and the supporting institutions.
- Socio-economic goals (broader objective): local and provincial govt. agencies, non-govt. agencies, R&D organisations, industry, ICT human resources, easy and cheap access to ICT, local involvement and awareness, and development of ICT infrastructure at the local level (rural areas).
- When the inter linkages are stronger between various elements, then it leads to an efficient ICT innovation system.
- When the linkages between them are weaker or when some actors are absent (or not strong), then it is likely to lead to an uneven or lopsided ICT innovation system.

# Results from Country Studies

- The NIS in all countries except Southern African countries have shown Lopsided and uneven characteristics, with distinctive national patterns of evolution.
- It appears that the effort to foster technology specific system -- ICT in these countries has not reduced the lopsided or uneven feature of the national innovation systems.
- However, there have been quantifiable achievements in both industrial-economic growth and broader social-economic goals in nearly all the case countries.
- In the case of Southern Africa, because of and to overcome their weak or absent national innovation systems, the countries appear to have turned towards a regional approach to foster ICT knowledge - innovation.

# Case Study of Brazil: Findings

- After liberalization, sophisticated telecom innovation system that was developed over many years was totally disarticulated.
- Telecom infrastructure started growing rapidly, but access remained uneven or lopsided, service tariffs remained high. Govt. trying to address this through initiatives such as 'Universal Access Plan'.
- IT policies in the 1980s had built up a significant capabilities in small computers, peripherals, various types of automation equipment.
- Most Brazilian hardware makers disappeared after liberalization.
- Only software and computer services industries experienced some growth, hardware industry never recovered the dynamism of the 1980s; several R&D teams were dismantled and R&D investment declined.

# Case Study of Brazil: Findings

- In case of wider access to computers, internet, increasing IT literacy, e-commerce, and e-governance: Made significant progress, still faces serious challenges.
- Internet users, telephone lines and mobile phones per 1000 population registered significant increase.
- Due to low levels of general literacy and prohibitive cost of computers, IT literacy and skills are below target levels.
- Diffusion of ICT was affected and hampered by very uneven income distribution. Large sections of northern and central parts do not have access to ICT.
- Trying to foster collaboration between public and private sector to successfully implement ICT programmes. But private sector participation was not at expected level.
- Majority of the Brazilian population is still very much excluded from the information economy and society.

# Case Study of China: Findings

- Government played an instrumental role in actively pursuing the goal of 'ICT for development'.
- China gradually built up a comprehensive ICT infrastructure.
- A 'top-down' approach, where central government guides ICT development through a mixture of investment, intervention and policy initiatives, while local governments come up with implementation.
- Implementation often start with pilot projects to allow learning and gaining of experience before they are spread to the whole country.
- 'Localisation' of ICT policies is encouraged to make the ICT application better suited to local conditions and needs.
- But overlapping responsibilities between ministries appear to have led to tensions which reduced the effectiveness of implementation.

# Case Study of China: Findings

- Liberalization brought only limited competition in the telecommunication sector, more liberalization and competition is needed.
- Given the stronger innovation capability and efficiency of foreign companies, Chinese ICT companies have to improve their competitiveness to be able to survive.
- On the other hand, opening up will bring more opportunities for Chinese companies to collaborate with foreign companies.
- China's effort in bridging 'digital divide' has seen initial results, but the gap still appears to be large.
- Diffusion of ICT depends on people's ICT literacy. This is an area China needs to make significant investment.
- Although ICT has the potential to narrow the gap between the higher efficiency and lower efficiency tiers of national innovation system, so far it has achieved only limited success in this area.

# Case Study of India: Findings

- Comprehensive policy framework to build a strong ICT industry and to achieve socio-economic transformation and to make India a 'knowledge superpower'.
- State has played a vital role in developing the technology specific system - ICT.
- Implemented a number of policies and programmes towards achieving these goals.
- Created a strong ICT industrial base and capacity to compete in some areas such as IT software and ITES-BPO in the global market.
- Does not appear to have achieved same level of capacity in the area of utilising ICT for socio-economic changes.

# Case Study of India: Findings

- However, a number of initiatives (national, regional, and local level) have been taken in e-education, e-health, e-government, and so on and some progress appears to have been made.
- These are unevenly spread across the country.
- Succeeded when local people were clearly informed of their benefits and where there were local participation and good co-ordination and understanding between local people and the officials.
- Significant progress in facilitating universal access to ICT, particularly in the areas of mobile telephones, TVs, computers, and internet.
- Still most of the rural population and sizeable urban population have no access to ICT.

# Case Study of South Africa: Findings

- Formulated a strong policy/institutional framework for developing an efficient technology specific system - ICT.
- Like its uneven/lopsided national innovation system, the technology specific system - ICT has proved more efficient only in certain areas and inefficient in many other areas.
- In ICT industrial sector, there has been significant growth in terms of turnover, exports and employment, particularly in the area of software.
- But the industry lacks the necessary competitiveness to operate at a higher level of value chain and technological complexity.
- In socio-economic development and ICT diffusion, collaborative approach to designing and implementing projects by the government, private sector, and non-government (non-profit sector) agencies have been working successfully.

# Case Study of South Africa: Findings

- Number of collaborative ICT projects in the area of e-education, e-health, e-government, IT literacy, and IT skills creation have been implemented at different levels (national, provincial, and local).
- But their impact is not yet fully evaluated or clear.
- However, there have been significant achievements in ICT usage like the increase in the use of fixed and mobile phones, computers, internet, IT literacy and IT skills.
- Large sections of people and the country, particularly rural areas, have no access to ICT and they are not even aware of the benefits of ICT.
- Technology specific system - ICT in South Africa has not been able to remove the historical imbalances in the sector.
- ICT definitely has the potential to reduce certain economical, social and regional disparities, but it is unlikely to solve fundamental problems such as rural poverty and under development and imbalances in health care and education.

# Case Study of Thailand:

## Findings

- Since 1990s, two ICT master plans, together with the establishment of the ICT Ministry, and more structured ICT institutional framework.
- While ICT policies have been relatively well formulated, the actual implementation has not been systematically monitored or evaluated.
- Made significant progress in fostering ICT for development, but there are still major weaknesses.
- Electronics sector, the number one exporting industry, appears to be locked up in the lower end of the value chain, notwithstanding recent evidence suggesting an upward mobility along the value chain.
- Software industry and ICT services are still lagging behind other countries of the region.
- Access to ICT is still largely confined to relatively a small section of the society, mainly due to low income level and slow spread of computer literacy.

# Case Study of Southern African Countries: Findings

- Southern African economies are generally too small and lack necessary institutional infrastructure to design effective ICT policies on their own.
- Regional initiatives have proved to be a key means to develop harmonised frameworks that serve as a basis for national ICT policies.
- Regional economic communities have been the foundation for horizontal cooperation to emerge and for regional collaborative e-projects.
- These projects need coordination among themselves. Otherwise, Southern African countries might end up with several pieces of redundant infrastructure.
- Role of NEPAD and its e-Africa Commission in overseeing the priorities, overlaps and gaps of infrastructure e-projects becomes crucial.

# Case Study of Southern African Countries: Findings

- Some of the routes for interconnectivity do not attract commercial interest because markets are too small and/political risks are too high.
- Despite the relevance of regional initiatives, individual African national governments need to provide incentives for private investors to fill the financial gap.
- This should be coupled with more pro-active initiatives such as the provision of soft loans or specific licensing schemes.
- Despite these efforts to harmonise ICT development in the region, the status of ICT policies and activities varies greatly across countries.
- Southern Africa still faces many challenges in achieving its ICT development goals.
- However, war and poverty have not hindered the emergence of a path towards ICT development through collaboration.

**Table 1: Comparison of Selected Countries – Major Characteristics of and Major Events/Factors Shaping the National Innovation System**

<b>Brazil</b>	<b>China</b>	<b>India</b>	<b>South Africa</b>	<b>Thailand</b>	<b>Southern Africa</b>
<p>Lopsided and uneven characteristics, with distinctive national patterns of evolution.</p> <p>Influence of macroeconomic liberalization of the 1990s.</p> <p>NIS going through major changes, but continues to be lopsided and uneven.</p> <p>Aggravates even further the uneven and lopsidedness of economy and society.</p>	<p>Lopsided and uneven characteristics, with distinctive national patterns of evolution.</p> <p>Influence of macroeconomic reforms and opening up of economy from the mid 1980s.</p> <p>Resulted in two-tier NIS – higher efficiency level and lower efficiency level.</p> <p>Aggravates social, rural/urban and regional inequalities.</p>	<p>Lopsided and uneven characteristics, with distinctive national patterns of evolution.</p> <p>Influence of the shift from inward looking to outward looking NIS since early 1990s.</p> <p>Islands of excellence in selective civil and dual-use sectors.</p> <p>Aggravates social, rural/urban and regional inequalities.</p>	<p>Lopsided and uneven characteristics, with distinctive national patterns of evolution.</p> <p>Stratified by racial, and first economy (advanced industrial) and second underdeveloped economy.</p> <p>Aggravates rural/urban, social and regional inequalities.</p>	<p>Lopsided and uneven characteristic, with distinctive national patterns of evolution.</p> <p>Weak, fragmented and even stagnant, slow technological learning.</p> <p>Undergoing <i>system transition</i> since 2001 due to major shift in government policies and practices.</p>	<p>Weakly formed institutional arrangements for building national systems of innovation.</p> <p>Making and designing of innovation systems at South African Regional level may be the most likely route to organize capacity and innovative learning.</p>

**Table 2: Comparison of Selected Countries – Trajectory of ICT Contribution to Industrial-economic Growth**

<b>Brazil</b>	<b>China</b>	<b>India</b>	<b>South Africa</b>	<b>Thailand</b>	<b>Southern Africa</b>
<p><i>After liberalization:</i> Sophisticated telecom innovation system that was developed over the years was totally disarticulated.</p> <p>Most Brazilian hardware makers either disappeared or were bought out by foreign firms.</p> <p>Indigenous R&amp;D investment and capacity have declined.</p> <p>Significant achievements in Software sector.</p>	<p>Significant growth in all ICT sectors. But uneven growth between hardware and software sectors.</p> <p>In telecom sector, liberalization brought only limited competition.</p> <p>To increase the amount and quality of service, more liberalization and competition is needed.</p> <p>Chinese ICT companies have to improve their competitiveness to survive.</p>	<p>State has played a vital role in developing an innovation system for ICT, and created a strong ICT industrial base.</p> <p>High level of capability to compete globally in IT software and IT enabled services.</p> <p>But failed to develop such capability in the hardware sector.</p>	<p>In ICT industrial sector, there has been significant growth in terms of turnover, exports and employment.</p> <p>Significant growth, particularly in the software sector.</p> <p>However, the industry lacks the necessary competitiveness to operate at a higher level of value chain and technological complexity.</p>	<p>Government policy has been active in providing incentives for firms to change from their risk-averse state to more risk-taking actors</p> <p>Industry is locked up in the lower end of the value chain and software industry and ICT services are still lagging behind other countries of the region.</p>	<p>Weakly formed institutional arrangements for building systems of innovation in ICT sector</p> <p>Adequate institutional system and the ability to design and implement an effective ICT strategy are the main problems.</p> <p>Regional effort to build basic ICT infrastructure and capabilities</p>

**Table 3: Comparison of Selected Countries – Trajectory of ICT Contribution to Socio-economic Development Goals**

<b>Brazil</b>	<b>China</b>	<b>India</b>	<b>South Africa</b>	<b>Thailand</b>	<b>Southern Africa</b>
<p>Made significant progress in terms of increasing access to ICT such as internet, fixed and mobile telephones, and computer literacy.</p> <p>Still faces serious challenges in achieving all objectives.</p> <p>Attempt to spread ICT diffusion to the society as a whole “appears to have made little headway”.</p> <p>Majority of Brazilians are still very much excluded from the information economy and society.</p>	<p>Instrumental role played by the Chinese state in pursuing the goal of ICT for broader socio-economic development.</p> <p>Significant growth in terms of access to PCs, internet, fixed line and mobile phones, and IT education.</p> <p>Gap between rural and urban areas and the Western and Eastern regions.</p> <p>Historic ‘East-West divide’ in levels of development is also mirrored in the degree of ICT diffusion, presenting a picture of ‘digital divide’.</p>	<p>Significant developments such as access to internet, computer, fixed and mobile phones and IT education</p> <p>Despite numerous initiatives and programmes, India has not so far succeeded in effectively utilising ICT for socio-economic changes.</p> <p>Ambition to make India as ‘knowledge super power’ resides mainly in the development of the ICT industry and not in the broader diffusion of ICT to achieve social-development goals.</p>	<p>Collaborative approach to designing and implementing ICT projects by the government, private sector, and non-government agencies have been working successfully.</p> <p>Large sections of people and the country, particularly rural areas, have no access to ICT and they are not even aware of the benefits of ICT.</p> <p>Like the lopsided nature of national innovation system, its ICT innovation system has proved to be more successful in the first economy and not so in the second economy.</p>	<p>ICT policies have been well formulated, but implementation is still slow.</p> <p>Made significant progress in fostering ICT for development, but there are still major weaknesses.</p> <p>ICT access to wider society is low mainly due to low income and slow spread of computer literacy</p>	<p>Regional economic communities have been the foundation for regional collaborative ICT projects.</p> <p>Lack of coordination among projects.</p> <p>Despite regional initiatives for ICT development, there are great variations across countries.</p> <p>Role of NEPAD and its e-Africa Commission in overseeing the priorities, overlaps and gaps of ICT projects crucial.</p>

# Findings on Conceptual Question

- *How much does ICT form an integral part of the national system of innovation of the selected economies?*
- Brazil: NIS (which continues to be lopsided) is going through a major change and technology specific ICT system in Brazil has followed the trend in NIS that saw the role of production dominated by the MNC's subsidiaries growing over that of indigenous firms.
- China: Although ICT has the potential to narrow the gap between the higher efficiency and lower efficiency tiers of national innovation system, so far it has achieved only limited success in this area.
- India: Technology specific ICT system in India has not been able to overcome the 'lopsided' phenomenon of its NIS. This led to uneven growth within narrow ICT industry and in wider socio-economic development.

# Findings on Conceptual Question

- *How much does ICT form an integral part of the national system of innovation of the selected economies?*
- South Africa: Like its uneven/lopsided NIS the technology specific ICT system has proved more efficient only in certain areas and inefficient in many other areas.

Although it has the potential to reduce certain economical, social and regional disparities, it is unlikely to solve fundamental problems such as rural poverty and under development in health care and education.

- Thailand: It is not very clear and it is difficult to locate the exact nature of spillover effects of ICT on Thailand's national innovation system.
- Southern Africa: Weak institutional arrangements for building national systems of innovation. Turning towards regional effort to build institutions and capabilities.

# ***General Findings***

- All country case studies accept that it is important to develop technology specific ICT systems.
- All agree on ICT's importance in contributing towards economic growth; and its potential for solving some social issues is also clear.
- They also accept that government role is critical in stimulating the ICT industry and meeting broader social objectives.
- Creating a dynamic ICT sector and integrating it to the wider system of innovation can create significant developmental economies, efficiencies and dynamics.
- It is pivotal that ICT is recognised as a key technology system that can strengthen a country's national system of innovation.

# ***General Conclusions***

- ICT infrastructures are public goods and creating them requires large investment.
- In developing countries with weak private sectors, only government has such resources, which means government needs to invest heavily in ICT infrastructure to provide necessary physical condition for ICT diffusion.
- Autonomous and specialised policy agencies outside bureaucratic red-tape might be better instruments in formulating and coordinating national ICT policies.
- Extent to which a country can benefit from ICT depends on the quantity and quality of its human capital. Education therefore holds the key to a country's ICT development and diffusion.

- Policy makers should review and learn from implemented programmes and promote successful cases and examples to enable the experiences to be shared across departments and regions.
- Many developing countries are doing relatively well in policy formulation, but they are weak in implementing and monitoring these policies.
- Need for bottom-up rather than top-down strategy in achieving wider ICT diffusion.
- Imperative to address root causes for unsatisfactory results of ICT for development programmes -- poor access to ICT, obstacles to computer literacy, and failure to 'localise' ICT contents and applications.

- Policy makers should not ignore the limitations of ICT and should strive to integrate it with other national policy frameworks to solve the problems of poverty, inequality, exclusion and division.
- Unless development of ICT is also shaped within a socially and politically framed national system of innovation, it is likely to create more diseconomies than economies.
- Where the value added from the ICT would come would be when it is integrated with the national innovation system to achieve what Friedrich List called mental capital building as a means of wealth accumulation.

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