

Discussion Paper: e-Development Index

The Discussion Paper Series is intended to encourage discussion on the draft version of the papers. The idea is to bring out quickly research in progress and have comments from experts in the field. Any suggestions/comments are welcome.

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Discussion Paper: e-Development Index

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Executive Summary

As per economic theory, digitalisation of the economy impacts economic growth in two ways: one as an input in to production process and the other as an enhancer of productivity through technological process. The connection between digitalisation and economic development in the Indian Context is now empirically, well established.

- India ranked among the first five countries in the export of commercial services, computer and information services, communication services and other business services in 2008. ICT that made all commercial sectors tradable across borders without movement of natural persons has been identified as the catalyst in the process of transcendence to economic leadership in trade of commercial services within a short span of less than a decade.
- India's skill stock to capture ICT opportunities, the demographic dividend have been identified as the reasons behind India's transcendence. The beneficial impact is evident in terms of employment of knowledge professionals in the Indian IT and BPU sector-which numbered more than 2 million in 2008.
- The macro impact of digitalisation on economic growth and employment has been estimated by the Central Statistical Organisation in the form of output and employment multipliers for the computer services trade in the Input-Output Table. The Social Accounting Matrix framework developed by the planning commission traces the impact of an increased production in IT sector at disaggregated levels by sectors in both urban and rural areas.

Given the extensive and intensive levels of IT's role in the Indian economy, there is a keen desire to know the progress in digitalisation of the national economy as well as drivers of the digitalisation.

In this paper we have attempted to conceptualise digitalisation in the Indian context and propose to develop the e-Development Index to measure the progress in extent of digitalisation and the factors which are driving to accelerate the process of economic development.

The three elements digitalisation, in the Indian context, can be conceived of as:

1. Connectivity/Networks consisting of end user connections and the exchange points between the lines; could be mobile phones, satellite communications and packet switching.
2. HR and IT services consisting of the skill stock to capture IT related opportunities, and IT service to administer networks and ensure that security standards are adhered to
3. Content/Information in the form of digital goods such as land record, caste certificates, government schemes for development etc delivered via the internet in the regional language of the users choice.

The three main Stakeholders Government, Industry and Individuals use the elements of digitalisation to develop e-Government applications, software products and/or download complex internet products. The factors which are driving to accelerate the process of economic development would be e-Innovation such as innovation in processes/products that aid financial inclusion, facilitate marginalised sections in the use of IT Networks, as well as e-Social factors that have demonstration effects.

In other words the measure of extent of digitalisation as well as the factors driving the process of economic developed can also be conceived of as a composite index measure of the following sub-indices:

1. e-Readiness Index
2. e-Government Index
3. e-Industry Index
4. e-Innovation Index and
5. e-Social Index

Discussion Paper: e-Development Index

1.0 Invitation of Views and Suggestions

- 1.1. The Department of Information Technology (DIT) is releasing a discussion paper/concept paper on a composite index called e-Development Index (eDI). DIT in collaboration with the National Council of Applied Economic Research (NCAER) in the development of this digitalisation index. This index will measure the extent of digitalisation and the drivers of the digitalisation process in the Indian economy. The present concept paper provides details on enlarging the vision of development to include digitalisation.
- 1.2. NCAER and DIT have been measuring the e-Readiness of Indian States/UTs since 2003. The DIT-NCAER e-Readiness Index is a composite index which measures the ability of state governments/UTs to pursue and realise value creation opportunities facilitated by ICT. eDI represents transcendence from the development of e-Readiness indicators.
- 1.3. The views and suggestions are specifically invited on the concept paper to enable the Department to decide on the way forward. The views expressed in the note should not be construed as the views of the Department.

2.0 Introduction

2.1 ***Development and Digitalisation:*** The present concept paper provides details on enlarging the vision of development to include digitalisation. The simplest definitions of the two key terms as they exist in economic theory are:

2.1.1 ***Digitalisation*** is the process of expressing information in strings of 0 and 1. It affects all economic segments without necessarily being visible. The three main components of digitalisation are networks, information technology (IT) services and digital goods. (Vogelsang, 2010)

2.1.2 ***Development*** is thought of as a “multidimensional process involving major changes in social structures, popular attitudes, and national institutions, as well as the acceleration of economic growth, the reduction of inequality, and the eradication of poverty” (Todaro and Smith, 2006).

2.2 The paper focuses on ***the digitalisation of this multi- dimensional process, i.e., the supply side***. Specifically, we are going to use a composite index to measure the extent of digitalisation of the supply side of the Indian economy. Our objective is attained through a three-step process. They are:

- How digitalisation has facilitated and can further enable the process of Indian growth and development
- To understand the concept of digitalisation in the Indian context.
- To devise a way to measure digitalisation in the Indian economy.

3.0 Theoretical Linkages Between Digitalisation and Economic Development

3.1 In this section we understand the theoretical linkages between digitalisation and economic growth & development.

3.2 ***Digitalisation and Economic Growth:*** As per economic theory, digitalisation can affect economic growth in two ways. It can be an input in the production process as well as enhance productivity through technological progress (Vogelsang, 2010). Both ways increase the ability of an economy to use its increased resources in a more efficient manner to produce more goods and services and, in turn, foster overall economic growth. In other words, digitalisation supply facilitates supply side response.

3.3 ***Digitalisation and Economic Development:*** Technology has the innate ability to enable participation of the marginalised and bring them into the mainstream, which aids economic development.

4.0 Why is the connection between Digitalisation and Economic Development important in the Indian context?

4.1 In this section we show the rising importance of the services sector especially computer and information services for the Indian economy both in terms of output and employment.

- 4.2 **Services Sector:** “The services sector has been India’s workhorse for well over a decade”. The compounded annual growth rate (CAGR) for the services sector was 9 per cent in contrast to 5.8 per cent CAGR for the non-services sector for the period 2000-01 to 2006-07. The shares of the three sectors in GDP at factor cost for 2009-10 are 14.6 per cent, 28 per cent and 57.2 per cent for agriculture, industry and services, respectively (Economic Division, Department of Economic Affairs, Ministry of Finance, Government of India, 2010).
- 4.3 **Trade in Services Sector:** World Trade Organisation (WTO) labels trade in services as trade in commercial services (not including trade in government services). Trade in commercial services includes trade in transport, travel and other commercial services. Trade in other commercial services includes trade in communication, construction, insurance, financial, computer and information, royalties and licence fees, other business and personal, cultural and recreational services. Trade in computer and information services is not related to trade in merchandise, whereas trade in financial services is complementary to trade in goods. Telecommunications and computer technology have made all commercial services tradable across borders without movement of natural persons.
- 4.3.1 “Among top exporters/importers of services (with EU-27 taken as a single unit), India ranked among the first five countries in the export of commercial services, computer and information services, communication services & other business services and in the import of computer and information services and financial services in 2008” (Economic Division, Department of Economic Affairs, Ministry of Finance, Government of India, 2010).
- 4.3.2 The reasons behind India’s emergence as a top exporter in commercial services are:
- Skill stock to capture opportunities
 - Employment
 - Demographic dividend
- 4.4 **Employment in the Services Sector:** Services account for approximately 26 per cent of total organised sector employment in the country. The contribution to employment of services (excluding construction) rose from 22.8 per cent to 23.4 per cent, while the workforce increased from 397.0 million to 457.8 million between 1999-2000 and 2004-05 (Planning Commission, Government of India, 2008).
- 4.4.1 The number of total knowledge professionals employed in the Indian IT-BPO sector increased from 230,000 in 1998 to nearly 2 million 2007-08, with a higher proportion of people working for the export & BPO sectors (Planning Commission, Government of India, 2008).
- 4.5 **Empirical Evidence of Digitalisation on Economic Growth and Development:** The Central Statistical Office (CSO) has estimated through its Input-Output Table for reference year 2003-04, where computer-related services has been included as a

separate row item, that the **Output Multiplier for computer-related services is 2.1**. This means that for every one unit of output in the sector, the domestic economy would be stimulated by an additional 1.1 unit. In other words, export of one unit by the IT sector may stimulate the domestic sector's output by an equal amount. Since Information Technology (IT) is intertwined with communication services, the forward linkage of the IT sector is also significant (Venkatesan et al., 2007).

4.5.1 The Social Accounting Matrix (SAM) framework allows us to study the impacts of the IT sector at a disaggregated level by sectors. **The SAM analysis finding was that while the major impact of increased IT production was on affluent urban households, rural poor households also felt the positive impact on account of increased production** (Venkatesan et al., 2006).

5.0 Concept of Digitalisation in India and e-Development Index

5.1 In this section we conceptualise digitalisation in the Indian context and define the e- Development Index.

5.2 The ***international concept of digitalisation*** is that it is composed of three elements – networks, IT services and digital goods.

5.2.1 **Networks** are divided in two components – end-user connections and the exchange points between the lines. Mobile phones, satellite connections and packet switching have replaced copper wires, fibre cables and circuit switching of telephone data networks (Vogelsang, 2010).

5.2.2 **IT services** are a subset of commercial services, which include hardware- and software-related services and data-processing services. They include the following (RBI, 2010):

- Hardware and software consultancy and implementation services.
- Maintenance and repair of computer peripheral equipment
- Disaster recovery services, provision of advice, and assistance on matters related to management of computer resources.
- Analysis, design and programming of systems ready to use (including webpage development and design), and technical consultancy related to software.
- Development, production, supply and documentation of customised software, including operating systems made to order for specific users.
- System maintenance and other support services such as training provided as a part of consultancy
- Data processing services such as data entry, tabulation and processing on a timesharing basis
- Webpage hosting services (i.e., the provision of server space on the Internet to host clients' web pages).
- Computer facilities management

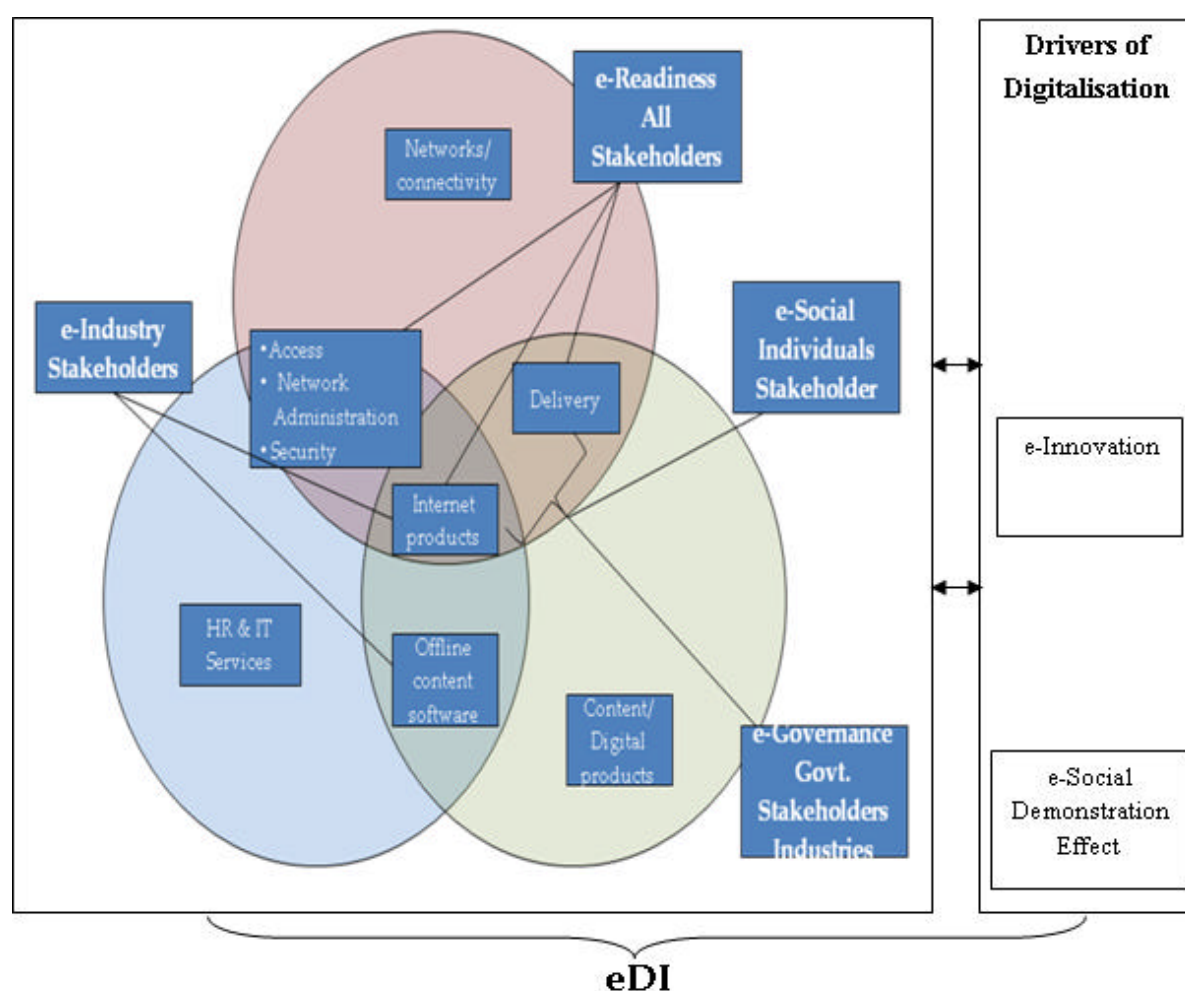
- 5.2.3 **Digital Goods** are those which are expressed in binary 0 and 1 strings, such as music files, mobile ring tones, and electronic books (Vogelsang, 2010).
- 5.3 **Indian context:** With a 60% literacy rate and a mere 6.9% penetration rate of the Internet, it is important to re-define digitalisation in the Indian context.
- 5.3.1 **Adapting Digitalisation to the Indian Context:** We re-label networks as connectivity or environment. IT services is expanded to include both human resources (HR) and IT services as the Indian experience shows that appropriate skilled labour is a crucial element in adaptation and dissemination of IT in a developing country. Digital goods are relabelled as content which in the Indian context would mean that users have the information they want available and in the regional language of their choice.
- 5.3.1.1 Connectivity or Environment is crucial for the delivery of human resources (HR) & IT services and digital goods.
- 5.3.1.2 HR& IT services here control and administer networks, and ensure that security standards are adhered to.
- 5.3.1.3 Content may be land records, agriculture-related input and advice, government schemes for development, caste certificates, and computer courses that could be delivered via the Internet in the regional language of the users' choice.
- 5.3.1.4 When the "Government", as an important stakeholder, uses the intersection of connectivity, content and delivery, it creates various governance (Internet) applications or e-Governance.
- 5.3.1.5 When IT services and connectivity intersections are used by the main stakeholder, "Industry", offline content/software products and complex internet products are developed which can also be delivered to both domestic and international markets. In other words, this is e-Industry.
- 5.3.1.6 When the other major stakeholder, "Individual", downloads exam results, s/he uses complex Internet products. Also the individual stakeholder participates in the intersection of content and connectivity when s/he seeks delivery of services from the government and business economic sectors.
- 5.3.1.7 "e-Innovation" refers to innovation in products and/or processes. For example, innovation may allow for speech-based value added services through mobile Internet, thereby enabling people to connect, irrespective of their literacy status.

5.3.1.8 “e-Social” refers to an intersection of content and connectivity for individual stakeholders. The “demonstration effect” can act as a driver for faster adaptation of IT services or getting appropriate HR skills.

5.3.1.9 Figure 1 shows the digitalisation model in the Indian context.

5.4 Therefore, *the e-Development Index (eDI) is a composite index which measures the extent of the digitalisation of the Indian economy and the factors which are driving it to accelerate the process of economic development in India.*

Figure 1: Digitalisation of the Indian Economy: Relationship between Content, Connectivity and IT Services



5.5 The entire model represented in Figure 1 where all stakeholders — individuals, businesses and government — participate represents the “extent of digitalisation” of the information society. The drivers of digitalisation are the e-Innovation and e-Social economic components. Table 1 sums up digitalisation in India with its various components.

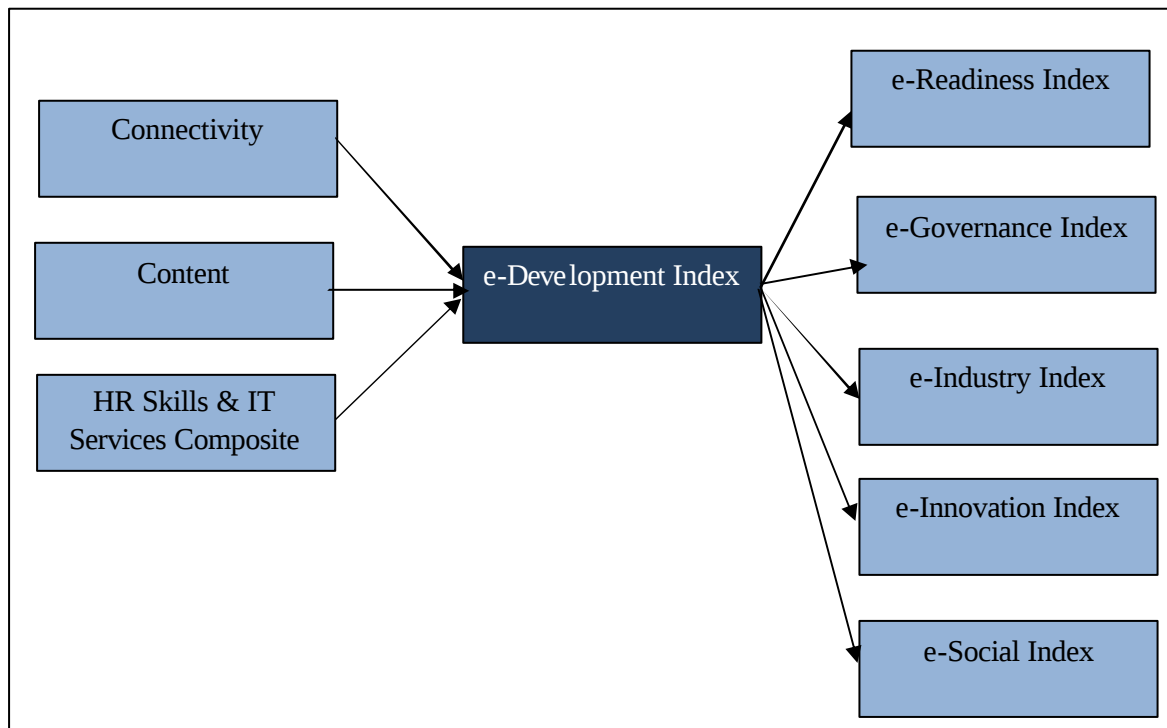
Table 1: Components of Digitalisation in India

Stakeholders	IT Segments	Drivers
Government Individuals Businesses	- Connectivity/Network/Environment - HR & IT services - Content	- e-Innovation - e-Social Demonstration Effect

5.6 The intersection of stakeholders, IT segments and drivers from Figure 1 yields the “five pillars” of eDI (three products/processes and two drivers) illustrated in Figure 2. The five pillars are:

- **Products/Processes**
 - ❖ e-Readiness (economic): Identification and realisation of value-creation opportunities facilitated by ICT for stakeholders.
 - ❖ e-Governance (administrative): ICT-enabled governance potential at the State/ UT level.
 - ❖ e-Industry (industry and services): Production, exports and employment of IT services (technology embedded), ICT-triggered services (commercial services), ICT goods and ICT-triggered goods.
- **Drivers**
 - ❖ e-Innovation (innovation triggered by IT): Innovation activities facilitated by IT in technology-embedded and technology-enabled services including banking, services sector development in rural areas, etc.
 - ❖ e-Social (Demonstration Effect): Applications of IT in health and education and measurement of disparity in access/usage of IT.

Figure 2: e-Development Index

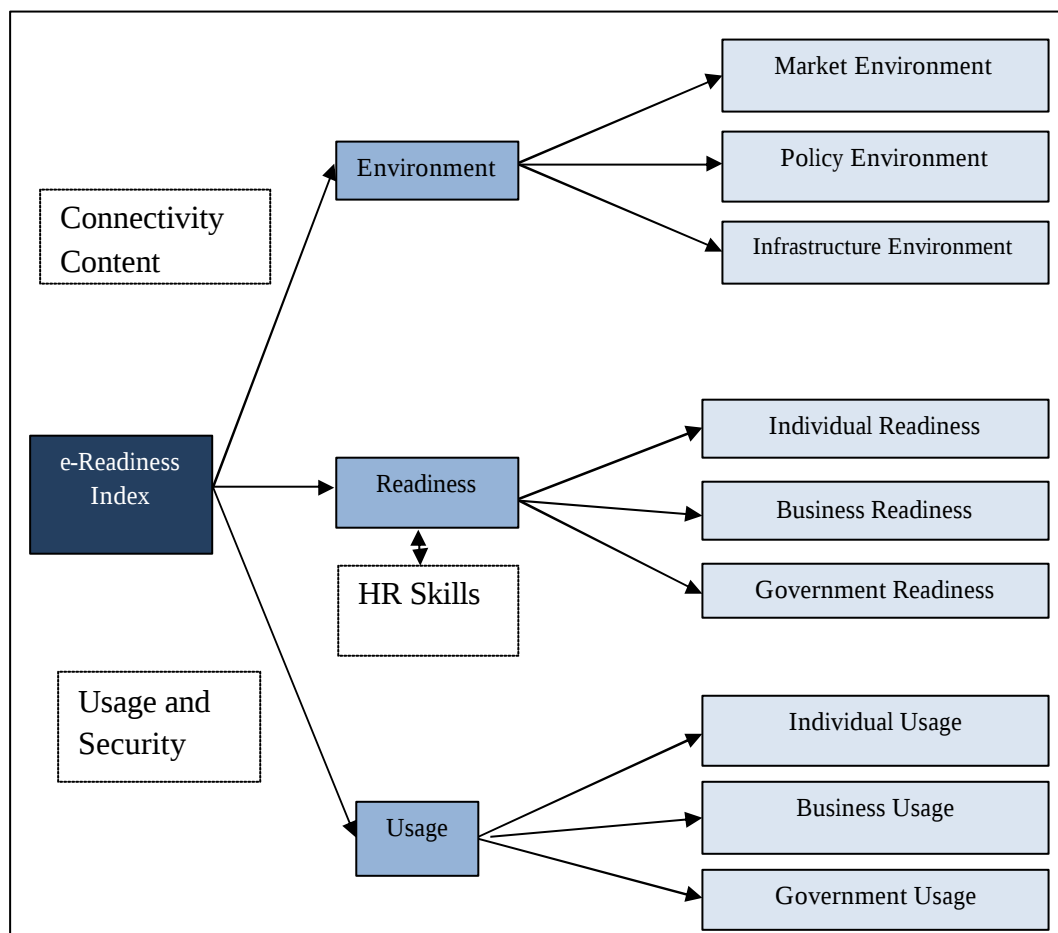


6.0 Measure of Digitalisation: Five Pillars of the eDI

6.1 e-Readiness Index

6.1.1 Our understanding of e-Readiness is that it is the ability to pursue and realise value creation opportunities facilitated by information and communication technology (IT). Therefore, it goes beyond IT tools such as computers, websites, Internet service providers, internet connections, telephones and mobiles, and considers the ability or readiness of the main stakeholders as well as the effective use of technology. The three main stakeholders that we consider explicitly for conceptualising and measuring the e-readiness index are individuals, businesses and the government.

Figure 3: e-Readiness Index



6.1.2 The framework of the e-Readiness Index being used since 2003 is shown in Figure 3. This framework covers the characteristics of connectivity, content, human resource skills, security and usage. The three major components of e-Readiness are: environment, readiness and usage. It is our understanding that a sound environment needs to be put in place at the initial stage for effective use of IT and this covers connectivity and content. This environment would include policy environment, market

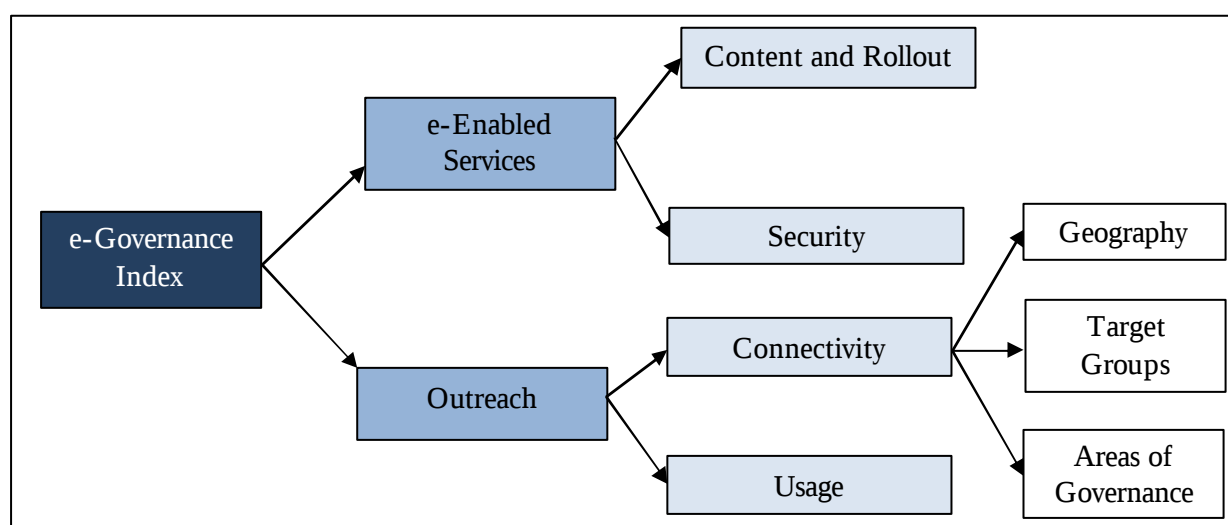
environment (competition) and infrastructure environment. Readiness includes capacity building or skill formation within the different stakeholders as well as their access to the infrastructure which may have been put in place either by the public or the private sector. This therefore covers the area of human skills. Usage is the actual utilisation of information technology given a conducive environment and positive state of readiness. In this sense, the level of environment and readiness is a precondition for usage of a certain level. Usage and security characteristics would be covered under this component.

6.2 *e-Governance Index*

6.2.1 IT-enabled governance at the state/UT level for improving the delivery of public services, for improving intra-governmental co-ordination and for efficient co-ordination with businesses and administrators at various levels was included as the next major step in evolving the composite e-development indicator.

6.2.2 Figure 4 shows the framework of the e-Governance Index. It is made up of two components — e-enabled services and outreach. e-Enabled services would cover content characteristics, i.e., whether government services are available and, if available, are they available in the local language. Outreach covers a variety of characteristics including connectivity, usage and human resource skills. Connectivity here would include connectivity across geography, target groups and areas of governance. Usage would translate to actual uptake of available government services. Outreach will also measure the ability of government representatives to actually enable users to use the programs and information in a secured environment.

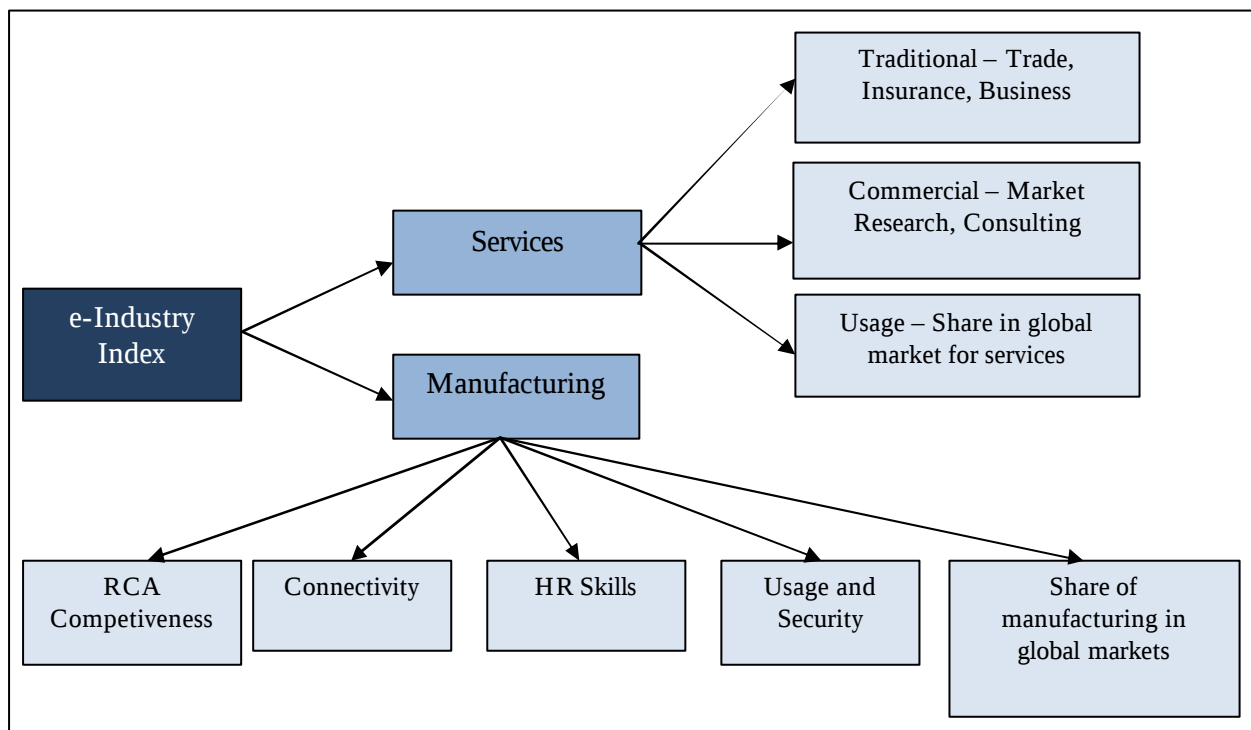
Figure 4: e-Governance Index



6.3 *e-Industry Index*

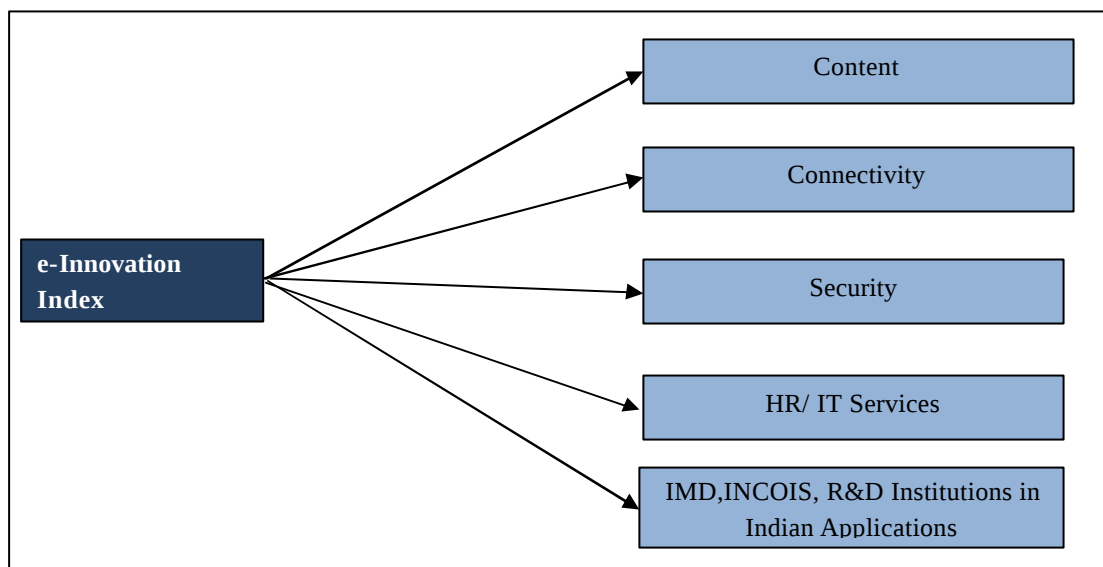
6.3.1 e-Industry is designed to capture IT, IT-triggered and IT-enabled activities in the economy, including both manufacturing and services. This component of eDI will realise the competitive advantages with economic aspects such as connectivity, HR skills, and usage & security. The “usage” characteristic will not only capture the domestic aspect but also the share of services and manufacturing in their respective global markets. Figure 5 illustrates the components of e-Industry and how they capture various characteristics of the IT industry.

Figure 5: e-Industry Index



6.4 *e-Innovation Index*

Figure 6: e-Innovation Index

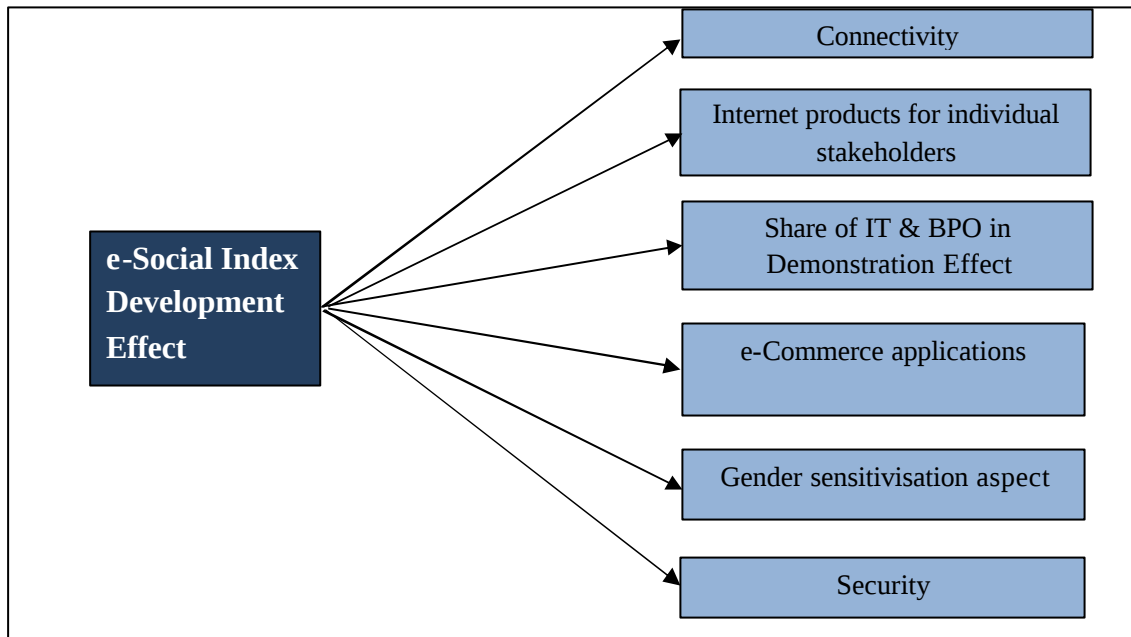


6.4.1 Innovation would not be restricted to hardware but would include mainly:

- Content – in Indian languages and in diverse application areas;
- Connectivity – Financial inclusion (banking for the unbanked), connectivity for target groups and rural areas through Computer Service Centres (CSCs);
- HR and IT Services – would include higher HR skills to evolve methods of delivery of service innovations; and
- Security – to ensure that cyber security is upgraded to deal with unforeseen cyber-attacks.

6.5 ***e-Social Index***: The demonstration effect of society while responding to digitalisation is captured by the e-Social Index. The economic components of this sub-index include connectivity, access to Internet products by individuals, the impact of employment in the IT and BPO sectors, e -Commerce applications, etc.

Figure 7: e-Social Index



6.6 *To encapsulate eDI would be the weighted mean of*

$$\text{e-Development Index} = \text{e-Readiness Index} + \text{e-Governance Index} + \text{e-Industry Index} + \text{e-Innovation Index} + \text{e-Social Index}$$

7.0 How is eDI derived?

- 7.1 The five components of eDI given above will be combined. A multi-stage Principal Components Analysis (PCA) will be used to derive the weights in the respective components. Individual indicators within each component may be divided as per the characteristics of the IT sector in the Indian economy. The weights assigned to the variables are directly proportional to their respective strength of statistical association with the other variables, thereby eliminating indicators which have less influence.
- 7.2 PCA explains the maximum percentage of variation of the original dataset, and is therefore used to calculate the composite index. The likelihood that the first principal component explains a greater percentage of variation of the original data increases if the variables are small in number. This is the reason for using multistage PCA, where smaller number of variables for sub-indices is again integrated to construct a higher-order index.
- 7.3 The eDI index ideally, need to be calculated for 35 states/UTs and another one that reflects the national average. In the interim, we plan to derive eDI index as a combination of three products/processes and two drivers. We need to validate these results by examining the extent of digitalisation & the role of drivers in

arrising at the composite eDI The International Telecommunications Union (ITU) in its recent report has chosen this method over others due to its advantages in: 1) its ability to select relevant variables in constructing the composite index and 2) its scientific basis for assigning weights.

- 7.4 The indicators to be used for developing e-Readiness, e-Governance, e-Industry, e-Innovation and e-Social indices are detailed in Annex 1.

8.0 Comparison of the indices

- 8.1 In DIT-NCAER's e-Readiness composite Index, the e-Readiness indicator is considered as the ability to pursue and realise value creation opportunities facilitated by ICT and to judge whether the digital divide in States/UTs is widening or narrowing. The data used to calculate the index as mentioned earlier is taken from the primary survey of state/UT governments and also hard data available from DoT, TRAI, the Ministry of HRD, the RBI, etc.
- 8.2 The ICT Development Index developed by ITU measures the widening or narrowing of the global digital divide and measures the usage of ICT for social and economic development in relative terms.
- 8.3 The UN e-Government Readiness Index has a citizen-centric approach to delivery of ICT services. This is a cross-country study of 192 countries and has three main sub-indices: the web measure index which reflects government readiness, telecommunications infrastructure index and human capital index. Data are procured from sources like ITU, UNESCO, UNDP Human Development Report, and the UN Web Assessment Survey.
- 8.4 The EIU e-Readiness Index focuses on ICT infrastructure and stakeholders' ability to use ICT infrastructure. The index is calculated for 70 countries and data is taken from sources like the EIU, Pyramid Research, World Bank, United Nations, and WIPO.
- 8.5 The WEF's NRI measures the propensity for countries to exploit the opportunities offered by ICTs; more specifically, the NRI seeks to comprehend the impact of ICT on the competitiveness of 134 nations. The index has the same variables or indicators as DIT-NCAER's e-Readiness Index. The hard data used in the calculation of the index is taken from the UN and the WB, while the primary data is ITU Survey Data from the WEF's annual Executive Opinion Survey.
- 8.6 Table 2 below summarises the drawbacks/merit of different approaches in measuring the extent of digitalisation.

Table 2: Comparison of e-Readiness Studies

Back Outline	UN e-Government Index	EIU e-Readiness Index	WEF NRI	IDC (ITU)	NCAER
Mission Statement Purpose	- e-Government to connected Government “Citizen centric” delivery of services & content	- Quality of ICT infrastructure - Ability of stakeholders to use it to their benefit	- To comprehend ICT impact on the competitiveness of Nations - Relative concept	- Global Digital Divide is widening or narrowing - ICT use on social & economic development - ICT achievements relative to others	- States’ ability to pursue & realise value creation opportunities facilitated by ICT - States/UTs Digital Divide is widening or narrowing
Components	- Composite Index of 3 sub indices: - Web measure Index (5 stages) - Telecomm infrastructure - Human capital index	6 categories: - Connection & Technology Infrastructure - Business environment - Social & central environment - Govt. policy & vision - Individual policy & vision	3 sub indices & 9 pillars: - Environment (ME, PRE, IE) - Readiness (IR, BR, GR) - Usage (IU, BU, GU)	- ICT Readiness (Infrastructure & Access) - ICT capability (skills) - ICT use (incensory)	3 sub indices: - Environment (ME, PRE, IE) - Readiness (IR, BR, GR) - Usage (IU, BU, GU)
Drawback / Merit	- No analytical model - One stake holder prominence - Weights - subjective - Composite index equal weights for sub indices	- No analytical model - Weights subjective - Composite indicator based on analysts perception of Importance of sub indices	- Analytical model applied - Weights are subjective - Composite indicator equal weight for sub indices	3 stage information society model - Use of PCA to eliminate indicators that have less influence - PCA for obtaining weights (implicitly assumed) - Analytical model is not	3 stage information society model - Use of PCA to eliminate indicators that have less influence - PCA for obtaining weights

9.0 Other Studies

- 9.1 As an input factor, the adoption of IT impacts economies at two different but interrelated levels. The first is the contribution of ICT to output, i.e., the contribution in output and employment due to production of IT-related goods and services (Joseph and Abraham, 2007). Heeks (2002) describes this as the “extensive” role of ICT.
- 9.2 The second contribution of IT to an economy is increased productivity, competitiveness, growth and human welfare due to IT diffusion (Joseph and Abraham, 2007) or what Heeks (2002) calls “intensive” uses of IT.
- 9.3 Extensive Level – IT’s role on the input side: There is clear and unambiguous evidence that India has been very successful in this area. Ramchandraiah (2003) finds that the development of the ICT sector in India has boosted Indian service sector exports and employment and Kapur (2002) stresses the importance of the IT sector as a catalyst for India's growth.
- 9.4 Intensive Level – IT’s role as productivity enhancer. The evidence is more mixed when it comes to the intensive role of ICT in India. Tanguturi and Harmantzis (2008) find that India lags behind China in ICT infrastructure. Lal (2004) analysed garment manufacturing firms located in Okhla, India and found that firms which adopted e-business tools generated a higher level of exports; Lal

(2001) finds a positive relation between labour productivity and IT investment. Basant *et al.* (2006) studied IT adoption and productivity in developing countries; using firm level data for India and Brazil they found results similar to Lal (2001). Joseph and Abraham (2007) find evidence of a positive impact of IT investment on productivity in India's manufacturing sector.

9.5 *IT in Rural Applications*

9.5.1 One successful example of ICT in the rural sector that is often cited in the Indian literature is the implementation of ICT in milk collection in Gujarat (Chakravarty, 1999). However, Tiwari and Sharmistha (2008) find that the uptake of e-services in rural areas is lower than optimum because of low demand and informational asymmetries; this uptake is even lower among the illiterate. Singh (2006) has examined extensively ICTs and rural India both on the demand and supply side. He finds that significant challenges exist in making ICT available to rural India but conditions are slowly and steadily improving. Heeks (2002) and Tiwari and Sharmistha (2008) mention a gender bias in ICT usage in India, both in the manufacturing and rural sectors. Dada (2006) hypothesises that one reason for the failure of e-government in developing countries is the difference between actual technology (hard) and the social context (people, culture, politics, etc.) in which it operates (soft). Dada (2006) provides support for this hard-soft gap hypothesis using an example from e-government initiatives in Kerala (Mahon, 2004).

10.0 Conclusion

10.1 Digitalisation has a positive impact on economic growth and development. Digitalisation in the Indian context means that the three stakeholders — individuals, industry and government — are connected through HR& IT services and content. Innovation and the demonstration effect intensify the adoption of IT. Out of these, five components of digitalisation emerge — e-Readiness, e-Governance, e-Industry, e-Innovation and e-Social. These five components measure the extent of digitalisation and the factors which are driving it to accelerate the process of economic development in India.

References

- Basant, R., S. Commander, R. Harrison and N. Menezes-Filho. 2006. "ICT Adoption and Productivity in Developing Countries: New Firm Level Evidence from Brazil and India". IZA Discussion Paper No. 2294. September.
- Central Statistical Office, National Statistical Organisation, Ministry of Statistics and Programme Implementation, Government of India. 2010. "Value Addition and Employment Generation in the ICT Sector in India".
- Chakravarty, R. 1999. "Use of IT at Milk Collection Centres in Co-operative Dairies". Paper presented in the workshop on Information and Communication Technology for Rural Development in India. IIM Ahmedabad. March 18-20.
- Dada, D. 2006. "The Failure of E-Government in Developing Countries: A Literature Review". *Electronic Journal of Information Systems in Developing Countries*, 26(7): 1-10.
- Dutta, S. and I. Mia. 2010. "Global Information Technology Report 2009-10: ICT for Sustainability". http://www.weforum.org/pdf/GITR10/GITR%202009-2010_Full%20Report%20final.pdf. World Economic Forum and INSEAD, Geneva, Switzerland.
- Economic Division, Department of Economic Affairs, Ministry of Finance, Government of India. 2010. "Economic Survey 2009-10". Government of India. February.
- Heeks, R. 2002. "i-Development not e-Development: Special Issue on ICTs and Development". *Journal of International Development*, 14(1): 1-11.
- International Telecommunications Union. 2009. "Measuring the Information Society: The ICT Development Index 2009". International Telecommunications Union. Geneva, Switzerland.
- Joseph, K.J. and V. Abraham. 2007. "Information Technology and Productivity: Evidence from India's Manufacturing Sector". Centre for Development Studies Working Paper. No. 389.
- Kapur, D. 2002. "The Causes and Consequences of India's IT Boom". *India Review*, 1(2): 91-110. April.
- Lal, K. 2001. "The Determinants of the Adoption of Information Technology: A Case Study of the Indian Garments Industry". In Matti Pohjola (Ed.), *Information Technology, Productivity, and Economic Growth: International Evidence and Implications for Economic Development*. Oxford: Oxford University Press. pp. 149-174.

- _____. 2004. "E-business and Export Behavior: Evidence from Indian Firms". *World Development*, 32(3): 505-517.
- Mahon, S. 2004. "Evaluating the Developmental Impact of E-Governance Initiatives: An Exploratory Framework". *Electronic Journal of Information Systems in Developing Countries*, 20(5): 1-13.
- Planning Commission, Government of India (2008). "Report of the High Level Group on the Services Sector". planningcommission.nic.in/reports/genrep/rep_ser.pdf.
- Ramachandriah, C. 2003. "Information Technology and Social Development". *Economic and Political Weekly*, 38(12-13): 1192-1197.
- Reserve Bank of India. 2010. "Survey on Computer Software and Information Technology Exports: 2008-09". *RBI Monthly Bulletin*. August.
- Singh, N. 2006. "ICTs and Rural Development in India". Munich Personal RePEc Archive (MPRA) Paper No. 1274. <http://mpa.ub.uni-muenchen.de/1274>.
- Tanguturi, V.P. and F.C. Harmantzis. 2008. "ICT Infrastructure in Two Asian Giants: A Comparative Analysis of China and India". <http://ssrn.com/abstract=1085928>. January 10.
- Tiwari, M. and U. Sharmistha. 2008. "ICTs in Rural India: User Perspective Study of Two Different Models in Madhya Pradesh and Bihar". *Science Technology and Society*, 13, 233.
- Todaro, M.P. And S. C. Smith. 2006. *Economic Development*. 9th Edition. Addison-Wesley.
- Venkatesan, R. Sen, S and W. Wadhwa. 2006. "India: e-Readiness Assessment Report 2008. For States/Union Territories".
- _____. 2007. "India: e-Readiness Assessment Report 2005. For States/Union Territories".
- _____. 2010. "India: e-Readiness Assessment Report 2008. For States/Union Territories".
- Vogelsang, M. 2010. *Digitalization in Open Economies: Theory and Policy Implications*. Physica-Verlag HD. 1st Edition.

Annex

Table A1: e-Industry Index Data for Manufacturing

Required Data	Source
Manufacture of computers and peripheral equipment	ISIC
Manufacture of magnetic and optical media	ISIC
Wholesale trade of computers, peripherals equipment to total wholesale trade	ISIC
Exports of hardware to total exports of goods	ISIC
High tech goods exports as a proportion of total exports of goods	ISIC
Manufacture of telecom equipment	ISIC
Exports of telecom equipment	ISIC

Table A2: e-Industry Index for Services

Required Data	Source
Computer-related services as a proportion of total GDP	CSO
Computer-related services as a proportion of Business Services	CSO
Total software and services revenue growth rate as a proportion of GDP growth rate	NASSCOM
Total software and services revenue growth as a proportion of GDP services growth rates	NASSCOM
Total IT software consumption as a proportion of total IT software; Total IT exports as a percent of total	NASSCOM
Telecom services as percentage of total services	CSO/TRAI Annual Reports
Persons employed in computer-related services as percent of organised sector regular employment (NIC Code 72)	NSSO, NASSCOM
Ownership of ICT own-account enterprises	NSSO, NASSCOM

Table A3: e-Innovation Index Data Requirements

Required Data	Source
Company spending on R&D in the ICT sector	DSIR/NASSCOM
New products as percent of total output	NASSCOM,
Quality of scientific research institutes	MHRD, DST
DST investment in Geo-spatial Computer-Aided Techniques through NRDMS project	DST
Citations of ICT literature state-wise	DST/DSIR
Patents filed in India in the ICT sector state-wise	Patents Office, DIPP
Number of all research manpower (PhDs and Masters) in a state	MHRD/DST
INCOIS/IMD/ISRO	Numerical Methods Models

Table A4: e-Social Index Data Requirements

Required Data	Source
Persons employed in computer-related services (NIC Code 72) state-wise and gender-wise	NSSO, NASSCOM
Ownership of ICT own-account enterprises state-wise and gender-wise	NSSO, NASSCOM
ICT-facilitated education programmes as percentage of total education programmes	MHRD
ICT-facilitated health programmes as percentage of total health programmes	Ministry of Health and Family Welfare
Persons employed in computer-related services state-wise as percent of organised labour	Ministry of Labour