

**Information and Communication Technology (ICT) - Significance in Research & Infrastructure Development**Vandana Dabla<sup>1, \*</sup>, Pradeep K Dabla<sup>2</sup>

1. Research Scholar, Faculty of Public Administration, School of social Sciences, IGNOU, Delhi-110068, India
2. Assistant Professor, Department of Biochemistry, Chacha Nehru Bal Chikitsalya, Associated to MAMC, Delhi-110031, India

Email: [vandana.dabla@gmail.com](mailto:vandana.dabla@gmail.com)

**Abstract:** Information and Communication Technology (ICT) has made a tremendous advancement in recent years. It has led to improvement in many areas from life sciences to industry and from traditional physical library to modern digital library. The word information technology has been changed in all corners of the global areas leading to formation of unique single global society. In this new era of global economy the information technology has begun to play important role in contributing strategic planning process within the organizations to achieve competitive advantage. Present paper discusses the use of ICT in R & D libraries explaining the digital library and the infrastructural facilities and barriers in use of ICT in R & D libraries, significance of ICT in education and economic development, scope of ICT formulation in developing countries infrastructure and its policies constraints and desirables. From this study it confirms that ICT tools are integral part of all round development.

[Vandana Dabla, Pradeep K Dabla. **Information and Communication Technology (ICT) - Significance in Research & Infrastructure Development.** *Academia Arena* 2013;5(7):28-34] (ISSN 1553-992X). <http://www.sciencepub.net/academia>. 4

**Keywords:** Information Communication Technology, Digital Library, R&D Library, Developing Countries, ICT Policies constraints, ICT desirables

**1. Introduction**

Information and Communication Technology (ICT) is being increasingly used in library and information services for the acquisition, storing, processing and dissemination of information. Libraries and information centres have been using ICT based resources and services to satisfy the diverse information needs of their users. At the same time it is found that the use of information and communication technology has become increasingly important in R & D libraries. R & D libraries are switching over to ICT based resources and services at an accelerated pace. E-journals, CD-ROM databases, online databases, e-books, web based resources and a variety of other electronic resources are fast replacing the traditional resources of R & D libraries. Technology application in libraries is raising awareness about the use of Information Technology in R&D libraries specifically information processing, organizing, storing, searching and retrieving Information. The significance of ICTs is realized in many aspects such as improved access to learning by all (Kaino, 2007), creation of conducive learning environment by gender (Kaino, 2007), quality of knowledge delivery (Kaino, 2008), expanded secondary and post secondary education, reduction of expenditure on training and many others. This is to the advantage of advances in Information Technology (IT) that have changed ways of communication in education and delivery of knowledge to society.

The contribution of academic knowledge to economic and social development of societies is widely emphasized. This recognition has raised attention to the role of higher learning institutions such as universities in research outputs and their relevance to society. Universities have the role not only to teach and carry out research but also to contribute directly to economic growth of the society in which they were embedded (Etzkowitz, 2002). University research has a potential in the contribution to achievement of Millennium Development Goals (MDGs) such as Education for All (EFA) goals and expanded access to secondary, vocational and higher education by 2015. Set for the year 2015, the MDGs are an agreed set of goals that can be achieved if all actors work together and do their part (MDGs, 2008).

**2. Trends & Revolutions in ICT**

The new delivery technologies such as electronic learning (e-learning) in virtual programs, internet courses delivery strategies, audio and video communications have changed and challenged ways of knowledge delivery in the education sector.

The *first revolution* comprised of films, radio, television and satellite broadcasting, while the *second* comprised telecommunications and microcomputers (Paisley, 1985). The integration of telecommunications and microelectronic technology in computing was termed a "*third revolution*" and came to be what is called Information Technology (IT). The third revolution was said to promise not

only a more productive person, a problem-solver and a lifelong learner, but also a better informed, rational and participative citizen, a modern 'renaissance' person, living in the web and network of a worldwide electronic community (Papagiannis et al. 1987). This latter revolution came at a time when there was increasing financial and economic stress in many countries of the world.

The current "fourth revolution" in ICT has a globalization component force that has replaced other revolutions and accelerated its influence worldwide. Globalization has been described as the intensification of interconnectedness, a process of elimination of economic borders and increase in international exchange and transnational interaction (Dolan, 1993) and a process by which peoples of the world are incorporated into a single global society.

### 2.1 Digital Library

The new digital libraries, extends the concept of library far beyond physical boundaries with features not possible in traditional libraries. They will provide innovative resources and services. It increases the ability to interact with information: rather than presenting a reader with a table of numbers, digital libraries allow users to choose from a variety of ways to view and work with the numbers, including graphical representations that they can explore. With the extensive use of hypertext links to interconnect information, digital libraries enable users to find related digital materials on a particular topic" (PITAC, 2001). This vision of digital libraries is funded by agencies such as the National Science Foundation. In 2002 movie version of the H.G. Wells classic science fiction novel, *The Time Machine*, portrays the library of 2030 as Vox, a holographic character who walks, talks, and sings excerpts of the library materials in response to user queries (Winograd, 2002).

Supporting diverse information uses that facilitate interaction in these repositories and libraries beyond searching and browsing is however, still in the early stages. Such dynamic and multimedia-based interactivity is important as distances across the globe shrinks, brings diverse cultures into contact with one another, and the research and learning functions of a library are better fused to help in both activities. Coleman and Oxnam (2002) define interactional digital libraries as being made up of information spaces, learning spaces, and interaction spaces. McKnight (2000) uses information space to mean "objects (real or virtual) to which the individual turns to acquire information. In the interactional digital library, information spaces are increasingly made up of heterogeneous formats which can be called complex objects. These objects are structured

as learning spaces; i.e., they display the best information for learning in an optimal manner. Summarizing, we can say that **Interactional Digital Libraries** are:

- Information spaces with complex objects
  - It provide interactions beyond information discovery, searching and retrieval
- Components of such libraries are:
- Collections (content)
  - Services (information discovery, searching, identification, inventory, metadata creation)
  - Tools for information use (annotation, personalization)
  - Interfaces (for searching, for browsing, for creating metadata)

## 3. Significance of ICT

### 3.1. In Education

The delivery of knowledge using ICTs has influenced the design of various educational programmes nationally and globally. Through the computer network, learners were able to communicate with the instructor on the material and could discuss assignments involved. In this process learners were able to attend lectures "online". Technologies in e-learning such as AulaNet tend to provide a groupware for creation, participation and maintenance of Web-based courses emphasizing group learning where individuals shared ideas online (Fuks, 2000). It has been argued that ICT was a way to move from elite to mass education through digital media where more learners could get access to education for both campus and distance-learning students. While the benefits of these technologies have been acknowledged there have been some constraints of adoption especially in developing countries including, access to computers (email and internet), affordability of computers and connectivity, telephone and electricity infrastructure, computer literacy, expertise, etc. (Sibiya, 2003). While such problems have been acknowledged, the main reasons behind the slow pace of adoption have been identified as lack of effective policies on ICTs.

Recent changes in universities in developed countries suggest an entrepreneurial model of academic research. The key feature of this model is said to be accepted by universities that have the responsibility not only to provide teaching and carry out research, but also to contribute directly to economic growth of the society (Etzkowitz, 2002). The triple helix model (of academic-industry-government relations) by Etzkowitz et al. (2000) outlines the entrepreneurial paradigm that describes an "entrepreneurial university" as the one that encompasses a 'third mission' of economic

development in addition to teaching and research. This model involves both internal development of the university and external influences on academic structures associated with the emergence of knowledge based innovations.

### **3.2. In Economic and Social Development**

The significance of ICTs in economic and social development of societies is now widely recognised and the need for higher learning institutions to contribute knowledge in this area is emphasized. There are many ICT studies that have been conducted by these universities, and how the projects have benefited or intend to benefit the communities in these countries is not yet explored and disseminated to researchers in neighbouring universities. Also how this knowledge has been disseminated for the benefit of the people in the region is not known. The university research on ICTs has place in realization of Millennium Development Goals (MDGs) by year 2015 which would alleviate poverty if they are achieved. Dissemination of ICTs knowledge to targeted groups in community can increase access and participation in educational, social and economic activities that are believed to contribute to well being of society. Currently, it is proper to take the advantage of the versatility of ICTs that provide a conducive interaction nature for participation of both sexes. It is yet to be encouraged and popularized in developing countries where some traditional approaches have to be innovated with current technologies for development.

## **4. The Scope of ICT Infrastructure in Developing Countries**

### **4.1 Human Resources (skills)**

With the increased importance of information technology within organizations, the role of the IT executive has taken on more of a strategic rather than a support function. The IT executive in today's organization is usually charged with the responsibility of developing and implementing the strategic information system plan for the organization (Enns et al. 2001). In most organizations, the senior IT executive is the person that would be charged with the responsibility of transforming the IT department to fit the needs of the new market environment which requires significant leadership skills. In a survey conducted between September and October 2001, and published in the CIO magazine (2002), it was highlighted that the three skills that are most important for the IT executive to succeed are communication skills, understanding the business processes and strategic planning. The ability to maintain and utilize the technology to its fullest capacity is one of the major components of effective

technology development and management that will lead to economic growth. Within a developing country environment the lack of local technical and managerial skills can cause the cost of this development, maintenance and management to be far greater than it would be in developed regions. The "brain drain" of professionals from developing to developed countries makes it extremely difficult and expensive for developing countries to advance in technological development and effective management. The availability of a local pool of skilled IT executives will be affected by the quality and level of investment in IT and other technical and managerial training as well as the migration rate of competent individuals from the country (Hawkins 2002).

### **4.2 Technology Infrastructure**

Innovative technologies have rapidly changed the way the world communicates and does business. Participation in this new global economy requires each country to have a scalable and flexible network infrastructure that is economical and technically reliable. Comparatively, developing countries traditionally tend to have a more inferior computer technology infrastructure than developed countries. In the year 2000, countries such as Jamaica had an average of 199 mainline telephones and 39.4 personal computers per 1000 people, while the US had 700 mainline telephones and 585 personal computers per 1000 people (World Bank, 2002).

A study conducted by the World Economic Forum sought to identify how ready individual nations were for this global networked world. A network readiness index rank was derived using factors such as network use, others were network access, network policy factor, networked society factor, networked economy factor. These four enabling factors were then used to determine an overall network readiness index rank. A ranking scale of 1 (top) to 75 (bottom) was utilized. Countries such as the US, Finland and Singapore are ranked in the top ten, with ranks of 1, 3 and 8 respectively, while countries such as Zimbabwe and Nigeria rank at the bottom of the scale with ranks of 70 and 75 respectively (Kirkman et al. 2002).

### **4.3 Economic and Government Policies**

The economic state of any country will affect the ability of that country to invest in information technology infrastructure and implement technical and managerial programs in public schools and universities. The prevalence of imperfect markets in developing countries also adds to the challenges faced by IT executives in developing regions. The procurement and taxation policies of government, the

exchange rate of the local currency, inflation as well as tax incentives and special discounts to public and private sectors can all have an impact on the implementation and management of technology in developing countries (Seally, 2003). Increased involvement by the private and public sectors will also have a positive effect on the management of technology throughout the country.

### 5. ICT policies Constraints

One of the main obstacles to adoption of ICTs in developing countries in particular, has been identified as ineffective policies in government departments (Kaino, 2004). While much efforts have been made to stipulate ICT policies, not much have been done on the implementation side and especially on the structures and processes in place. Different institutions and departments interpret the policy in various forms for implementation.

The policy has no gender dimension not only on ICT but on education as a whole. The latter aspect was observed in many countries in the region as shown by data on access, participation and expenditures on education (Kaino, 2007). To realize full impact of ICTs, educational policies and programs need to be coordinated with those in other ministries, such as economic development, human resource development, telecommunications, agriculture, rural and urban development. Countries like Singapore and Finland have national plans for implementing ICTs in education. Typically the plans describe the hardware, software, and networking that will be implemented in schools as well as technical support and training of teachers.

The national plans should specify measurable goals, authorize and fund specific programs and projects to advance the vision and provide the resources needed to implement them. Policy leadership is key to any successful development strategy, particularly if these efforts are to contribute to economic and social transformation, for example in Finland, successful development was guided by a clear vision of how the availability of new technologies could increase economic productivity, improve the quality of life and enrich the culture .

#### 5.1 ICT associated Strategy Development

Studies in the field of knowledge utilization are based on two designs: the *discrete event design* and the *decision-making process design*. In the **first design**, respondents are asked to identify how the findings of a single study affect a discrete decision by the users of research. According to Weiss (1980), instrumental use is rare and when observed, it would tend to be more frequent in private than in public organizations (Dunn, 1980). In the **second design**,

respondents are asked to identify how the knowledge produced across all stages of the research process influence all the spectrum of the stages of the decision-making process of the users (Landry, Amara and Lamari, 2000). An assumption that a discrete decision can be attributed to the use of a discrete research report has been considered to be simplistic because research findings generate many effects, not a single effect, and because decisions do not depend on a single piece of research, but on a series of research results converging toward one direction.

Empirical evidences regarding the particular categories of factors that explain the utilization of knowledge in a statistically significant manner has been debated for a number of years. More recently, the importance of other exploratory factors such as dissemination and linkage and exchange between researchers and users of research output is stressed. The one-way flow of information and “traditional” dissemination approaches have not proven to be effective in encouraging the adoption and implementation of new research results. When researchers invest resources to adapt their products as to facilitate their appropriation by users, it increases the use of research. The lack of interaction between researchers and their potential audiences has been identified as the main problem in under-utilizing research findings. This diagnostic has given rise to the interaction explanations (Lamari, 2000).

It suggests that knowledge utilization depends on various disorderly interactions occurring between researchers and users rather than on linear sequences beginning with the needs of the researchers or the needs of the users. The mechanisms linking researchers and users considered include informal personal contacts, participation in committees, and transmission of reports to non-academic organizations. It was premised that the more resources the users and researchers invest in these types of linkage mechanisms, the higher the use of research.

### 6. Influencing factors & barriers for ICT

#### 6.1 Technology Related Factors

1. **Cost:** It is still a critical barrier. Even the adopter of ICT is unwilling to upgrade the information systems or to adopt other advanced ICT service applications because of the high adoption cost. On the other hand, the lowered price of ICT service platforms caused them to change their business partners or to disconnect them.

2. **Maintenance and Training:** The technological knowledge can be a barrier to the adoption and extension of the information systems. Some CEOs are worried about the introduction of ICT because of the fear that their employees might be

not familiar with it. Fear factor (Security, technology): The fear of the leakage of company information, such as the transaction and the accounting information can be a critical barrier to indirectly or directly adopting and extending implementation of new ICT service applications.

**3. Technology availability:** It influences directly to ICT adoption. The companies may find difficult to sustain the ICT adoption, while some may points out that the absence of a suitable application program, including the lack of the development of an application, is one of the barriers to adopt new ICT.

## 6.2 Organizational Environment Related Factors

**1. Awareness:** It estimates the awareness of ICT adoption and of business extension via ICT.

**2. Perceived benefit:** It includes the expectation of benefits of new ICT that organisation may try to adopt as the perceived benefit. The perceived benefits are highly related to new ICT adoption through previous experience.

## 6.3 Business Related Factors

**1. Outsourcing elements:** This factor is closely related to the cost of management or transaction and the capability of organisation. Krajewski and Ritzman (2002) describe outsourcing as “allotting work to suppliers and distributors to provide needed services and materials and to perform those processes that the organization does not perform itself.” However, after using the ICT service platform, the CEOs had to entrust it to a certified accountant with a high expenditure. These outsourcing elements and the existence of the alternatives (ICT) can be an excellent anti-barrier that helps to adopt ICT. This change comes from the increasing trend of the on-line transaction.

**2. Buyer and Supplier:** This is a barrier and driving factor e.g, one has difficulty sending its estimates and blueprints to the customers on the Internet because the main customers are women in their 50s who are not familiar with the Internet. Therefore, it has to retain both an online and offline business structure. In addition, other has used an accounting program that enables them to do Internet transactions according to the increasing trends of Internet business. This type of problem can be a barrier to extend the internet business.

**3. Business partner:** Organisations, who are subcontractors or agents of the big enterprises that use EDI or e-commerce, tend to adopt an EDI system or e-commerce solution (KIMI, 2003).

## 6.4 Government Related Factors

**1. Cost related financing:** According to the KIMI study (2003), most organisations desire various and appropriate support from the government. Among them, especially in financial supports their major requests are divided into three groups: The support of the standardization and the development of ICT service platforms (41.3%), supporting training programs (27.5%), and loan and fund financing (57.9%).

**2. Cooperation Work:** They are divided into five business domains: Content Service, Telecommunication Service, Application Service, Web-hosting, and online training. Owing to the sharing of work between the members of the consortiums, service providers, as members of the consortium, can afford to reduce the cost of development of ICT service platforms.

**3. Information channel:** ICT information comes through various channels: an acquaintance, customers, the Internet, newspapers, etc. Ironically, many organisations could reach the information of ICT service platforms not from marketers or advertisement of the ICT service providers, but from their acquaintances and other parties.

## 7. Goals & Desirables

### 7.1 ICT development Goals

The ICT policy framework should basically have an ICT for development approach. The ICT for development approach is to analyze objectives, institutional frameworks, local capacity and development benefits of ICT. The ICT policy principles to be considered in the framework, to increase impact on targeted communities and marginalized groups are:

1. Policy decisions on the type and location of technology by local community based on needs of the target groups.

2. Nature of dialogue with target groups about information they wish to communicate, the most appropriate communication of this information, and impact an ICT project have on cultural and social norms of the community.

3. Understanding of different ways in which people learn, communicate and use information when designing an ICT program.

4. Incorporation of monitoring and evaluation during project design, and impact assessment and ensuring these components are implemented.

5. Design process of holistic projects: incorporating the social, economic, and communication systems already in place in the target group.

6. Nature of creation of partnership with public and private institutional infrastructures; building on

existing formal and non-formal organisations and communication networks.

7. Nature of provision of ICT skills at all levels, according to community need. Paying attention to youth, women and marginalized groups.

### 7.2 Research Libraries Desirables

1. Research libraries should adopt a hybrid collection development policy.

2. All research libraries should concentrate on procuring online database of journals, books, patents, thesis/ projects and others.

3. Majority of research libraries should give stress on need-based, value added users services through automated library.

4. For the new digital environment the existing rare and valuable documents should be digitized in a phased manner for preservation and for future use.

5. All research libraries should catalogue, classify and Index the web-resources for the effective use.

6. All research libraries should safeguard their resources by implementing any one of the electronic security systems in addition to professional security. It may be video cameras, closed circuit television, electronic security systems, etc.

7. Research library professionals should get wide varied user education programmes for maximum utilization of Information Technology based library facilities and services.

### 8. Conclusion

Researchers have become increasingly reliant on IT tools to reduce the costs and boost the productivity of R&D sciences. Bioinformatics employment opportunities also have been expanding. The Research & Development libraries have given due recognition and importance in terms of collection, budget, infrastructure facility, staff and users. In the Meanwhile they are using Information and Communication Technology, as a source for book selection, display of new arrivals for library publications and for database creations.

Developing countries world-wide are characterized by weak currencies, weak economies, imperfect markets, inadequate technical and other physical infrastructures, inadequate management and technical skills, inadequate public education facilities and limited economic resources. In order to gain the benefits of these innovative technologies organizations in developing countries must undertake various transformation and restructuring processes in order to benefit from economies of scale and scope by sharing their physical and human resources. Effective management of technology in developing regions can lead to organizations in those locations

being able to improve productivity, increase competitiveness and take advantage of various economic opportunities globally, thereby leading to long-term and sustained growth of industries in those regions.

### Corresponding Author:

Vandana Dabla

Research Scholar, Faculty of Public Administration, School of social Sciences, IGNOU, Delhi-110068, India

Email: [vandana.dabla@gmail.com](mailto:vandana.dabla@gmail.com)

### References

1. Batchelor S, Norrish P. Sustainable Information and Communication Technology. London, DFID. Management of technology in Developing Countries 2003.
2. CIO Magazine. The State of the CIO 2002. Retrieved on Oct 1, 2012, from [http://www.cio.com/archive/030102/survey\\_results.html](http://www.cio.com/archive/030102/survey_results.html).
3. Coleman A, M Oxnam. Journal of Digital Information 2002.2(4). URL:<http://jodi.ecs.soton.ac.uk/Articles/v02/i04/editorial/>.
4. Dolan M. Global economic transformation and less developed countries. In Slater, R.O. et al. Global transformation and the third world. Boulder, Lynne Rienner Publishers 1993.
5. Enns HG, Huff SL, Golden BR. How CIOs obtain Peer Commitment to Strategic IS Proposals: Barriers and Facilitators. The Journal of Strategic Information Systems 2001.10(1); 3-14.
6. Etzkowitz H. The Second Academic Revolution: MIT and the Rise of Entrepreneurial Science. Gordon and Breach, London 2000.
7. Etzkowitz H. MIT and the Rise of Entrepreneurial Science. Routledge Press, London 2002.
8. Fuks H. Groupware technologies for education in AulaNet. Computer applications in Engineering Education 2000.8(3/4); 170-177.
9. Hawkins RJ. Ten Lessons for ICT and Education in the Developing World. In: The Global Information Technology Report 2001-2002 (G. S. Kirkman, K. Schwab, J. Sachs and P. Cornelius eds.) 2002.4; 38-44.
10. Kaino LM. The use of Information and Communication Technology (ICT) in learning: students' attitudes in Botswana secondary schools by gender. Study sponsored by the Organization of Social Science Research in

- Eastern and Southern Africa (OSSREA). Research Report 2008.
11. Kaino LM. The use of Information and Communication Technology (ICT) in learning: students' attitudes in Botswana secondary schools by gender. Research Report. Study sponsored by the Organization of Social Science Research In Eastern and Southern Africa (OSSREA) 2007.
  12. Kaino LM, Salani E. Students' gender attitudes towards the use of calculators in mathematics instruction. In Hoines, M.J. & Fuglestad, A.B.(Eds). Proceedings of the International Group for the Psychology of Mathematics Education (PME), Bergen, Norway 2004.3; 113-120.
  13. KIMI. Whitepaper of ICT Adoption of SME 2003. Retrieved on Oct 2012.URL: <http://www.kimi.or.kr/pds/2003w-paper/sub/header.html>.
  14. Kirkman GS, Osorio CA, Sachs JD. The Networked Readiness Index: Measuring the Preparedness of Nations for the Networked World. In: The Global Information Technology Report 2001-2002 (G. S. Kirkman, K. Schwab, J. Sachs and P.Cornelius eds.) 2002.2; 10-30.
  15. Krawjewski LJ, Ritzman LP. Operations management: strategy and analysis. Upper Saddle River, NJ: Prentice Hall 2002.
  16. Landry R, Amara N, Lamari M. Utilization of Social Science Research Knowledge in Canada, Research Policy 2002.
  17. McKnight C. The personal construction of information space. Journal of the American Society for Information Science 2002.51(8); 730-733.
  18. Millennium Development Goal. UNDP Millennium Development Goals (MDGs) Report 2008. <http://www.undp.org/mdg/>. Retrieved 29th October 2012.
  19. Paisley W. Children, new media and microcomputers: continuities of research. Children and microcomputers: Research on the Newest Medium 1985.
  20. Papagiannis GJ, Douglas C, Williamson N, Le Mon R. Information technology and education. Implications for theory research and practice. IDRC, Canada 1987.
  21. PITAC. PITAC Report to the President, "Digital Libraries: Universal Access to Human Knowledge" 2001; 3. Retrieved on 14 Oct 2012. URL: <http://www.ccic.gov/pubs/pitac/pitac-dl-9feb01.pdf>.
  22. Seally WU. Empowering Development through E-G Information and Library Review 2003.35; 335-338.
  23. Sibiya TG. Information and Communication Technology and Education. In Proceedings of the 11th annual conference on improving cooperation among researchers, policy formulators and implementors of policy in mathematics, science and technology education, SAARMSTE. Putsoa, B. et al (Eds) 2003; 26-32.
  24. Weiss CH. Knowledge Creep and Decision Accretion, Knowledge: Creation, Diffusion, Utilization 1980.1; 381-404.
  25. Winograd T. "Interaction spaces for twenty-first century computing". In Human-Computer Interaction in the New Millenium, edited by John M. Carroll (New York: ACM Press) 2002; 259-276.
  26. World Bank. World Development Indicators 2001. Issued By: International Bank for Reconstruction and Development 2002.

6/12/2013